Department of Infrastructure

Northern Central City Corridor Study Environmental Component Scenario Appraisal Report

SEPTEMBER 2002

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Northern Central City Corridor Study

Environmental Component Scenario Appraisal Report

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	23/8/02	Draft	Katie Barlow Project Manager	Original Signed
B	13/9/02	Draft Final	Katie Barlow Project Manager	

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1 Introduction

1 Introduction

1.1 Study Objective

The aim of the study is to significantly improve public transport services in order to increase public transport usage and to reduce congestion levels within the Northern Central City Corridor study area. The overall study objective is to produce:

> 'An integrated transport and land use strategy to improve the amenity and sustainability of the inner north whilst meeting the travel needs of people and goods (DoI 2001)'.

This report presents the findings of an appraisal of the potential environmental impacts of various strategy elements tested as part of the development of an integrated transport strategy for the inner north.

The results of this assessment, together with the results of assessments undertaken by other technical specialists, will allow assessment of the various strategy options against the defined 'triple bottom line' goals developed as part of the study.

1.2 Scope of Work

Seven strategy elements have been developed for assessment as follows:

- Improved Public Transport
- Reduced Traffic on Local Streets
- Improved Pedestrian and Bicycle Networks
- Reduced Car Dependency
- Land Use Changes to Reduce Travel
- Rapid Transit on Eastern Freeway Corridor
- Improved Arterial Road Network

These strategy elements are indicative only and provide examples of possible initiatives that could be implemented to meet the overall study objective stated above. In particular these strategy elements aim to improve public transport services and to reduce congestion levels within the study area. Further details of each of the strategy elements and the testing scenarios adopted are provided in Section 2.

This report evaluates each of the seven strategy options in terms of defined goals that a successful strategy would aim to achieve for the following environmental issues:

- Noise emissions
- Air quality and greenhouse gas emissions
- Soil and groundwater contamination
- Vegetation and habitat
- Stormwater and water quality

The remainder of this report includes the following sections:

1 Introduction

Section 2 – Assessment Framework – provides an overview of the assessment framework used to evaluate indicative land use and transport strategies for the study area.

Section 3 – Noise and Vibration – assesses strategy elements A to G in terms of impacts on the noise environment within the study area.

Section 4 – Air Quality - assesses strategy elements A to G in terms of air quality and greenhouse gas emissions within the study area.

Section 5 – Soil and Groundwater Contamination – assesses strategy elements A to G in terms of potential impacts on soils and groundwater within the study area.

Section 6 – Vegetation and Habitat - assesses strategy elements A to G in terms of potential impacts on vegetation and habitat within the study area.

Section 7 – Stormwater and Water Quality - assesses strategy elements A to G in terms of potential impacts on water quality within the study area.

Section 8 – Appraisal Summary – provides a summary of the key environmental features, benefits and impacts attributed to each scenario tested.

Section 9 – References - provides a list of relevant references.

This report should be read in conjunction with *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001).

2 Assessment Framework

2 Assessment Framework

2.1 Strategy Goals

As part of the study, a number of strategy goals were developed inline with the overall study objective to improve the amenity and sustainability of the inner north. The strategy goals are based on a triple bottom line approach covering social, environmental and economic categories. The goals represent targets that a successful strategy would aim to achieve. The goals for a successful land use and transport strategy for the study area are presented in Table 2.1.

Table 2.1: Goals for NCCC Transport and Land Use Strategy

Primary Category[1]	Goals
Social	**Improve amenity and liveability of the inner north by:**
	• Significantly reducing the impacts of noise and air pollution from transport • Improving safety – reducing fatalities/casualties to or beyond state targets • Significantly enhancing urban landscape and heritage values in key areas • Minimising through traffic on local streets • Improving access and travel choices for residents, visitors and workers, including disadvantaged groups • Providing facilities for people with mobility disadvantages
Environmental	**Protect and enhance environmental sustainability in the inner north by:**
	• Ensuring a contribution to overall reductions in greenhouse gas emissions • Reducing car use for travel through, to/from and within the inner north • Substantially increasing public transport mode share • Increasing the use of walking and cycling • Protecting and enhancing biodiversity
Economic	**Support growth in economic activity, especially in and around Melbourne's CBD, by:**
	• Enhancing access for commercial activities including tourism and recreation • Catering for increased residential population in the inner north and surrounding areas • Providing for commercial travel movements, including safe, efficient primary routes for freight • Efficiently serving travel needs through, to/from and within the inner north • Maximising the economic return on investment in transport and land use initiatives

Note [1]: Most goals have implications for all three 'triple bottom line' categories (social, environment, economic); they are shown here in their primary categories.

2 Assessment Framework

Source: DoI (2002) NCCCS Study Goals. Assessment Framework and Strategy Elements Discussion Paper

2.2 Strategy Initiatives

As indicated in Section 1, seven strategy elements, or initiatives, for increasing public transport usage and reducing congestion levels within the inner north were developed for the study as follows:

- Improved Public Transport
- Reduced Traffic on Local Streets
- Improved Pedestrian and Bicycle Networks
- Reduced Car Dependency
- Land Use Changes to Reduce Travel
- Rapid Transit on Eastern Freeway Corridor
- Improved Arterial Road Network

These initiatives have been proposed in order to consider potential measures that could be adopted to attract people onto public transport and non-motorised transport modes, to induce people to use cars less, and to determine whether major infrastructure initiatives are required to achieve the desired changes in transport, land use and amenity.

Each of the strategy initiatives is built onto the 'Base Case' or 'Do-Nothing' scenario for 2021. The Do-Nothing or Base Case scenario for 2021 represents a forward projection of expected travel and land use trends within the study area, based on currently committed or highly likely transport infrastructure. The Base Case scenario includes the initiatives listed in Table 2.2.

Table 2.2: 2021 Base Case Scenario

Public Transport	Roads
Existing services as at 2001 plus:	**Existing road links as at 2001 plus:**
	Western Ring Road upgrades (West Gate to Greensborough)
Rail:	
Sydenham rail extension	Monash Freeway extension to Narre Warren (Hallam bypass)
South Morang rail extension	
Airport transit link?	Geelong Road upgrade
	Eastern Freeway extension to Ringwood
Tram:	Western Freeway (Deer Park Bypass)
Box Hill tram extension	Hume Freeway (Craigieburn Bypass)
Knox tram extension	Scoresby Freeway
Route 109 upgrade (franchisees' commitment)	Dingley Arterial (Warrigal Road to Boundary Road)
	Calder/Tullamarine Freeway interchange
	Frankston Bypass
Bus:	Pakenham Bypass
Smartbus routes 1 & 2	Cooper Street duplication
Doncaster Road park and ride	Pascoe Vale Road duplication
	Western Ring Road widening stages
All modes:	Tullamarine Freeway – additional EB lane, Calder to Bulla
Other public transport franchisee commitments (new rolling stock, service level improvements etc – from business	Calder Freeway - Keilor Park Dr to Melton Hwy - 4 to 6 lanes

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Public Transport	Roads
plans/contractual obligations) Other public transport elements of Scoresby package (Wellington Road tram, for example)	Mickelham Rd duplication Bell St - Quinn to Liberty - 6 lanes divided Somerton Rd - Hume to rail crossing - duplication Greensborough Bypass - 6 lanes Western Freeway/Leakes Rd - all movements interchange Western Freeway/Hopkins Rd - all movements interchange Princes Freeway - West Gate to Maltby - 8 lanes Princes Freeway - Maltby to Geelong - 8 lanes Point Cook Road - 4 lanes Palmers/Robinson/Sayers to Western Hwy - 4 lanes Maribyrnong River crossings (VicRoads NW Metro) Plenty Rd - Centenary to McDonalds - duplication Macedon St - Horne to Evans - duplication Mickleham Rd - Alanbrae to Barrymore - duplication Greensborough Hwy - Lower Plenty to Yallambie - widening Kingsbury Dr - Plenty to Waiora - duplication Eltham-Yarra Glen Rd - upgrade to C class Edgars Rd - Kingsway to Cooper - duplication Melton Hwy - duplication
Bicycle/pedestrian commitments	**Road/rail freight initiatives**
Committed works from local council plans, VicRoads and Bicycle Victoria	Somerton interchange Container parks

Source: DoI (2002) NCCCS Study Goals. Assessment Framework and Strategy Elements Discussion Paper

A brief overview of each of the proposed strategies is provided below. Further details of each strategy are presented in the Strategy Costs Report (Sinclair Knight Merz, 2002).

2.2.1 Improved Public Transport

The aim of this strategy is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels within the study area. Key elements of the strategy include:

- Frequency Improvements
- Upgraded Signalling
- Station Access Improvement
- Route 109 Upgrades
- Modal Interchanges in Study Area
- Hoddle Street Bus Priority

2.2.2 Reduced Traffic on Local Streets

The primary aim of this strategy is to divert through traffic from local residential streets to the arterial road network. The strategy includes Area Wide Traffic Management

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2.2.3 Improved Pedestrian and Bicycle Networks

The aim of this strategy is to increase bicycle routes and pedestrian routes within the study area. The strategy is based on various improvements and programs to encourage walking and cycling. Examples include:

- Enforce dog leashing
- Development of shared path codes
- Consideration of pedestrians in development applications
- Demolition of driveways included in building demolition permits
- Reduction in footpath clutter
- New shared paths in parks
- Navigation and signage improvements
- New pedestrian operated signals
- Improved street lighting
- Pedestrian priority at traffic signals
- Increased footpath repair and replacement
- Improvement to laneways for pedestrians
- Verandahs in shopping precincts
- Additional seating
- Legalise bikes in gardens
- Improved signage to assist navigation
- Improved bicycle parking at places of employment
- Provision of showers at work places

2.2.4 Reduced Car Dependency

The aim of this strategy is a reduction in the volume of car travel within the study area. Key elements of the strategy include:

- Changes to Local Parking – limited free parking space and limited duration of parking, CBD parking price increases
- Behavioural Changes – targeted marketing to achieve a mode shift to green transport modes (eg TravelSMART) [1]

2.2.5 Land Use Changes to Reduce Travel

The aim of this strategy is the introduction of land use strategies that can be implemented in order to increase public transport usage and to reduce congestion levels within the study area. Key elements of the strategy are:

- Limiting Road and Parking Supply – allocation of space and pricing
- Improving Alternatives – development of specific strategies and development improvement plans to increase public transport, cycling and walking
- Changing Behaviour – promotion of greener transport (eg TravelSMART)

[1] The TravelSMART program is aimed at encouraging people to choose sustainable travel alternatives such as cycling, walking or catching public transport, and reducing their dependency on the car. The TravelSMART program is currently being piloted in the City of Moreland, the City of Greater Dandenong and the City of Port Phillip.

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2.2.6 Rapid Transit on Eastern Freeway Corridor

This strategy involves the addition of a new rapid transit service from Doncaster Hill to the CBD, known as Doncaster Area Rapid Transit (DART). The strategy is based on the development of a guided bus-way, light rail or heavy rail system from Doncaster Hill to Alexandra Parade. The strategy also includes:

- Major interchange at Doncaster Hill
- Interchanges at Doncaster Road, Bulleen Road and Chandler Highway
- Park and ride facilities
- Extension of dedicated bus lanes on Alexandra Parade

The introduction of a toll on the Eastern Freeway has also been considered as an option within this strategy.

2.2.7 Improved Arterial Road Network

The aim of this strategy is a reduction in congestion levels within the study area through the implementation of road building projects to provide for the major north-south, east-west and CBD access movements.

The strategy is based on a dual two lane deep tunnelled link from the Eastern Freeway east of Hoddle Street to near Flemington Road. Options include a tunnel with, or without, interchanges. Where interchanges are included, exit and entry portals to the tunnel have been located at Royal Parade and Nicholson Street.

A north-south tunnel link commencing on the Eastern Freeway near Hoddle Street and terminating in the vicinity of Victoria Parade/Nicholson Street intersection has also been considered as an option within this strategy.

2.3 Strategy Testing Scenarios

The strategies listed above were grouped into a set of scenarios (A to G) for testing purposes. Details of the testing scenarios are presented in Table 2.3.

Table 2.3: Intitatives and Scenarios for Testing

Types of initiative/Strategy	Strategy Scenarios for Testing						
	A	B	C	D	E	F	G
Significant improvements to bus, tram and rail routes/services	V	V	V	V	V	V	V
Measures to remove traffic from local streets and reduce community severance effects		V	V	V	V	V	V
Improvements to bicycle and pedestrian networks, encouragement of cycling and walking			V	V	V	V	V
Measures to reduce car use such as parking, pricing, policy and behavioural initiatives - CBD parking price increase - TravelSMART behavioural program				V	V	V	V

2 Assessment Framework

Types of initiative/Strategy	Strategy Scenarios for Testing						
	A	B	C	D	E	F	G
Land use-related measures to accommodate growth and reduce or minimise the need for travel					V	V	V
Doncaster rapid transit system - Bus - Light rail - Heavy rail - Toll on Eastern Freeway						V	V
Options within the inner north to improve the efficiency of the arterial network - E-W tunnel - E-W tunnel without intermediate interchanges - Tunnel to CBD							V

Source: DoI (2002) Northern Central City Corridor Study – Study Goals, Assessment Framework and Strategy Elements Discussion Paper.

The testing scenarios A to G represent the strategy initiatives on a cumulative basis as detailed in Table 2.4. The scenarios have been built incrementally to gauge the possible effects of a range of components. To assist the appraisal, scenarios A, B, C, F and G were modelled using the Melbourne wide Zenith transport model. The modelling was conducted by Veitch Lister Consulting. The results of the modelling provide an indication of likely transport effects of the strategies on mode share and average trips within the study area.

Table 2.4: NCCCS Testing Scenarios (as improvements to Base Case 2021)

Scenario	Description
Scenario A	Public Transport Improvements
Scenario B	Scenario A + Local Street Management
Scenario C	Scenario B + Cycling and Walking Initiatives
Scenario D1	Scenario C + CBD Parking Prices Increase
Scenario D2	Scenario D1 + TravelSMART Implementation
Scenario E	Scenario D2 + Land Use Policies
Scenario F	Scenario E + Doncaster Area Rapid Transit (Light Rail)
Scenario F1	Scenario F + Toll on Eastern Freeway
Scenario F2	Scenario F1 + Doncaster Area Rapid Transit (Heavy Rail)
Scenario G	Scenario F2 + E-W Road Tunnel
Scenario G1	Scenario G + Intermediate interchanges
Scenario G2	Scenario G1 + Tunnel from Eastern Freeway to CBD

2.4 Performance Indicators

Appropriate performance indicators were developed as part of the Study to enable assessment of each of the strategy scenarios in terms of the identified goals listed in Section 2.1.

The key performance indicators for environmentally related goals are presented in Table 2.5. These indicators have been used to address the performance of each of the strategy scenarios against environmentally related goals.

Table 2.5: Indicators for Environmentally Related Goals

Goal	Indicator
Significantly reducing the impacts of noise and air pollution from transport	Extent of noise-sensitive land uses (especially residential) exposed to low/medium/high changes in noise exposure. Indices will relate not just to noise levels, but also to community effects such as annoyance and sleep disturbance.
	Concentration of air pollutants at relevant sites according to adopted standards
Ensuring a contribution to overall reductions in greenhouse gas emissions	Estimated total greenhouse gas emissions (by mode of transport) - both metropolitan-wide and for travel to, from, within and through the inner north
Protecting and enhancing biodiversity	Effect on natural habitats
	Effect on exotic habitats
	Effect on water quality
	Effect on soil/groundwater contamination

2.5 Assessment Framework

The following assessment framework has been used to assess each of the strategy scenarios listed in Section 2.3 against achievement of the goals listed in Table 2.5.

The appraisal has been undertaken by comparing the performance of each of the scenarios A to G against existing conditions (2001) and/or the 'do-nothing option' for 2021, depending on the environmental component being assessed. Existing environmental conditions (2001) are as reported in *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001).

The specific assessment methodology and results of the assessment undertaken for each of the environmental components, are presented in Sections 3 to 7as follows:

- Section 3 – Noise Environment
- Section 4 – Air Quality and Greenhouse Gas Emissions
- Section 5 – Soil and Groundwater Contamination
- Section 6 – Vegetation and Habitat
- Section 7 – Stormwater and Water Quality

2 Assessment Framework

An overall summary assessment is provided in Section 8. This section discusses the key environmental features, benefits and impacts attributed to each strategy.

3 Noise Environment

3 Noise Environment

3.1 Introduction

This section summarises the key results of an appraisal of the proposed scenario in terms of the noise environment, as reported by Marshall Day Acoustics. For further information, the Marshall Day Acoustics Noise Environment Scenario Appraisal Report is included in Appendix A.

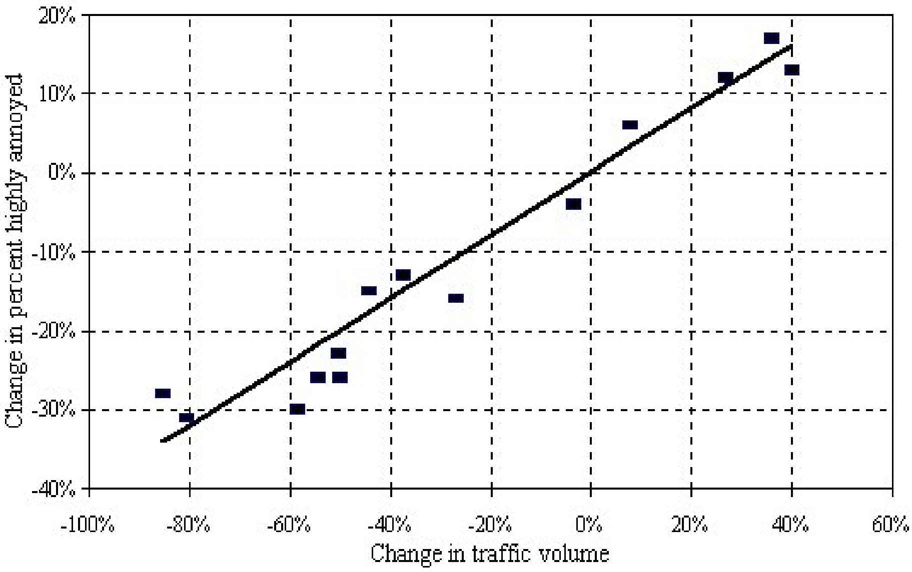
3.2 Assessment Methodology

Traffic levels were obtained from the Zenith Model for each of the NCCCS scenarios. The effect of the various scenarios on traffic noise was assessed by looking at the change in traffic volume on selected links within the study area. The links assessed are detailed in Appendix A of the Marshall Day Acoustics Report.

