

Australian Transport Assessment and Planning Guidelines

M5 Travel Behaviour Change



This publication was prepared by the Australian Transport Assessment and Planning (ATAP) Steering Committee and approved by the Transport and Infrastructure Senior Officials' Committee. The Committees cannot accept responsibility for any consequences arising from the use of this information. Readers should rely on their own skill and judgment when applying any information or analysis to particular issues or circumstances.

ISBN 978-1-925401-66-0

INFRA-2932

© Commonwealth of Australia 2016

August 2016

For enquiries or feedback about this publication please contact:

ATAP Steering Committee Secretariat
Australian Transport Assessment and Planning
Guidelines
Commonwealth Department of Infrastructure and
Regional Development
GPO Box 594 CANBERRA ACT 2601
Email: atap@infrastructure.gov.au

This publication is available in PDF format from the website <http://atap.gov.au/>

Contents

1. Introduction.....	4
1.1 What are travel behaviour change projects?.....	4
1.2 Why are separate guidelines needed for TBhC?	5
1.3 When should these guidelines be used?	6
1.4 Background	8
2. Economic analysis framework.....	9
2.1 Background	9
2.2 Theoretical framework.....	10
2.3 Application of framework to TBhC projects	12
3. Travel demand impacts – diversion rates.....	16
3.1 Introduction.....	16
3.2 Diversion rate interpretation issues.....	16
3.3 Diversion rate evidence.....	17
3.4 Default diversion rates.....	20
3.4.1 Household/community based initiatives.....	21
3.4.2 Workplace travel plans.....	23
3.4.3 School travel plans.....	26
3.5 Durability of changes.....	28
3.6 Modelling of travel behaviour change	30
4. Benefits of TBhC initiatives.....	31
4.1 Overview.....	31
4.2 Benefits to mode changers.....	31
4.3 Resource cost corrections.....	34
4.3.1 Travel time savings	35
4.3.2 Private vehicle operating costs	35
4.3.3 Car ownership costs	36
4.3.4 Car parking.....	36
4.3.5 Road tolls	37
4.3.6 Cycle operating costs.....	37
4.3.7 Walking costs	38
4.3.8 Public transport fares	38
4.4 Externality benefits	38
4.4.1 Decongestion	38
4.4.2 Induced traffic effect.....	39
4.4.3 Road system benefits	39
4.4.4 Accident cost savings – car	39
4.4.5 Accident costs – cycle/walk	40
4.4.6 Accident costs – public transport	41

4.4.7	Environmental externality reductions	41
4.4.8	Health (fitness) benefits of cycling/walking	41
4.4.9	Other - not quantified	42
4.5	Summary of resource cost corrections and externality benefits	42
5.	Economic analysis procedure	45
5.1	Introduction.....	45
5.2	Stages of analysis	45
5.3	Project definition	46
5.4	Project costs	46
5.5	Calculation of project benefits	48
5.5.1	Select diversion rates.....	48
5.5.2	Determine number of diverted trips	48
5.5.3	Trip lengths	49
5.5.4	Unit costs	51
5.5.5	Cost per trip.....	51
5.5.6	Total unperceived costs and benefits for each trip type	52
5.5.7	Mode changer perceived net benefits.....	52
5.5.8	Calculate total benefits per day.....	52
5.5.9	Calculate total benefits per year	52
5.6	Appraisal period	53
5.7	Value for money measure	53
6.	Monitoring and Evaluation	54
6.1	Introduction.....	54
6.2	Monitoring focus and outcomes	54
6.3	Methodology	55
6.3.1	Monitoring approaches	55
6.3.2	Panel survey v independent samples	56
6.3.3	Survey timing	57
6.3.4	Monitoring program participants	57
6.3.5	Control group	57
6.3.6	Sample size.....	58
6.3.7	Systematic survey bias issues	58
6.4	Maximising survey response	58
6.5	External monitoring sources.....	59
	References	60
Appendix A	Worked Example - Economic appraisal of household/community program	61
A.1	Program details	61
A.2	Appraisal.....	61

Figures

Figure 1	Categories of costs associated with a car trip	13
Figure 2	Change in perceived costs resulting from TBhC project	14
Figure 3	Public transport mode share of motorised travel	32

Tables

Table 1	Travel behaviour change and its fit with travel demand management	4
Table 2	Household programs – default diversion rates	22
Table 3	Workplace travel plans – scoring and classification	23
Table 4	Workplace travel plans – default diversion rates	25
Table 5	School travel plans – default diversion rates for primary and secondary schools.....	27
Table 6	School travel plans – default diversion rates for tertiary institutions	27
Table 7	Mode changer perceived net benefit values (\$ per trip)	33
Table 8	Summary of default resource cost corrections and other benefit unit values (cents/km and cents/trip)	42
Table 9	Default average trip lengths (km)	49

1. Introduction

1.1 What are travel behaviour change projects?

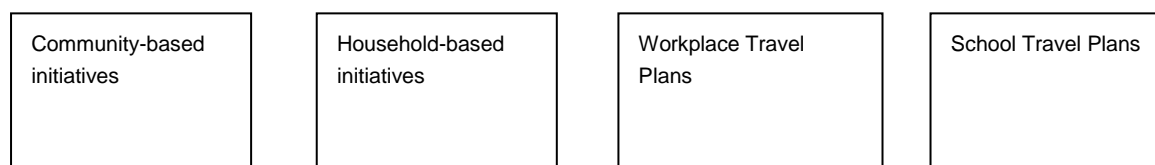
This document has been prepared in conjunction with NGTSM Volume 4 Part 2 Urban Transport to provide additional guidance on the assessment of travel behaviour change (TBhC) initiatives.

TBhC initiatives and programs are a sub-set of travel demand management measures. Through the use of education, information, and marketing-based approaches they aim to encourage voluntary changes in 'personal' or 'private' travel behaviour to reduce the need to travel, reduce dependence on private cars and increase physical activity. TBhC initiatives may be targeted at the travel patterns and behaviour of the community at large or at individuals within households, workplaces or schools and universities. Table 1 illustrates the relationship between travel behaviour change and other travel demand management measures.

Table 1 Travel behaviour change and its fit with travel demand management

	Travel Demand Management			
Strategies	Land use	Network for all users	Travel behaviour change	Pricing/taxes
Definition	Shaping community development	Moving people and goods	Voluntary mode shift	Road pricing options User charges / taxes
Examples	District plan changes Zoning	Traffic calming High occupancy vehicle lanes PT services	Travel planning Personalised marketing Ride share	Tolls Electronic road pricing Parking supply management

Travel Behaviour Change Techniques



Source: *Travel Behaviour Change Guidance Handbook, Land Transport NZ, 2004*

In Australia TBhC projects have been implemented under various names including Travel Smart, Living Smart, travel blending and others.

TBhC initiatives are often implemented as packages of complementary measures designed to achieve the overall objectives identified in the second paragraph above. Such packages may include small scale infrastructure projects and enhancements. For example, a school travel plan might include upgrading of pedestrian crossings, while a workplace travel plan might include the provision of bicycle lockers.

1.2 Why are separate guidelines needed for TBhC?

The United Kingdom Department for Transport (DfT) makes a useful distinction between:

- 'Hard' measures, defined as measures that have a direct impact on travellers' generalised cost, whether financial cost, time or other quality factors that are normally valued and included as components of generalised cost
- 'Soft' measures, defined as measures that affect behaviour without affecting travellers' cost - instead changing travellers' responses to cost.

Most economic analysis guidelines are focussed on assessing 'hard' measures that change the generalised cost of existing users. Additional guidelines are required for TBhC projects because they mostly comprise 'soft' measures and usually do not change the actual service level, quality or price (and hence generalised cost) of any mode.

Benefit unit values (parameter values) and demand elasticity values for 'hard' measures are provided in the relevant parts of the ATAP Guidelines for public transport and active transport and such measures can generally be assessed using this guidance. However, these other parts of the Guidelines do not contain advice on the responsiveness of demand to TBhC 'soft' measures or on valuing the benefits of such measures. This Part of the Guidelines is intended to fill that gap.

The purpose of many 'hard' measures is also to change travel behaviour - for example, by the provision of physical alternatives or rearrangements (such as infrastructure or revamped public transport services), regulation and enforcement or financial and economic stimulation (such as rewards, fines, taxes, subsidies and pricing policies) that usually leave the individual with little or no choice about how they behave. The distinction between 'hard' measures and travel behaviour change, in terms of how they change behaviour, is the means used to achieve change. TBhC measures tend to approach demand management by supporting and encouraging a change of attitude and behaviour, and are generally non-coercive or voluntary in nature.

Some measures that are traditionally referred to as 'soft', such as real time passenger information systems, bus quality improvements and so on, provide benefits that can be valued and included as components of generalised cost. These should be considered as 'hard' measures and do not require this TBhC guidance.

Separate additional guidance on the assessment of TBhC initiatives is also provided due to the following characteristics of such projects:

- They often comprise a package of several relatively small scale measures.

- With other existing project appraisal procedures, the required level of appraisal effort is disproportionate to the scale of many TBhC projects.
- TBhC projects result in small impacts to a large number of people and the impact tends to be different for each participant, whereas with typical transport projects most users tend to be attributed the same benefit.
- Evidence on the effects of TBhC initiatives and the durability of changes shows significant variations and is still evolving.
- Benefits to travel behaviour changers sometimes appear to be negative when estimated in accordance with standard assessment guidelines and hence require a different valuation approach.

Developing the material contained in this Part through the collaborative national ATAP Guidelines process allows it to act as a standard to promote consistency across Australia in the application of cost–benefit analysis (CBA) to travel behaviour change projects.

1.3 When should these guidelines be used?

These guidelines may be applied when assessing TBhC initiatives involving 'soft' measures and when assessing TBhC packages that include such measures and small scale complementary infrastructure enhancements. Such initiatives and packages are likely to be characterised by changes in travel behaviour and mode changing to public transport and active transport modes that occurs in the absence of any significant benefits to the existing users of these modes.

The following are examples of types of TBhC measures that may be assessed using these guidelines:

- *Community- or household-based initiatives to support efficient travel decisions*
 - Personalised trip analysis and advice (travel blending, trip chaining, forward planning)
 - Pre-trip information about options and conditions for specific trips
 - 'Living neighbourhoods'
 - Ride share matching service
 - Education, information and training
- *Community- or household-based initiatives to encourage reductions in the use of cars*
 - Marketing of PT / walking / cycling
 - Improve image of PT and other environmentally friendly modes
 - Advertising and education on travel choices, impacts and costs
 - Counter fear of personal insecurity using other environmentally friendly modes
 - Marketing of travel choices (such as personalised marketing)
 - Education, information and training
 - Car clubs / car sharing

- *School travel*
 - Education and training (such as TravelSmart, cycle training, street crossing behaviour)
 - Travel plans
 - Establish non-motorised alternatives (walking school buses, cycle trains)
- *Workplace trip reduction*
 - Workplace parking management / provision
 - Company van pools / ride share
 - Voluntary trip reduction
 - Flexible work hours
 - Guaranteed ride home programmes
 - Workplace car sharing
- *Substitutes for travel (may be done through workplaces or at a community level)*
 - Tele-working
 - Tele-conferencing
 - Tele-shopping / home shopping
 - E-commerce
- *Financial inducements to potential users of alternative modes*
 - Discounts for walking shoes or cycling gear
 - Free cycle maintenance
 - Discounted public transport tickets
 - Free ticket to try public transport.

Workplace travel plans and school travel plans are commonly made up of a package of TBhC measures. 'Personalised marketing' and 'travel blending' projects are also commonly delivered as packages rather than single measures. The elements of such a package may draw upon several of the above measures, as well as possibly including small scale infrastructure and service changes.

These guidelines should not be used to assess projects that involve significant improvements to public transport infrastructure or services, or improvements to cycling and walking infrastructure that can be analysed as 'hard' measures. Such projects should be assessed in accordance with the public transport or active transport guidance as appropriate. Where such projects are being undertaken as part of packages with TBhC measures, only the 'soft' measures should be assessed with these guidelines.

It is difficult to provide a precise threshold for when infrastructure or service enhancements are small scale and can be assessed as part of TBhC packages and when they should be assessed separately. Analysts should make a reasonable judgement in borderline cases. TBhC procedures do not attribute benefits to 'existing' or 'current' public transport or active transport users (those who do not change mode), so where components of a package will provide substantial benefits to existing users it will be more appropriate to analyse these separately from the TBhC package.

In summary, TBhC measures that may be assessed using these guidelines include:

- Household-based initiatives (such as personalised marketing, travel blending or living neighbourhoods)
- Community-based initiatives (such as travel awareness campaigns or ride share initiatives)
- School travel initiatives
- Workplace-based initiatives
- Substitutes for travel (such as teleworking).

Workplaces include commercial business operations, government offices and agencies, community organisations, hospitals, tertiary educational institutions and others.

As noted in Section 1.2, the required level of appraisal effort if a full CBA approach is adopted is disproportionate to the scale of many TBhC initiatives. The economic analysis procedure outlined in Section 5 and illustrated in the worked example is intended to provide a simplified approach that is appropriate for most TBhC initiatives, including smaller scale projects. Economic appraisal may not be justified for very small TBhC initiatives where even the small cost of a simplified CBA is high relative to the cost of the proposed measure.

These guidelines are primarily concerned with the ex-ante economic appraisal of TBhC initiatives. However, guidance on ex-post monitoring and evaluation aspects is also provided in Section 6.

1.4 Background

This Part of the ATAP Guidelines draw on developments and experience over the last 15 years in Australia, the United Kingdom and New Zealand. The economic analysis procedures described in this Part are based on procedures that were developed for Transfund New Zealand (predecessor of the New Zealand Transport Agency) in 2004 (Maunsell et al, 2004a, Maunsell et al, 2004b and Maunsell et al, 2004c) and the Victorian Department of Transport in 2006 (Maunsell, 2006). The New Zealand project included an extensive and thorough review of Australian TBhC projects and project appraisals, as well as TBhC related reports and papers that had been completed up to that time

The procedures have been adapted and updated so that they are aligned with the public transport and active transport guidance provided in the ATAP Guidelines and reflect knowledge gained from more recent monitoring and evaluation of travel behaviour change projects in Australia.

Another useful reference in the development of these guidelines has been the UK Department for Transport's new Transport Analysis Guidance – Modelling Smarter Choices (DfT, 2014).

2. Economic analysis framework

2.1 Background

A number of existing TBhC appraisals and appraisal procedures were examined during the preparation of this Part of the Guidelines. Key objectives were to investigate what problems had been encountered in applying existing appraisal procedures to TBhC projects, why these procedures were considered unsuitable for TBhC projects and how, if at all, other countries/jurisdictions had overcome these issues. The New Zealand Transport Agency and the United Kingdom Department for Transport in particular have introduced guidelines in this area in recent years.

Perceived problems and issues raised in relation to TBhC appraisals include the following:

- Existing economic analysis guidelines were mainly focused on infrastructure projects or projects that change generalised cost for existing users.
- TBhC projects often do not change the actual service level, quality or price (and hence generalised cost) of any mode.
- Effects are diverse and dispersed and hence difficult (and/or costly) to measure, estimate and incorporate accurately in an appraisal – the effort involved in this is often not justified by the project cost as TBhC projects tend to be smaller projects.
- There is uncertainty and an apparent variability in the diversion rates and other effects (such as lengths and timing of avoided trips).
- Diversity of TBhC projects means that analysts have to adapt existing procedures and cannot just 'follow the formula'.
- Newness of TBhC means analysts have to make assumptions and projections on limited experience, which results in inconsistent treatment of various aspects in appraisals.

The examination of existing TBhC appraisals did not find a common approach on many of these issues. It is apparent that a significant degree of approximating, aggregating and averaging will need to be accepted for most small to medium scale TBhC projects.

Most appraisals attempted to deal with the above problems and issues within a CBA framework. This is appropriate for the following reasons:

- Many of the benefits of TBhC projects are of the same types as those of other projects, such as travel time savings for remaining road users and reduced environmental externalities. Unit values for these benefits already exist. It may be more difficult to estimate the effects/changes to which to apply these unit values in the case of TBhC projects, but this problem is likely to lessen as further post-implementation monitoring and evaluation evidence is accumulated.
- Transport authorities are likely to want to propose TBhC initiatives as part of integrated packages of measures that combine road, public transport and walking/cycling projects, and possibly pricing measures. These packages will be easier to analyse and compare if consistent appraisal procedures have been used for all components and for alternative investments.

- Given that a CBA framework forms the basis of the economic analysis guidelines for other modes, a similar framework for TBhC has the advantage that analysts already have a working knowledge of the framework.
- A further advantage of using a CBA framework for TBhC projects is that if such projects are as effective as some experience to date indicates they may be, the use of appraisal procedures that enable them to be compared directly with other types of transport interventions will help to establish their credibility more quickly with policy and funding agencies.

Based on these considerations, a CBA framework is appropriate for the appraisal of TBhC projects and the guidance in this Part follows the same general principles set out in the ATAP Guidelines for public transport - that is, with:

- Transport system user benefits derived from changes in perceived costs (that is, changes in consumer surplus) and with resource cost corrections added/subtracted to translate the analysis to resource costs
- Costs and benefits discounted to present values to reflect the relative value of impacts in future years
- Indicators such as the benefit–cost ratio (BCR) and net present value (NPV) used to show the economic merit of the initiative.

2.2 Theoretical framework

Travellers make travel decisions based on their perception of their total ‘cost’ of travel, where this cost includes monetary amounts paid (and perceived as being incurred) and a range of other quality and service factors such as the time, comfort, reliability, security and cleanliness of travel.

The ‘cost’ is usually described as the private generalised cost of travel, but may also be called the perceived cost of travel or the behavioural cost of travel. The private generalised cost of travel is used to forecast the mode and route choice of trips. As it represents the perception of users, it also represents their willingness-to-pay for a journey and hence is used to value changes in their travel choices. Refer to the mode specific parts of these Guidelines and Part T2 for further discussion of generalised cost/price.

A key feature and objective of TBhC initiatives is people changing between modes (such as from car to public transport or cycling and walking). When people change modes, they make this decision on the basis of their perception of the relative costs of the alternative modes. Some of these perceived costs are different from resource costs. CBA is based on resource costs, so CBA procedures need to include adjustments (termed resource cost corrections) to offset these differences.

A conventional theoretical framework for CBA of transport projects involving users changing between modes (of which TBhC projects are a subset) assesses the benefits as the sum of the following:

- (A) Benefits of the project to existing users of the 'to' mode¹ (estimated as changes in private generalised cost for that mode, usually including cost, time and comfort aspects)
- (B) Perceived benefits to new users of the 'to' mode, including mode changers (generally valued at half the unit benefits to existing users of the 'to' mode)
- (C) Benefits from avoidance of unperceived costs² associated with the 'from' mode (the previous behaviour of mode changers), comprising:
 - (i) resource cost corrections for mode changers themselves, including monetary (such as car maintenance and other non-fuel variable vehicle operating costs and car parking costs) and non-monetary (such as accident trauma)
 - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (such as decongestion and reductions in private car-related environmental and accident externalities)
- (D) Unperceived costs associated with the new users of the 'to' mode, comprising:
 - (i) resource cost corrections for mode changers themselves, including monetary (such as public transport fare payments that are perceived as a cost but in fact are a transfer rather than a resource cost³) and non-monetary (such as health benefits of cycling and walking, which may be under-perceived)
 - (ii) other resource cost impacts (externalities) on other transport system users or of the transport system (such as environmental, accident and health externalities - to the extent that the costs of poorer health were being incurred by society rather than the behaviour changer).

Category (A) benefits are the benefits to existing users of the mode that is improved by the infrastructure project or public transport service improvement. Benefits to existing users are changes in generalised cost and usually include mainly aspects of cost, time and comfort.

If people change mode in response to an infrastructure project or public transport service improvement, their perceived benefits (B) are valued at half the unit benefits to existing users (A) (the 'rule of half'). When choosing between modes, travellers are assumed to fully perceive relative time and comfort aspects and out of pocket costs such as fuel, tolls, parking charges and public transport fares. These aspects/costs are taken into account in their choice of mode and are assumed to be included in (A) and (B).

¹ The 'to' mode is generally the mode that is being improved by the transport project. In the examples given here the 'to' mode is public transport and/or cycling and walking while the 'from' mode is the private car. These would be reversed in the case of a highway improvement.

² Unperceived costs comprise all variances between perceived costs and resource costs and include privately incurred resource costs that are not perceived (e.g. most non-fuel private vehicle operating costs), private costs that are perceived but are not actually resource costs (e.g. fares, tolls and fuel taxes), and externalities to third parties (e.g. environment and accident-related externalities).

³ Any increase in operating costs for the 'to' mode (in this case public transport) are accounted for in full in the costs side of the CBA, yet the fare payments (which are a transfer reflecting this same cost) are included in the perceived net benefit of new users of the 'to' mode (as a disbenefit). A resource cost correction equal to the fare is required to avoid double counting of costs.

However, travellers' perceived benefits usually do not equate to all of the resource cost changes resulting from a project, which are necessary for transport project appraisal. For the mode changers, the resource cost adjustments (C(i) and D(i)) are also added. These represent the additional unperceived resource cost savings to the behaviour changers themselves resulting from replacing a car trip with a public transport trip (or cycle/walk trip) that are not included in the perceived (rule of half) benefit.

Finally, the other resource cost impacts on other transport system users or of the transport system (C(ii) and D(ii)) are added. These include decongestion and net environmental externalities.

This is the approach used in appraising public transport initiatives and it is also considered to be the most appropriate framework for economic appraisal of TBhC initiatives. The approach and principles are also similar to those used for evaluating user benefits in situations where there is induced traffic.

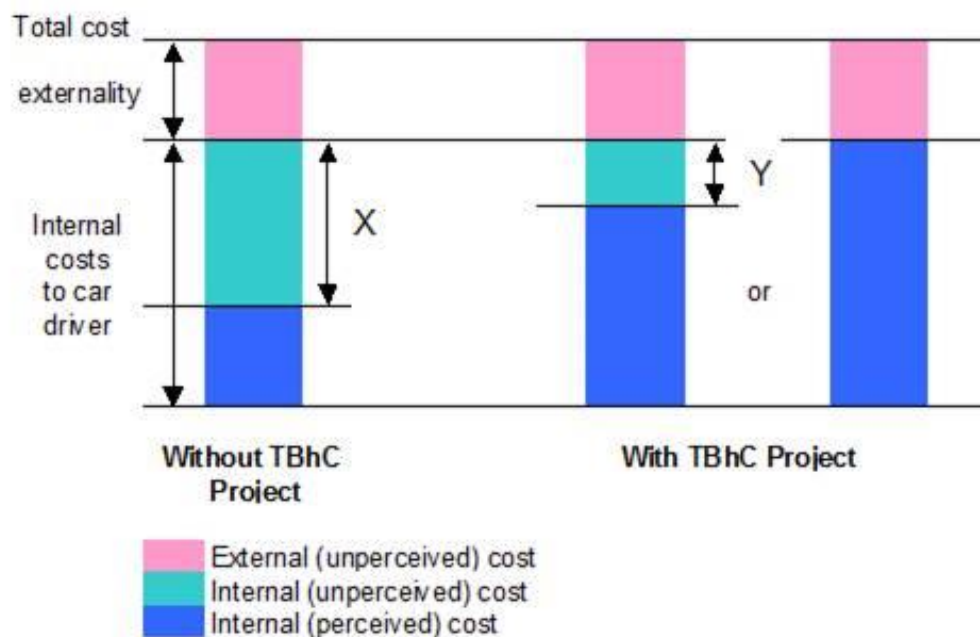
2.3 Application of framework to TBhC projects

TBhC programs change the information available to households and individuals and, partly as a result, their perceptions about alternative travel modes and choices – even where there are no changes to the system itself.

Economic theory assumes that decision makers have perfect knowledge about the attributes of the choices available to them. TBhC initiatives start from the premise that people's knowledge is imperfect and can be improved. The benefit is the same as would occur had the actual range, quality and prices of the choices available to them been improved, when in fact it is only their knowledge of the range, quality and prices of available choices that has improved.

Figure 1 breaks down the costs associated with a car trip into perceived and unperceived components, including externalities. Normally, car drivers only consider the internal perceived costs described above and shown in the blue shaded lower segments in the figure. Other internal costs, such as non-fuel variable vehicle operating costs and accident costs, are considered to be unperceived as shown by the middle green shaded segments (X). externality costs (such as environmental effects), shown in the top pink shaded segments, are also generally considered to be unperceived.

Figure 1 Categories of costs associated with a car trip



One of the effects of a TBhC project is to provide travellers with information that changes their perceptions of costs of different modes. This is illustrated by the two scenarios on the right hand side of Figure 1. The first scenario shows the situation if the TBhC program corrects a proportion of the internal unperceived costs (X). Segment Y shows remaining unperceived internal costs of the car trip following the TBhC project. This is the required resource cost correction that is counted as a benefit in addition to the net perceived benefit if a car trip is removed by a TBhC project. The second scenario shows the situation where all internal costs are perceived as a result of the TBhC project and the required resource cost correction is reduced to zero. TBhC projects can also induce mode changes by reducing the perceived costs of 'to' modes.

TBhC projects primarily involve 'soft' measures such as marketing and information that aim to change perceptions and knowledge about different travel options and choices rather than changing generalised cost. Therefore, category (A) benefits are typically zero or negligible for TBhC projects. Some types of TBhC projects, such as school travel plans, may involve some infrastructure improvements that change generalised cost for people already using that infrastructure, and this may still need to be quantified in some cases if significant. If an initiative will result in significant existing user benefits, the component of the package that is producing these benefits should be assessed separately using the public transport or active transport guidelines.

Also it could be argued that the more accurate perception of costs that is achieved by the TBhC project is a benefit to existing users even if they do not change mode or they already use environmentally friendly modes. This effect is ignored as the TBhC appraisal is mainly interested in actual behaviour change, not simply changed 'travel awareness' without any change in behaviour.

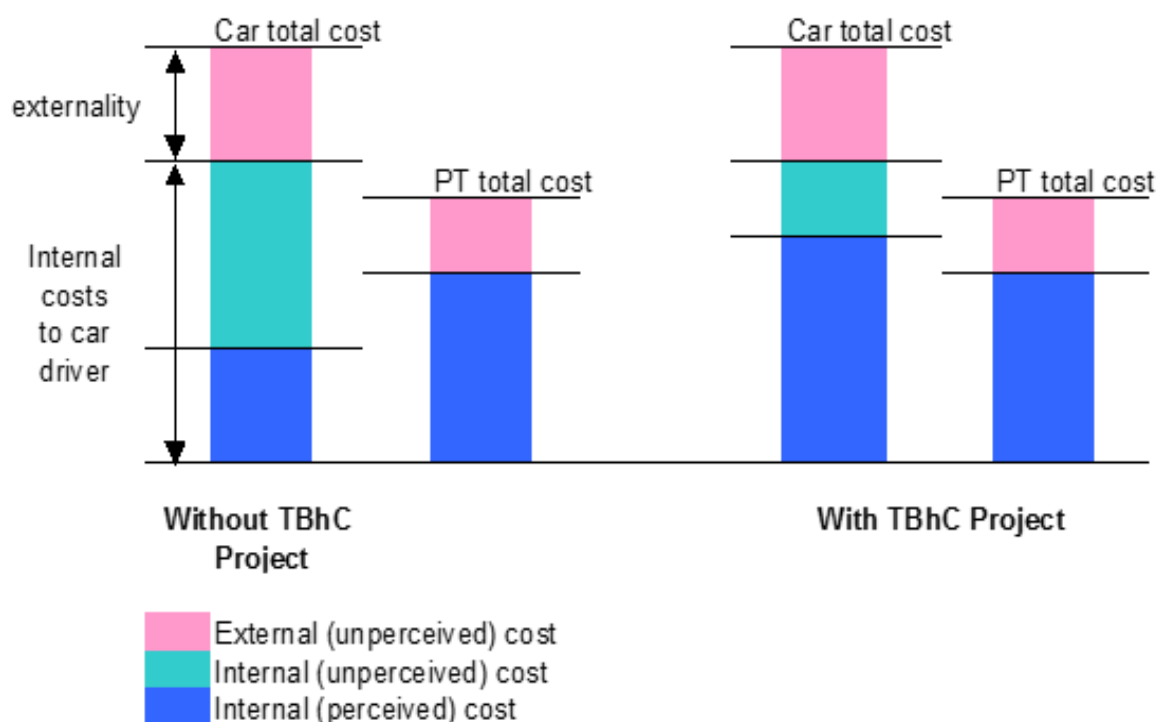
Estimating category (B) benefits is therefore difficult with TBhC projects. Normally, the benefits to mode changers can be valued at half of the unit benefits to existing users (Category A) but, as noted above in the case of TBhC projects, such benefits are often zero. The benefit to mode changers cannot be zero or people would be indifferent about changing behaviour. The explanation, as noted above, is that TBhC programs change households' and individuals' perceptions about alternative travel modes and choices even where there are no changes to the system itself.

In the case of TBhC projects, people make changes because the new information:

- Corrects an information gap or misperception and they realise that the alternative actually is more attractive on balance than the private car trip that it replaces
- Changes their attitude so that they are willing to accept the disadvantages of the alternative mode because they feel that it is the right thing to do - for example, they feel they are being more environmentally responsible. This is still a valid benefit.

The change in perceived benefits/disbenefits resulting from the TBhC project causes people to make the travel behaviour change as they now perceive the cost of making the trip by car as being higher than the alternative. This is shown in Figure 2.

Figure 2 Change in perceived costs resulting from TBhC project



In the situation without the TBhC project, Figure 2 shows that for a particular individual the perceived costs of travel by public transport are greater than by car, so car is the preferred mode. The TBhC project causes the individual to become aware of a greater proportion of the actual costs of car travel and, as a result, the perceived costs of a car trip now exceed those of undertaking the trip by public transport and public transport becomes the preferred mode. The difference between the car total resource cost and public transport total resource cost represents the benefit of this behaviour change. Some of this accrues to the behaviour changer as savings in perceived and unperceived internal costs and some to society due to the lower externality costs associated with a public transport trip compared with a car trip. Note that there is no actual change in the total cost of either the car or public transport trip, but that the behaviour change and resulting benefits arise solely from the change in perceived costs brought about by the TBhC project.

In the above example, changes in internal unperceived costs of travel behaviour changers are the category C(i) and D(i) benefits, or resource cost corrections, in the theoretical framework. Category C(i) benefits will include unperceived costs of car use (car maintenance and other non-fuel variable costs, tolls, parking subsidies, part of accident costs, health costs and so on) and D(i) will include public transport fares and cycle costs.

In summary, consistent with the analysis of public transport projects, the economic appraisal of TBhC initiatives involves estimation of the following three main benefit categories:

- User benefits – benefits to travel behaviour changers (the users' perceived benefits from their changed travel choices)
- Resource cost corrections – changes in the resource costs that are borne by or affect travel behaviour changers but are not perceived by them, and adjustments for transfer payments that are perceived as costs by travellers but do not represent use of any resources
- Externality benefits (disbenefits) – reductions (increases) in resource costs that are neither perceived nor borne by the travel behaviour changer.

These benefit categories are considered in more detail in Section 4.

3. Travel demand impacts – diversion rates

3.1 Introduction

To value the benefits of a TBhC project, it is necessary to have estimates of the impacts that the project is likely to have on travel demand, including impacts on mode shares, average trip lengths, and any changes in the overall amount of travel.

Diversion rates are the (quantitative) estimates of the differences or changes in travel on various modes between the Base Case (without the initiative) and Project Case (with the TBhC initiative). Diversion rates are expressed as changes in mode share, with decreases for some modes (private car) and increases for others (public transport and cycling/walking).

It is also necessary to define the target population to which the diversion rate applies. For example, for a workplace travel plan this might be the total number of people employed at the workplace; for a household/community based initiative, it might be either the total population of the area covered by the initiative or just the households actually contacted or agreeing to participate in the program.