Change in traffic volume was considered to be a useful measure of change in noise exposure because:

- As shown in Figure 3.1, the change in traffic volume can be directly related to change in community annoyance for sudden changes in noise exposure.
- Change in traffic volume can be directly related to change in average noise levels. For example, a change in traffic volume of 25% will result in a change in average noise level of approximately 1dBA.

Figure 3.1: Community Annoyance and Traffic Volume



As indicated in Table 3.1, two levels of change in the traffic volume were considered. Table 3.1 also shows the associated change in noise level and change in community annoyance. It can be seen that if changes in traffic volume in this magnitude occur gradually the change in community annoyance is not significant.

3 Noise Environment

Table 3.1: Changes in Traffic Volume Considered

Change in traffic volume	Equivalent change in noise level	Change in annoyance	
		Gradual	Sudden
15%	Less than 1dBA	1%	5%
30%	1–2dBA	2%	10%

The strategy elements under consideration result in scenarios that would consist primarily of gradual changes in traffic volume (such as the “Do Nothing” scenario), and scenarios which consist of very visible projects which would result in relatively sudden changes (such as Scenario G). Most scenarios consist of a combination of gradual and sudden changes. Thus, the community response might lie somewhere between the figures shown in Table 3.1.

It is noted that both positive changes (decreases in traffic volume) and negative changes (increased in traffic volume) have been considered.

For convenience, the term ‘noticeable’ has been applied to a change in traffic volume of 15%, and the term ‘significant’ has been applied to a change in traffic volume of 30%. It is noted that the ‘significant’ range is included in the ‘noticeable’ range. This means that any road link that experiences a ‘significant’ change in traffic volume will also register as experiencing a ‘noticeable’ change.

For each of the road links in Appendix A, the number of residences was estimated. The number of residences exposed to ‘noticeable’ or ‘significant’ changes in traffic volume were determined by adding up the number of residences over the whole study area adjacent to links on which ‘noticeable’ or ‘significant’ changes in traffic volume occurred. The proportion of residences exposed to noticeable or significant changes in traffic volume has been reported as a percentage of the total number of residences adjacent to the selected links.

It is noted that, for some scenarios, it may be possible for one of the major effects to be a redistribution of traffic, so that some areas experience improvements in noise environment while other areas experience degradations.

While heavy vehicle modelling was undertaken by Veitch Lister Consulting, the results are not considered to be sufficiently accurate to allow a quantitative assessment of changes on particular road links. As such a qualitative assessment of the impacts of heavy vehicles on the noise environment was undertaken at this stage.

3.3 Assessment

The defined goals identified for a successful land use strategy for the study area include the ‘improvement of amenity and liveability of the inner north’. Under this overall social goal a number of more specific goals have been identified including ‘significantly reducing the impacts of noise and air pollution from transport’’. The performance indicator that has been used to measure this specific goal is as follows:

- Extent of noise-sensitive land uses (especially residential) exposed to low/medium/high changes in noise exposure.

All scenarios have been appraised using the following qualitative framework:

- Comparison to Existing Situation (2001)
- Comparison to the Base Case (2021)
- Changes relative to Previous Scenario

3.3.1 Changes relative to existing situation

Table 3.2 shows the proportion of residences affected by noticeable or significant changes in traffic noise exposure compared to the existing situation (2001). This is based on a comparison of the modelled traffic volumes for the various scenarios and the modelled traffic volumes for 2001.

Table 3.2: Proportion of Residences Affected Compared with Existing Situation

	Base Case 2021	A	B	D	F	F2	G	G1	G2
Significant improvement	0%	2%	19%	19%	19%	19%	28%	23%	23%
Noticeable improvement	0%	2%	22%	22%	22%	22%	34%	29%	27%
Noticeable degradation	71%	36%	51%	44%	42%	41%	24%	19%	41%
Significant degradation	23%	14%	19%	19%	19%	19%	10%	10%	15%

Whichever scenario is adopted, 10-23% of residences adjacent to the selected links will experience a significant degradation of their traffic noise exposure. However, as the cumulative effects of the various scenarios build up toward Scenario G the extent of degradation becomes more limited.

The proportion of residences experiencing a significant improvement shows more markedly the benefit of the various scenarios compared to the 2021 Base Case. Scenarios B to F2 show 19% of residences experiencing a significant improvement. This is due to the heavy restrictions on traffic volumes on certain links in Scenario B. Scenario G also appears to provide a worthwhile improvement, with 28% of residences experiencing a significant improvement.

3.3.2 Base Case (2021)

The future Base Case scenario represents a projection of expected travel and land use trends, with currently committed or highly likely transport infrastructure included. The initiatives listed under the future Base Case scenario are as presented in Table 2.2. Table 3.3 shows the proportion of residences affected compared with the Base Case scenario.

Table 3.3: Proportion of Residences Affected Compared with Base Case Scenario

	A	B	D	F	F2	G	G1	G2
Significant improvement	5%	22%	22%	24%	24%	32%	29%	28%
Noticeable improvement	13%	31%	31%	27%	31%	51%	51%	41%
Noticeable degradation	0%	11%	1%	2%	2%	1%	1%	4%
Significant degradation	0%	0%	0%	0%	0%	1%	0%	0%

Compared to the Base Case scenario, none of the scenarios show more than 1% of residences exposed to a significant degradation in traffic noise exposure. However, the proportion of residences experiencing a significant improvement in noise exposure reaches 22% by Scenario B and 32% by Scenario G.

3.3.3 Changes Relative to Previous Scenario

As discussed in Section 2, the scenarios are cumulative – that is, each scenario includes the traffic management measures incorporated in the previous scenario. In order to determine the additional benefit of the measures in each scenario that do not form part of the previous scenarios the traffic volumes for each scenario were compared with those for the previous scenario. Table 3.4 shows the proportion of residences affected compared with the previous scenario.

Table 3.4: Proportion of Residences Affected Compared with Previous Scenario

	A	B	D	F	F2	G	G1	G2
Significant improvement	5%	20%	3%	1%	3%	14%	2%	2%
Noticeable improvement	13%	21%	4%	4%	4%	27%	2%	3%
Noticeable degradation	0%	25%	0%	2%	2%	3%	10%	27%
Significant degradation	0%	1%	0%	2%	0%	3%	3%	8%

The greatest improvement was achieved by Scenario B. This was due to the spectacular traffic volume reductions on local collector links where free speed was downgraded to 10km/hr. However, Scenario B also increases traffic on arterials with a consequential increase in noticeable degradation.

Scenario G achieved a high level of improvement, although one third of the improvement was on links already significantly improved by Scenario B. The other two thirds of the improvement (or about 9% of the total) was due to significant traffic volume reductions on McArthur Road, Princes Street, Alexandra Parade and even Brunswick Road between Sydney Road and Nicholson Street.

The highest proportion of residences experiencing a significant degradation (8%) was achieved by Scenario G2.

3.4 Assessment of Other Scenarios

Not all of the scenarios listed in Section 2 were modelled by Veitch Lister Consulting. Those not modelled are:

- Scenario C – cycling and walking strategies
- Scenario D2 – TravelSMART
- Scenario E – local land use strategies

Table 3.5 provides a qualitative assessment of these three scenarios.

Table 3.5: Qualitative Assessment of Scenarios C, D2 and E

Scenario	Assessment
C	Road traffic volume decreases due to mode shift to walking and cycling are likely to be unnoticeable.
D2	According to the summary figures provided by DoI, the TravelSMART program will provide an estimated 9% decrease in the number of car trips within the study area. It is not clear whether longer or shorter trips will be more or less affected, but assuming that a 9% decrease in car trips will produce a decrease in traffic volumes of about 9%, this is still somewhat less than the 15% nominated in Section 2.3 as “noticeable”. Therefore, in general, the improvements will tend to be minor. However, it is possible that, when traffic volume decreases occur, the through trips on smaller local roads will shift to major roads and there may be traffic volume decreases on local roads greater than 15%.
E	A range of land use management options has been prepared and discussed as part of the land use component of the study. The effect of these strategies on the number of trips (in particular car-based trips) is not estimated. However, according to the NCCCS Land Use Component Discussion Paper (Maunsell Australia, 2002) significant population growth is expected in the study area without significant changes in the proportion of the population who own cars. A number of strategies for limiting car parking in an effort to reduce the rates of car ownership are proposed. However, it is not clear whether such measures will sufficiently negate any increase in traffic volumes due to population increase. Changes in traffic noise exposure as a consequence of these strategies is likely to be unnoticeable.

3.5 Changes in Heavy Vehicle Numbers

None of the scenarios includes measures to specifically reduce impacts due to heavy vehicle traffic, however, there is likely to be some changes in heavy vehicle numbers, especially for Scenario G. Table 3.6 provides a qualitative assessment of the various scenarios based on heavy vehicle modelling undertaken by Veitch Lister Consulting.

Table 3.6: Qualitative Assessment of Changes in Heavy Vehicle Numbers

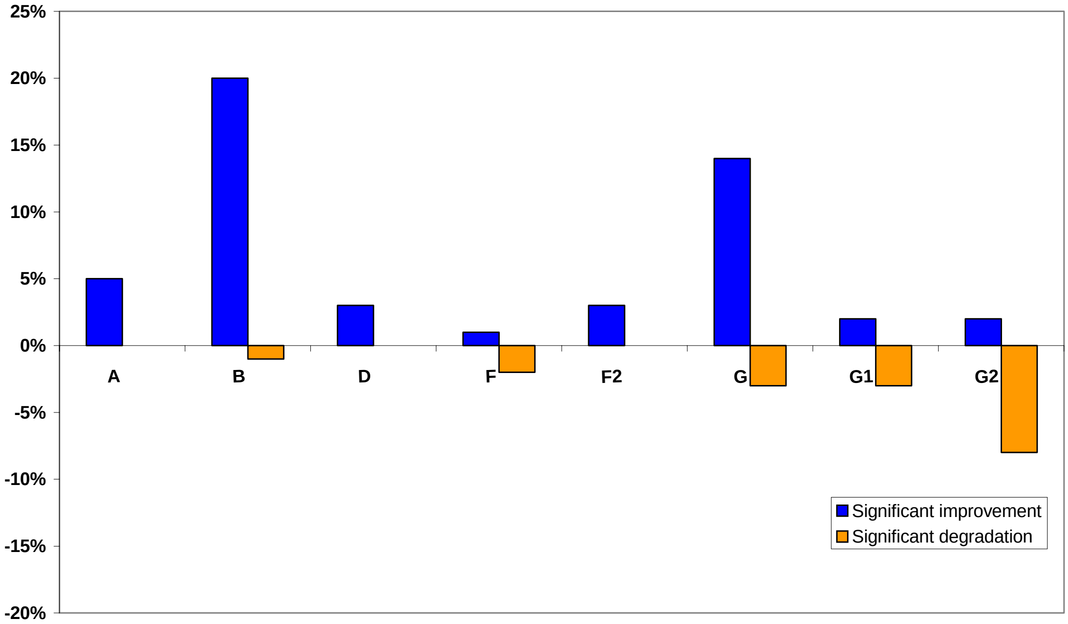
Scenario	Assessment
A	This scenario will apparently lead to some minor increases in congestion on major roads. This may deflect a small number of heavy vehicle trips from the study area. For example, the daily truck volume in Gertrude Street was reduced to less than 1,000.
B	This scenario will remove heavy vehicles almost entirely from the collector streets downgraded to a 10km/hr free speed. Daily truck volumes were reduced to less than 1,000 in Abbotsford Street, Arden Street, Errol Street, Gatehouse Street west of Royal Parade, Gertrude Street, Grattan Street, Queensberry Street, Smith Street, Wellington Street and Wreckyn Street. Several arterial roads apparently will suffer significant increases in congestion which could deflect some heavy vehicle trips from the study area.
C	The enhanced pedestrian and cyclist facilities will apparently include a greater number of pedestrian and cycle crossings on major roads. This may lead to a greater number of occurrences of braking and accelerating by heavy vehicles. This may noticeably change the character of the noise environment which could be a source of annoyance for some individuals.
D	Neither the CBD parking price increase nor the TravelSMART program are likely to affect truck volumes.
E	Unlikely to affect truck volumes.
F, F1, F2	None of the variations on this scenario are likely to affect heavy vehicle numbers, even with a toll on Eastern Freeway. It understood that the toll on City Link does not discourage use of the route by heavy vehicles.
G, G1, G2	The tunnel is likely to have a major effect on heavy vehicle numbers on some of the existing roads in the study area. However, only two of the links unaffected by Scenario B achieved a daily truck volume of less than 1,000, namely Elliott Avenue and Macarthur Road.

3.6 Summary

Of the various traffic management strategies assessed, the greatest benefit was achieved by the significant downgrading of certain roads (Scenario B) and the east-west tunnel with intermediate interchanges (Scenario G). This is illustrated in Figure 3.2, which shows the proportion of residences experiencing a significant degradation or improvement in traffic noise exposure compared to the previous scenario. These scenarios, or similar scenarios, are recommended for further evaluation.

3 Noise Environment

Figure 3.2: Proportion of residences affected compared with previous scenario



It is also recommended that there be some evaluation of measures to specifically reduce impacts due to heavy vehicle traffic. For example, the use of night-time truck bans on particular routes is likely to have benefits. The selection of routes would depend on a number of factors including the diversion of trucks onto other routes.

4 Air Quality and Greenhouse Gas Emissions

4 Air Quality and Greenhouse Gas Emissions

4.1 Introduction

This section summarises the key results of the ERM appraisal of the proposed scenarios in terms of air quality impacts and greenhouse emissions. For further information the Air Quality and Greenhouse Gas Emissions Scenario Appraisal Report is included in Appendix B.

4.2 Assessment Methodology

As indicated in the NCCCS Issues and Trends Report (DoI, 2001), emissions from private motor vehicles are the major source of air quality pollutants in the study area, and have been identified as the most significant contributor to Melbourne's air pollution.

The quantification of air emissions for the study has been conducted based on the traffic projections from the Zenith model and an analysis of vehicle emission rates that accounts for the improvements in fuel consumption and emission control technology that are expected to occur between now and 2021.

Traffic levels were obtained from the Zenith Model for each of the proposed scenarios. Vehicle categorisations supplied in the data were for private vehicles, commercial vehicles, and buses. The vehicle kilometres travelled (VKT) for vehicle types at a higher resolution were determined by splitting the modelled categories into individual vehicle types utilising data from the Fuel Quality Review Analysis (Environment Australia, 2000).

Emissions from motor vehicles have been estimated using the vehicle kilometres travelled for each of the vehicle classes derived from the transport model. The VKT were combined with the emission rates per kilometre for each pollutant and vehicle type considered. Emission rates have been developed based on previous Australian studies that have utilised the database of new and in-service vehicle testing results held by the EPAs of NSW and Victoria and estimations of the composition of the future vehicle fleet. Emission rates for the vehicle fleet in 2021 have been derived utilising an analysis of the likely emission characteristics of individual vehicles. The future characteristics of the future vehicle fleet have been assessed based on proposed new emission regulations, new fuel standards, emission standards from overseas and likely rates of new technology adoption. Further details on the derivation of these figures are presented in the Air Quality and Greenhouse Gas Emissions Scenario Appraisal Report included in Appendix B.

Greenhouse emissions from transport within the region have been based on the average fuel consumption of vehicles in the region and assumed fuel efficiency improvements over the period to 2021.

The emission rates developed from this analysis for 2001 and 2021 are presented in Table 4.1 and Table 4.2.