Diversion rates should be based on evidence from similar previous TBhC initiatives that have been implemented and then monitored and evaluated subsequent to implementation. Robust monitoring and evaluation of TBhC initiatives is difficult and expensive. Nevertheless, some studies have now been conducted that provide a fair indication of the likely effects of different types of TBhC initiatives in different situations. Default diversion rates based on this evidence are provided in Section 3.4.

3.2 Diversion rate interpretation issues

A significant issue in relation to diversion rates is the different ways that they are expressed and the different target populations against whom the changes are measured. If diversion rates are derived from relevant local studies, rather than the default rates in this guidance, care is required to identify the approach that has been adopted in each study.

If a diversion rate that was derived as a change in the travel behaviour of the people participating in a TBhC project (which could be quite high) is assumed to apply to the whole population in an area when forecasting the impacts of a TBhC project, the effects are likely to be over-estimated. It is important to be clear what target population the diversion rate applies to, both when collating diversion rates from the literature and when using appraisal procedures to assess potential projects. The different target populations against which diversion rates have been expressed in appraisals and monitoring include:

- Total population in the suburb/area covered by a TBhC project
- Total households in the suburb/area covered by a TBhC project
- Total population or households to be contacted by the project
- Total number of people actually participating in TBhC project

- Total roll of a school covered by a school travel plan
- Total number of students participating in project
- Total number of employees in a workplace
- Combined total of employees and visitors for a hospital.

Diversion rates are sometimes expressed as the percentage point change in mode share and sometimes as the percentage change from the initial mode share. As an example, if the car mode share of all trips (total trips by all modes) is 66 per cent without the TBhC project and 62 per cent with the project, this might be expressed as either a 4.0 percentage point reduction in car mode share or as a 6.1 per cent $((66 - 62) / 66)$ reduction from the initial car mode share.

Diversion rates are also sometimes expressed as the percentage change in a variable such as car trips or car vehicle kilometres travelled (VKT) compared with the situation that would have occurred without the TBhC project.

Care is required to avoid misinterpreting and/or misapplying diversion rates.

3.3 Diversion rate evidence

Most of the evidence on the effects of TBhC initiatives is drawn from a literature review conducted during the development of New Zealand's travel behaviour change appraisal procedures in 2004. That study collated diversion rates from a range of projects in Australia, New Zealand and the United Kingdom. This has been supplemented with evidence from subsequent Australian monitoring and evaluation studies.

The observed diversion rates were often represented as a percentage change in the number of trips, or percentage point change in mode shares, but some were also in terms of an increase or decrease in vehicle kilometres travelled.

Some of the diversion rate information was taken from ex-ante assessments rather than from monitoring of projects that have been implemented. However, these tended to be based on previous reports and pilot studies and therefore still reflect actual experience.

Substantial investment was made in TBhC projects in Australia in the first half of the 2000s, particularly in Western Australia, South Australia, Victoria and Queensland.

A paper at the Australasian Transport Research Forum (Roth et al, 2003) presented results achieved by Individualised Marketing programs from around the world. Reductions in car driver trips ranging from 6 to 14 per cent were observed in the various programs. Based on these findings, the paper suggested that reductions in car driver trips could range from 5.5 to 13 per cent of whole populations (that is, including non-participants). The paper also noted European evidence suggesting that little to no maintenance is required for five years to maintain public transport patronage increases.

Another paper presented at the same forum (Stopher et al, 2003) reported the findings of a 'critical appraisal' of travel behaviour modification programs in Australia. This indicated that the reduction in car driver trips was in the order of 7 to 9 per cent for those who participate in a project and 5 to 7 per cent for a target population as a whole (allowing for non-respondents). UK evidence summarised in the Smarter Choices report (Cairns et al, 2004) suggested a lower range of 1 to 5 per cent reduction in all car driver trips over 10 years.

The most extensive monitoring and evaluation project in Australia in recent years was conducted by the Institute of Transport and Logistics Studies (ITLS), which is also reported in an ATRF paper (Stopher et al, 2013).

During the four-year period from 2004 to 2007, various TBhC programs were implemented in South Australia, Victoria, Queensland and the ACT using social marketing and community development initiatives. The ITLS study measured the travel patterns of a number of households in these states over a five-year period from 2007 to 2012, following the completion of the TBhC programs. GPS devices were used to measure household members' travel over a 15 day period in September to November each year. The survey covered roughly 120 households per year, of which approximately 80 had participated in TravelSmart and 40 households had not participated (the control group). Each year, some households declined to continue participating and were replaced with new households to maintain the numbers in each state and in the participant and control groups.

The ITLS study concludes that the aggregate analysis of the six waves of long term data (one before TravelSmart implementation and one each year for five years after implementation) indicates that there has been a continuing decrease in total person kilometres of travel (PKT) by car over the five-year monitoring period for both TravelSmart and non-TravelSmart households. Non-TravelSmart households performed consistently more PKT per day than their TravelSmart counterparts, and the difference between the two remained more or less the same throughout the monitoring period. This suggests that TravelSmart households succeeded in reducing PKT by car during the implementation of this intervention, and then maintained their lower level of driving though the long-term monitoring. There is no evidence of a return by the overall sample to levels of driving that match those prior to the TravelSmart intervention. Presumably other factors have led to a continuing decrease in PKT by car for all households in the areas surveyed in subsequent years.

A limitation of the study report is that it does not show what proportion of the decrease in PKT by car was matched by an increase in travel by other modes and what proportion was simply a reduction in the amount of travel. This is important in determining the net benefits of a TBhC initiative.

The study also observed that the measured reductions in PKT almost certainly include some level of change due to other reasons. TravelSmart non-participants decreased their vehicle kilometres travelled by 15.3 per cent over the five years while participants decreased their vehicle kilometres travelled by 18.2 per cent. Almost half of the reduction for both participants and non-participants occurred in the last two years of the study, well after the TravelSmart programs had been delivered. The difference between these results suggest that TravelSmart household programs may achieve an approximate (non-statistically reliable) one-off reduction in car travel of approximately 2.9 per cent and maintain this over the medium term (five or more years), but that other factors appear to have had a much greater effect on changes in travel over the monitoring period.

Prior to the above five-year monitoring study, the ITLS performed a shorter duration TravelSmart monitoring study, also using GPS data logging, for the South Australian Department of Transport, Energy and Infrastructure (Stopher et al, 2009). This was expanded into the subsequent larger five-year study.

A conclusion from the above evidence is that the long term effect of TBhC household/community initiatives is probably lower than some of the ranges suggested in the early years and is more in line with the ranges noted in the United Kingdom. Another conclusion is that the changes achieved by TBhC programs do appear to persist over the medium to long term.

The UK Smarter Choices report (Cairns et al, 2004) presented a range of diversion rates for 10 different types of TBhC projects surveyed in that report. It also provided diversion rates for the combined effect of overlapping TBhC initiatives recognising the potential to double count impacts if diversion rates are simply added together.

Workplace travel plans in the UK achieved reductions of 5 to 9 per cent in all car trips to/from work in the area and appear to be able to achieve larger reductions due to being tailored to particular workplaces and hence able to influence a greater proportion of the population (the workforce at the workplace in this case).

A significant issue is the range of diversion rates that can apply for the same type of TBhC project in different situations. For example, in the case of workplace travel plans, where there is a considerable amount of experience and evidence, the UK Smarter Choices report found that broadly:

- 10% of travel plans achieve no change
- 20% reduce car use by >0 – 10%
- 35% reduce car use by >10 – 25%
- 25% reduce car use by >25 – 35%
- 10% reduce car use by over 35%.

Australian experience for all types of TBhC projects has been similar. For example, Perkins (2001) conducted a statistical analysis of the observed travel behaviour change against a set of commonly measured socio-demographic characteristics. Perkins' paper analysed the results of the implementation of Travel Blending pilot programs in Adelaide and concluded that the characteristics that explained a significant amount of the variation in the total number of trips made by a household were unable to explain any significant amount of the change in travel behaviour, suggesting no relationship between socio-demographic characteristics and the diversion rates achieved by a project. The paper concluded that either the travel behaviour change is explained by a set of characteristics not currently measured or that the sample size was too small to determine any relationship. However, it was highlighted that those individuals who used cars the most tended to make the greater degree of positive change.

Research in Western Australia in 2005, while not conclusive, indicated at least a partial relationship between TBhC diversion rates (for household programs) and suburb form (land use mix, connectivity, amenity for active transport and public transport options) in Perth.

The work to derive default diversion rates described in the next section attempted to differentiate the factors that might contribute to higher or lower diversion rates and to provide different sets of diversion rates based on these. However, often there were no statistically significant differentiating factors and it needs to be accepted that the effects and hence benefits are always likely to be uncertain. The best results will be achieved by drawing on all available experience, selecting target areas with the greatest potential to achieve the proponent organisation's objectives and investing effort in good design and implementation of TBhC projects.

3.4 Default diversion rates

Default diversion rates are provided for work travel plans, school travel plans and household/community based projects. These have been collated from the New Zealand and Victorian studies and reviewed in the light of more recent evidence from monitoring studies of TBhC initiatives in Australia.

If TBhC project proponents and analysts have different diversion rates, supported by sound evidence, that they consider would be more applicable for their particular project, these may be used instead of the default rates. Different diversion rates can also be used for sensitivity testing.

Originally it was envisaged that there would be a number of different sets of default diversion rates for each of the TBhC project types, based on characteristics of the target population and the scope of the TBhC programs. However, statistical analysis of the available data on results of TBhC projects did not support greater disaggregation than what has been provided.

Results reported in previous evaluations and papers are often an upper bound because they only report the observed behaviour changes for a certain subset of the population. For example, the reported diversion rate may be, say a 14 per cent reduction in car as driver mode share amongst those who participated in the program. This does not take into account the individuals that did not participate in the program (such individuals can be classified into two categories: those who did not respond/could not be contacted to participate in the program and those who chose not to participate in the program). The 14 per cent diversion is an upper bound because for this same reduction to apply across the entire population requires the assumption that all non-participants would have made the same average change as those who participated. Basing default diversion rates only upon the upper bounds will result in a consistent over-estimation of the likely benefits from a TBhC project.

To make a correction for this, a lower bound was calculated in these cases by adjusting the reported diversion rate for the program participation rate. The assumption for calculating the lower bound is that individuals in the target population who do not participate make no change in their travel behaviour and that they have average mode share prior to the implementation of a TBhC project.

Information about the TBhC program will disseminate throughout a community, resulting in the actual diversion rate for a target population being between the upper and lower bounds. The default diversion rates are based on mid-points between upper and lower bounds.

Default diversion rates are presented as percentage point changes in mode shares, chosen in preference to percentage changes relative to initial (Base Case) mode shares⁴. The use of percentage point changes supports simplified analysis procedures. Using change relative to initial mode share would require the initial mode shares of trips in a community, company or school to be known prior to the analysis. Also, tables of default diversion rates would be more complex, as would the resulting calculations. Fortunately, the evidence from TBhC projects implemented to date is that the percentage point change in mode share does not appear to vary significantly across projects with different initial mode shares.

The use of percentage point changes for the default diversion rate values might be seen as placing a constraint on the analysis because it assumes that total trip numbers are unchanged. In the derivation of default diversion rates, it is necessary that the sum of the diversion rates for the 'from' modes equals, in magnitude, the sum of the diversion rates for the 'to' modes (and they will be opposite in sign). This ensures that total mode share sums to 100 per cent. This constraint can be overcome, if necessary for a particular TBhC project, by including an additional 'to' mode labelled 'no trip' with a diversion rate equal to the percentage reduction in total trips (also see Section 5.5.3).

The benefits for a particular mode changer depend on both the 'from' mode and the 'to' mode. For example, the benefits associated with cycling will differ from walking, due to the different lengths of car journeys replaced and the different level of physical activity. However, the distinction in benefits between car as passenger and car sharer is not so well defined. Primarily, the difference between the two will depend upon average trip lengths and, since this is likely to be marginal, it is assumed that there will be no difference in trip lengths for car sharer and car passenger trips. Hence, for appraisal purposes the two are the same - so car as passenger incorporates the diversion to car sharer.

3.4.1 Household/community based initiatives

After considerable investigation and statistical analysis, the New Zealand and Victorian studies concluded that household programs cannot be categorised into groups with similar diversion rates based upon socio-economic or other characteristics of the area, or upon the measures to be implemented. Similar TBhC household programs have been implemented in a number of different areas and the diversion rates observed have varied from one area to the other, with little consistent relationship to any of the above criteria.

⁴ For example, if the initial mode shares of total trips by all modes are 85% car and 10% PT (and 5% other) and a project changes this to 80% car and 15% PT this is a change of - 5 percentage points for car mode share and +5 percentage points for PT. The percentage change relative to initial car mode share is - 5.88% (- 5/85). If initial mode shares were 75% car and 20% PT and a project changed this to 70% car and 25% PT this would still be a - 5 percentage point change in car mode share and +5 percentage point change for PT. However, in this case the percentage change relative to initial car mode share would be - 6.67% (- 5/75).

Given the above findings, a standard set of default diversion rates is provided based on the average of all household/community projects that have been undertaken and monitored. A low set of default rates is also provided, based on the average of the bottom half of diversion rates achieved, to account for any projects that may not implement the full range of initiatives that have become standard in household based programs such as TravelSmart, or where public transport services or cycle/walk facilities are poor: the decision to use the low set is at the discretion of analysts.

The two sets of default rates were estimated by sorting data into ascending order based on the change in car as driver mode share. The standard set of diversion rates for each mode used the average mode shares from the whole sample, while the low set used the average from the half of results with the least change in car as driver. It was also necessary to adjust these values to meet the constraint of mode share summing to 100 per cent.

The two sets of default diversion rates for Household based programs are shown in Table 2.

Table 2 Household programs – default diversion rates

	Car as driver	Car as passenger	PT	Cycling	Walking
Low	-1.0%	-0.2%	0.5%	0.3%	0.4%
Standard	-3.1%	-0.5%	1.4%	0.9%	1.3%

These percentage point changes apply to the whole population in the area (such as a suburb or region) targeted by the TBhC program (the target population), not just the households or people in that area who agree to participate in the program⁵.

It is recommended that the standard diversion rate profile based on the average of all case studies is used for most household TBhC projects. The low set of default rates, based on the average of the bottom half of diversion rates achieved, may be more appropriate for any projects that may not implement the full range of initiatives that have become standard in household-based programs such as TravelSmart, and where public transport services or cycle/walk facilities are poor.

The WA Department of Transport has accumulated a significant database of results from 16 TBhC household/community projects in Perth (delivered to a target population of 388,733 residents). These results indicate that Perth has achieved higher than average diversion rates of -5% car-as-driver, 0% car-as-passenger, +2% PT, +1% cycling, and +2% walking.

TBhC project proponents may consider using higher diversion rates than the standard rates if they have a suitable depth of evidence to support this and their projects are delivered with matching content and commitment.

⁵ If the target population only comprised the TBhC program participants in the area covered by the program, the diversion rates would be higher but the target population would be lower - so that the resulting numbers of mode changers would be the same.

3.4.2 Workplace travel plans

A large number of workplace travel plans were analysed for to determine diversion rate impacts. After considerable investigation, there was found to be insufficient data to determine statistically significant differences between the diversion rates that were achieved with different combinations of characteristics. Instead, an approach that assigns one of three default diversion rates to a project based on a scoring system was favoured.

A proposed project is scored against the measures listed below and then classified into a set of default diversion rates based upon the aggregate score:

- Car parking management strategies
- Public transport service improvements and/or public transport subsidies
- Improvements to walking/cycling facilities
- Promotion of ride sharing.

Evidence in the literature suggests that the most significant factors in achieving lower car as driver mode share are initiatives targeted at the availability of parking, and provision of an adequate substitute for car commuting. Parking management strategies and public transport service improvements or subsidies are the two types of measures that address these barriers most directly and are thus weighted more heavily.

The scoring and classification worksheet for workplace travel plans is shown in Table 3 The various categories and guidance for scoring are described in the paragraphs following the table.

Table 3 Workplace travel plans – scoring and classification

WORKPLACE TRAVEL PLANS SCORING AND CLASSIFICATION			
	Parking management strategy		
Is there a car parking constraint/issue	No strategy	One or more parking strategies in travel plan	Parking Strategies include:
No	0	1	<ul style="list-style-type: none"> • Parking cash out • Parking charges • Reduced supply, etc.
Yes	1	2	
Parking management score		—	
Are these attributes part of the Travel Plan	Yes/No		
score of 1 if Yes, 0 if No			
Public transport service improvements		—	
Public transport subsidies		—	
Ride sharing matching service		—	
Improved cycling/walking facilities		—	
Total Score (out of 6)		—	
Diversion Rate	Score		
Low		1 or 2	
Medium		3 or 4	
High		5 or 6	
Separate diversion rates are provided for projects that include public transport measures such as service improvements or fare subsidies			

Car parking management strategies

A wide range of measures could fall into the category of a parking management strategy including, but not limited to, the introduction of car parking fees, parking cash-out schemes and restricting/reducing the supply of car parking spaces. It is also important to consider the current parking situation - that is, whether there is currently ample car parking space or whether parking availability is already constrained.

It is suggested that projects be given scores of zero, 1 or 2 for parking. A score of zero would be applicable if current parking arrangements adequately meet demand and a parking management strategy is not implemented as part of the plan. This reflects the fact that without a parking issue, and without the introduction of parking demand management, there are fewer incentives for individuals to change.

If parking arrangements are already constrained in some way (in other words, there is a parking issue), it is more probable that individuals are seeking an alternative mode and that the travel plan will stimulate a change in mode. In this case, a project should receive a score of 1.

A travel plan that introduces a parking management strategy is also likely to deter people from driving to work (for example, by charging for parking, some individuals will consider it more attractive to travel by another mode) and should receive a score of 1.

Implementing a single parking management strategy is probably not as effective as the introduction of a number of measures (such as introducing parking charges and reducing the number of car parks available for staff). However, analysis of the case study data did not show sufficient evidence to justify a higher score for the introduction of a combination of parking management strategies.

A score of 2 should be assigned in situations when there is an existing parking issue/constraint and the workplace travel plan involves the introduction of one or more parking management strategies.

Public transport service improvements

Improvements to public transport services could be through the provision of new bus/train routes or through the introduction of new services along existing routes. The provision of a company shuttle bus could also count as a public transport system improvement.

If a workplace travel plan includes any such improvements to the public transport system (although it is not limited to those listed above), then a score of 1 is appropriate. If no such improvements are included, a score of zero should be given.

Two sets of diversion rates are estimated, one set for when there are no public transport service improvements as part of the travel plan and one set for when service improvements or subsidies are included.

Public transport subsidies

Public transport subsidies could be either in the form of a subsidy to an operator (to improve services and/or reduce fares) or through direct fare subsidies to employees (such as free or subsidised weekly/monthly tickets). A score of 1 should apply if public transport subsidies are a measure to be included in a work travel plan, and zero otherwise.

Ride sharing

Ride sharing can be promoted in a number of ways, through the provision of preferential parking for car sharers or through the introduction of a ride sharing matching service or similar. If the travel plan introduces a ride sharing measure (or a number of measures), then a score of 1 should apply, and a score of zero otherwise.

Improvements to cycling/walking facilities

Improving the conditions for cyclists and pedestrians will encourage the use of these two modes. Two common improvements to cycling and walking facilities are the improvement of onsite facilities (such as lockers, showers and bike storage) and the improvement to external facilities (such as cycling paths/tracks/lanes). A score of 1 should apply if a cycling/walking measure is implemented and zero otherwise.

Select appropriate diversion rate based on score

The scoring system is intended to assign individual projects the correct magnitude of car as driver mode share reduction. Within the case studies reviewed, the distribution of this percentage point change across the 'to' modes is influenced by the measures implemented by the travel plan. For plans that do not include any public transport service improvements, it is expected that the diversion to public transport will be similar to diversion to the other 'to' modes. For a project that is done in conjunction with public transport service improvements or that includes company provided transport (such as a shuttle from nearest train station), the evidence suggests that a far greater proportion of the mode shift will be to public transport. Hence, separate sets of diversion rates are derived for 'with public transport measures' and 'without'.

The recommended sets of diversion rates for use in the appraisal of workplace travel plans are shown in Table 4.

Table 4 Workplace travel plans – default diversion rates

Score	Set	Car as driver	Car as passenger	PT	Cycling	Walking
WITH PT service improvements						
2 or less	Low	0.0%	0.0%	0.0%	0.0%	0.0%
>2 but <5	Medium	-5.0%	1.3%	2.6%	0.3%	0.8%
5 or more	High	-12.9%	3.3%	7.4%	1.0%	1.2%
WITHOUT PT service improvements						
2 or less	Low	0.0%	0.0%	0.0%	0.0%	0.0%
>2 but <5	Medium	-5.0%	1.3%	1.3%	0.6%	1.8%
5 or more	High	-12.9%	3.3%	3.7%	2.7%	3.2%

The target population for these diversion rates is the total workforce (number of employees) at the workplace covered by the travel plan.

Back-testing of this scoring system with actual case studies (mainly from UK experience) showed a good match for the 'from' mode (car as driver) diversion rates but considerable variation in distributions across the 'to' modes. This was found to depend on whether or not projects involved or were accompanied by public transport service improvements.

The adoption of an alternative set of distributions for the 'to' modes for workplace travel plans that were not accompanied by public transport service improvements, as shown in the lower half of Table 4, improved the accuracy of the scoring system.

Estimation of 'without PT' diversion rates was done by assuming that half the public transport diversions (in the 'with' sets) is redistributed between walking and cycling. The amount that either walking or cycling receives is weighted by the relative sizes of the two in the 'with' group of diversion rates.

There is increasing interest in the use of travel plans as tools to influence travel demand for large new shopping complexes and expansions of existing centres. As customers generate significantly larger travel demand to these centres than staff, such travel plans are likely to include measures for both groups, not just staff. Adjustments to default diversion rates for workplaces should be made if a travel plan is directed at customers as well as staff. Diversion rate evidence from household/community initiatives might be considered for these adjustments.

3.4.3 School travel plans

Evidence on the effects of school travel plans comes mostly from the UK. This was supplemented with Australian data for tertiary institutions, in particular from Victoria.

The only differentiating factor between primary, secondary and tertiary educational institutions that it gave clearly different sets of diversion rates is the level (age group) of the school or institution: that is, whether it is primary, secondary or tertiary. Other factors, such as the socio-economic level of the area, may be considered likely to cause differing effects but any such differences were not discernible from the evidence.

Primary school students typically only have a short journey, are often accompanied by their parents and generally do not use public transport. Secondary school students have longer journeys on average (relative to primary school students) and make substantial use of public transport. Tertiary institutions are different again. Student trip lengths vary significantly, with students living on campus or in close proximity having very short journeys, whereas others commute long distances. Also, the majority of tertiary students hold a driver licence and have access to a car.

The mean percentage point change in car as passenger for primary and secondary schools combined is used as the default 'from' diversion rate for both primary and secondary schools.

In the case of primary schools, the 'to' diversion rates are considered to be mainly cycling and walking. Evidence suggests that public transport is generally not an important mode for most primary schools, largely due to the relatively short journey distances for most students.

A proportion of children attending private primary schools do use public transport, possibly because such schools have a wider catchment area than public schools. The default diversion rates for secondary schools are more appropriate for such schools.

Default diversion rates for secondary schools were estimated for public transport, cycling and walking. There is limited evidence on proportions of 'to' mode shares. Based on experience and judgement, public transport is considered to account for most diversion and cycling is considered to receive the least change.

The default diversion rate values for primary and secondary schools are shown in Table 5. The secondary school diversion rate profile is also appropriate for private primary schools. The target population that these diversion rates apply to is the total school roll.

Table 5 School travel plans – default diversion rates for primary and secondary schools

	Car as passenger	PT	Cycling	Walking
Primary schools – public	-9.0%	0.5%	2.0%	6.5%
Secondary schools	-9.0%	5.0%	3.5%	0.5%

Default diversion rates for tertiary institutions were derived from a post-implementation review of a TravelSmart program at Melbourne's Monash University Clayton Campus. University campuses vary significantly in their location and transport availability. Monash is considered to represent an average of the characteristics of tertiary campuses and hence the default diversion rates will be appropriate for programs covering several tertiary institutions in different locations as well as individual institutions with similar 'middle-ring' locations and transport facilities.

Adjustments to the default diversion rates may be justified for travel plans for individual institutions that are located in more central locations close to a CBD or more distant outer metropolitan locations. Given the size of workforce at many tertiary institutions, it would also be appropriate to cross-check diversion rates against the default rates for workplace travel plans, particularly if both staff and students are targeted by the travel behaviour change program.

In some States the types of measures included in travel plans for tertiary institutions are closer to those in workplace travel plans than school travel plans. However, this does not mean that workplace diversion rates should be applied for tertiary institutions. Adjustments to default diversion rates for tertiary institutions could be made if the travel plan implementation is directed more at staff than students or than students and staff.

The Monash University TravelSmart program led to a 9.2 percentage point reduction in car as driver mode share by first year students compared with the previous year and significant increases in car as passenger and public transport mode shares. These results have been rounded to obtain the default diversion rates.

The default diversion rates for tertiary institutions are shown in Table 6.

Table 6 School travel plans – default diversion rates for tertiary institutions

	Car as driver	Car as passenger	PT	Cycling	Walking
Tertiary institutions	-9.0%	3.5%	5.0%	0.5%	0.0%

3.5 Durability of changes

The default diversion rates in the previous section apply to the first year benefits after the implementation of a TBhC project. An economic appraisal also requires an understanding of the likely trend of benefits in future years. There are two interrelated aspects to this that need to be decided:

- Whether benefits of TBhC projects persist or decay over time, and at what rate
- Whether travel by all modes grows at the same rate in future years.

An issue for the appraisal procedure is whether benefits of TBhC projects persist or decay after the completion of the program. The following four possibilities have been suggested based on experience to date:

- Benefits decay over time (in the absence of periodic ‘maintenance’ efforts)
- Benefits can be maintained by ongoing “maintenance” expenditure
- Benefits are durable without maintenance
- Benefits increase over time.

Some early TBhC economic appraisals assumed that benefits would decay over time or that maintenance expenditure would be required. For example, the paper by Tisato and Robinson (1999) included an assumption that benefits of (an individualised marketing program in Adelaide) would decay without maintenance. To maintain the level of benefits, they included cost estimates for annual reinforcement programs and periodic (five-year) repeats of the travel diary. Recent experience in Western Australia also points to a gradual drop-off over time, particularly at workplaces and schools, unless there are ongoing incentives and support.

Other papers give examples of TBhC programs where benefits appeared to have been sustained for up to four years after the program and more recent evidence supports the case that benefits may be self-sustaining without specific maintenance. The most intensive study was the recent ITLS five-year monitoring project (Stopher et al, 2013) that found no drop-off in the effect of TBhC programs in four states over the five years from 2009 to 2013. This was achieved without any systematic follow-up reinforcement TBhC programs.

The UK Smarter Choices report discussed the possibility of ongoing growth in benefits in future years, but there does not appear to be any evidence to support this (without further TBhC investment).

It is intuitively plausible that if TBhC programs provide information to correct misperceptions about alternative travel options and modes of which people were unaware, many of the people making changes will find the new option to be an improvement and will not have an incentive to revert. Reversion is more likely in cases where people were persuaded to change to a less convenient option because this was more environmentally sustainable. People in this situation may be more likely to revert without occasional reinforcement. If TBhC projects are implemented along with infrastructure changes, this may also help to increase the durability of benefits.

For household/community initiatives there appears to be some reversion to previous travel choices over the first nine months following the TBhC project, but people who have not reverted by this time tend to stay with their new travel choice. Experience from Perth over a four- to five-year period in the 2000s indicated stable mode shares at the same proportions as they settled at 9 – 12 months after the TBhC project. This finding, reported in Maunsell et al (2004b), was drawn from a number of papers on the Perth TBhC experience between 1999 and 2004.

Default diversion rates are based on results from before and after surveys. The first 'after' surveys are typically undertaken around 12 months after implementation of a project when the initial reversion described above has already occurred.

Therefore appraisals of household/community projects could generally assume that benefits will be retained in future years with little or no maintenance expenditure, subject to adopting a suitable appraisal period. As a result of consultation during the development of the ATAP Guidelines, a default appraisal period comprising three years of benefits following implementation of a TBhC initiative has been adopted as being appropriate for most projects when there is no follow up expenditure.

Workplace travel plans and particularly school travel plans are more likely to require ongoing maintenance expenditure due to staff and student turnover. In the case of workplace travel plans, some of this will become part of the companies' cost of business. However, in the case of school travel plans, this may require ongoing expenditure that would need to be estimated and included in the analysis. Embedding the learning of road rules and about active travel in the school curriculum may reduce the need for ongoing expenditure.

A related issue is whether travel by all modes would grow at the same rate in future years. In other words, if underlying growth in total travel is forecast at 2 per cent per annum, is it reasonable to assume the same growth rate for trips by all modes in the absence of any intervention, and is the TBhC project likely to change the relative future year growth rates in addition to the initial shift in mode shares?

Possible assumptions that could be adopted are that trips on all modes grow at the same rate as underlying demand growth or that, after the initial response, there is no further growth in the changed trips — all subsequent growth in each mode is what would have occurred anyway in the absence of the TBhC project.

The preferred option in this case is to assume that benefits of the TBhC project do not grow in line with traffic growth in future years. This is not to say that trips by alternative modes will not grow, but rather that this is underlying growth that would have occurred anyway in the Base Case and is not attributable to the TBhC project. It could only be attributed to the TBhC project if the project was being repeated each year and 'diverting' the usual proportion of the growth in car trips.

3.6 Modelling of travel behaviour change

For smaller TBhC initiatives, which are likely to account for the majority of projects, the most cost-effective approach for estimating benefits is likely to be spreadsheet calculations using diversion rates, trip lengths, benefit unit values and other default data provided in this guideline. However, for major TBhC programs and packages involving significant expenditure, it may be appropriate to consider using a strategic transport network model to assist with estimating the benefits.

The UK Department for Transport's TAG Unit M5.2 Modelling Smarter Choices provides helpful guidance on the use of four-step multi-modal transport network models for estimating TBhC benefits. The guidance in UK TAG M5.2 is directed primarily at modelling practitioners. However, TAG M5.2 also contains advice that is relevant to the economic assessment of TBhC initiatives more generally.

As noted earlier, TAG M5.2 makes a distinction between 'hard' measures and 'soft' measures in a TBhC package. It notes that there is some evidence about the combined effects of several TBhC measures, but much less evidence about the isolated effects of individual 'soft' measures in a form that can be included in models. The suggested approach to modelling packages of TBhC initiatives is to use a step-by-step approach, where 'hard' measures are modelled specifically using the existing model demand vs generalised cost relationships, and adjustments for 'soft' measures are used in order to achieve the diversion rates suggested by the evidence (such as the default diversion rates). Once adjustments have been made that achieve the expected diversion rates, the model outputs can be used as estimates of the economic benefits.

4. Benefits of TBhC initiatives

4.1 Overview

As discussed in Section 2.3, existing users of individual transport modes generally do not receive a benefit in TBhC project appraisals. If some components of a TBhC package do result directly in a change in generalised cost for existing users of the affected mode, these are considered 'hard' initiatives and should be analysed with the relevant PT and active transport guidelines. With 'soft' TBhC initiatives, only the travel behaviour changers will receive a benefit (or they would not make a change). Since this cannot be estimated by the traditional 'rule of half' method from existing user benefits, an alternative valuation approach is required, as described below⁶.

The alternative user benefit estimation approach is based on users' perceived costs so overall project benefits also need to include resource cost corrections for unperceived resource costs as well as externality benefits.

4.2 Benefits to mode changers

Section 2.3 explained that the perceived benefits to mode changers are a valid benefit to estimate and include in the economic appraisal of TBhC projects. This approach is consistent with theory incorporated in transportation planning modelling and in the assessment of benefits to induced traffic. This section discusses the derivation of appropriate values for use in TBhC project appraisals.

In a 2004 ATRF paper, Winn (2004) described a method and derived estimates of the benefits perceived by mode changers from the mode split relationships incorporated in strategic transport planning models. These relationships reflect the change in mode shares between two modes that will result from changes in the relative perceived generalised costs of the two modes.