4 Air Quality and Greenhouse Gas Emissions

Table 4.1: Vehicle Emission Rates 2001(g/km)

Vehicle Category	Pollutant					Greenhouse		
	NOx	NMVOC	SOx	CO	PM10	CO2	CH4	N2O
	g/km	g/km	g/km	g/km	g/km	g/km	g/km	g/km
Cars								
ULP Post 1986	1.113	1.412	0.022	7.063	0.05	232.4	0.090	0.023
Leaded Pre 1986	1.589	3.185	0.052	27.048	0.05	257.0	0.140	0.003
Diesel	0.943	1.446	0.385	0.989	0.15	319.6	0.010	0.010
LPG	1.800	2.528	0.031	20.038	0.05	232.7	0.080	0.008
Light Trucks								
Petrol	1.760	2.930	0.049	23.580	0.05	306.1	0.140	0.012
Diesel	1.180	1.490	0.394	1.109	0.22	327.6	0.010	0.014
LPG	1.981	2.680	0.035	21.990	0.05	255.4	0.090	0.008
Medium Trucks								
Petrol	4.649	5.090	0.093	57.800	0.09	473.7	0.174	0.006
Diesel	3.101	1.950	0.634	1.820	0.88	527.4	0.020	0.018
LPG	2.820	3.421	0.051	24.001	0.31	364.2	0.130	0.012
Heavy Trucks								
Petrol	4.661	7.049	0.151	121.301	0.09	768.7	0.210	0.010
Diesel	15.291	3.741	1.413	7.862	0.88	1198.6	0.072	0.027
LPG	4.828	5.168	0.087	23.999	0.31	624.2	0.219	0.021
Buses								
Petrol	3.955	4.468	0.079	49.156	0.05	402.2	0.151	0.005
Diesel	4.540	2.405	0.928	2.667	0.62	769.8	0.029	0.023
LPG/LNG	2.642	2.307	0.047	22.982	0.11	341.6	0.115	0.011

Table 4.2: Vehicle Emission Rates 2021 (g/km)

Vehicle Category	Pollutant					Greenhouse		
	NOx	NMVOC	SOx	CO	PM10	CO2	CH4	N2O
	g/km	g/km	g/km	g/km	g/km	g/km	g/km	g/km
Cars								
ULP Post 1986	0.267	0.480	0.017	1.978	0.03	176.533	0.069	0.017
Leaded Pre 1986	0.381	1.083	0.041	7.573	0.03	201.114	0.110	0.003
Diesel	0.226	0.492	0.029	0.277	0.04	253.033	0.008	0.008
LPG	0.432	0.859	0.026	5.611	0.02	194.958	0.067	0.006
Light Trucks								
Petrol	0.423	0.996	0.040	6.603	0.03	250.275	0.114	0.010
Diesel	0.283	0.507	0.029	0.311	0.04	261.023	0.008	0.011
LPG	0.475	0.911	0.030	6.157	0.02	217.627	0.076	0.007
Medium Trucks								
Petrol	1.116	1.731	0.082	16.184	0.05	417.870	0.153	0.006
Diesel	0.744	0.663	0.052	0.509	0.34	460.786	0.017	0.016
LPG	0.677	1.163	0.045	6.720	0.12	326.441	0.117	0.011
Heavy Trucks								
Petrol	1.119	2.397	0.140	33.964	0.05	712.837	0.195	0.010
Diesel	3.670	1.272	0.128	2.201	0.34	1131.988	0.068	0.026
LPG	1.159	1.757	0.081	6.720	0.13	586.384	0.206	0.019

4 Air Quality and Greenhouse Gas Emissions

Vehicle Category	Pollutant					Greenhouse		
	NOx	NMVOC	SOx	CO	PM10	CO2	CH4	N2O
	g/km	g/km	g/km	g/km	g/km	g/km	g/km	g/km
Buses								
Petrol	0.949	1.519	0.068	13.764	0.03	346.363	0.130	0.005
Diesel	1.090	0.818	0.079	0.747	0.24	703.164	0.026	0.021
LPG/LNG	0.634	0.785	0.042	6.435	0.05	303.771	0.103	0.010

4.3 Assessment

The defined goals identified for a successful land use strategy for the study area include the 'improvement of amenity and liveability of the inner north'. Under this overall social goal a number of more specific goals have been identified including 'significantly reducing the impacts of noise and air pollution from transport' and 'ensuring a contribution to overall reductions in greenhouse gas emissions'. Performance indicators to measure these goals are as follows:

- Concentration of air pollutants at relevant sites according to adopted standards.
- Estimated total greenhouse gas emissions (by mode of transport) - both metropolitan-wide and for travel to, from, within and through the inner north.

All scenarios have been appraised using the following qualitative framework:

- Estimation of anticipated total emission loads for the Base Case 2021
- Estimation of anticipated total emission loads for Scenarios that have been modelled using the Zenith transport model
- Opportunities and constraints
- Impacts on NCCCS area
- Impact on externalities

4.3.1 Base Case (2021)

The future Base Case scenario represents a projection of expected travel and land use trends, with currently committed or highly likely transport infrastructure included.

Significant Base Case 2021 road projects include:

- Eastern Freeway Extension to Ringwood
- Scoresby Freeway

Significant 2021 Base Case public transport projects include:

- All tram and train services have a 20% higher frequency
- Smartbus Routes along Springvale Road (existing routes 888 & 889) and Blackburn Road (existing route 703)
- Cranbourne East Rail Extension

Most of the transport infrastructure initiatives are located in the middle and outer suburbs and will not have a significant bearing on traffic demands and patterns in the NCCCS Study Area. The Victorian population is anticipated to increase by 22

4 Air Quality and Greenhouse Gas Emissions

percent. The mode share estimate for existing conditions (2001) and the future Base Case Scenario (2021) is detailed in Table 4.3.

Table 4.3: Zenith Model Estimates of Travel for Base Case Scenario Melbourne Metropolitan Area

Mode	2000 Existing		2021 Base Case		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	9,325	77.5	11,745	77.7	2,419	25.9
Transit	784	6.5	1,028	6.8	244	31.2
Walk/Cycle	1,918	16.0	2,332	15.4	414	21.6
Total	12,028	100	15,107	100	3,078	25.6

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 4.4: Air Emissions from the Base Case Within the Metropolitan Area

Pollutant	2000 Existing	2021 Base Case	Change
	Emission (tonne)	Emission (tonne)	(%)
Nitrogen Oxides	43,169	13,076	-69.7%
Volatile Organic Compounds	55,792	20,394	-63.4%
Sulfur Dioxide	3,011	830	-72.5%
Carbon Monoxide	347,217	86,056	-75.2%
PM10	2,738	1,574	-42.5%
Carbon Dioxide Equivalents (Gg/year)	7,966	8,239	3.4%

The resulting emissions from the 2021 Base Case are compared with existing conditions in Table 4.4. These show a significant decrease in all emissions, with the exception of $C0_2$-e which show a small decrease (3.4%) despite the improvements in fuel consumption. It must be remembered that these data represent emissions from the entire network. Due to the spatial distribution of public transport systems it is expected that much of these changes would occur in the inner Melbourne region. As such the percentage changes in the NCCCS area would be significantly higher.

Opportunities And Constraints

The development of low emission cars represents an opportunity to minimise the air quality and greenhouse gas impacts of the proposed increase in vehicle trips associated with the Base Case (2021). There are a number of plausible technology mix scenarios for the introduction of low emission vehicles. The most likely major technology changes that may begin to be seen on our roads within the next 20 years are:

- Significant improvements in fuel efficiency above and beyond that expected.
- Market share increase of commercial hybrid vehicles, such as the Toyota Prius and Honda Insight released here last year.
- Introduction to the Australian market of commercial fuel cell and hydrogen powered vehicles, these may be available around 2010 but without significant technology and price breakthroughs will not reach large numbers in the study period.

While it is likely that some or all of these technologies will be introduced over the next twenty years, it is anticipated that these will have a minimal impact on the emission characteristics of the vehicle fleet as a whole. Unless the Government introduces a paradigm shift in policy direction, it is likely that low emission vehicles will represent a maximum of 5 to 10% of the new vehicles entering the market.

The principle constraint of the **Base Case 2021** is that the NCCCS area is predicted to receive an additional 110,000 trips in private vehicles in an area in which the community residents group have expressed dissatisfaction with traffic and related problems, namely pollution, congestion, truck volumes, traffic noise and parking facilities.

Impacts on NCCCS Area

The predicted traffic volumes for Base Case 2021 indicate a significant increase of trips in the NCCCS area. Further congestion on the roads in the NCCCS area will reduce the average speed of roads and therefore increase emissions per vehicle kilometre. This is due to the characteristic increase in emissions with reducing speed and the increase in stop/start driving. This is likely to have an increased impact on air quality in the local area, which may be partially offset through new vehicle engine and pollution control technologies.

4.3.2 Scenario A - Improved Public Transport

The aim of Scenario A is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

Significant initiatives include:

- Train frequency increase of 50% or more on the Upfield, Ringwood, Northern, Epping & Hurstbridge lines
- Improvements to bus and tram access to railway stations to reflect interchange service coordination
- Increase of 50% for all study area tram services
- Bus frequency increases for the Eastern Freeway, Johnston St & Northern groups to achieve a frequency of 10 minutes during peak and double the present frequencies in the off peak
- Increased spatial cover for city end Bus routes for the Eastern Freeway and Johnston Street groups.

The mode share estimate for the Base Case Scenario (2021) and Scenario A is detailed in Table 4.5.

Table 4.5: Zenith Model Estimates of Travel for Scenario A and Base Case Scenarios Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario A		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,500	56	-245	-2.1
Transit	1,028	6.8	1,356	30	327	31.8

	2021 Base Case		Scenario A		Change	
Walk/Cycle	2,332	15.4	2,250	14	-82	-3.4
Total	15,107	100	15,107	100	0	0

Source: Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from Scenario A are compared with the 2021 Base Case in Table 4.6. These show a small decrease in NOx, CO and VOC emissions, a 1.7% increase in particle emissions resulting from increasing use of diesel fuelled buses. It must be remembered that these data represent emissions from the entire network. Due to the spatial distribution of public transport systems we would expect that much of these changes would occur in the inner Melbourne region. As such the percentage changes in the NCCCS area would be significantly higher.

Table 4.6: Air Emissions from Scenario A Within the Metropolitan Area

Pollutant	2021 Base Case	Scenario A	Change
	Emission (tonne)	Emission (tonne)	(%)
Nitrogen Oxides	13,076	13,051	-0.2%
Volatile Organic Compounds	20,394	20,067	-1.6%
Sulfur Dioxide	830	830	0.0%
Carbon Monoxide	86,056	84,022	-2.4%
PM10	1,574	1,600	1.7%
Carbon Dioxide Equivalents (Gg/year)	8,239	8,235	0.0%

Opportunities And Constraints

The improvement of public transport systems has the potential to reduce the amenity of private vehicle use though additional tram and bus traffic that could increase public transport use further. Increased vehicle congestion would however increase the emission rates in affected areas.

With increasing public transport and walk/cycle use we would expect that the health of travellers would be improved by reductions in emissions and through the additional exercise being undertaken. These health improvements would flow through to reduced public and private health costs.

Increased buses on residential roads are likely to lead to a reduction in amenity, and potentially localised air quality impacts particularly in the vicinity of stops, resulting from diesel exhaust plumes. These impacts will be reduced by future emission legislation and significantly improved fuel economy. The air quality impacts could be reduced if LNG fuelled buses are widely introduced.

Impacts On NCCCS Area

The main impact on the NCCCS area is that private car trips reduce by approximately 10% compared to the 2021 Base Case. It would also be expected that the air pollution emissions from this source would reduce by a similar amount. A secondary impact from the reduction in private vehicle use would be that the lower levels of congestion expected would result in lower emission rates per kilometre travelled.

If it is assumed that private cars remain predominantly petrol fuelled and buses remain predominantly diesel fuelled, the reduction in car use and increase in bus use would result in reduction of CO, VOC and NOx, but an increase in particle emissions and sulfur dioxide emissions compared to the 2021 Base Case.

Impact On Externalities
Comparative migration of private vehicle trips to public transport across the metropolitan region would lead to significant reduction in greenhouse emissions, and corresponding pollutant emissions. However, increased bus use would result in some increases in NOx and particle emissions.

4.3.3 Scenario B – Scenario A + Reduced Traffic on Local Streets

Significant initiatives include:

- Lower free flow speeds assumed on specified local streets in the NCCCS area
- Removal of through traffic from local roads

The mode share estimate for the Base Case Scenario (2021) and Scenario B is detailed in Table 4.7.

Table 4.7: Zenith Model Estimates of Travel for Base Case and Scenario B Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario B		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,486	76.0	-259	-2.2
Transit	1,029	6.8	1,367	9.1	339	32.9
Walk/Cycle	2,333	15.4	2,253	14.9	-79	-3.4
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from Scenario B are compared with the 2021 Base Case in Table 4.8. These show a very small decrease in NOx, CO, PM10, SO_2 and VOC emissions, with reductions less than 0.1% over that achieved in Scenario A. In this scenario, the strategies are specific to the NCCCS region and would result in the displacement of some traffic to regions outside the NCCCS region. Consequently, the percentage changes in the NCCCS area would be significantly higher.

Table 4.8: Air Emissions from Scenario B Within the Metropolitan Area

Pollutant	2021 Base Case	Scenario B	Cumulative Change
	Emission (tonne)	Emission (tonne)	(%)
Nitrogen Oxides	13,076	13,047	-0.22%
Volatile Organic Compounds	20,394	20,055	-1.66%
Sulfur Dioxide	830	830	0.06%
Carbon Monoxide	86,056	83,969	-2.43%
PM10	1,574	1,600	1.67%
Carbon Dioxide Equivalents (Gg/year)	8,235	8,232	-0.09%

Opportunities And Constraints

One of the largest advantages of local street management programs is that the measures impact directly on traffic in the NCCCS region and will likely displace traffic onto roads outside the region.

It is expected that the air quality impacts on affected and surrounding streets would be significant, due to the decrease in traffic flow.

The key constraint on implementation relates to the impact of the measures on residents amenity in the streets affect. The reduction in amenity could arise because of restricted access to homes and other locations and noise resulting from speed humps.

Impacts On NCCCS Area

The impact on the region in general will be significant in terms of emissions released. However, this is no guarantee of significantly improved air quality as emissions are transported through the region from other areas as well as those produced locally. There is also likely to be increased congestion on some roads within the NCCCS region and an associated increase in air emissions.

Impact On Externalities

Nearby regions will likely experience some increased traffic flows, congestion and associated air emissions as travellers avoid the restricted areas in the NCCCS region.

4.3.4 Scenario C – Scenario B + Improved Pedestrian and Bicycle Networks

General improvements to the facilities available for walking and cycling are likely to increase the number of trips carried out by this mode. Specific actions may include new bike paths or on-road lanes, improved signage, improved lighting, secure parking facilities or shower and change facilities at workplaces.

The mode share estimate for the Base Case Scenario (2021) and Scenario C is detailed in Table 4.9.

Table 4.9: Zenith Model Estimates of Travel for Base Case Scenarios Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario C		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,462	75.9	-79	-2.4
Transit	1,028	6.8	1,360	9.0	331	32.2
Walk/Cycle	2,332	15.4	2,285	15.1	-48	-2.1
Total	15,107	100	15,107	100.0	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from Scenario C have not been determined explicitly because of the difficulty in quantifying the relationship between trips and distance travelled. However the following conclusions can be reached based on the change in the number of trips forecast.

The number of trips made by cycling and walking increases by approximately 5% of the base case value as a result of this scenario, representing an 18% increase over that in the previous Scenario. If we assume that most of these trips are short and occur within the NCCCS region, there will be a measurable reduction in the quantity of emissions released by vehicles within the region. Trips replaced by walking or cycling are largely passenger vehicle trips, indicating that significant short car trips are removed from the region.

4.3.5 Scenario D – Scenario C + Reduced Car Dependency

This scenario includes the evaluation of the impacts of an increase in the cost for parking in the CBD to reduce the demand for commuter travel by private vehicle.

The reduction in trips for the metropolitan region are shown in Table 4.10. These data show a reduction in private car use of approximately 1% over the preceding scenario.

Table 4.10: Zenith Model Estimates of Travel for Scenario D Melbourne Metropolitan Area

	2021 Base Case		Scenario D		Cumulative Change	
Mode	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,402	75.5	-79	-2.9
Transit	1,028	6.8	1,397	9.2	368	35.7
Walk/Cycle	2,332	15.4	2,308	15.3	-25	-1.1
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from this scenario are presented in Table 4.11 and show an additional reduction in emissions for most pollutants of around 0.5% over the previous scenario.

Table 4.11: Air Emissions from Scenario D Within the Metropolitan Area

Pollutant	2021 Base Case Emission (tonne)	Scenario D Emission (tonne)	Cumulative Change (%)
Nitrogen Oxides	13,076	13,001	-0.57%
Volatile Organic Compounds	20,394	19,971	-2.07%
Sulfur Dioxide	830	827	-0.30%
Carbon Monoxide	86,056	83,597	-2.86%
PM10	1,574	1,595	1.37%
Carbon Dioxide Equivalents (Gg/year)	8,235	8,201	-0.46%

Opportunities and Constraints

This scenario removes private car trips from the transport network replacing them with public transport or walking/cycling options. The benefits obtained are limited by political will to implement such measures and a likely reduced impact over time as some travellers decide the convenience of private transport is worth the additional cost.

Impacts on NCCCS Area

Emissions of major pollutants and greenhouse gas emissions reduce by approximately 0.5% within the metropolitan region. The distribution of these trip reductions is likely to be dispersed over much of the metropolitan region, resulting in a smaller percentage change in the emissions in the NCCCS region.

Impact on Externalities

The impact of this initiative will be distributed over the entire metropolitan region and is not specific to NCCCS.

Scenario D2

The TravelSmart program is an education based traffic demand management program that has undergone successful trials in Adelaide and Perth. Trials are currently underway in Melbourne. The results of the trials indicate that it may be possible to reduce private vehicle travel by 7-8%.

The applicability of this option in Melbourne regions is unknown at the current time, as the effectiveness will depend upon the available public transport options and their current patronage. The mode share estimate for the Base Case Scenario (2021) and Scenario D2 is detailed in Table 4.12.

Table 4.12: Zenith Model Estimates of Travel for Base Scenario D2 Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario D2		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,348	75.1	-79	-3.4
Transit	1,028	6.8	1,433	9.5	404	39.3
Walk/Cycle	2,332	15.4	2,326	15.4	-7	-.3

Mode	2021 Base Case		Scenario D2		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Emissions have not been estimated from this option because of the difficulty in converting trip reductions to VKT under this scenario.

The main impact from the TravelSmart program is the transfer of private vehicle trips to public transport and walking/cycling. This would result in significant reductions in vehicle emissions both within and external to the NCCCS region. Assuming that the results of the Perth trial could be replicated throughout the metropolitan region significant reductions in emissions could be achieved across the city.

4.3.6 Scenario F – Scenario E + Rapid Transit on Eastern Freeway Corridor

This scenario considers the implementation of the Doncaster Area Rapid Transit (DART) system that incorporates a high capacity light rail system operating between Doncaster Shoppingtown, NCCCS and the City. The service will operate at high frequency and with high quality priority and stops.

The mode share estimate for the Base Case Scenario (2021) and Scenario F is detailed in Table 13.

Table 4.13: Zenith Model Estimates of Travel for Scenario F Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario F		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,339	75.1	-79	-3.5
Transit	1,028	6.8	1,440	9.5	411	40.0
Walk/Cycle	2,332	15.4	2,328	15.1	-5	-0.2
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from this scenario are presented in Table 4.14 and show an additional reduction in emissions for most pollutants of between 0.5% and 1.0% over the previous scenario. These reductions are the result of significant shifts of travel from private cars and buses to the DART.