The mode split between two modes is a function of the difference in perceived generalised cost between the two modes. The relationship can be used in reverse to determine the change in perceived generalised cost difference that is required to achieve an observed change in mode share. Because the mode share relationships in the transport models are calibrated to actual observed travel choices, this generalised cost difference can be equated to the perceived benefit associated with a given change in mode share.

Winn described the estimation process as follows:

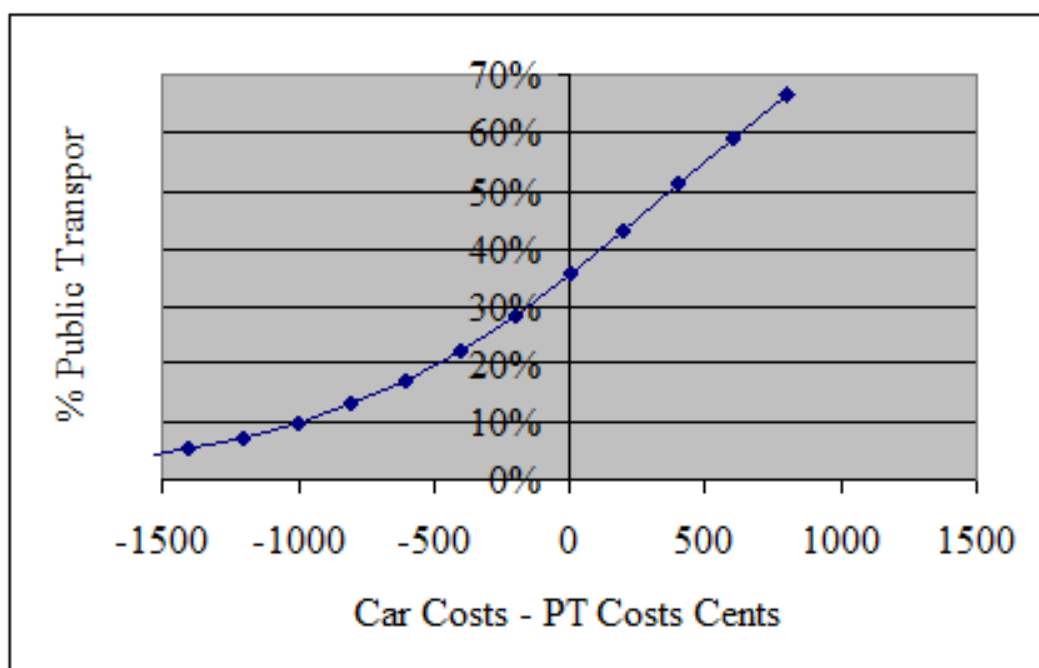
⁶ To the extent that a TBhC initiative reduces car trips, remaining highway users may also receive a decongestion benefit. This benefit is estimated and included in the CBA procedure described in these TBhC guidelines. However, while this could be interpreted as an existing user benefit, it is not one that can be used with the rule of half to estimate the perceived net benefit of mode-changers.

“For the valuation of the user benefits associated with changes in the mode of travel a logit based mode split model is used. This model form is commonly used in four stage strategic transport models to allocate trips between motorised and non-motorised modes and between public transport and motor car within the motorised category. The market share of one mode compared to another is a function of the difference in generalised cost, with a slope parameter governing the rate of change and a shift parameter included to take account of the attributes not included in the generalised cost formulation.

Figure 3 illustrates the public transport share of motorised transport using typical parameters found in the Melbourne Integrated Transport Model (2000). Notice that where there is no difference in generalised cost public transport accounts for 35% (not 50%) of trips. This reflects the inherently superior comfort and convenience attributes of car-based travel (that are not accounted for in the generalised costs).

As a further illustration; if the current public transport mode share of motorised travel was 10% (which occurs if public transport costs are \$10 more than car costs), then a reduction in public transport costs relative to car of about \$5 (500 cents) would be required to raise the public transport mode share to 20%.

Figure 3 Public transport mode share of motorised travel



This information can be used in the following way to infer a value for the user benefits of those who switch from car to public transport for the same type of journey:

- in the example TBhC application considered, a 15% increase in public transport trips and a consequent increase in the public transport share of motorised trips from 13% to 17% was assumed (i.e. a four percentage point increase in public transport mode share); this is consistent with experience in Australia and internationally;

- applying the relationship shown in [Figure 4] suggests a change in the generalised costs of public transport compared to car of around \$2 (200 cents) would be required to effect this shift, and
- the rule of half should be applied to set the average benefit per user at half the full benefit (a downward sloping demand curve implies that some (marginal) car users would require only a small change in cost to switch while some would require the full \$2 shift to move).

A similar approach may be followed to value the benefits for those switching from car travel to walking and cycling. This analysis assumes a 10% increase in walk trips and a 75% increase in cycling (from a low base), raising the walk/cycle share of all trips from 25% to 29% (a four percentage point increase in active transport mode share). The Melbourne Integrated Transport Model parameters suggest a change in relative generalised cost of about \$1.50 is required to achieve this change indicating that the average benefit for those switching is \$0.75.”

For these Guidelines, the analysis described above has been generalised to derive mode changer perceived net benefit values for TBhC initiatives that result in different diversion rates than the 4 percentage point diversion assumed in Winn’s example.

A similar approach was used to derive mode changer benefits during development of the New Zealand TBhC appraisal procedures. This gave similar benefit values to those obtained by Winn. The Winn values were also reviewed and reaffirmed in a TravelSmart economic analysis for the Victorian Department of Infrastructure in 2006 (Maunsell, 2006).

Table 7 shows the proposed perceived net benefit values to be used for mode changers following further review of the above analysis. These values have been updated to 2014 from the values derived earlier and rounded slightly, reflecting the degree of approximation in the methodology for their estimation.

Table 7 Mode changer perceived net benefit values (\$ per trip)

Mode change	Size of mode change (percentage points)	Benefit (\$/trip)
Car driver/passenger to public transport		
	1	\$0.35
	2	\$0.70
	4	\$1.40
Car driver/passenger to cycle/walk		
	1	\$0.25
	2	\$0.50
	4	\$1.00

It is proposed to use the same benefit values for peak and off-peak periods because the model relationships produced little difference or were not reliably different. Values for other percentage point changes in mode share may be interpolated or extrapolated from Table 7.

Consideration was given to whether different benefit values may apply in cities with less extensive public transport choices but again evidence was not available to confirm or refute this. There appears little reason for the values for people changing from car driver/passenger to cycle/walk to vary by location as the perceived benefits are likely to be similar wherever they occur.

It is worth restating that the mode changer perceived net benefit values in Table 7 are the net total of all the savings and costs that the average mode-changer perceives they are incurring when changing to the new mode. As these values are derived from a multi-modal transport network model, they incorporate the net saving across all the usual perceived cost components that are included in the private generalised costs of the 'from' and 'to' modes in such models. For example, for highway trips the components include travel time, fuel, tolls and perceived parking charges. The values also include any other intangible perceived benefits and costs that are not specifically itemised in the model but that are incorporated in the logit model and calibration factors that are used to ensure that the transport model reflects observed mode choice decisions and mode shares.

Previous studies have noted that the method and detail of obtaining benefit values from mode choice relationships is still evolving and suggested the following issues for further consideration and investigation:

- It is likely that the mode choice relationship will change as a result of the TBhC project itself - that is, the position and slope of curve may change from that represented in the strategic transport model and therefore indicate different benefits.
- We might not be measuring the slope at a point on the curve that is representative of mode changers. Changers might tend to come mostly from a particular (flatter or steeper) part of the curve.
- More information is needed on how the mode choice models are constructed. The statistical validity of the curve will depend on how much detailed survey data on actual travel characteristics and choices has been used to calibrate the model.

4.3 Resource cost corrections

This section discusses the benefit and disbenefit components that are internal to (that is, directly affect) mode changers but that are not fully perceived and included in the mode changer net benefit values in the previous section.

One of the main ways that TBhC projects seek to change travel behaviour is by informing and educating travellers about the full costs of travelling by different modes, particularly by private car. It follows that the 'misperception' of resource costs by travel behaviour changers is likely to be less in the Project Case than without the TBhC project and, therefore, that different resource cost correction values might be required for TBhC projects than for public transport and active transport projects that do not include such information and education aspects.

The following paragraphs discuss each of the normal benefit categories, whether they require resource cost corrections and whether TBhC project-specific resource cost corrections need to be derived. Suggested default parameter unit values for resource cost corrections and externalities are summarised at the end of this section.

4.3.1 Travel time savings

Travel time savings (or increases) do not need to be assessed directly when using the recommended perceived cost approach because travel time changes and related impacts are considered to be fully internalised in the mode changer net benefit values estimated in the previous section. This includes effects such as differences in travel time by different modes, differences in the value of that time, other time costs such as waiting and transfers, and trip time reliability. All of these tend to be readily taken into account by users based on their experiences and directly influence their mode choice and other travel behaviour decisions.

4.3.2 Private vehicle operating costs

A proportion of vehicle operating costs are perceived by motorists and hence taken into account in their mode choice decision. However, it is normally considered (and reflected in multi-modal transport models) that motorists only perceive the fuel component of vehicle operating costs. Therefore, in public transport economic appraisals, a resource cost correction is required for the difference between this and total VOC resource costs avoided as a result of motorists' mode change. Furthermore, fuel costs are perceived in market prices that include fuel excise duty and indirect tax (GST), which are not resource costs.

Accordingly, the resource cost correction for reductions in private vehicle operating costs normally includes two components:

- A positive correction for the unperceived non-fuel resource costs
- An offsetting negative correction for the duty and tax proportions of fuel costs that are part of perceived cost, but are not resource costs.

One of the objectives of TBhC projects is to provide information that corrects people's misperceptions of the costs of private car use. For TBhC project appraisals, it is assumed that TBhC projects will provide sufficient information to make users aware of a greater proportion of the previously unperceived vehicle operating costs and hence their perceived costs will be equal to resource costs⁷. A VOC resource cost correction of zero should therefore be adopted for TBhC projects.

⁷ This assumption does not mean that people perceive all non-fuel costs as a result of the TBhC project. Rather they perceive enough of the non-fuel costs so that their total perceived cost, which includes fuel taxes, equals the total resource cost (which does not include the taxes). This is not a demanding assumption.

4.3.3 Car ownership costs

Car drivers who transfer to public transport and/or cycling and walking may be able to avoid the need to own a car due to the change in mode. If this is the case, and given the general conclusion that motorists do not perceive vehicle depreciation or the opportunity cost of capital when making individual travel decisions, a resource correction is normally needed to take account of the additional, unperceived resource saving. However, for similar reasons to private vehicle operating costs, the resource cost correction for reduced car ownership should be set to zero for TBhC projects.

4.3.4 Car parking

Reduced car use results in a reduction in the demand for parking facilities. The resource costs of car parking include the opportunity cost of using land for parking, the capital cost of parking facilities and the provision of adequate security.

Motorists are charged a fee for the use of parking. This charge differs depending on the destination of a journey and the time of day that the journey is made. Parking charges are higher for trips to the CBD and during peak times, and lower for off-peak and non-CBD trips. For many commuters, car parking is subsidised or provided free by employers. Also, many businesses, shopping centres and other destinations provide free parking. Overall, the parking fees paid by car users are less than the resource cost of providing parking. Motorists who change to public transport or active modes are likely to consider only the parking fee that they actually save in their perceived net benefit. People are assumed not to be aware of, or take account of, any difference between the fee they pay and the actual resource cost of providing the parking facilities, so a resource cost correction is required for this difference.

In the absence of specific research it is normally estimated that, on average, only about 50 per cent of car parking resource costs are perceived. Hence, a resource cost correction equal to the remaining unperceived 50 per cent is applied.

Some cities impose CBD parking levies that partially or wholly offset this difference. These should be taken into account when determining resource cost corrections for car parking.

Some of the strategies included as part of TBhC projects are measures to make car users more aware of the full costs of car parking, so it is assumed that TBhC projects will reduce the misperception of car parking resource costs and hence the required resource cost correction will be less than for public transport projects. Nevertheless, many commuters will continue to benefit from car parking that is subsidised or provided free by employers and hence will not perceive any change.

For TBhC project appraisals it is assumed that, on average, TBhC initiatives will reduce the resource cost misperception by a half, resulting in TBhC participants perceiving 75 per cent of resource costs after implementation of the TBhC initiative. Therefore, for each car driver trip diverted to public transport or active transport, a resource cost correction of 25 per cent of the car parking resource cost (per trip) should be included in the benefits.

The car parking resource cost per trip is obtained by dividing the daily parking resource cost by two (that is, between the inbound and return trips). The car parking resource cost correction is not applied for avoided car passenger trips, only avoided car driver trips.

4.3.5 Road tolls

A resource cost correction is required for road tolls. Tolls are charged to recover the capital and operating costs of toll roads and therefore could be considered to reflect a resource cost. However, sometimes tolls are just charged to recover the cost of purchasing a concession from the government to charge tolls on an existing road. In either case, by the time trips are made on a road the capital costs are 'sunk' and use of the road causes minimal on-going resource costs. Trucks may cause pavement wear and the road operator needs to provide traffic management and incident response functions, but these costs are small compared to the financing and amortisation of the capital costs.

It might also be argued that cars impose congestion costs on other road users in peak periods and that the tolls reflect this resource cost. However, congestion costs and reductions in congestion are explicitly estimated in an economic analysis. It would be double counting to include tolls paid by new highway users (or saved by lost users) as a resource cost in a project evaluation in addition to the congestion costs (or savings) resulting from changes in traffic volume. Each of the foregoing explanations result in the conclusion that tolls are a transfer and the resource cost of tolls is zero.

Savings in toll payments form part of the perceived benefits of toll road users who transfer to public transport and hence are included in the mode changer perceived net benefit values in Section 4.2. If a TBhC initiative will divert trips from a toll road, a resource cost correction is required because this perceived saving is not actually a resource cost saving. The resource cost correction for a trip diverted away from a toll road is a negative amount equal to the full toll saving - that is, it reduces total benefits.

From a practical viewpoint, it will usually be difficult to identify whether avoided car trips due to TBhC projects would have used a toll road, so this resource cost correction is not included in the benefit unit values in Table 8. If a TBhC initiative will significantly reduce trips on a particular toll road, the reduction in toll payments should be quantified and included as a resource cost correction.

4.3.6 Cycle operating costs

Resource cost values for cycle operating costs are provided in the mode specific active transport guidelines (M4) and/or parameter value guidance (PV4).

People changing mode from car to cycle are likely to be aware of the probable incremental cycle costs. It could be argued that, as with cars, people do not fully take into account infrequent costs such as tyres and maintenance. However, TBhC projects typically correct these misperceptions and the same is likely to apply for cycle costs. TBhC project appraisals should assume that cycle costs are correctly perceived and taken into account in the mode changer net benefit value and therefore adopt a resource cost correction of zero for cycle costs.

4.3.7 Walking costs

In theory, these would be treated the same as cycle costs. In practice, they are ignored because they are likely to be negligible.

4.3.8 Public transport fares

A resource cost correction is also required for public transport fares. This is because fares are, in the first instance, a benefit gained by public transport users before they become a financial transfer (from mode changer to public transport operator). They are not an actual resource cost. If the public transport operator does incur additional operating costs, these are accounted for directly in the cost side of the economic analysis. The person changing to public transport perceives fares as a cost but they are not a resource cost, so it is necessary to make a resource cost correction (as a benefit) equal to the (tax inclusive) amount of fare. Tax inclusive fare is used because this is the cost that the mode changer perceives.

Analysts should use average fares for the city where the TBhC project is to be implemented. The average fare per passenger is included as a resource cost correction benefit for each trip diverted to public transport as a result of the TBhC project. An average child concession fare should be used for appraisal of school travel plans.

A fare resource cost correction is required for all trips that divert to public transport, including former car passenger trips as well as car driver trips.

4.4 Externality benefits

In addition to the internal perceived and unperceived benefits and disbenefits to travel behaviour changers, TBhC initiatives also result in externality effects on other transport system users and on society. These are discussed in the following paragraphs.