Table 4.14: Air Emissions from Scenario F Within the Metropolitan Area

Pollutant	2021 Base Case	Scenario F	Cumulative Change
	Emission (tonne)	Emission (tonne)	(%)
Nitrogen Oxides	13,076	12,834	-1.85%
Volatile Organic Compounds	20,394	19,835	-2.74%
Sulfur Dioxide	830	815	-1.75%

Pollutant	2021 Base Case Emission (tonne)	Scenario F Emission (tonne)	Cumulative Change (%)
Carbon Monoxide	86,056	83,351	-3.14%
PM10	1,574	1,560	-0.84%
Carbon Dioxide Equivalents (Gg/year)	8,235	8,084	-1.88%

Opportunities and Constraints

The DART provides for rapid transport from Doncaster to the city on a dedicated line and will therefore compete with bus traffic on the freeway routes. Significant numbers of trips are expected to be migrated from bus to DART resulting in significantly reduced emissions.

Although the project provides significant benefits these are distributed to one particular area of Melbourne, similar systems to other regions would improve conditions to a greater degree.

Impacts On NCCCS Area

Significant reductions in all pollutants including greenhouse gases are expected as a result of the DART. Associated with this are improvements in traffic levels and congestion.

Impact On Externalities

The external regions to NCCCS are expected to get most of the benefits of the DART both in terms of access to use of the system and emission reduction benefits.

4.3.7 Scenario G – Scenario F + Improved Arterial Road Network

The east-west tunnel option provides an underground link between the Eastern Freeway and Flemington Road. This option is the only option considered that is likely to increase travel demand. The modelled trip data for this scenario is presented in Table 4.15.

Table 4.15: Zenith Model Estimates of Travel for Base Case Scenarios Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario G		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,341	75.1	-79	-3.4
Transit	1,028	6.8	1,438	9.5	409	39.8
Walk/Cycle	2,332	15.4	2,328	15.4	-5	-0.2
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

The resulting emissions from this scenario are presented in Table 4.16 and show an additional increase in emissions for most pollutants of around 0.1-0.2% over the previous scenario. These increases are the result of shifts of travel to private cars resulting from reduced congestion and travel time.

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Table 4.16: Air Emissions from Scenario G Within the Metropolitan Area

Pollutant	2021 Base Case	Scenario G	Cumulative Change
	Emission (tonne)	Emission (tonne)	(%)
Nitrogen Oxides	13,076	12,836	-1.84%
Volatile Organic Compounds	20,394	19,840	-2.71%
Sulfur Dioxide	830	815	-1.73%
Carbon Monoxide	86,056	83,376	-3.11%
PM10	1,574	1,561	-0.83%
Carbon Dioxide Equivalents (Gg/year)	8,235	8,086	-1.86%

Ventilation stacks are likely to be required for the tunnels. The resulting emissions from surface roads and emitted through the tunnel stack are presented in Table 4.17. The emissions removed from surface level and emitted through the tunnel stack amount to less than 0.5% of total emissions. The impact of the emissions exiting the stack are unlikely to cause discernable impact on local areas providing that the stack is effectively designed. A recent report on monitoring of the City Link stacks and surrounding areas has shown that the impact of the stacks cannot be detected above the existing ambient levels.[2]

Table 4.17 Emissions Removed from Surface Roads and Released Through Stack

Pollutant	Emissions to Stack
	Tonne/year
Nitrogen Oxides	53
Volatile Organic Compounds	83
Sulfur Dioxide	3
Carbon Monoxide	350
PM10	6
Carbon Dioxide Equivalents (Gg/year)	53

Opportunities and Constraints

A constraint of this option is that ventilation stacks for the tunnels are likely to be required. The siting of ventilation stacks has a number of perceived and real issues that would need to be resolved.

Ventilation stacks are commonly located near the exit portals of tunnels. This placement conserves the energy required to vent exhausts as the one-way vehicle traffic movement creates a ‘piston effect’. Ventilation stacks have been situated in areas other than a portal, however any benefits for doing so would need to be weighed against the additional greenhouse gas emissions resulting from fan operation.

[2] EPA, 2002, “Annual Review of Air Quality Monitoring Data – CityLink Project”, Publication No. 864, July 2002.

Ventilation stack diameter, height, velocity and treatment would need to be determined during the preliminary engineering design. Plume dispersion modelling would also be required to show that the emissions from any proposed ventilation stacks meet the requirements of the State Environmental Protection Policy (Air Quality Management).

Impacts On NCCCS Area

Although the emissions generated from road traffic increase in this scenario, the actual impact on air pollution in the NCCCS region is difficult to quantify. The difficulty arises because the emissions that are generated in the tunnel are effectively removed from the ground level emissions. Air from the tunnel will be emitted from a stack at some height and with some velocity resulting in impacts at ground level that may be lower than that experienced previously. The location, height and exit velocity of the stack will primarily determine the impacts at ground level in the vicinity of the stack.

The NCCCS region will benefit significantly from the reduced travel by through traffic on the roads in the region. The reduced travel through the region results in approximately 0.4% of the ground level emissions from the metropolitan region. As most of this would be removed from within the NCCCS area a significant reduction in emissions at ground level would result.

Quantifying the impacts of the elevated emissions in comparison to the ground level emissions would require additional study including dispersion modelling of emissions from the stack.

Impact On Externalities

There are likely to be no significant impacts on air quality in areas outside the NCCCS region as most of the traffic in the tunnel would be removed from within the NCCCS region itself. External regions would benefit greatly from the use of the tunnel and the resulting improved travel times.

4.4 Summary of Findings

A summary of the findings of the assessment of the NCCCS scenarios in terms of total vehicle emissions as a percentage of existing conditions (2001) is presented in Table 4.17.

Emissions of the criteria pollutants reduce significantly over the period to 2020 despite a significant increase in vehicle travel. The reduction is a result of increasingly stringent vehicle emission requirements, new fuel standards and increased fuel efficiency.

Figures 4.1 and 4.2 present the assessment findings of the scenarios in terms of air quality and GHG emissions as a percentage of existing conditions (2001) and as percentage of Base Case conditions (2021), respectively.

Table 4.17: Total Vehicle Emissions (percent of 2001 value)

	2001	Base	A	B	D	F	G	F1	G1	G2	F2
Criteria Pollutants											
Nox	100.0%	30.3%	30.2%	30.2%	30.1%	29.7%	29.7%	29.7%	29.7%	29.7%	29.7%
NMVOC	100.0%	36.6%	36.0%	35.9%	35.8%	35.6%	35.6%	35.5%	35.6%	35.6%	35.5%
Sox	100.0%	27.5%	27.6%	27.6%	27.5%	27.1%	27.1%	27.1%	27.1%	27.1%	27.1%
CO	100.0%	24.8%	24.2%	24.2%	24.1%	24.0%	24.0%	24.0%	24.0%	24.0%	24.0%
PM10	100.0%	57.5%	58.5%	58.4%	58.3%	57.0%	57.0%	57.0%	57.0%	57.0%	57.0%
Greenhouse Gases											
CO_2	100.0%	103.1%	103.1%	103.1%	102.7%	101.2%	101.2%	101.2%	101.2%	101.2%	101.2%
CH_4	100.0%	89.3%	87.1%	87.0%	86.6%	86.3%	86.4%	86.3%	86.3%	86.4%	86.3%
N_2O	100.0%	127.4%	125.1%	125.0%	124.5%	123.7%	123.7%	123.6%	123.7%	123.7%	123.6%
CO_2E	100.0%	103.4%	103.4%	103.3%	103.0%	101.5%	101.5%	101.4%	101.5%	101.5%	101.5%
Total VKT	100.0%	134.1%	131.3%	131.2%	130.6%	130.0%	130.0%	129.9%	130.0%	130.1%	129.9%

4 Air Quality and Greenhouse Gas Emissions

Figure 4.1: Emissions of NOx, Particles and CO_2-e as a Percent of 2001 Emissions (note: scenario results are additive and include all previous scenarios)

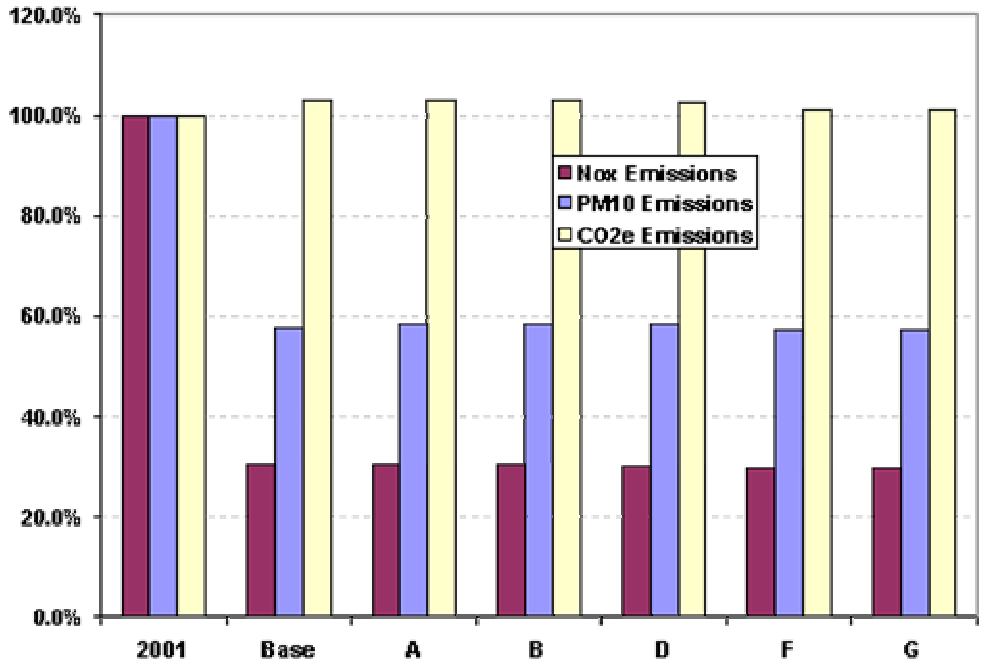
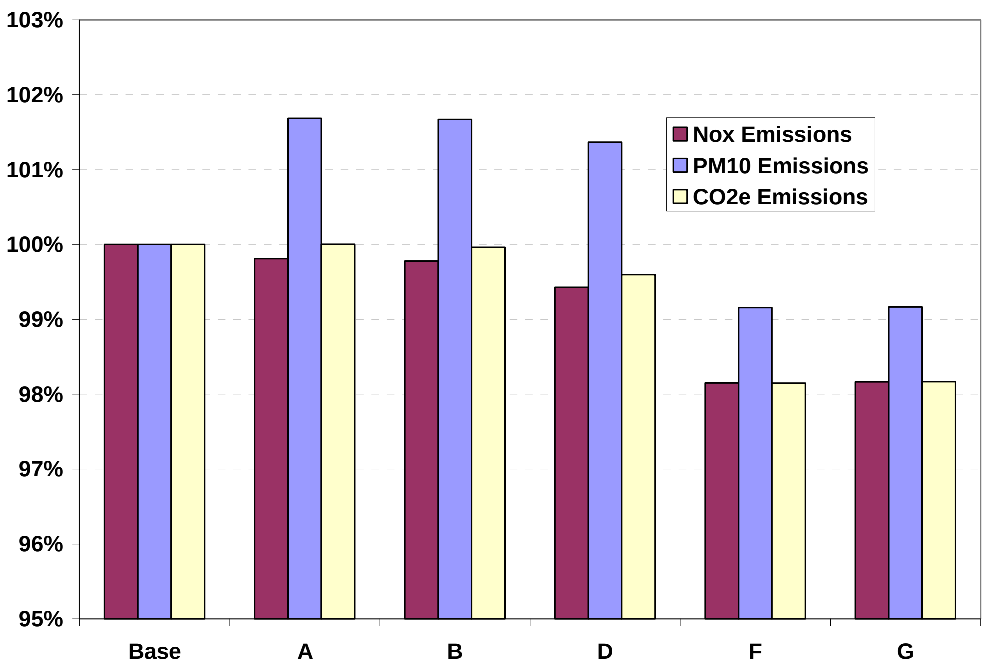


Figure 4.2: Emissions of NOx, Particles and CO_2-e as a Percent of Base 2021 Emissions (note: scenario results are additive and include all previous scenarios)



4 Air Quality and Greenhouse Gas Emissions

It should be noted that Figure 4.1 and 4.2 utilise significantly different scales.

The data presented in Figures 4.1 and 4.2 show a number of interesting trends in vehicle emissions. Compared to the 2001 levels, emissions of NOx and PM10 drop significantly by the 2021 Base Case, however following this the additional strategies have little impact in reducing the level of emissions. Greenhouse gas emissions increase by about 2% from 2001 to 2021 despite the improvements in fuel consumption. However, the modelled scenarios go some way to reducing these emissions particularly when the DART is introduced because of its impact on reducing road transport in general. In Strategy A and B much of the reduction in private traffic is picked up in bus travel and as a result the reduction in emissions is not as significant. This transfer to bus transport also has the effect of increasing particle emissions in Strategies A, B and D.

Overall, the air quality response to each of the strategies is relatively minor, and most of the impacts are a result of national programs aimed at reducing air emissions and greenhouse gas emissions. The air quality impacts of a particular strategy will only be a significant decision variable if large localised impacts can be identified.

5 Soil and Groundwater Contamination

5 Soil and Groundwater Contamination

5.1 Introduction

Over the years many different hazardous industries have been and still are located and operated within the study area. These industries include dye works, textile works, galvanising works, electroplating works, general metal works, tanneries, commercial printing works, breweries, maintenance and repair workshops, and general minor hazardous facilities. These industries present a continuing source of environmental concern, and are a potential cause of residual soil and groundwater contamination within the study area.

Although the study area is going through a period of gentrification with large areas of previously industrial land and infrastructure being re-zoned for residential and light commercial purposes, there is still potential for residual soil and groundwater contamination from historical and current operations to occur.

5.2 Assessment Methodology

5.2.1 Environmental Risk Assessment

A risk-based assessment based on Australian/New Zealand Standard AS/NZS 4360:1999 Risk Management, was adopted for appraisal of the scenarios proposed to increase public transport usage and reduce congestion levels within the inner north.

The risk assessment involved consideration of the sources of environmental hazards, their consequences and the likelihood that those consequences may occur. Potential environmental impacts were considered in relation to their effects on specific areas of significance, their frequency, duration and spatial impact.

The main elements of the risk assessment process are detailed below.

5.2.2 Criteria for Evaluation of Risks

Consequence and likelihood were adopted as the criteria for the evaluation of risks. The consequence of an environmental risk is the outcome of the risk, or the potential for adverse effects on the environment. Likelihood is often used as a qualitative description of probability and frequency in relation to the chance that something will occur. The likelihood of a specific outcome is expressed as the ratio of specific outcomes to the total number of possible outcomes. Likelihood is also expressed as the number of occurrences of an event in a given time. Given the preliminary nature of this Appraisal Study, a qualitative approach was adopted for the risk assessment.

Consequence

The criteria used to evaluate the potential consequences of an environmental risk are presented in Table 5.1.

5 Soil and Groundwater Contamination

Table 5.1: Qualitative Measures of Consequence

Level	Descriptor	Description
1	Insignificant	No lasting effect. Low-level impacts on biological or physical environment. Limited damage to minimal area of low significance
2	Minor	Minor effects on biological or physical environment. Minor short-medium term damage to small area of limited significance
3	Moderate	Moderate effects on biological or physical environment but not affecting ecosystem function. Moderate short-medium term widespread impacts
4	Major	Serious environmental effects with some impairment of ecosystem function (eg, displacement of a species). Relatively widespread medium-long term impacts
5	Catastrophic	Very serious environmental effects on highly valued species, habitat or ecosystem to the point of eradication. Long term, widespread effects on significant environment

Likelihood

The criteria used to evaluate the potential likelihood of an environmental risk are presented in Table 5.2.

Table 5.2: Qualitative Measures of Likelihood

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

Estimating Risk

In order to estimate the risk of an environmental issue, it is necessary to combine the severity of the consequence resulting from the impact as well as the likelihood of that consequence. Risk estimates were determined using the qualitative risk analysis matrix presented in Table 5.3, as defined in the AS/NZS 4360:1999.

Table 5.3: Qulitative Risk Analysis Matrix – Level of Risk

Likelihood	Consequence				
	Insignificant (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Catastrophic (5)**
Almost Certain (A)	H	H	S	S	S
Likely (B)	M	H	H	S	S
Moderate (C)	L	M	H	S	S
Unlikely (D)	L	L	M	H	S
Rare (E)	L	L	M	H	H

Legend: S = Significant Risk, H = High Risk, M = Moderate Risk, L = Low Risk

5 Soil and Groundwater Contamination

5.3 Assessment

The defined goals identified for a successful land use strategy for the study area include for the ‘protection and enhancement of biodiversity’. Performance indicators to measure ‘protection and enhancement of biodiversity’ include the ‘effect on soil/groundwater contamination’.

Each of the strategy scenarios A to G was assessed in terms of the ‘effect on soil/groundwater contamination’. In addition, the future Base Case scenario was also assessed in terms of the ‘effect on soil/groundwater contamination’. The assessment was based on a qualitative assessment of impacts, and assessment of enhancement opportunities. Appraisal of the strategy scenarios in terms of soil and groundwater contamination was undertaken by comparing the performance of each of the scenarios against the existing conditions (2001) as reported in *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001).

As previously noted, it is important to note that the strategy elements are indicative only. As such, the potential impacts of each of the strategies on soil/groundwater as identified below are those typically attributed to the elements. Where potential impacts have been identified, suitable mitigation measures to minimise potential impacts have been suggested.

5.3.1 Base Case (2021)

The future Base Case scenario represents a projection of expected travel and land use trends, with currently committed or highly likely transport infrastructure included. The initiatives listed under the future Base Case scenario are as presented in Table 2.5. In view of the large number of transport initiatives involved in the Base Case scenario, this assessment has investigated the potential impact of the overall scenario on soil/groundwater, rather than assessment of each of the transport initiatives involved in the scenario on an individual basis.

As there is potential for residual soil and groundwater contamination to occur within the study area (as a result of historical and current industrial activities), construction activities associated with the Base Case scenario have the potential to increase the risk of contamination through the exposure of contaminated soil or groundwater. Construction activities may also result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored and used on the construction site. In addition, there is also potential for construction works associated with the Base Case scenario to generate acid sulphate soils. Acid sulphate soils are typically associated with low-lying areas generally less than 5 metres above sea level that were deposited during the Holocene geological age, for example the Coode Island silt formation. Coode Island Silt deposits are known to be present in the North Melbourne area to the west of Flemington Road. Acid sulphate soils are soils, sediments or rock that contain elevated levels of metal sulphides (principally pyrite, FeS_2). Exposure of metal sulphides to oxygen, for example by drainage or excavation, can generate sulphuric acid which can result in the acidification of soils, groundwater and surface water.

5 Soil and Groundwater Contamination

Potential impacts of the major elements of the Base Case scenario on soil/groundwater are indicated in Table 5.4. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 5.10. It is noted that where there is potential for exposure of contaminated soil and groundwater, there are also potential opportunities for enhancement of soil and groundwater conditions. Enhancement opportunities may include the removal of contaminated material off-site, or the clean up of contaminated sites.

Table 5.4: Base Case – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impacts	Enhancement Opportunities
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites. Potential for additional protection from further contamination.
Various rail initiatives	Rail extensions	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Various tram initiatives	Tram extensions, route upgrades	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Various bus initiatives	Doncaster park and ride	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Improved bicycle and pedestrian network	Improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places.	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Limited potential for removal of contaminated soil.

5 Soil and Groundwater Contamination

It is assumed that detailed investigations of the potential impacts of each of the infrastructure projects involved in the Base Case scenario on soil/groundwater would be conducted as part of feasibility studies to be undertaken prior to any construction activity. It is also assumed that control measures to mitigate potential impacts due to the exposure of contaminated soil/groundwater/acid sulphate soils, or the contamination of soil/groundwater, would form part of infrastructure development requirements.

Mitigation measures to minimise impacts on soil/groundwater resulting from construction works associated with the Base Case scenario may include:

- Implementation of a Site Environmental Management Plan during construction.
- Any contaminated or acid sulphate soils produced as a result of construction works to be controlled and managed as described in the Environment Protection Authority *Industrial Waste Management Policy (Waste Acid Sulphate Soils)* (EPA 1999) and *Environmental Guidelines for Major Construction Projects* (EPA 1995).
- Any contaminated material excavated during construction works to be disposed to an approved landfill in accordance with the *Environment Protection (Prescribed Waste) Regulations 1998*. This includes using approved and EPA licensed contractors and a tracking system to ensure the waste has been accepted by a licensed treatment or disposal facility. Any material classified as "clean fill" or "solid inert" can be disposed at a normal landfill.
- Any contaminated soil or fill excavated is to be stockpiled away from other 'clean' soil. Potentially contaminated run-off from the stockpile should be limited by covering the pile with plastic or similar material. Potentially contaminated run-off from any contaminated fill remaining within the excavation should also be limited by minimising infiltration of stormwater onto the excavation. This should be undertaken by covering the excavated areas with plastic or similar and working quickly such that the excavation is open only for a short period of time
- All hazardous materials (oils, fuels and chemicals) required at works sites to be stored in accordance with relevant guidelines such as the *EPA Bunding Guidelines* and other regulations such as *Dangerous Goods (Storage and Handling Regulations 2000)*.
- Fuel and chemicals to be stored in appropriate areas, away from environmentally sensitive waterways.
- Facilities such as absorption materials or spill kits to be maintained on site to contain and recover any inadvertent spillage of fuels or chemicals.
- Any spillage of hazardous materials to be contained and cleaned up immediately, stockpiled separately and disposed of appropriately by a licensed contractor. Any contaminated soil arising from incidents during construction to be removed for treatment and/or disposal at an appropriate facility.
- Special precautions to be implemented if acid sulphate soils are discovered during construction activity. The hierarchy for management of acid sulphate soils is: minimise disturbance; prevent oxidation; treat to reduce acidity; re-use and dispose (EPA 1999).

5 Soil and Groundwater Contamination

It is likely that potential impacts on soil/groundwater arising from construction activities associated with the Base Case scenario will be minimal assuming that suitable mitigation measures such as those listed above are implemented.

5.3.2 Scenario A – Improved Public Transport

The aim of Scenario A is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

Both minor construction activities (eg construction of security fences and lighting), as well as more major construction works associated with station access improvements at metropolitan rail stations and modal interchanges within the vicinity of Melbourne University, will be associated with this strategy. As a result, there is potential for exposure of contaminated soils and/or groundwater to occur if these materials are present within the areas to be excavated. Construction activities may also result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored on site. Other components of the strategy, for example increase in tram frequency or increased reliability, will have little impact on contaminated soils and /or groundwater.

Potential impacts of the major elements of Scenario A on soil/groundwater are indicated in Table 5.5. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 5.10.

Table 5.5: Improved Public Transport – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Frequency Improvements	Increase in frequency of rail, tram and bus services	Not expected.	None expected.
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for exposure of contaminated soil/groundwater during excavation activities. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Limited potential for removal of contaminated material.
Improve Tram Frequencies	Increase in frequency of trams	Not expected.	None expected.
Route Upgrades	Reduced travel times, increased reliability	Not expected.	None expected.
Various Bus improvements	Increase in frequency of buses	Not expected.	None expected.

5 Soil and Groundwater Contamination

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below-ground bus interchange and walkway.	Potential for exposure of contaminated soil/groundwater during excavation activities. Potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material or clean up of contaminated sites.
Modal Interchanges – Railway Stations	Access improvements at Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material.
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material.
Changes to Bus Services	Increase in coverage and services	Not expected.	None expected.
Bus Priority on Hoddle Street	Bus priority lanes	Not expected.	None expected.

It is likely that potential impacts arising from Scenario A on soil/groundwater will be minimal assuming that suitable mitigation measures such as those listed in Section 6.3.1 above are implemented.

5.3.3 Scenario B – Reduced Traffic on Local Streets

The potential impacts of Scenario B on soil/groundwater include those resulting from reduced traffic on local roads through the diversion of traffic from local residential streets to the arterial road network.

Minor construction activities (eg construction of kerbs and small roundabouts) within existing road reserves will be associated with a reduction in traffic on local roads. As a result, there is limited potential for exposure of contaminated soils and/or groundwater to occur. There is also limited potential for construction activities to result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored on site.

5 Soil and Groundwater Contamination

The key elements and potential impacts of Strategy B on soil/groundwater are listed in Table 5.6 below. The likelihood, consequence and level of risk associated with this scenario are indicated in Table 5.10.

Table 5.6: Reduced Traffic on Local Streets – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Diversion of traffic away from local streets	Implementation of kerb stand-outs, small roundabouts etc	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material.

It is likely that potential impacts arising from Scenario B on soil/groundwater will be minimal assuming that suitable mitigation measures such as those listed in Section 5.3.1 above are implemented.

5.3.4 Scenario C – Improved Pedestrian and Bicycle Networks

The potential impacts of Scenario C on soil/groundwater include those resulting from improved pedestrian and bicycle networks through the study area.

Minor construction activities, generally within existing road reserves or footpaths, will be associated with the improvement of pedestrian and bicycle networks through the study area. As a result, there is limited potential for exposure of contaminated soils and/or groundwater to occur. There is also limited potential for construction activities to result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored on site.

The key elements of improved pedestrian and bicycle networks through the study area and potential impacts on spoil/groundwater are listed in Table 5.7 below. The likelihood, consequence and level of risk associated with this scenario are indicated in Table 5.10.

Table 5.7: Improved Pedestrian and Bicycle Networks – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Improved pedestrian network	Improved surfaces, footpath repair and replacement, reduced footpath clutter, sitting and propping places	Limited potential for exposure of contaminated soil/groundwater during excavation activities. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	Potential for removal of contaminated material.
Improvements to the Bicycle Network	Road resurfacing	Limited potential for spillage of hazardous material causing soil/groundwater contamination.	None expected.

It is likely that potential impacts arising from Scenario C on soil/groundwater will be minimal assuming that suitable mitigation measures such as those listed in Section 5.3.1 above are implemented.

5.3.5 Scenario D – Reduced Car Dependency

The potential impacts of Scenario D on soil/groundwater include those resulting from a reduction in the volume of car travel within the study area.

Reduced car dependency includes changes to local parking by limiting the amount of free parking space (increased metering) and the duration of parking (shortened parking times) throughout the study area. Reduced car dependency also includes behavioural changes resulting from targeted marketing to achieve a mode shift to green transport modes (eg TravelSMART).

There is little potential for impacts on soil/groundwater to occur as a result of Scenario D, however fewer cars may indeed enhance the local environment by reducing the risk attributed to contamination from cars.

5.3.6 Scenario E – Land Use Changes to Reduce Travel

The potential impacts of Scenario E on soil/groundwater include those resulting from land use changes within the study area designed to increase public transport usage and to reduce congestion levels.

Land use changes include limiting road and parking supply through the allocation of space and pricing. The availability of suitable new sites for car parking within the study area is limited by land values and the historic nature (and controls) of the study area.

5 Soil and Groundwater Contamination

> As there is little potential for the development of new car parking areas within the study area, potential impacts of land use changes on soil and groundwater are limited.

5.3.7 Scenario F – Rapid Transit on Eastern Freeway Corridor

The potential impacts of Scenario F on soil/groundwater include those resulting from the addition of a new rapid transit service from Doncaster Hill to the CBD, known as Doncaster Area Rapid Transit (DART).

DART is based on the development of a guided bus-way or light rail system from Doncaster Hill to Alexandra Parade. DART also includes:

- Major interchange at Doncaster Hill
- Interchanges at Doncaster Road, Bulleen Road and Chandler Highway
- Park and ride facilities
- Extension of dedicated bus lanes on Alexandra Parade

Major construction activities will be associated with DART, although the majority of these activities will generally occur outside the study area, for example construction of the interchanges at Doncaster Road, Bulleen Road and Chandler Highway. DART assumes that the construction of a guided bus-way or light rail system would occur within the central reservation of the Eastern Freeway and Alexandra Parade, and as such impacts on soil/groundwater will be minimal. There is potential for impacts on soil/groundwater to occur however, if excavation occurs in areas containing residual soil and groundwater contamination. In addition, there is also potential for construction works to generate acid sulphate soils. Construction activities may also result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored on site.

The key elements of the DART service and potential impacts on soil/groundwater are listed in Table 5.8 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 5.10.

Table 5.8: DART – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Guided Bus Way or Light Rail System	Concrete guided way for buses or light rail system within existing road reserve	Limited potential for exposure of contaminated soil/groundwater during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material.

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Major interchanges	Underground interchange at Doncaster Hill	Potential exposure of contaminated soil/groundwater (outside the study area) during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Park and Ride Facilities	Provision of parking spaces: Doncaster Road – 400 spaces, Bulleen Road – 300 spaces, Chandler Highway – 200 spaces	Potential exposure of contaminated soil/groundwater (outside the study area) during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Bus Lanes to Alexandra Parade	Extension of dedicated bus lanes	Minor.	Not expected.
Toll on the Eastern Freeway (Scenario F2)	Introduction of a toll	Not applicable.	Not applicable

It is likely that potential impacts on soil/groundwater arising from Scenario F will be minimal assuming that suitable mitigation measures such as those listed in Section 5.3.1 above are implemented.

5.3.8 Scenario G – Improved Arterial Road Network

The potential impacts of Scenario G on soil/groundwater include those resulting from the construction of a dual two lane deep tunnelled link from the Eastern Freeway east of Hoddle Street to near Flemington Road.

Major construction activities will be associated with the construction of a dual two lane deep tunnelled link. As a result, there is potential for exposure of contaminated soils and/or groundwater if present in the areas to be excavated. There is also potential for construction works associated with an improved arterial road network to generate acid sulphate soils. Construction activities may also result in the contamination of soil and/or groundwater through the spillage of hazardous materials (oils, fuels and chemicals) stored on site.

The tunnel link also has the potential to generate groundwater for disposal depending on the tunnel design. At this stage it is unknown whether the tunnel would be tanked (built to withstand ground water pressure and fully sealed thus preventing groundwater draw down) or drained (an unsealed tunnel; groundwater that penetrates the tunnel would be collected and pumped to an outfall). Any groundwater collected from the tunnel would require testing to determine its suitability for the proposed method of discharge (eg to sewer) or reuse.

5 Soil and Groundwater Contamination

The key elements of the tunnelled link and potential impacts on spoil/groundwater are listed in Table 5.9 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 5.10.

Table 5.9: Tunneled Link – Assessment of Potential Impacts on Soil/Groundwater

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to near Flemington Road	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Tunnel Connection	Potential requirement for groundwater discharge from tunnel	Potential exposure of contaminated groundwater.	Potential for treatment of contaminated groundwater.
Entry/Exit Portals	Entry/exit portals at Eastern Freeway and Elliot Avenue	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material, or clean up of contaminated sites.
Intermediate interchanges (Scenario G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for removal of contaminated material.
Optional Tunnel Access to CBD (Scenario G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Potential exposure of contaminated groundwater. Potential exposure of contaminated soil/ groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	Potential for treatment of contaminated groundwater. Potential for removal of contaminated material, or clean up of contaminated sites

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It is likely that potential impacts arising from Scenario G on soil/groundwater will be minimal assuming that suitable mitigation measures such as those listed in Section 5.3.1 above are implemented.

Additional mitigation measures may also include:

- Ongoing monitoring of groundwater discharged from the tunnel, if relevant.
- Monitoring of groundwater bores downstream of the tunnel.

5.4 Risk Assessment

Where potential impacts have been identified, the likelihood, consequence and level of risk for each of the strategy elements are indicated in Table 5.10. Table 5.10 also indicates potential for enhancement opportunities and presents a revised level of risk assuming that appropriate mitigation measures are implemented. It is important to note that the information presented in Table 5.10 is indicative only.

The criteria used to evaluate the potential consequences and likelihood of an environmental risk are presented in Tables 5.1 and 5.2, respectively. The level of risk was determined using the qualitative risk analysis matrix presented in Table 5.3

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Table 5.10: Risk Assessment of Potential Impacts on Soil Grounwater

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Base Case (2021)								
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	2	B	H	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	M
Various rail initiatives	Rail extensions	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	2	B	H	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	M
Various tram initiatives	Tram extensions, route upgrades	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	2	C	M	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Various bus initiatives	Doncaster park and ride facilities	Potential for exposure of contaminated soil/groundwater and/or acid sulphate soils (outside the study area) during excavation. Potential for spillage of hazardous material causing soil/groundwater contamination.	2	C	M	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Improved bicycle and pedestrian network	Improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places.	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	D	L	Limited potential for removal of contaminated soil.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Scenario A								
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for exposure of contaminated soil/groundwater during excavation activities. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	C	L	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below ground bus interchange and walkway.	Potential for exposure of contaminated soil/groundwater during excavation activities. Potential for spillage of hazardous material causing soil/groundwater contamination.	2	C	M	Potential for removal of contaminated material or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Modal Interchanges – Railway Stations	Access improvements at Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	2	C	M	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	D	L	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Scenario B								
Diversion of traffic away from local streets	Implementation of kerb stand-outs, small roundabouts etc	Limited potential for exposure of contaminated soil/groundwater during excavation. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	D	L	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Scenario C								
Improved pedestrian network	Improved surfaces, footpath repair and replacement, reduced footpath clutter, sitting and propping places	Limited potential for exposure of contaminated soil/groundwater during excavation activities. Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	D	L	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Improvements to the Bicycle Network	Road resurfacing	Limited potential for spillage of hazardous material causing soil/groundwater contamination.	1	D	L	None expected.	All site works to be undertaken in accordance best practice guidelines.	L
Scenario F								
Guided Bus Way or Light Rail System	Concrete guided way for buses or light rail system within existing road reserve	Limited potential for exposure of contaminated soil/groundwater (outside the study area) during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	D	L	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines.	L

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Major interchanges	Underground interchange at Doncaster Hill	Potential for exposure of contaminated soil/groundwater (outside the study area) during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	C	M	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines.	L
Park and Ride Facilities	Provision of parking spaces: Doncaster Road – 400 spaces, Bulleen Road – 300 spaces, Chandler Highway – 200 spaces	Potential exposure of contaminated soil/groundwater (outside the study area) during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	C	M	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines.	L
Scenario G								
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to near Flemington Road	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	3	C	H	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	M

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Tunnel Connection	Potential requirement for groundwater discharge from tunnel	Assuming that groundwater is discharged appropriately according to groundwater quality. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	C	M	Potential for treatment of contaminated groundwater.	Ongoing monitoring of groundwater pumped from tunnel.	L
Entry/Exit Portals	Exit/entry portals at Eastern Freeway and Elliot Avenue	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	D	L	Potential for removal of contaminated material, or clean up of contaminated sites.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L
Intermediate interchanges (G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Potential exposure of contaminated soil/groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	2	C	M	Potential for removal of contaminated material.	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	L

5 Soil and Groundwater Contamination

Strategy component	Elements	Potential Impacts	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Optional tunnel Access to CBD (G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Potential exposure of contaminated groundwater. Potential exposure of contaminated soil/ groundwater and/or acid sulphate soils during excavation activities. Potential for spillage of hazardous material causing soil/ groundwater contamination.	3	C	H	Potential for treatment of contaminated groundwater. Potential for removal of contaminated material, or clean up of contaminated sites	All site works to be undertaken in accordance best practice guidelines. Contaminated soils and acid sulphate soils to be controlled and managed in accordance with EPA guidelines.	M

5 Soil and Groundwater Contamination

5.5 Overall Risk

The overall risk of each of the scenarios in terms of impacts on soil/groundwater (as compared with the previous scenario) is presented in Table 5.11.

Table 5.11: Overall Risk – Impacts on Soil/Groundwater

Scenario	Overall Individual Risk
Base Case	Medium
A	Low
B	Low
C	Low
D	Low
E	Low
F	Low
G	Medium

Of the various strategies assessed, the greatest impact on soil/groundwater is associated with the do-nothing option (Base Case) and the tunnelled link (Scenario G) due to the level of high construction activities associated with these two scenarios. However, it can be assumed that potential impacts on soil/groundwater arising from all scenarios can be mitigated with the implementation of suitable control measures.