4.4.1 Decongestion

Decongestion refers to the reduced congestion costs (time and vehicle operating cost) experienced by remaining road users as a result of some car drivers changing to public transport or active transport modes - it does not include the saving to the mode changers themselves as this is part of their internalised benefit. Travel time savings provide most of the decongestion benefits, with vehicle operating cost savings typically contributing only about 5 – 10 per cent of the total decongestion benefits.

For most TBhC projects, it will be appropriate to make a simple estimate by multiplying the reduction in vehicle kilometres travelled with a unit value for congestion relief benefits in terms of cents per vehicle kilometre of reduced car travel under relevant traffic conditions. Unit values per vehicle kilometre of avoided car travel under various conditions are provided in the parameter unit values guidance (M1 / PV1).

4.4.2 Induced traffic effect

The reduction in congestion resulting from TBhC projects is likely to make car travel more appealing for other potential road users, leading to increases in car use by other individuals and thereby partially reducing the first round decongestion benefit. The induced traffic effect should be valued as a disbenefit equivalent to 50 per cent of the decongestion benefit. In other words, half of the potential 'first round' decongestion benefits are offset by induced traffic disbenefits. This estimate is based on research by Booz Allen, which noted that induced traffic disbenefits as high as 70 per cent of decongestion benefits were estimated for heavily congested parts of London and which recommended a disbenefit of 50 per cent for peak periods in Auckland.

4.4.3 Road system benefits

Road system benefits include the benefit of reduced road maintenance and deferral of road capacity increases. It would be valid to include road maintenance savings but these are negligible for the numbers of car trips and/or car vehicle kilometres that are likely to be removed by TBhC projects. Benefits from deferral of road capacity increases are not included because they are also expected to be negligible. Furthermore, it would not be correct to include both the value of deferring improvements and the full decongestion benefit discussed above. If the capacity improvements were undertaken rather than deferred, the congestion levels would be less and the decongestion benefit theoretically somewhat lower.

4.4.4 Accident cost savings – car

A shift of some car drivers to public transport or cycling and walking can result in a decline in the number of accidents due to fewer car-kilometres of travel. This may be offset by the change in the number and severity of accidents due to changes in road traffic conditions such as higher speeds⁸.

Accident costs can be considered in three parts: internal costs (those affecting the travel behaviour changer) that are perceived and hence included in the mode changer net benefit value; internal costs that are not perceived and hence require resource cost correction; and external costs borne by others.

⁸ In typical urban conditions, at the margin any reduction in total accident numbers due to reduced traffic volumes is likely to be offset by increased accident costs due to higher speeds. However, the effect of speeds on urban accident costs appears not to be well researched. If the two effects are assumed to be equal/opposite, there would be no net effect on car accident costs. However, if such an assumption was adopted it should apply to all urban transport economic appraisals. Hence, this issue is noted for future consideration but the conventional assumption of accident cost savings due to avoided VKT is adopted in these Guidelines.

There is little information available on the extent to which people perceive accident risks and costs and take this into account in their travel choices. If it is considered that people take full account of the accident risk and costs to themselves, then this is already included in the mode changer net benefit value and only the externality costs need to be added. However, if people under perceive their accident costs, a resource cost correction is required. Intuitively, it is likely that people do not perceive much accident cost and therefore most, if not all, of their internal accident cost will require a resource cost correction. If this is the case, the resource cost correction plus the externality costs will equal the total resource cost of accidents.

For TBhC projects it will be appropriate to make a simple estimate by multiplying the reduction in vehicle kilometres travelled with a unit value for accident saving benefits per vehicle-kilometre of avoided car travel in relevant road traffic conditions.

4.4.5 Accident costs – cycle/walk

The same considerations apply in relation to cycle and walking accident costs as for car accident costs. Two additional considerations with cycle and walk accident costs are that people who change from car to walking and, in particular, cycling probably have some perception of the associated accident risk, so possibly some of this (disbenefit) is included in the mode changer net benefit values, and that an increase in the number of pedestrians and cyclists might actually lead to a fall in the average per kilometre accident cost per pedestrian or cyclist (referred to as the 'safety in numbers effect').

If internal (personal) accident costs are perceived and already included in the mode changer net benefit values, the required resource cost correction is zero and only the external proportion of the accident costs needs to be counted as a disbenefit. However, when cyclists and pedestrians are involved in accidents, external costs are likely to be much smaller than in motor vehicle accidents. For TBhC projects, even these costs will be offset to some extent by the 'safety in numbers effect' - so, overall, any changes in cycling and walking accident externality costs are likely to be negligible and can be assumed to be zero in TBhC assessments.

4.4.6 Accident costs – public transport

Accidents still occur with public transport, as indicated by claims made against public transport agencies by passengers and damage caused to public transport and other vehicles. In most cases, TBhC projects will not change the distance actually travelled by public transport vehicles and hence public transport vehicle accident costs attributable to the project can be assumed to be zero⁹. For TBhC packages that include increases in public transport services, and public transport project appraisals in general, accident disbenefits should be estimated using the increase in public transport vehicle kilometres and relevant resource cost unit values in the parameter unit values guidance (M1 / PV1).

4.4.7 Environmental externality reductions

Environmental externalities include local air pollution, noise and water pollution, and greenhouse gas emissions. Less car use reduces environmental costs, according to the reduction in vehicle-kilometres of travel and changes in traffic congestion. Resource cost unit values for the environmental benefits from reduced car use are presented in the parameter unit values guidance (PV5). The resource value of various environmental impacts is expressed in relation to the quantity of vehicle use (that is, car-kilometres of travel). The quantity of saved car-kilometres needs to be estimated to determine the monetary value of the benefit. As the resource value of environmental costs is not generally perceived by motorists, the benefit will be equal to the total reduction in car-kilometres of travel multiplied by the appropriate (marginal) unit resource value of environmental benefits.

Public transport vehicles also cause externalities such as noise and air pollution that impose costs on the community. As discussed above under public transport accident costs, in most cases TBhC projects will not change the distance actually travelled by public transport vehicles and hence environmental externality costs attributable to the TBhC project can be assumed to be zero.

4.4.8 Health (fitness) benefits of cycling/walking

Parameter unit values for health benefits of cycling and walking are provided in Part M4 Active Travel. For TBhC project appraisals, the health benefits of cycling and walking are considered in three components in the same way as accident savings or costs. However, unlike accident savings it seems implausible that at least some of these benefits are not perceived by mode changers and hence not included in the mode changer net benefit values. One of the main selling points of TBhC projects, that results in people taking up cycling or walking, is the promotion of the health benefits.

As an approximation, it is assumed that half of the total health benefit is perceived by the mode changer and hence already included in the mode changer net benefit values.

⁹ Some public transport accidents (such as slips and trips at stations and when boarding and alighting) are likely to change in proportion to the numbers of trips; however, these have been assumed to be relatively minor. This could be an area for refinement.

Consequently, only the remaining half of the benefits is explicitly included in the appraisal as a combined value covering internal unperceived benefits (requiring a resource cost correction) and/or externality benefits to society (such as avoided hospital and other health care costs). This benefit is estimated by multiplying the increase in cycling and walking distance of people who divert to active transport modes due to the TBhC initiative by 0.5 times the respective unit values for health benefits of cycling and walking from the parameter unit values guidance (M4 / PV4).

4.4.9 Other - not quantified

A number of other potential benefits are identified in some appraisals of TBhC projects but have not been quantified to date. These include:

- Reduced community severance
- More sustainable land use/urban form
- Community cohesion
- Improved security/safety to the community
- Less dependence on fossil fuels
- Viability of local shops and businesses
- Synergy with other marketing initiatives

These impacts are generally harder to quantify and include in appraisals, but some of them may be as worthwhile as some of the other quantifiable impacts. Some of these benefit types could also apply to other types of transport initiatives and some of them possibly can be achieved more effectively by more targeted non-transport policies.

4.5 Summary of resource cost corrections and externality benefits

Suggested default values for the resource cost correction and externality benefit unit values discussed in the above sections are shown in the table below.

Table 8 Summary of default resource cost corrections and other benefit unit values (cents/km and cents/trip)

	Peak		Off peak	
	Large city ¹	Other city ²	Large city	Other city
Car driver per km				
VOC resource cost correction	0.0	0.0	0.0	0.0
Congesting externality x 0.53	42.5	11.5	11.5	0.0

Accident cost externalities	8.7	8.7	8.7	8.7
Environmental externalities	6.2	6.2	6.2	6.2
<i>Total per km</i>	<i>57.4</i>	<i>26.4</i>	<i>26.4</i>	<i>14.9</i>
per trip				
Parking resource cost correction				
- trips to/from CBD	200.0	100.0	50.0	25.0
- trips to/from other destinations	50.0	25.0	0.0	0.0
Car passenger⁴ per km				
VOC resource cost correction	0.0	0.0	0.0	0.0
Congesting externality x 0.5 ³	21.3	5.8	5.8	0.0
Accident cost externalities	4.4	4.4	4.4	4.4
Environmental externalities	3.1	3.1	3.1	3.1
<i>Total per km</i>	<i>28.7</i>	<i>13.2</i>	<i>13.2</i>	<i>7.5</i>
per trip				
Parking resource cost correction	0.0	0.0	0.0	0.0
Public transport passenger per km				
Accident cost externalities	0.0	0.0	0.0	0.0
Environmental externalities	0.0	0.0	0.0	0.0
<i>Total per km</i>	<i>0.0</i>	<i>0.0</i>	<i>0.0</i>	<i>0.0</i>
per trip				
Fare resource cost correction	-300.0	-225.0	-300.0	-225.0
Cycling per km				
Accident externality	0.0	0.0	0.0	0.0
Health effects	-73.0	-73.0	-73.0	-73.0
<i>Total per km</i>	<i>-73.0</i>	<i>-73.0</i>	<i>-73.0</i>	<i>-73.0</i>
Walking per km				

Accident externality	0.0	0.0	0.0	0.0
Health effects	-145.0	-145.0	-145.0	-145.0
<i>Total per km</i>	-145.0	-145.0	-145.0	-145.0

These values are costs (resource cost corrections and externalities) per kilometre or per trip. They become benefits if a trip is avoided, or costs if a trip is added. A negative value indicates that the effect is a benefit of a new trip on that mode; for example, health effects are benefits of cycling and walking trips.

Notes:

1 Large city = population \geq 1 million

2 Other city = population < 1 million

3 Net congestion externality is 0.5 x congestion externality to account for induced traffic effect, which acts in opposite direction

4 Car passenger per km values are 50% of car driver values (rather than zero) to account for a proportion of trips being made specifically for the passenger

5. Economic analysis procedure

5.1 Introduction

TBhC projects tend to result in small impacts to a large number of people. They are much more difficult to evaluate than conventional projects because the impact tends to be different for each participant, whereas - for example - with simple road projects most users tend to be attributed the same benefit. This leads to a conflict between procedures that accurately reflect all of the different individual responses to TBhC projects (but which may cost more to actually apply than the cost of the project being evaluated) and procedures that are cost effective to use but that may involve significant approximations and averaging of the effects on different participants.

The analysis procedures recommended in this guidance seek to strike an appropriate balance between these two criteria for most TBhC projects. More detailed, disaggregated analysis, possibly including the use of strategic transport models, may be considered for large scale TBhC projects.

5.2 Stages of analysis

Economic analysis of TBhC initiatives involves the following steps:

1. Define the type and scope of the TBhC initiative or package that is to be analysed (such as workplace travel plan, school travel plan, household and community based initiatives)
2. Separate out any 'hard' measures (such as cycling/walking infrastructure or public transport improvements) for separate analysis using relevant guidelines (see Section 1.3)
3. Identify the target population (such as all employees at a workplace/total population of an area to be covered by a TravelSmart household individualised marketing program)
4. Determine the costs of the proposal, including costs of any intended follow-up refresher program or ongoing support
5. Determine the expected level of diversion (the changes in mode shares)
6. Determine the number of diverted trips per day of each trip type – multiply target population (3) by diversion rate percentages (5) and average daily trips per person
7. Determine average trip lengths and any other trip changes by different modes
8. Obtain unit costs for each trip type. Use TBhC-specific unit values provided in this Part (or other standard values, provided that all perceived costs are excluded)
9. Determine average costs per trip for each trip type - combine average trip lengths (7) with unit costs (8) for each trip type
10. Determine total costs of each trip type – multiply number of diverted trips (6) by costs per trip (9) for each trip type, separately for the former and new modes
11. Determine the total perceived net benefits of mode changers
12. Determine total benefits per day – sum of trip costs avoided (10) less trip costs of new trips (10) plus mode changer perceived net benefits (11)

13. Calculate the annual TBhC benefits – multiply benefits per day (12) by an appropriate annualisation factor
14. Discount the costs and benefits over the period of analysis (a default analysis period of three years from completion of the initiative is suggested, unless it includes follow-up or ongoing expenditure)
15. Calculate benefit cost ratio and net present value
16. Conduct sensitivity tests if required

More details and guidance on the above steps is provided in the following sections. A worked example is provided in Appendix A.

5.3 Project definition

Poor project specification and ‘scope creep’ leading to cost overruns are common problems with public transport projects and other infrastructure projects. TBhC projects are less susceptible to cost overruns because they are relatively predictable. Also, they are scalable and less visible. This means that if unforeseen costs arise during implementation, the coverage of a program may be reduced to keep it within the approved budget without this impacting in a highly visible way on the overall project.

Nevertheless, any reductions in scope will change either the target population of a TBhC initiative or the effectiveness of the initiative, both of which will reduce the overall benefits - so it is important for projects to be well researched, scoped and costed.

Project appraisal normally requires the definition of a Base Case and a Project Case, with project costs and benefits being determined as the differences between these cases. This is simplified for TBhC projects as discussed in the following sections.

5.4 Project costs

Base Case costs will normally include capital and recurrent expenditures needed over the appraisal period in order to continue to provide either the existing services or a variant of these services that offers a similar service level and quality. The Project Case includes corresponding costs for the project scenario, with the project cost being calculated as the difference between the two cost streams. However, TBhC initiatives do not usually result in any savings of potential Base Case costs - so, for TBhC project appraisals, the TBhC initiative can be assumed to be independent of and additional to all other expenditure. The only difference between Base Case and Project Case costs is the cost of the TBhC initiative itself (including any budgeted future year costs such as future refresher/reinforcement exercises or costs of ongoing program support staff) and therefore the estimated cost of the TBhC initiative is used directly as the project cost in the appraisal.

TBhC project costs are likely to include:

- Government department staff time for development and facilitation of programs

- Production of information and education material
- Personnel time and expenses (in-house or consultants) to deliver the program
- Small-scale infrastructure or transport service changes

In some places, TBhC initiatives are jointly funded and promoted by state and local governments. Project costs should include the costs incurred by both levels of government.

With workplace travel plans, some of the implementation costs are likely to be incurred by businesses. These do not need to be included in project costs in the economic appraisal as businesses are assumed to gain offsetting benefits that are also not included (and would be difficult for TBhC project proponents to estimate). It is assumed that the benefits that businesses obtain must at least equal, in some form or other, the investment that they make or they would not participate in the travel plan.

All costs should be included for school travel plans, regardless of whether schools are public or private, because all funding for these programs is either from government or fees paid by students, whose benefits are included in the CBA.

Public transport operating costs would need to be included as a cost if the increase in demand resulting from a TBhC project was sufficiently great to require the operation of additional services. It is assumed that for off-peak travel there is generally spare capacity to handle the likely mode changes to public transport resulting from TBhC projects and that there will be no additional public transport operating costs associated at off peak times. Some larger scale household-based projects may result in greater increases in public transport demand but these tend mostly to influence off-peak trips when spare capacity is greatest.

For peak period trips, it is considered that increases in patronage may lead to marginal increases in operating costs (given that existing services are at capacity in peak periods). Therefore, in principle, additional public transport operating costs should be included for new peak period public transport trips resulting from TBhC projects. However, it is considered that if the demand for public transport increases sufficiently to require additional public transport services, these would probably be subject to a separate economic assessment in accordance with the public transport component of the ATAP Guidelines. In this case, the additional public transport operating costs would be included as a cost in that separate analysis and should be ignored in the TBhC appraisal. If the increase in peak period public transport demand from the TBhC project is only small, the potential additional costs of any additional services could also be ignored¹⁰.