6 Vegetation and Habitat

6 Vegetation and Habitat

6.1 Introduction

The study area has been extensively developed for a significant period of time, however a small amount of native vegetation and fauna habitat remains, generally located along waterways and within some of the parks within the study area. In addition, several of the streets and spaces in the study area have significant plantings of natives, including some mature trees, for example Neil Street and parts of Alexandra Parade.

The present occurrence of fauna habitat in the study area largely parallels the distribution of remnant native vegetation, in that the bulk of the remaining habitat occurs along the Yarra River and Merri Creek, with some valuable bird habitat in the River Red Gum stands at Royal Park.

Although there are relatively few flora and fauna values remaining in the study area, any proposal within the area will need to meet the relevant legislative and policy requirements.

6.2 Assessment Methodology

A risk-based assessment based on Australian/New Zealand Standard AS/NZS 4360:1999 Risk Management, was adopted for appraisal of the scenarios proposed to increase public transport usage and reduce congestion levels within the inner north, as detailed in Section 5.2.

6.3 Assessment

The defined goals identified for a successful land use strategy for the study area include for the ‘protection and enhancement of biodiversity’. The performance indicators identified to assess each of the scenarios in terms of vegetation and habitat are as follows:

- Effect on natural habitats; and
- Effect on exotic habitats

These two performance indicators have been addressed as a single component as part of this assessment. The only exotic habitats within the study area are artificial wetlands associated with parks and gardens (eg Melbourne Zoo) that provide habitat for waterbirds but which have few or no flora values. None of these exotic habitats will be impacted by the proposed land use scenarios.

The effect on natural habitats for each of the scenarios was assessed through the qualitative assessment of impacts and identification of enhancement opportunities. It is noted that at this stage of the study, only an assessment can be made of the likely impacts of each of the strategy options on vegetation and habitat, based on the likely areas of the study area to be affected. As previously noted, it is important to note that the strategy elements are indicative only. As such, the quantification of areas to be affected has not been adopted as the assessment criteria for this assessment stage.

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Where potential impacts have been identified, suitable mitigation measures to minimise potential impacts have been suggested.

Once specific options are developed it would be desirable to undertake a field assessment to determine the actual values present at any sites to be affected and to quantify the areas to be effected. Depending on the level of certainty required in assessing the options, this could range from a reconnaissance level assessment, from which indicative potential impacts could be assessed, to the collection of detailed survey data at a level suitable for a full environmental impact assessment.

Appraisal of the strategy initiatives in terms of vegetation and habitat was undertaken by comparing the performance of each of the scenarios against the previous scenario. For the Base Case (2021) scenario, the appraisal was conducted by a comparison with the existing vegetation and habitat conditions (2001) as reported in *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001).

6.3.1 Base Case (2021)

The Base Case scenario represents a projection of expected travel and land use trends, with currently committed or highly likely transport infrastructure included. The initiatives listed under the future Base Case are as presented in Table 2.2.

In view of the large number of transport initiatives involved in the Base Case scenario, this assessment has investigated the potential impact of the overall scenario on vegetation and habitat rather than assessment of each of the transport initiatives involved in the scenario on an individual basis.

The majority of native vegetation and fauna habitat that remains within the study area is located along the waterways and within some of the parks. As a result, the implementation of any infrastructure project under the Base Case scenario that infringes on these areas has the potential to result in loss of native vegetation and habitat.

Potential impacts of the major elements of the Base Case scenario on vegetation and habitat are indicated in Table 6.1. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 6.6. It is noted that where there is potential for impacts on vegetation and habitat, there are also potential opportunities for enhancement of biodiversity.

Table 6.1: Base Case – Assessment of Potential Impacts on Vegetation and Habitat

Strategy Component	Elements	Potential Impact	Enhancement Opportunities

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Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Potential for loss of vegetation and habitat in existing road reserves or where new road corridors pass through native vegetation.	Potential for enhancement of native vegetation and habitat in the vicinity of the works.
Various rail initiatives	Rail extensions	Potential for loss of vegetation and habitat where new rail corridors pass through native vegetation.	Potential for enhancement of native vegetation and habitat in the vicinity of the works.
Various tram initiatives	Tram extensions, route upgrades	No impacts expected as tram extensions will occur in existing road reserves.	Not applicable.
Various bus initiatives	Doncaster park and ride	Potential for loss of vegetation and habitat (outside the study area) where facilities are located in native vegetation.	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.
Improved bicycle and pedestrian network	Improved surfaces, foot path repair and replacement, Reduced foot path clutter, sitting and propping places	Limited potential for loss of native vegetation and habitat as a result of establishment of sitting and/or propping places.	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.

It is assumed that investigations into the potential impact of the infrastructure projects involved in the Base Case scenario on vegetation and habitat would be conducted as part of feasibility studies to be undertaken prior to any construction works. It is also assumed that control measures to mitigate potential impacts on vegetation and habitat would form part of the development requirements.

Mitigation measures to minimise impacts on vegetation and habitat resulting from construction works associated with the Base Case scenario may include:

- Implementation of a Site Environmental Management Plan during construction.
- Limit the area affected by the construction works to the smallest possible area.
- Confine works to existing disturbed areas where possible.
- Where significant vegetation clearance is required, consultation with local NRE contact officers will be required.
- Implementation of a weed control program.
- Compensation areas to be planted and maintained in accordance with the No Net Loss/Net Gain principles.

6.3.2 Scenario A - Improved Public Transport

The aim of Scenario A is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

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Minor construction activities (eg construction of security fences and lighting) will be associated with this scenario. Construction works will also be undertaken as part of station access improvements at metropolitan rail stations and modal interchanges within the vicinity of Melbourne University. Where works are proposed in existing urbanized areas, potential for impacts on vegetation and habitat will be unlikely. Other components of the scenario, for example increase in tram frequency and improved reliability, will have no impact on vegetation and habitat.

The key elements of this scenario and their potential impact on vegetation and habitat are listed in Table 6.2 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 6.6.

Table 6.2: Improved Public Transport – Assessment of Potential Impacts on Vegetation and Habitat

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Frequency Improvements	Increase in the frequency of rail, tram and bus services	Not expected.	Not applicable.
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for loss of native vegetation and habitat.	Not expected.
Improve Tram Frequencies	Increase in frequency of trams	Not expected.	Not applicable.
Route Upgrades	Reduced travel times, increased reliability	Not expected.	Not applicable.
Various Bus improvements	Increase in frequency of buses	Not expected.	Not applicable.
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below-ground bus interchange and walkway.	Potential for loss of native vegetation and habitat.	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.
Modal Interchanges – Railway Stations	Access improvements at Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	Limited potential for loss of native vegetation and habitat.	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for loss of native vegetation and habitat.	Not expected.
Changes to Bus Services	Increase in coverage and services	Not expected.	Not expected.

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Bus Priority on Hoddle Street	Bus priority lanes	Not expected.	Not expected.

It is likely that potential impacts on vegetation and habitat arising from Scenario A will be minimal assuming that suitable mitigation measures such as those listed in Section 6.3.1 above are implemented.

6.3.3 Scenario B – Reduced Traffic on Local Streets

The potential impacts of Scenario B on vegetation or habitat include those resulting from reduced traffic on local roads through the diversion of traffic from local residential streets to the arterial road network.

The reduction of traffic on local streets includes measures such as the implementation of kerb out-stands and small roundabouts within existing road reserves.

As such, there would be very few likely impacts on native vegetation or habitat or potential biodiversity enhancement opportunities associated with a reduction in traffic on local streets.

6.3.4 Scenario C – Improved Pedestrian and Bicycle Networks

The potential impacts of Scenario C on vegetation or habitat include those resulting from an improvement in pedestrian and bicycle networks through the study area.

Minor construction activities (eg improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places) will be associated with an improvement in pedestrian and bicycle networks through the study area. Many of the pedestrian and cycle paths within the study area traverse parks and gardens, as well as running alongside the Yarra River, Merri Creek and Moonee Ponds Creek. These areas typically support the small amount of native vegetation and fauna habitat that remains within the study area. As a result, there is potential for impacts on native vegetation and habitat arising from construction activities to occur. However, construction activities are likely to be minor and are likely to affect only a limited area.

The key elements of improved pedestrian and bicycle networks and their potential impact on native vegetation and habitat are listed in Table 6.3 below. Where impacts have been identified, the likelihood and consequence of potential impacts, and the level of risk are indicated in the Table 6.6.

Table 6.3: Improved Pedestrian and Bicycle Networks – Assessment of Potential Impacts on Vegetation and Habitat

Strategy Component	Elements	Potential Impact	Enhancement Opportunities

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Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Improved pedestrian network	Improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for loss of native vegetation and habitat as a result of establishment of sitting and/or propping places.	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.
Improvements to the Bicycle Network	Road resurfacing	Not expected.	Not expected

It is likely that potential impacts on vegetation and habitat arising from Scenario C will be minimal assuming that suitable mitigation measures such as those listed in Section 6.3.1 above are implemented.

6.3.5 Scenario D – Reduced Car Dependency

The potential impacts of Scenario D on vegetation or habitat include those resulting from a reduction in the volume of car travel within the study area. Reduced car dependency includes changes to local parking by limiting the amount of free parking space (increased metering) and the duration of parking (shortened parking times) throughout the study area. Reduced car dependency also includes behavioural changes resulting from targeted marketing to achieve a mode shift to green transport modes (eg TravelSMART).

There are very few likely impacts on native vegetation and habitat, or potential biodiversity enhancement opportunities associated with a reduction in the volume of car travel within the study area.

6.3.6 Scenario E – Land Use Changes to Reduce Travel

The potential impacts of Scenario E on vegetation or habitat include those resulting from land use changes within the study area designed to increase public transport usage and to reduce congestion levels.

Land use changes include limiting road and parking supply through the allocation of space and pricing. The availability of suitable new sites for car parking within the study area is limited by land values and the historic nature (and controls) of the study area.

As there is little potential for the development of new car parking areas within the study area, potential impacts of land use changes on vegetation and habitat will be limited.

6.3.7 Scenario F – Rapid Transit on Eastern Freeway Corridor

The potential impacts of Scenario F on vegetation or habitat include those resulting from the addition of a new rapid transit service from Doncaster Hill to the CBD, known as Doncaster Area Rapid Transit (DART). DART is based on the development of a guided bus-way or light rail system from Doncaster Hill to Alexandar Parade. DART also includes:

- Major interchange at Doncaster Hill
- Interchanges at Doncaster Road, Bulleen Road and Chandler Highway
- Park and ride facilities
- Extension of dedicated bus lanes on Alexandar Parade

Major construction activities will be associated with DART, although the majority of these activities will generally occur outside the study area, for example construction of the interchanges at Doncaster Road, Bulleen Road and Chandler Highway. DART assumes that the construction of a guided bus-way or light rail system would occur within the central reservation of the Eastern Freeway and as such impacts on native vegetation or habitat would be minimal. There is potential for impacts on native vegetation and habitat to occur however, if native vegetation and/or habitat is present within works areas outside existing road reserves, for example at interchanges or along roads such as Alexandra Parade where mature trees occur.

The key elements of the DART system and potential impacts on native vegetation and habitat are listed in Table 6.4 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 6.6.

Table 6.4: DART – Assessment of Potential Impacts on Vegetation and Habitat

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Guided Bus Way or Light Rail System	Concrete guided way for buses or light rail system within existing road reserve.	Unlikely to occur - works within existing road reserves	Not expected.
Major Interchanges	Underground interchange at Doncaster Hill	Potential for loss of native vegetation and habitat (outside the study area) as a result of proposed works.	Potential for enhancement of native vegetation and habitat in the vicinity of the works.
Park and Ride Facilities	Bus feeder and park and ride facilities at Doncaster Road, Bulleen Road and Chandler Highway	Potential for loss of native vegetation and habitat (outside the study area) as a result of proposed works.	Potential for enhancement of native vegetation and habitat in the vicinity of the works.
Bus Lanes to Alexandra Parade	Extension of dedicated bus lanes	Potential for loss of mature trees along Alexandra Parade.	Not expected.
Toll on the Eastern Freeway (Scenario F2)	Introduction of a toll	Not applicable.	Not applicable.

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It is likely that potential impacts on vegetation and habitat arising from Scenario F will be minimal assuming that suitable mitigation measures such as those listed in Section 6.3.1 above are implemented.

6.3.8 Scenario G – Improved Arterial Road Network

The potential impacts of Scenario G on vegetation or habitat include those resulting from the construction of a dual two lane deep tunnelled link from the Eastern Freeway east of Hoddle Street to near Flemington Road.

Major construction activities will be associated with the construction of a dual two lane deep tunnelled link. As a result, there is potential for impacts on native vegetation and habitat, if present within works areas. Surface construction in the vicinity of the tunnel portals will generally take place in existing road reservations. However, it is anticipated that construction would be required in two areas outside existing road reserves. These areas are:

- Land in the vicinity of the westbound exit portal at Racecourse Road; and
- Land in Royal Park in the vicinity of the eastbound entry portal near Flemington Road.
- Mature trees in the median of Alexandra Parade between Smith and Nicholson Street's.

As discussed in the *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, 2001), Royal Park contains remnant River Red Gums stands that are of high local to regional significance, depending on their condition. The River Red Gums provide valuable bird habitat within the study area. Depending on the area of land to be affected by the proposed works in the vicinity of the eastbound entry portal near Flemington Road, there is potential for native vegetation and habitat within Royal Park to be impacted. It is suggested that further field assessment would be required in the vicinity of the proposed portal works to determine the actual values of vegetation and habitat present at the site. As previously stated, at this stage of the study only an assessment can be made of the likely impacts of each strategy on flora and fauna. Control measures to mitigate potential impacts on native vegetation and habitat would be required as part of the development requirements.

The key elements of the tunnelled link and their potential impact on native vegetation and habitat are listed in Table 6.5 below. The likelihood and consequence of potential impacts, and the level of risk are indicated in Table 6.6.

Table 6.5: Tunneled Link – Assessment of Potential Impacts on Vegetation and Habitat

Strategy Component	Elements	Potential Impact	Enhancement Opportunities

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Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to near Flemington Road	Unlikely to occur as tunnel will be bored.	Not expected.
Exit / Entry Portals	Entry/exit portals at Eastern Freeway and Elliot Avenue	Potential for loss of native vegetation and habitat, particularly at Royal Park.	Potential for enhancement of native vegetation and habitat in the vicinity of the works.
Intermediate interchanges (Scenario G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Limited potential for loss of vegetation and habitat.	Limited potential for enhancement of vegetation and habitat in the vicinity of the works.
Optional Tunnel Access to CBD (Scenario G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Unlikely to occur if works within existing road reserves	Not expected.

It is likely that potential impacts on vegetation and habitat arising from Scenario G will be minimal assuming that suitable mitigation measures such as those listed in Section 6.3.1 above are implemented.

6.4 Risk Assessment

Where potential impacts have been identified, the likelihood, consequence and level of risk for each of the strategy elements are indicated in Table 6.6 also indicates the potential for enhancement opportunities and presents a revised level of risk assuming that appropriate mitigation measures are implemented. It is important to note that the information presented in Table 6.6 is indicative only.

Table 6.6: Risk Assessment of Potential Impacts on Vegetation and Habitat

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Base Case (2021)								
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Potential for loss of native vegetation and habitat in existing road reserves or where new road corridors pass through native vegetation.	3	C	H	Potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	M
Various rail initiatives	Rail extensions	Potential for loss of native vegetation and habitat where new rail corridors pass through native vegetation.	3	C	H	Potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	M
Various bus initiatives	Doncaster park and ride	Potential for loss of native vegetation and habitat (outside the study area) where facilities are located in native vegetation.	2	C	M	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	L
Improved bicycle and pedestrian network	Improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for loss of native vegetation and habitat as a result of establishment of sitting and/or propping places.	2	D	L	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	L

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Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Scenario A								
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for loss of native vegetation and habitat.	1	E	L	Not expected.	All site works to be undertaken in accordance best practice guidelines.	L
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below ground bus interchange and walkway.	Potential for loss of native vegetation and habitat.	2	C	M	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	
Modal Interchanges – Railway Stations	Access improvements at Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	Limited potential for loss of native vegetation and habitat.	1	D	L	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	L
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for loss of native vegetation and habitat as a result of works.	1	E	L	Not expected.	All site works to be undertaken in accordance best practice guidelines.	L
Scenario C								
Improved pedestrian network	Improved surfaces, foot path repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for loss of native vegetation and habitat as a result of establishment of sitting and/or propping places	2	D	L	Limited potential for enhancement of native vegetation and habitat in the vicinity of the works	All site works to be undertaken in accordance best practice guidelines.	L

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Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Scenario F								
Major Interchanges	Underground interchange at Doncaster Hill.	Potential for loss of native vegetation and habitat (outside the study area) as a result of proposed works.	2	C	M	Potential for enhancement of native vegetation and habitat in the vicinity of the works	All site works to be undertaken in accordance best practice guidelines.	L
Park and Ride Facilities	Bus feeder and park and ride facilities at Doncaster Road, Bulleen Road and Chandler Highway	Potential for loss of native vegetation and habitat (outside the study area) as a result of proposed works.	2	C	M	Potential for enhancement of native vegetation and habitat in the vicinity of the works	All site works to be undertaken in accordance best practice guidelines.	L
Bus Lanes to Alexandra Parade	Extension of dedicated bus lanes.	Potential for loss of mature trees along Alexandra Parade.	2	C	M	Not expected	All site works to be undertaken in accordance best practice guidelines.	M
Scenario G								
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to near Flemington Road	Unlikely to occur as tunnel will bored.	2	D	L	Not expected.	All site works to be undertaken in accordance best practice guidelines.	L
Exit / Entry Portals	Numerous exit/entry portals at Eastern Freeway and Elliot Avenue	Potential for loss of native vegetation and habitat particularly at Royal Park.	3	B	H	Potential for enhancement of native vegetation and habitat in the vicinity of the works	All site works to be undertaken in accordance best practice guidelines.	M

6 Vegetation and Habitat

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Intermediate interchanges (Scenario G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Limited potential for loss of vegetation and habitat.	2	D	L	Limited potential for enhancement of vegetation and habitat in the vicinity of the works.	All site works to be undertaken in accordance best practice guidelines.	L
Optional Tunnel Access to CBD (Scenario G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Unlikely to occur if works within existing road reserves.	2	D	L	Not expected.	All site works to be undertaken in accordance best practice guidelines.	L

6 Vegetation and Habitat

6.5 Overall Risk

The overall risk of each of the scenarios in terms of impacts on vegetation and habitat (as compared with the previous scenario) is presented in Table 6.7.