Existing public transport users could experience an increase in crowding costs if a TBhC initiative caused diversion to public transport in peak periods and public transport capacity was not increased. This would be a disbenefit for the TBhC initiative and, if significant, should be included as an additional per-kilometre cost for public transport in the unit values in Table 7.

¹⁰ Care needs to be taken with TBhC projects that involve both 'hard' and 'soft' initiatives. It is possible for mode changer net benefits of the 'soft' TBhC initiatives to be double counted in the new user benefits of the 'hard' initiative (such as public transport infrastructure or service improvements).

In general, the costs of post-implementation monitoring should be excluded from the economic appraisal even though this might be a significant cost for TBhC projects and is likely to be included as part of funding requests. This is because monitoring is not specifically included in the costs of other types of projects and should not be an additional hurdle for TBhC projects. Rather, the additional monitoring costs should possibly be regarded the same as research and development or demonstration project expenditure.

5.5 Calculation of project benefits

Benefits are the total resource costs of the avoided private car trips minus the resource costs of the replacement trips on public transport and active transport. As explained in the previous sections, the resource cost changes are calculated by combining mode changer perceived net benefits, resource cost corrections for unperceived costs (and savings) and externalities.

Benefit values are calculated as a total annual benefit of the proposed TBhC project. The procedure for calculating this value is as follows.

5.5.1 Select diversion rates

Select the appropriate set of diversion rates for the type of TBhC project from the range of default diversion rates in Section 3 (or local evidence if this is more relevant and robust). These are a measure of the expected percentage point change in mode share from car as driver to other main modes that have been derived from past experience on similar projects. The diversion rates represent the differences between base case and project case travel behaviour resulting from the TBhC initiative.

5.5.2 Determine number of diverted trips

Determine the number of diverted trips per day for each trip type (see Section 3). Multiply the total target population for the TBhC initiative by the diversion rate for each mode and the estimated daily trips per person. Separate diverted trip totals need to be calculated for each 'from' mode - 'to' mode pair. For example:

- Car driver to public transport
- Car driver to cycling
- Car driver to walking
- Car passenger to public transport
- Car passenger to cycling
- Car passenger to walking.

5.5.3 Trip lengths

Benefits of TBhC projects also depend on the lengths of the car trips that are avoided and the lengths of the replacement trips on other modes. For most TBhC initiatives, the main effect is that trips are still made but they are made by a different mode following the TBhC intervention. The diversion rates in Section 3 are based on all avoided car as driver trips being replaced by trips on other modes (with trip lengths as in Table 9).

Table 9 provides default average trip lengths for different modes in different situations. These have been synthesised from Australia and New Zealand travel survey data for various size cities.

Table 9 Default average trip lengths (km)

	Large cities (pop ≥ 1 million)			Other cities (pop ≥ 1 million)		
	Peak	Peak	Off peak	Peak	Peak	Off peak
	To/from CBD	Other destination	All destinations	To/from CBD	Other destination	All destinations
Commuting						
car driver	14.0	12.5	11.0	12.0	12.0	7.5
car passenger	13.0	11.5	10.0	11.0	11.0	7.5
public transport	18.0	17.0	15.0	13.0	13.0	9.0
cycle	7.0	7.0	5.0	5.0	5.0	4.5
walk	2.0	2.0	2.0	2.0	2.0	2.0
Other trips						
car driver	10.0	10.0	8.0	10.0	10.0	7.5
car passenger	9.0	9.0	7.5	9.0	9.0	7.5
public transport	12.0	12.0	11.0	10.0	10.0	8.5
cycle	5.0	5.0	4.5	5.0	5.0	4.5
walk	2.0	2.0	2.0	2.0	2.0	2.0
Primary school						
car driver						
car passenger		4.0	4.0		4.0	4.0
public transport		11.5	11.5		10.0	10.0

cycle		2.0	2.0		2.0	2.0
walk		1.0	1.0		1.0	1.0
Secondary school						
car driver		7.5	7.5		7.5	7.5
car passenger		7.5	7.5		7.5	7.5
public transport		11.5	11.5		11.5	11.5
cycle		3.0	3.0		3.0	3.0
walk		1.5	1.5		1.5	1.5
Tertiary institution						
car driver		12.5	12.5		10.0	10.0
car passenger		11.0	11.0		10.0	10.0
public transport		17.0	17.0		12.0	12.0
cycle		4.0	4.0		4.0	4.0
walk		1.5	1.5		1.5	1.5

The values in this table are appropriate averages that will be convenient to use for most TBhC project appraisals. Analysts may substitute relevant trip lengths from local surveys if they consider these to be more robust and applicable for their TBhC initiative.

It would not be correct to base the benefit of car trips avoided on the average trip lengths for car as driver from Table 9 and then the cost or benefit of the additional trips by environmentally friendly mode on the average lengths for these modes. This would imply that a 14 km car as driver trip could be replaced by, say, a 7 km cycle trip. Therefore, the costs for car as driver trips are based on the average trip lengths of the modes that people divert to rather than the average for all car as driver trips. This recognises that walk and cycle trips are more likely to replace shorter car trips and, conversely, that long car trips are more likely to divert to public transport. The benefit of avoided car as driver trips reflects a weighted average of the trip lengths of the 'to' modes.

Some TBhC initiatives have a particular emphasis on reducing the number of car trips and the overall distance travelled by combining or 'chaining' some activities that were previously undertaken by separate trips or by eliminating the need to travel altogether (such as teleworking and teleconferencing). For these projects, it would be appropriate to include an additional 'no trip' category to the diversion rates in Section 3 and use the car as driver trip lengths for this 'to' mode in the 'from' mode weighted average trip length calculation. However, for most types of TBhC initiatives this will not be necessary and the diversion rates to other modes in Section 3 can be used without further adjustment.

5.5.4 Unit costs

Obtain unit costs (resource cost corrections and externalities) for each of the parameters shown in Table 7 for trips by:

- Car driver
- Car passenger
- Public transport
- Cycling
- Walking.

Default unit costs can be obtained from Table 8. Note that some of these are a unit value per kilometre and some are a unit value per trip. Analysts may wish to substitute some values with locally specific estimates. These should be adjusted for the purposes of TBhC economic analysis as specified in Section 4.

5.5.5 Cost per trip

Combine the per kilometre and per trip costs (and benefits) from Table 8 and average trip lengths from Table 9 to calculate the cost per trip (unperceived costs and externalities) for each mode in each of the following situations (as relevant):

- Peak and off-peak periods
- Large cities and other cities (population less than one million)
- To CBD or other destinations
- For commuting, other, primary school, secondary school and tertiary education trip purposes.

The results of these calculations are the costs associated with an average trip by each mode in different time periods, locations and trip purposes, and they apply equally in the Base Case and the Project Case. Note that, as shown in Table 8, the per-kilometre and per trip costs include resource cost corrections and externalities (but not user-perceived costs).

Next calculate a weighted average cost per trip for each mode incorporating appropriate proportions of the unit costs for the different situations above. For example, the weighted average cost for car driver trips should reflect the proportions of travel behaviour change that occur in the peak and off-peak periods, which each have different unit costs. Similarly, the costs of public transport trips vary between the peak and off-peak.

Default assumptions for the proportions of travel behaviour change occurring in peak periods are:

- Household/community initiatives - 15% peak
- Workplace travel plans - 100% peak
- School travel plans - 55% peak (assume all 'to school' trips are in peak, 'from school' trips are 10% in peak, 90% in off-peak)

The default assumption of 15 per cent of changed trips in household/community TBhC projects being in the peak period is based on overseas experience that most trip change is off-peak. Estimates from studies indicate a range of 0 – 20 per cent being peak trips. The assumption of 15 per cent peak trips also captures the fact that there are only 230 workdays per person.

5.5.6 Total unperceived costs and benefits for each trip type

The costs per trip (resource cost corrections and externalities) from Section 5.5.5 are multiplied by the relevant number of diverted trips per day calculated in Section 5.5.2 to obtain total costs per day for each trip type. The total resource cost corrections and externalities of base case trips that are avoided in the project case (such as car driver trips) are a benefit. The total resource cost corrections and externalities of the diverted trips on the new modes in the project case are a cost (disbenefit), except for trips that have a negative cost, such as cycle and walking trips due to under-perceived health benefits, in which case the trips add to benefits.

5.5.7 Mode changer perceived net benefits

The mode changer perceived net benefit values for people changing from car driver/passenger to public transport and car driver/passenger to cycle/walk are then calculated based on the values in Table 7. The benefit per mode changer is determined by multiplying values from this table by the percentage point change from car to the relevant mode. These benefit values are then multiplied by the relevant number of trips to obtain the total mode changer perceived net benefits for each type of mode change.

5.5.8 Calculate total benefits per day

The total benefits per day are calculated as the total of avoided 'from mode' trip costs minus the total of 'to mode' trip costs plus the total mode changer perceived net benefits.

The diversion rates for car as driver are always a negative value (percentage point reduction) so when these are combined with the trip costs (which are always positive) the result is a negative value (saving) representing the benefit of avoided trips. Diversion rates for public transport, cycle, and walk are positive values so when these are combined with the cost of a trip the result is positive (a cost) if the additional trips involve net costs, or negative (a benefit) if the trips involve net benefits (such as due to the health benefits of cycling and walking).

5.5.9 Calculate total benefits per year

Multiply the total benefits per day by an appropriate annualisation factor to obtain the total benefits per year.

The following default days per year assumptions can be used unless different local evidence is available:

- Household/community initiatives - 365 days

- Workplace travel plans - 230 days
- School travel plans - 190 days.

5.6 Appraisal period

TBhC appraisals reviewed in the preparation of these Guidelines used appraisal periods between one year and 30 years, with most using appraisal periods of five or 10 years. The appraisal period did not appear to be related to the total project cost but rather to consideration of the likely longevity of the TBhC impacts. It does seem appropriate that TBhC projects should generally use a shorter appraisal period than the standard periods of 30 or 50 years when they are mostly 'soft' measures that do not necessarily generate a permanent change.

A default appraisal period of three years from completion of the initial TBhC implementation (that is, including a three-year benefit stream) is considered appropriate for most TBhC projects. This reflects the experience that behaviour change benefits tend to fade after about three years if there is no further investment in reinforcement or ongoing support after the initial implementation.

A longer appraisal period, up to 10 years, may be considered if a proposed TBhC initiative includes an appropriate level of expenditure on reinforcement and ongoing support programs to maintain the benefits in future years.

If a TBhC initiative includes items of infrastructure that are expected to have a service life longer than 10 years, these should be appraised separately in accordance with relevant guidelines.

5.7 Value for money measure

A benefit cost ratio and net present value are appropriate value for money measures for TBhC initiatives.

Project the first year benefits of the TBhC initiative as a uniform annual benefit over the appraisal period and discount the benefit stream to a present value using the standard discount rate. Calculate a present value of costs by discounting any future year implementation, reinforcement and ongoing maintenance costs and summing these together with the year 0 implementation costs.

The benefit cost ratio comprises:

- Numerator – discounted net perceived and indirect benefits and disbenefits to all travel behaviour changers, other transport system users affected by the project, and all other external effects
- Denominator – discounted costs of the TBhC project to the public sector (Commonwealth, State and other government entities, including local councils).

Calculate a net present value as the discounted benefits less the discounted costs.

6. Monitoring and Evaluation

6.1 Introduction

This section provides guidance on monitoring methodologies that will assist in the collection of useful data for ex-post evaluation of TBhC initiatives with least effort and cost. Monitoring for workplace and school travel plans is more straightforward than that for community- or household-based initiatives – there is a clearly identifiable target population and generally the focus is on specific trip types and purposes (commuting to and from work or the journey to and from school). In the case of community- and household-based initiatives, a wide variety of trip types and purposes by all members of a household are canvassed over varying times of the day and week. This creates a significant challenge to measure such potentially complex changes to travel behaviour with precision.

This section focuses on the methodology for the monitoring program, as well as identifying the monitoring focus for data for collection. No specific advice is given on questionnaire design or analysis of the data collected.

Given that there are various methodologies available to monitor TBhC initiatives (each with their own strengths, weaknesses, and complexities), only basic information can be provided here. Project proponents are advised to seek the advice of credible market research and travel measurement firms, particularly those with experience in monitoring these types of initiatives. Questionnaires and survey design must be tailored to the objectives to be met and the information required.

It is important that the monitoring task is designed as an integral part of the overall TBhC program (it often accounts for a substantial part of the overall program costs). The 'before' monitoring task is at least as important as the 'after' monitoring task in contributing to any conclusions on the effectiveness of the initiative. Thus the overall monitoring program needs to be designed at an early stage, along with the design of the initiative, and not considered only as an after-thought following implementation of the initiative itself.

6.2 Monitoring focus and outcomes

The primary outcome to be measured in monitoring TBhC initiatives is generally the overall change in VKT. Based on this indicator, it is possible to calculate benefits including decongestion, vehicle operating costs (including reductions in fuel use), environmental impacts (such as local air quality, CO₂ emissions and water quality) and accident reduction impacts.

Other key outcomes to be measured are changes in person kilometres travelled by mode. This is needed to identify the extent to which private motor vehicle trips have been replaced by public transport or cycling and walking trips as distinct from the extent to which trips have been eliminated altogether by 'trip chaining', using telecommunications or by alternative activities. This greater level of disaggregation is needed to calculate changes in mode share and benefits such as the health benefits of active modes. If monitoring is performed at this level, the results can also be aggregated to obtain overall change in VKT.

The focus of monitoring efforts should be on collecting evidence of both the mode share (for all modes) and the change in VKT as a 'single occupancy vehicle' driver by all household members living in the target population area.

Note that this focus on VKT is particularly important for household-based initiatives, as in some cases programs aim to achieve 'smarter' car use wherein the mode may not change, but the VKT does.

Various methods are available to collect VKT or person-kilometres travelled data from participants in a particular TBhC initiative. In the case of school and workplace travel plans, where the trip under observation is well defined (usually home to work or school, sometimes combined with other destinations/stops), it is more reliable to obtain geocode-able addresses than to rely on respondent estimates of the distances involved. For community and household-based initiatives, where a wide range and number of possible trips are involved, other methods may be preferable.

In addition to the mode shift and reduction of car driver vehicle kilometres, it is suggested that data be collected regarding the change in physical activity levels of the target population as this has an effect on the overall health and well-being of the community. This will be achieved if all travel by any mode is monitored at the individual person kilometre level.

It is recognised that organisations and local authorities may have other objectives within their monitoring programs, such as changes in target population attitudes (as opposed to behaviour), evaluating awareness of the TBhC initiative or the level and quality of information received. These may be added into the questionnaire(s) as desired. For example, the aims of TBhC initiatives may include reductions in congestion or improvements in safety around schools. The objectives of the proponent and funding organisations will influence the prioritisation of TBhC initiatives and most likely the factors that are to be monitored to measure performance against those objectives.

6.3 Methodology

TBhC monitoring programs establish the 'before' travel patterns for all members of the respondent household or other target population and then evaluate the change in these patterns 'after' the implementation of the various components of the TBhC initiative.

6.3.1 Monitoring approaches

The most common approach to date is to survey randomly selected households in the target population area. Historically, this focused on the use of travel diaries. These can provide full details of trips undertaken by a household and, given sufficient sample size, changes in total travel (trips, person- and vehicle-kilometres travelled) may be estimated for all modes. Usually travel diaries cover between one and seven days, although with anything over one or two days there is likely to be a significant loss of response and accuracy. Issues to do with sample size, respondent drop-off and bias are discussed further below.

Given the need to monitor changes in VKT, odometer-based surveys are an alternative (or complement) to travel diaries. Such surveys could record odometer readings for household vehicles at long intervals (such as three, six or 12 months apart) and directly derive VKT and VKT changes by household. However, using this method on its own will not permit assessment of mode shifts, changes in vehicle occupancy or changes in trip chaining behaviour. Other problems include the car may be sold, the preferred car may change in a multi-car household and/or long trips distort results.

More recently in Australia, successful monitoring of TBhC initiatives has been achieved by fitting Global Positioning System (GPS) devices to people and vehicles to record person-kilometres travelled and vehicle-kilometres travelled respectively. These devices have considerably greater accuracy than travel diaries, which have been found to have significant discrepancies between actual travel and reported travel – as high as 20 per cent. Short trips, the ones most likely affected by TBhC programs, are the most common type of trip omitted in travel diaries. GPS devices can easily produce information for one week's travel for a household, including travel times, destinations and trip duration. The ability to collect data for a whole week substantially reduces the sample size requirements for a monitoring program and may reduce respondent fall-off rates.