Table 6.7: Overall Risk – Impacts on Vegetation and Habitat

Scenario	Overall Risk
Base Case	Medium
A	Low
B	Low
C	Low
D	Low
E	Low
F	Medium
G	Medium

Of the various strategies assessed, the greatest impact on vegetation and habitat is associated with the do-nothing option (Base Case) and the tunnelled link (Scenario G) due to the level of high construction activities associated with these two scenarios. Impacts on specific areas of native vegetation and habitat arising from the Base Case scenario have not been assessed in detail as part of this study, and as such it is not possible to identify areas of native vegetation and habitat that may potentially be impacted. In the case of Scenario G, potential impacts on vegetation and habitat within Royal Park may occur.

7 Stormwater and Water Quality

7 Stormwater and Water Quality

7.1 Introduction

In urban catchments, stormwater is a major contributor to the pollution of receiving natural waterways. Further urbanisation of the study area has the potential to cause contamination of local waterways due to urban stormwater runoff. There is also potential for modified flow regimes resulting from increased hard surfaces (leading to higher velocities and volumes of stormwater) to contribute to erosion and reduced stream health.

7.2 Assessment Methodology

A risk-based assessment based on Australian/New Zealand Standard AS/NZS 4360:1999 Risk Management, was adopted for appraisal of the scenarios proposed to increase public transport usage and reduce congestion levels within the inner north, as detailed in Section 5.2.

7.3 Assessment

The environmental strategy goals to protect and enhance environmental sustainability in the inner north include for the 'protection and enhancement of biodiversity'. The performance indicator identified to assess each of the strategy initiatives in terms of water quality is 'effect on water quality'.

The effect on water quality for each of the strategy initiatives has been assessed through the qualitative assessment of impacts and enhancement opportunities.

As identified in the *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001), the study area is bounded by Moonee Ponds Creek to the west, the Yarra River to the east, and Merri Creek to the northeast, forming the lower reaches of the Yarra catchment. The Yarra River channel within the study area has been modified considerably as a result of urbanisation.

Water quality in Moonee Ponds Creek and Merri Creek was graded as fair to poor in 1999 according to the *State Environment Protection Policy (Waters of Victoria) 1988* objectives. Poor water quality in Moonee Ponds Creek is attributed to nutrient and bacterial contamination possibly arising from sewer leaks or intermittent sewer spills during high flows. Poor physical stream condition, low flows and industry in the northern suburbs are considered to be the dominant factors contributing to the poor health of certain parts of the Merri Creek catchment.

Appraisal of the future development scenarios on water quality has been undertaken by comparing the performance of each of the scenarios against the previous scenario. For the Base Case scenario, the appraisal was conducted by a comparison with the existing conditions as reported in *Northern Central City Corridor Study – Environment Component, Existing Conditions Report* (Maunsell McIntyre, September 2001).

7 Stormwater and Water Quality

As previously noted, it is important to note that the strategy elements are indicative only. As such, the potential impacts of each of the strategies on water quality as identified below are indicative only. Where potential impacts have been identified, suitable mitigation measures to minimise potential impacts have been suggested.

7.3.1 Base Case (2021)

The Base Case scenario represents a projection of expected travel and land use trends, with currently committed or highly likely transport infrastructure included. The initiatives listed under the future Base Case are as presented in Table 2.5.

In view of the large number of transport initiatives involved in the Base Case scenario, this assessment has investigated the potential impact of the overall scenario on, water quality rather than assessment of each of the transport initiatives involved in the scenario on an individual basis.

The implementation of the transport initiatives listed under the Base Case has the potential to further increase the urbanisation of the study area by replacing non-urbanised areas with impervious urban surfaces. This may occur where the transport initiatives include for road widening, freeway extensions, new roads and new rail lines, for example. Urbanisation, and an increase in the area of impervious surfaces, may lead to:

- higher volumes of runoff (as a result of reduced infiltration);
- more frequent high flow level events in local waterways;
- reduced lag time between rainfall events and runoff reaching local waterways (as a result of channelising and piping of flows); and
- reduced groundwater inflows to streams during dry weather.

Modified flow regimes resulting from increased hard surfaces (leading to higher velocities and volumes of stormwater) may contribute to erosion of local waterways and a reduction in stream health. Increased stormwater flows and velocities may also lead to increased pollutant loadings (eg litter, suspended solids, nutrients, bacteria and toxicants) resulting in contamination of local waterways.

Potential impacts of the overall Base Case scenario on water quality are indicated in Table 7.1. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 7.6. It is noted that where there is potential for impacts on water quality, there are also potential opportunities for enhancement of water quality. Enhancement opportunities may include the implementation of structural controls such as litter traps.

7 Stormwater and Water Quality

Table 7.1: Base Case – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Various rail initiatives	Rail extensions	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Various tram initiatives	Tram extensions, route upgrades	Potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.
Various bus initiatives	Doncaster park and ride	Potential for increased stormwater due to increase in impervious surfaces (outside the study area). Potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.
Improved bicycle and pedestrian network	Improved surfaces, footpath repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.

It is assumed that investigations into the potential impact of each of the initiatives on water quality would be conducted as part of feasibility studies to be undertaken prior to any construction works. It is also assumed that mitigation measures would form part of the development requirements where potential impacts on water quality have been identified.

Mitigation measures to minimise impacts on water quality resulting from construction works associated with the Base Case scenario may include:

- Implementation of a Site Environmental Management Plan during construction.
- Installation of appropriate controls to contain sediment run-off.
- All site works to be undertaken in accordance with the *Environmental Guidelines for Major Construction Projects* (EPA 1995).
- Confine all land disturbances to a minimum practical working area and to the vicinity of the construction site.

- Stockpiles to be located away from drainage lines and stabilised as soon as possible.

7.3.2 Scenario A – Improved Public Transport

The aim of Scenario A is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

Minor construction activities (eg construction of security fences and lighting, improved bicycle storage and installation of weather protection on walkways) will be associated with this scenario. Construction works will also be associated with station access improvements at metropolitan rail stations and modal interchanges within the vicinity of Melbourne University. These works are proposed in existing urbanized areas, and as a result, potential for impacts on water quality as a result of increased stormwater flows (due to increased impervious surfaces) will be minimal. Potential impacts on water quality arising from contaminated stormwater runoff during construction are also unlikely assuming that adequate control measures are implemented during construction. Other components of the scenario, for example increases in tram frequency and reliability, will have little impact on water quality.

The key elements of the strategy and potential impacts on water quality are listed in Table 7.2 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 7.7.

Table 7.2: Improved Public Transport – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Frequency Improvements	Increase in the frequency of rail, tram and bus services	Minor impacts expected	Not expected.
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.
Improve Tram Frequencies	Increase in frequency of trams	Not expected.	Not expected.
Route Upgrades	Reduced travel times, increased reliability	Not expected.	Not expected
Various Bus improvements	Increase in frequency of buses	Not expected.	Not expected.

7 Stormwater and Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below-ground bus interchange and walkway.	Potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Modal Interchanges – Railway Stations	Access improvements at Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	Consideration of stormwater issues during design stage.
Changes to Bus Services	Increase in coverage and services	Not expected.	Not expected.
Bus Priority on Hoddle Street	Bus priority lanes	Not expected.	No expected.

It is likely that potential impacts on water quality arising from Scenario A will be minimal assuming that suitable mitigation measures such as those listed in Section 7.3.1 above are implemented.

7.3.3 Scenario B – Reduced Traffic on Local Streets

The potential impacts of Scenario B on water quality include those resulting from reduced traffic on local roads through the diversion of traffic from local residential streets to the arterial road network.

The reduction of traffic on local streets includes measures such as the implementation of kerb out-stands and small roundabouts. These works are proposed in urbanized areas, and as a result, potential for impacts on water quality as a result of increased flows (due to increased impervious surfaces) will be minimal. Potential impacts on water quality arising from contaminated stormwater runoff during construction are also unlikely assuming that adequate control measures are implemented during construction.

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The key elements of reduced traffic on local roads and their potential impact on water quality are listed in Table 7.3 below. The likelihood and consequence of potential impacts, and the level of risk are indicated in Table 7.7.

Table 7.3: Reduced Traffic on Local Streets – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Diversion of traffic away from local streets	Implementation of kerb stand-outs, small roundabouts etc	Limited potential for runoff off contaminated stormwater during construction.	Not expected.

It is likely that potential impacts on water quality arising from Scenario B will be minimal assuming that suitable mitigation measures such as those listed in Section 7.3.1 above are implemented.

7.3.4 Scenario C – Improved Pedestrian and Bicycle Networks

The potential impacts of Scenario C on water quality include those resulting from improved pedestrian and bicycle networks through the study area.

Minor construction activities (eg improved surfaces, footpath repair and replacement, reduced foot path clutter, sitting and propping places) will be associated with an improvement of pedestrian and bicycle networks. There is limited potential for an increase in impervious areas to occur. Potential impacts on water quality arising from contaminated stormwater runoff during construction are unlikely assuming that adequate control measures are implemented during construction.

The key elements of improved pedestrian and bicycle networks and their potential impact on water quality are listed in Table 7.4 below. The likelihood and consequence of potential impacts, and the level of risk are indicated in Table 7.7.

Table 7.4: Improved Pedestrian and Bicycle Networks – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Improved pedestrian network	Improved surfaces, footpath repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	Not expected.
Improvements to the Bicycle Network	Road resurfacing	Potential for runoff off contaminated stormwater during construction.	Not expected.

7 Stormwater and Water Quality

It is likely that potential impacts on water quality arising from Scenario C will be minimal assuming that suitable mitigation measures such as those listed in Section 7.3.1 above are implemented.

7.3.5 Scenario D – Reduced Car Dependency

The potential impacts of Scenario D on water quality include those resulting from a reduction in the volume of car travel within the study area. Reduced car dependency includes changes to local parking by limiting the amount of free parking space (increased metering) and the duration of parking (shortened parking times) throughout the study area. Reduced car dependency also includes behavioural changes resulting from targeted marketing to achieve a mode shift to green transport modes (eg TravelSMART).

There will be minor positive impacts on water quality with reduced car dependency.

7.3.6 Scenario E – Land Use Changes to Reduce Travel

The potential impacts of Scenario E on water quality include those resulting from land use changes within the study area to increase public transport usage and to reduce congestion levels.

Land use changes include limiting road and parking supply through the allocation of space and pricing. The availability of suitable new sites for car parking within the study area is limited by land values and the historic nature (and controls) of the study area.

As there is little potential for the development of new car parking areas within the study area, potential impacts of land use changes on water quality will be limited.

7.3.7 Scenario F – Rapid Transit on Eastern Freeway Corridor

The potential impacts of Scenario F on water quality include those resulting from the addition of a new rapid transit service from Doncaster Hill to the CBD, known as Doncaster Area Rapid Transit (DART). DART is based on the development of a guided bus-way or light rail system from Doncaster Hill to Alexandra Parade. DART also includes:

- Major interchange at Doncaster Hill
- Interchanges at Doncaster Road, Bulleen Road and Chandler Highway
- Park and ride facilities
- Extension of dedicated bus lanes on Alexandra Parade

Major construction activities will be associated with DART, although the majority of these activities will generally occur outside the study area, for example construction of the interchanges at Doncaster Road, Bulleen Road and Chandler Highway. DART assumes that the construction of a guided bus-way or light rail system would occur within the central reservation of the Eastern Freeway. The DART system will also require the construction of a new crossing of the Merri Creek. Increases in the area of impervious urban surfaces within the study area itself will be minor. There is potential for contaminated runoff to occur during construction activities leading to possible impacts on water quality in local waterways, particularly Merri Creek and the Yarra River.

The key elements of the DART system and potential impacts on water quality are listed in Table 7.5 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 7.7.

Table 7.5: DART – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Guided Bus Way or Light Rail System	Concrete guided way for buses or light rail system within road reserve.	Potential for runoff off contaminated stormwater during construction of new Merri Creek crossing. Limited potential for increased stormwater due to increase in impervious surfaces.	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Major interchanges	Underground interchange at Doncaster Hill.	Potential for increased stormwater (outside the study area) due to increase in impervious surfaces. Potential for runoff off contaminated storm water during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Park and Ride Facilities	Bus feeder and park and ride facilities at Doncaster Road, Bulleen Road and Chandler Highway	Potential for increased stormwater (outside the study area) due to increase in impervious surfaces. Potential for runoff off contaminated storm water during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Bus Lanes to Alexandra Parade	Extension of dedicated bus lanes	Not expected.	Not expected.
Toll on the Eastern Freeway (Scenario F2)	Introduction of a toll	Not expected.	Not expected.

It is likely that potential impacts on water quality arising from Scenario F will be minimal assuming that suitable mitigation measures such as those listed in Section 7.3.1 above are implemented.

7.3.8 Scenario G – Improved Arterial Road Network

The potential impacts of Scenario G on water quality include those resulting from the construction of a dual two lane deep tunnelled link from the Eastern Freeway east of Hoddle Street to near Flemington Road.

7 Stormwater and Water Quality

Major construction activities will be associated with the construction of a dual two lane deep tunnelled link. There is potential for contaminated runoff during construction to impact on water quality in local waterways. Construction works at the eastern end of the tunnel link are located in the vicinity of the Merri Creek. The tunnelled link will also result in a small increase in urbanisation (increasing impervious urban surfaces within the study area) arising from the construction of entry and exit tunnel portals.

The key elements of the tunnelled link and potential impacts on water quality are listed in Table 7.6 below. Where potential impacts have been identified, the likelihood, consequence and level of risk are indicated in Table 7.7.

Table 7.6: Tunneled Link – Assessment of Potential Impacts on Water Quality

Strategy Component	Elements	Potential Impact	Enhancement Opportunities
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to near Flemington Road.	Potential for runoff off contaminated stormwater during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Entry/Exit Portals	Entry/exit portals at Eastern Freeway and Elliot Avenue	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Intermediate interchanges (Scenario G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.
Optional Tunnel Access to CBD (Scenario G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Potential for runoff off contaminated stormwater during construction	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.

It is likely that potential impacts on water quality arising from Scenario G will be minimal assuming that suitable mitigation measures such as those listed in Section 7.3.1 above are implemented.

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7.4 Risk Assessment

Where potential impacts have been identified, the likelihood, consequence and level of risk for each of the strategy elements are indicated in Table 7.7 also indicates the potential for enhancement opportunities and presents a revised level of risk assuming that appropriate mitigation measures are implemented. It is important to note that the information presented in Table 7.7 is indicative only.

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Table 7.7: Risk Assessment of Potential Impacts on Stormwater and Water Quality

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Base Case (2021)								
Various road initiatives	Road upgrades, road widening, freeway extension, road building	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	2	C	M	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	Installation of appropriate controls to contain sediment run-off. All site works to be undertaken in accordance with the *Environmental Guidelines for Major Construction Projects* (EPA 1995).	L
Various rail initiatives	Rail extensions	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated storm water during construction.	2	C	M	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Various tram initiatives	Tram extensions, route upgrades	Potential for runoff off contaminated storm water during construction.	2	C	M	Consideration of stormwater issues during design stage.	As above	L

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Various bus initiatives	Doncaster park and ride	Potential for increased stormwater due to increase in impervious surfaces (outside the study area). Potential for runoff off contaminated stormwater during construction.	1	C	L	Consideration of stormwater issues during design stage.	As above	L
Improved bicycle and pedestrian network	Improved surfaces, footpath repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	1	D	L	Consideration of stormwater issues during design stage.	As above	L
Scenario A								
Station Access Improvements - bus and tram access stations	Improved security fences and lighting, improved bicycle storage and weather protection on walkways	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	1	D	L	Consideration of stormwater issues during design stage.	As above	L
Modal Interchanges - Melbourne University	Pedestrian overbridge. Below ground bus interchange and walkway.	Potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.	1	C	L	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Modal	Access improvements at	Limited potential for	1	D	L	Consideration of	As above	L

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Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
Interchanges – Railway Stations	Clifton Hill and Victoria Park Stations (eg improved security fences, bicycle storage and weather protection on walkways)	increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction.				stormwater issues during design stage.		
Modal Interchanges – Bus/Tram Intersects	Shelters, improved seating, improved lighting	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	1	D	L	Consideration of stormwater issues during design stage.	As above	L
Scenario B								
Diversion of traffic away from local streets	Implementation of kerb stand-outs, small roundabouts etc	Limited potential for runoff off contaminated stormwater during construction.	1	D	L	Not expected.	As above	L
Scenario C								
Improved pedestrian network	Improved surfaces, footpath repair and replacement, reduced foot path clutter, sitting and propping places	Limited potential for increased stormwater due to increase in impervious surfaces. Limited potential for runoff off contaminated stormwater during construction.	1	D	L	Not expected.	As above	L
Improvements to the Bicycle Network	Road resurfacing	Limited potential for runoff off contaminated stormwater during	1	D	L	Not expected.	As above	L

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
		construction.						
Scenario F								
Guided Bus Way or Light Rail System	Concrete guided way for buses or light rail system within existing road reserve.	Potential for runoff off contaminated stormwater during construction of new Merri Creek crossing. Limited potential for increased stormwater due to increase in impervious surfaces	3	C	H	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	M
Major interchanges	Underground interchange at Doncaster Hill.	Potential for increased stormwater (outside the study area) due to increase in impervious surfaces. Potential for runoff off contaminated storm water during construction	1	C	L	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Park and Ride Facilities	Bus feeder and park and ride facilities at Doncaster Road, Bulleen Road and Chandler Highway	Potential for increased stormwater (outside the study area) due to increase in impervious surfaces. Potential for runoff off contaminated storm water during construction	1	C	L	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Scenario G								
Tunnel Connection	Dual two lane tunnel approx 25-30 m below ground level from the Eastern Freeway east of Hoddle Street to	Potential for runoff off contaminated stormwater during construction	2	C	M	Installation of structural measures to reduce stormwater pollution	As above	L

Strategy component	Elements	Potential Impact	Consequence	Likelihood	Risk Level	Enhancement Opportunities	Mitigation Measures	Revised Risk Level
	near Flemington Road.							
Entry/Exit Portals	Numerous entry/exit portals at Eastern Freeway and Elliot Avenue	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction	1	C	L	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Intermediate interchanges (Scenario G1)	Intermediate interchanges at Nicholson Street and Royal Parade	Limited potential for increased stormwater due to increase in impervious surfaces. Potential for runoff off contaminated stormwater during construction	1	C	L	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L
Optional Tunnel Access to CBD (Scenario G2)	Tunnel from Eastern Freeway near Hoddle Street to Victoria Parade/Nicholson Street.	Potential for runoff off contaminated stormwater during construction	2	C	M	Installation of structural measures to reduce stormwater pollution. Consideration of stormwater issues during design stage.	As above	L

7.5 Overall Risk

The overall risk of each of the scenarios in terms of impacts on soil/groundwater (as compared with the previous scenario is presented in Table 7.8.