In Western Australia, household programs have started to include monitoring as part of the TBhC intervention, with participating households asked a few questions about how they travel (mode and number of minutes) in the first and final coaching calls as another indicator of change. Although not statistically robust, such an approach does provide a cost effective early indicator of the effectiveness of the TBhC initiative.

6.3.2 Panel survey v independent samples

Regardless of what type of survey is adopted to monitor the project outcomes, there is the need to consider whether a 'panel survey' or 'independent samples' (also known as cross-sectional surveys) will be used. Panel surveys, wherein the same respondents are used for the before and after surveys, are considerably more statistically efficient than independent samples (where different groups are surveyed in either survey) and hence are generally preferred as lower sample sizes can be used for a given degree of confidence. However, panel surveys suffer from progressive drop-off of responses in successive surveys, which is especially important in cases of medium or longer term monitoring. This can only be partially overcome through a good survey approach and/or adopting unusually large sample sizes for the before survey (to allow for respondent loss in after surveys).

6.3.3 Survey timing

Travel patterns (especially for environmentally friendly modes) are substantially affected by seasonality: the before and after surveys should be undertaken 12 months apart (in the same month of the year), regardless of the monitoring approach. Hence, typically the initial after survey would be 12 months following the before survey, with program implementation between these two points. If this is not feasible, it is desirable that the after survey be at least nine months following project implementation to allow for new behaviour patterns to settle down and not record very short-term impacts. If this is the case, extra care will also need to be taken to account for seasonality factors that could be influencing monitoring results. It is probably beneficial to repeat after surveys in order to monitor the stability of changes. Any subsequent 'after' surveys should typically be at 12-month intervals.

It is known that there is considerable variability in travel across the days of the week and by travel mode. Given this, it is essential that surveys are spread across days of the week and, where the same households are being surveyed 'before' and 'after', the survey days of the week should be the same in both.

On any given day, travel is affected significantly by weather, special events or other factors. Some of these variation factors can be avoided (for example, avoid monitoring just before or after statutory holidays or local special events). For others, it is more difficult to do so and it may be necessary to rely on the control group being similarly affected (discussed below).

6.3.4 Monitoring program participants

The population of all households in the TBhC project area – those that participate in the program and those that do not (although it is useful to separate these in the analysis) – should be included in the monitoring program. This allows inclusion of 'diffusion' effects, where the project positively affects non-participants' behaviour, providing a much better basis (than just participating households) for assessing aggregate effects of the project.

It is preferable to involve the whole household, rather than just an individual from the household, in the monitoring program. TBhC projects generally provide information and incentives on a household basis. As a result, the effects are likely to diffuse through the household, meaning that travel behaviour changes could be under-estimated if only one individual from that household is monitored.

6.3.5 Control group

Regardless of which monitoring approach is taken, control groups are important for robust evaluation, particularly of household/community programs. Although some adjustments for 'external factors' may be possible in the absence of a control group (see below), these are most unlikely to be sufficient on their own.

The control group area should be as comparable as possible to the program area (but unaffected by the program) in terms of similar socio-demographics, car ownership and use levels, public transport levels of service and use, topographical features and distance from the central business district. Often, control groups are selected from suburbs adjacent to those where the program is being delivered. However, care is needed to ensure that these control group areas are not subject to the indirect influence of the program (for example, through local press publicity).

It is important that other local changes do not occur in either the project area or control area that may impact on travel behaviour of residents, such as increases in public transport services in anticipation of increased demand as a result of the TBhC initiative or other transport system changes (such as new roads, changes in public transport services or other TBhC initiatives introduced). Often it will not be possible or desirable to prevent or delay these. The important thing is to record when they occur and make appropriate efforts to distinguish the effects from these changes from those of the TBhC project.

6.3.6 Sample size

The required sample size to assess a defined degree of change, with a given level of statistical confidence, will depend upon a range of factors and it is best to obtain specialist advice for establishing the appropriate sample size for a particular project.

Sample sizes are essentially (almost) independent of the size of the population concerned (for large populations).

6.3.7 Systematic survey bias issues

For a random monitoring survey of all households, the typical before and after (successful) response rates are in the order of 50 per cent. Given this, the dangers of non-response (or self-selection) bias are considerable - that is, the change in the behaviour of the responding sample may differ substantially from that of the non-responding households in a way that is unknown. Hence, there is no reliable basis to extrapolate the sample results to the whole population's behaviour as, for example, less mobile households have a greater propensity to respond than more mobile households, but more mobile households may make bigger behavioural changes.

Some corrections can and should be made for this problem by comparing statistics (such as age, income, car ownership and so on) for the respondent sample with those for the area population as a whole, and differentially expanding from the sample to the total population. However, it should be recognised that these may not totally correct the entire problem.

6.4 Maximising survey response

The main problem relates to after surveys, as before survey data for households that do not complete the after survey cannot be used in panel surveys. It is therefore critical to minimise any drop-off from before to after responses. Suggestions for achieving this include:

- Reference may be made to standard market research texts on how to maximise survey response.
- Surveys need to be designed to be as simple as possible for respondents to complete.
- Personalised contact is likely to help (face-to-face contact is probably ideal).
- Incentives could be considered. While there is debate about the (cost) effectiveness of incentives in encouraging responses, it is reasonable to expect appropriate incentives (particularly for the after survey) would help.

6.5 External monitoring sources

A variety of 'external' monitoring sources might be used for before versus after evaluation to verify, supplement or potentially replace project-specific household surveys. These could use data that is collected in any event, usually for other purposes, or surveys undertaken for this particular purpose.

Examples are:

- Public transport patronage data (from electronic ticketing or other sources)
- Road traffic counts
- Cycle and pedestrian counts (not commonly undertaken).

Such data will establish changes in trips at a point or over a public transport route. They will not establish changes in trips by a given set of households.

If a program is undertaken on a metropolitan-wide scale, changes in trips by metropolitan households in total may be reasonably inferred. However, it will not generally be possible to identify to what extent the trip changes are the result of the program and to what extent they result from other factors. If a program is undertaken over a limited area (as is typically the case), then the impacts of the program on traffic counts and other sources will rapidly diminish further from the area. Even within the area, the impacts are likely to underestimate the changes in travel by area residents, because of the through traffic component. However, in particular circumstances, reasonable inference about the effects on travel by area residents might be made. In drawing any conclusions from external monitoring data, it will be necessary to compare any local changes in the area of the program with any changes in the wider area (as the 'control group').

For larger scale programs, such external surveys can provide useful evidence. However, this should normally be regarded as supplementary to, rather than in place of, direct household surveys.

For small scale programs, any changes in travel observed in external surveys are likely to be very small. Therefore, external monitoring sources will be of little practical use.

References

- Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A. and Goodwin, P. 2004, Smarter Choices – Changing the way we travel, prepared for the Department for Transport, United Kingdom. <https://www.gov.uk/government/publications/smarter-choices-main-report-about-changing-the-way-we-travel> - accessed 24 June 2014
- Department for Transport 2014, Transport Analysis Guidance (TAG) Unit M5.2, Modelling Smarter Choices, United Kingdom. <https://www.gov.uk/government/publications/webtag-tag-unit-m5-2-modelling-smarter-choices> - accessed 24 June 2014
- Maunsell Australia Pty Ltd 2006, TravelSmart III: Evaluation Procedure (draft), prepared for the Department of Infrastructure, Victoria.
- Maunsell Australia, Pinnacle Research and Booz Allen Hamilton 2004a, Travel Behaviour Change Evaluation Procedures and Guidelines: Literature Review – Evaluation Monitoring and Guidance, prepared for Transfund New Zealand/EECA, New Zealand.
- Maunsell Australia, Pinnacle Research and Booz Allen Hamilton 2004b, Travel Behaviour Change Evaluation Procedures: Technical Report, prepared for Transfund New Zealand /EECA, New Zealand.
- Maunsell Australia, Pinnacle Research and Booz Allen Hamilton 2004c, Travel Behaviour Change Guidance Handbook, prepared for Land Transport New Zealand/EECA, New Zealand.
- Perkins, A. 2001, The Greenhouse Abatement Potential of Travel Behaviour Change Initiatives for Transport SA for the NGS Measure 5.3 Taskforce.
- Roth, M., Ker, I., James, B., Brog, W., Ashton-Graham, C., Ryle, J., Goulias, K. and Richardson, E. 2003, A Dialogue on Individualised Marketing: Addressing misperceptions, Australasian Transport Research Forum, 2003.
- Stopher, P., Moutou, C. and Liu, W. 2013, Sustainability of Voluntary Travel Behaviour Change Initiatives – a 5-Year Study, Australasian Transport Research Forum 2013.
- Stopher, P., Zhang, Y., Zhang, J. and Halling, B. 2009, Results of an Evaluation of TravelSmart in South Australia, Australasian Transport Research Forum, 2009.
- Stopher, P. and Bullock, P. 2003, Travel Behaviour Modification – A Critical Appraisal, Australasian Transport Research Forum, 2003.
- Tisato, P. and Robinson, T. 1999, A Cost Benefit Analysis of Travel Blending, Australasian Transport Research Forum, 1999.
- van Geldermalsen, T., O'Fallon, C., Wallis, I. and Melsom, I. 2006, Travel Behaviour Change Evaluation Procedures and Guidelines, Australasian Transport Research Forum, 2006.
- Winn, R. 2004, Measuring the Economic Benefits of Travel Behaviour Change Programs, Australasian Transport Research Forum, 2004.

Appendix A Worked Example - Economic appraisal of household/community program

A.1 Program details

A household/community travel behaviour change program is being considered for a suburb in a large city (> 1 million population) to encourage residents to use modes other than their private cars for some of their trips. The total population of the target suburb is 10,000 people. The objectives of the proposed initiative are to reduce pressure on road capacity and the environment by reducing car use and to encourage people to choose active travel modes such as cycling and walking for some trips, complementing other programs promoting the health benefits of increased physical activity.

Location: Large city > 1 million population

Total population of target area: 10,000

TBhC program costs:

- Year 1: Program implementation - \$2.5 million
- Years 2 -10: Ongoing support - \$0.2 million per annum

A.2 Appraisal

Select diversion rate profile

	Car as driver	Car as passenger	PT	Cycling	Walking
Standard	-3.1%	-0.5%	1.4%	0.9%	1.3%

Proportion of diverted trips in off-peak: 85%

Proportion of diverted trips to CBD: 10%

Collate trip lengths

Collate relevant trip lengths (such as default values from Table 8) and calculate weighted averages.

	Peak 15%	Off peak 85%	Weighted average (km)
Car driver	10.0	8.0	8.3
Car passenger	9.0	7.5	7.7
public transport	12.0	11.0	11.2
cycle	5.0	4.5	4.6
walk	2.0	2.0	2.0

Household programs target all trips (not just trips to/from CBD)

Collate parameter unit values

Obtain unit values for unperceived costs (resource cost corrections) and externalities from Table 7 and calculate weighted averages incorporating peak/off peak and CBD/other destination.

		Peak 15%	Off peak 85%	Weighted average (cents)	Weighted average (\$)
Car driver					
per km					
VOC RCC		0	0		
Net congestion ext		42.5	11.5		
Accident ext		8.7	8.7		
Environmental ext		6.2	6.2		
Total per km		57.4	26.4	31.1	0.311
per trip					
Parking RCC (trips to CBD)	10%	200	100		
Parking RCC (trips other)	90%	50	25		
Total per trip				37.38	0.374
Car passenger					
per km					
VOC RCC		0	0		
Net congestion ext		21.25	5.75		
Accident ext		4.35	4.35		
Environmental ext		3.1	3.1		
Total per km		28.7	13.2	15.5	0.155
per trip					
Parking RCC		0	0		
Total per trip		0	0	0	0
Public transport passenger					
per km					
Accident costs		0	0		
Environmental costs		0	0		
Total per km		0	0	0	0
per trip					
Fare resource cost correction		-300	-300		
Total per trip		-300	-300	-300	-3.00
Cycling					
per km					
Accident costs		0	0		
Health effect		-73	-73		
Total per km		-73	-73	-73	-0.73
Walking					
per km					
Accident costs		0	0		
Health effect		-145	-145		
Total per km		-145	-145	-145	-1.45

Positive values indicate an unperceived resource cost; negative values indicate an unperceived resource cost saving (benefit). Per kilometre unit values for car passenger are set at 50% of car driver values based on a proportion of trips being undertaken specifically for the passenger.

Calculate total unperceived costs and benefits for each trip type

The following table combines the steps described in Sections 5.5.2, 5.5.5 and 5.5.6 and calculates the total resource cost correction and externality benefits per day for each former and new mode.

Benefit from avoided car driver trips which change to:	Diversion rate	Diverted trips per day $B = (A \times \text{Pop} \times \text{Trips})$	Trip length C	per km costs D	per trip costs E	total costs (\$) $F = (C \times D + E)$	Benefits/day $G = (B \times F)$
public transport trip	-1.21%	362	11.2	0.311	0.374	3.84	1387
cycle trip	-0.78%	233	4.6	0.311	0.374	1.79	417
walking trip	-1.12%	336	2.0	0.311	0.374	0.99	334
Sub Total	-3.10%						2139
Benefit from avoided car passenger trips which change to:	Diversion rate	Diverted trips per day	Trip length	per km costs	per trip costs	total costs (\$)	Benefits/day
public transport trip	-0.19%	58	11.2	0.155	0	1.73	101
cycle trip	-0.13%	38	4.6	0.155	0	0.71	27
walking trip	-0.18%	54	2.0	0.155	0	0.31	17
Sub Total	-0.50%						144
Cost of trips undertaken on new mode of:	Diversion rate	Diverted trips per day	Trip length	per km costs	per trip costs	total costs (\$)	Costs/day
public transport	1.40%	420	11.2	0.000	-3.00	-3.00	-1260
cycle	0.90%	270	4.6	-0.730	0	-3.34	-902
walk	1.30%	390	2.0	-1.450	0	-2.90	-1131
Sub Total	3.60%						-3293

Calculate mode changer perceived net benefits

The following table shows the calculation of the mode changer perceived net benefits as described in Section 5.5.7.

Benefits to mode changers for:	Diversion rate	Diverted trips per day $B = (A \times \text{Pop} \times \text{Trips})$	Diversion	Rate per 1% from Table 6 D	Benefit per person per trip $E = (100 \times C \times D)$	Benefits/day $F = (B \times E)$
car driver/passenger to public transport	1.4%	420	1.4%	\$0.35	0.49	206
car driver/passenger to cycle	0.9%	270	0.9%	\$0.25	0.23	61
car driver/passenger to walk	1.3%	390	1.3%	\$0.25	0.33	127
Sub Total	3.6%					393

Calculate total benefits per day

Add:

RCC and externality costs associated with avoided car driver trips — \$2,139

RCC and externality costs associated with avoided car passenger trips — \$144

Subtotal — \$2,283

Subtract:

RCC and externality costs associated with trips on the new modes — \$3,293

Subtotal (note subtracting a negative cost adds to benefits) — \$5,576

Add:

Mode changer perceived net benefits — \$393

Total benefit per day — \$5,969

Calculate total benefits per year

Multiply the total benefits per day by an appropriate annualisation factor (Section 5.5.9).

Total benefits per year = \$5,969 x 365 = \$2.179 million

Calculate NPV and BCR

Discount rate - 7%		Cost (\$'000)		Benefit (\$'000)	
Year	1		PV		PV
1	0.935	2500	2336	0	0
2	0.873	200	175	2179	1903
3	0.816	200	163	2179	1778
4	0.763	200	153	2179	1662
5	0.713	200	143	2179	1553
6	0.666	200	133	2179	1452
7	0.623	200	125	2179	1357
8	0.582	200	116	2179	1268
9	0.544	200	109	2179	1185
10	0.508	200	102	2179	1108
Total			3554		13266

Net present value = 13.266M – 3.554M = \$9.71 million

Benefit/cost ratio = 13.266/3.554 = 3.7