Table 7.8: Overall Risk – Impacts on Water Quality

Scenario	Overall Risk
Base Case	Low
A	Low
B	Low
C	Low
D	Low
E	Low
F	Medium
G	Low

Of the various strategies assessed, impact on water quality is similar for all scenarios assuming that suitable control measures are implemented to control stormwater run-off. In terms of increasing impervious surfaces, potentially leading to modified flow regimes, the Base Case Scenario and DART (Scenario F) would result in the greatest level of urbanisation. Construction activities associated with Scenario F would also involve works in close vicinity to Merri Creek.

8 Appraisal Summary

8 Appraisal Summary

8.1 Summary

A summary of the findings of the assessment for each of the environmental components (Noise, Air Quality and Greenhouse Emissions, Soil and Groundwater, Vegetation and Habitat, and Stormwater and Water Quality) in terms of the strategy goals and indicators is presented in Table 8.1.

The key environmental features, benefits and impacts attributed to each strategy are as follows:

Strategy A as compared with the 2021 Base Case – Small improvement in noise environment and air quality, with the exception of particle emissions which show a slight increase due to increasing use of diesel fuelled buses. Low risk of impact on natural habitats, water quality, and soil/groundwater contamination.

Strategy B as compared with Scenario A – Significant improvement in noise environment due to traffic volume reductions on local collector links, and very slight improvement in air quality and greenhouse gas emissions. Low risk of impact on natural habitats, water quality, and soil/groundwater contamination.

Strategy C as compared with Scenario B – Some improvement in air quality and greenhouse gas emissions expected due to a reduction in short car trips within the study area. Low risk of impact on natural habitats, water quality, and soil/groundwater contamination.

Strategy D as compared with Scenario B – Small improvement in noise environment, air quality and greenhouse gas emissions due to a reduction in car use. Low risk of impact on natural habitats, water quality, and soil/groundwater contamination.

Strategy E as compared with Scenario D – Low risk of impact on natural habitats, water quality, and soil/groundwater contamination.

Strategy F as compared with Scenario D – Slight improvement in noise environment, air quality and greenhouse gas emissions due to a shift in travel from private cars and buses to DART. Medium risk of impact on natural habitats and water quality, and low risk of impact on soil/groundwater contamination.

Strategy G as compared with Scenario F - Significant improvement in noise environment due to the east-west tunnel. Slight deterioration in air quality and greenhouse gas emissions resulting from a shift of travel to private cars resulting from reduced congestion and travel time. Medium risk of impact on natural habitats and soil/groundwater contamination, and low risk on water quality.

8 Appraisal Summary

Table 8.1 Summary of Assessment Findings - Environmental Component

		Possible Outcomes							
Goal	**Indicator**	**Base Case 2021**	**Scenario A**	**Scenario B**	**Scenario C**	**Scenario D**	**Scenario E**	**Scenario F**	**Scenario G**
Significantly reducing the impacts of noise from transport	Extent of residential land use exposed to changes in noise exposure.	Degradation of noise environment compared with existing (2001) conditions.	5% 'significant improvement' in noise environment compared with 2021 Base Case.	22% 'significant improvement' in noise environment compared with 2021 Base Case.	Changes in noise environment unlikely to be noticeable.	3% 'significant improvement' in noise environment compared with Scenario B.	Changes in noise environment unlikely to be noticeable.	3% 'significant improvement' in noise environment for DART with toll on the Eastern Freeway (F2) compared with Scenario D.	14% 'significant improvement' in noise environment compared with Scenario F.
Significantly reducing the impacts of air pollution from transport	Concentration of air pollutants.	Reduction in emissions compared with existing (2001) conditions.	Small decrease in NOx, CO and VOC, and increase in particle emissions, compared with 2021 Base Case.	Small decrease in NOx, CO and VOC compared with Scenario A.	Reduction in emissions expected compared with Scenario B.	Small decrease in NOx, CO, VOC, SO_2 and particle emissions compared with Scenario B.	Not assessed.	Small decrease in NOx, CO, VOC, SO_2 and particle emissions compared with Scenario D.	Slight increase in NOx, CO, VOC and particle emissions compared with Scenario F.
Ensuring a contribution to overall reductions in greenhouse gas emissions	Estimated total greenhouse gas emissions.	Increase in emissions compared with existing (2001) conditions.	No change in emissions as compared with 2021 Base Case.	Very slight decrease compared with Scenario A.	Reduction in emissions expected compared with 2021 Base Case.	Reduction in emissions compared with Scenario B.	Reduction in emissions expected compared with 2021 Base Case.	Reduction in emissions compared with Scenario D.	Slight increase in emissions compared with Scenario F.
Protecting and enhancing biodiversity	Effect on soil/groundwater contamination.	Medium risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risks of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Medium risk of impact. Potential for enhancement.
	Effect on natural habitats.	Medium risk of impact. Potential for	Low risk of impact. Potential for	Low risk of impact. Potential for	Low risk of impact. Potential for	Low risk of impact. Potential for	Low risk of impact. Potential for	Medium risk of impact. Potential for	Medium risk of impact. Potential for

		Possible Outcomes							
Goal	**Indicator**	**Base Case 2021**	**Scenario A**	**Scenario B**	**Scenario C**	**Scenario D**	**Scenario E**	**Scenario F**	**Scenario G**
		enhancement.	enhancement.	enhancement.	enhancement.	enhancement.	enhancement.	enhancement.	enhancement.
	Effect on water quality.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.	Medium risk of impact. Potential for enhancement.	Low risk of impact. Potential for enhancement.

9 References

9 References

The following references were used during the preparation of this report:

1. Maunsell McIntyre (September 2001) Northern Central City Corridor Study – Environment Component, Existing Conditions Report.
2. Booz Allen Hamilton (June 2002) Northern Central City Corridor Study – Appraisal of Transit Strategy Results – Draft Report.
3. Sinclair Knight Merz (July 2002) Northern Central City Corridor Study – Scenario Appraisal Report – Draft Report.
4. Sinclair Knight Merz (April 2002) Northern Central City Corridor Study – Strategy Costs Report – Draft Report.
5. Department of Infrastructure (2002) Northern Central City Corridor Study – Study Goals, Assessment Framework and Strategy Elements Discussion Paper.
6. Department of Infrastructure (2001) Northern Central City Corridor Study – Issues and Trends.

Appendix A Marshall Day Acoustics Noise Environment Scenario Appraisal Report

Draft

REPORT No.: 01136C

PROJECT: NORTHERN CENTRAL CITY CORRIDOR STUDY
ENVIRONMENTAL NOISE ISSUES
INITIAL ASSESSMENT OF TRANSPORT
SCENARIOS

CLIENT: Maunsell Australia Pty Ltd
Level 9
161 Collins Street
Melbourne Vic 3001

DATE: 10 September 2002

MARSHALL DAY ACOUSTICS

Reference	Description	Originator	Approved	Date	Comments
01136C	Preliminary draft	CPH		5 August 2002	
01136C	Revised draft	CPH		22 August 2002	
01136C	Draft	CPH	PRF	10 September 2002	

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Page No.

Draft

1.0 INTRODUCTION

Marshall Day Acoustics Pty Ltd has been commissioned by Maunsell Australia Pty Ltd to conduct an assessment of environmental noise issues for the Northern City Central Corridor Strategic Study being prepared for the Victorian Department of Infrastructure.

This report provides an initial assessment of a number of transport scenarios which are being evaluated as part of the study. As shown in Table 1, these scenarios consist of a cumulative sequence of strategy elements.

Table 1
Initial Scenarios

Scenario		Strategy elements
"Do nothing"		Only those elements currently proposed
A	"Do nothing" plus …	Improvements to bus, tram and rail routes/services.
B	Scenario A plus …	Measures to remove traffic from local streets and reduce community severance effects.
C	Scenario B plus …	Improvements to bicycle and pedestrian networks, encouragement of cycling and walking.
D1	Scenario C plus …	CBC parking price increase.
D2	Scenario D1 plus …	TravelSMART behavioural program.
E	Scenario D2 plus ...	Land use related measures to accommodate growth and reduce or minimise the need for travel.
F	Scenario E plus …	Doncaster area rapid transit system.
F1	Scenario F plus …	Toll on Eastern Freeway.
G	Scenario F1 plus ...	Tunnel linking Eastern Freeway and Tullamarine Freeway.
G1	Scenario G plus …	Intermediate interchanges at Nicholson Street.
G2	Scenario F plus ...	Tunnel from Eastern Freeway to CBD.

2.0 METHODOLOGY

2.1 Community effects

Section 3.0 of Marshall Day Acoustics' report No. 01136Arev1 *Preliminary Base Line Conditions* provides an overview of the ways in which environmental noise affects communities. A brief summary follows.

Annoyance

The effect of environmental noise on communities is often quantified in terms of the proportion of the community that considers the noise to be highly annoying. Figure 1 shows the relationship between noise level and community annoyance determined by a synthesis of over 50 annoyance studies from all over the world undertaken by the Netherlands' Organisation for Applied Scientific Research (TNO).

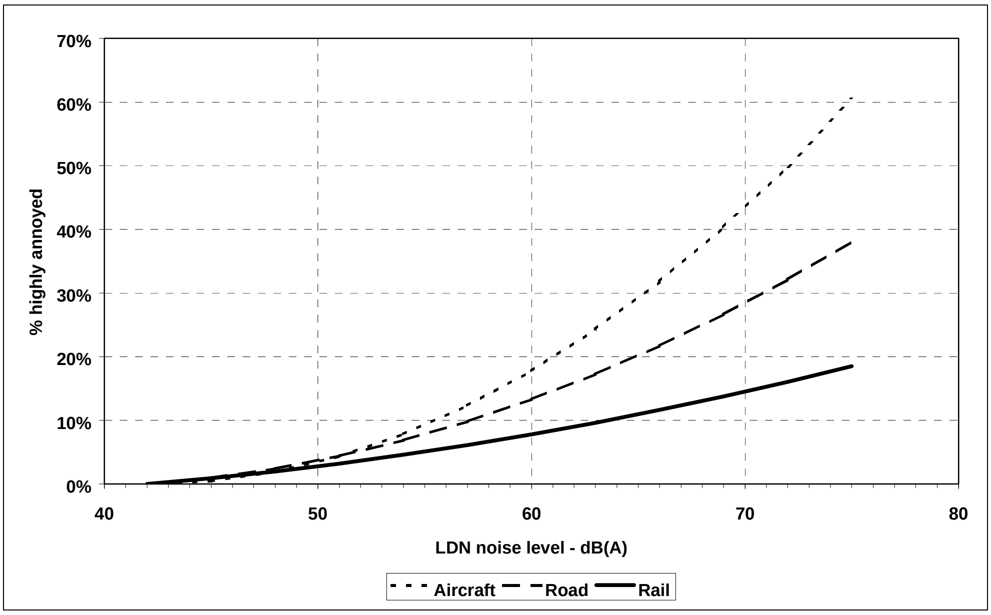

Figure 1 - Relationship between average noise level and community annoyance

It is generally considered that the TNO relationship applies to situations in which the community has not recently been exposed to relatively sudden changes in noise exposure. This type of exposure is often referred to as steady-state noise exposure.

When communities are exposed to relatively sudden changes in noise exposure that are associated with particular developments such as the construction of a new bypass, community response will generally be much greater than would be predicted by the TNO curves. Figure 2 shows the relationship determined by an analysis of 14 studies of community response to changes in traffic noise exposure. Note that the change in community annoyance has been related not to the change in noise level, but to the change in traffic volume.

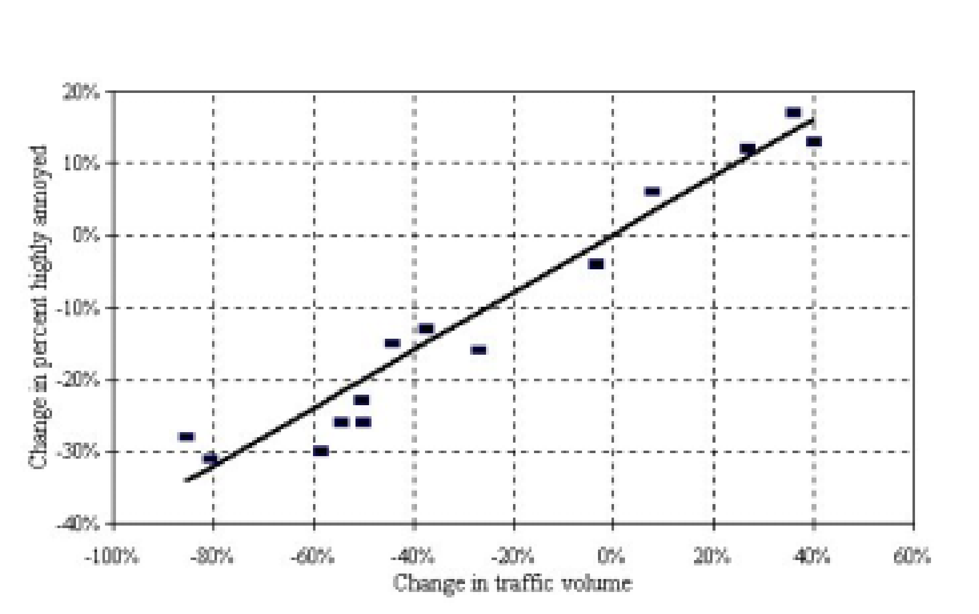

Figure 2 - Community annoyance and traffic volume

This type of community response to changes in noise exposure is sometimes referred to as short term response but studies have shown the effect to be extremely long lived amongst people resident at the time of the change, taking up to 20 years to return to steady-state annoyance levels.

Annoyance and heavy vehicle movements

There is much anecdotal evidence that noise from heavy vehicles is a significant aspect of the noise environment near major transport routes. It is common for complaints about road traffic noise to include references to heavy vehicle noise especially when such vehicles travel at night.

Noise from engine and exhaust brakes can also be a source of annoyance. An extensive and detailed review of the noise-related Australian Design Rules and engine brake noise from heavy vehicles has been recently completed by the National Road Transport Commission (NRTC). This report states that "*the use of* (engine brakes) *has often been identified by the community as one of the most intrusive road vehicle noises".*

In fact, there are studies that suggest that community annoyance can be directly related to heavy vehicle numbers. One study by Dr Ragnar Rylander of the Institute of Social and Preventative Medicine at the University of Geneva, Switzerland, found a correlation between community annoyance and noise exposure when the number of noisy events and their maximum noise levels are used as a measure of noise exposure. He extended this approach by describing a relation between the number of truck movements per day (in traffic) and the level of community annoyance. This relation is shown in Figure 3, which shows Rylander's relationship between the number of truck movements per 24-hour day and the level of community annoyance for two groups of data, one with a typical maximum noise level of 85dBA and the other with a typical maximum noise level of 95dBA.

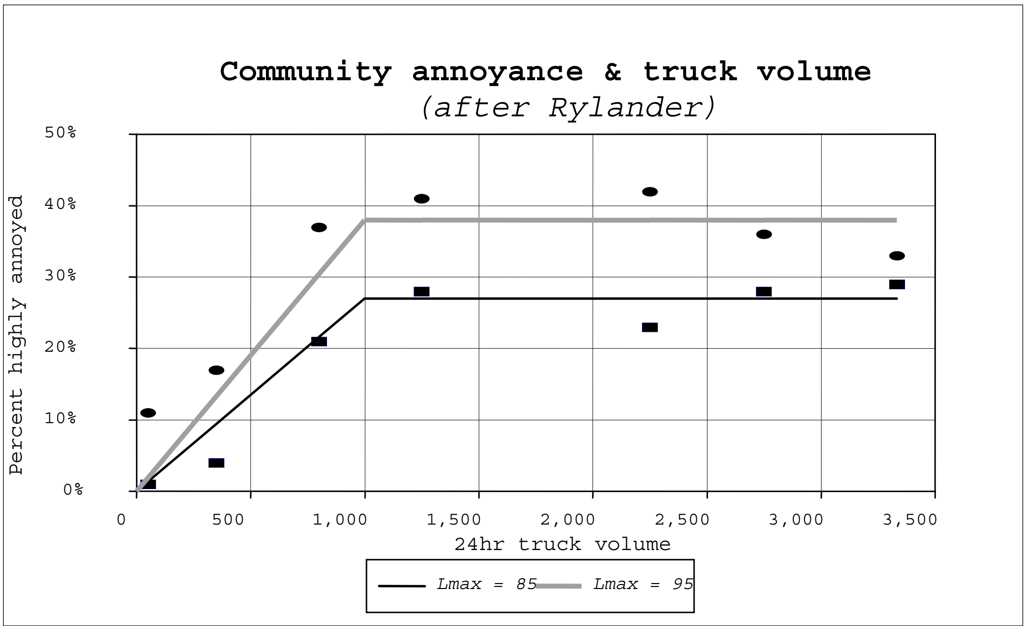

Figure 3 - Relationship between annoyance and truck volume

Sleep disturbance

As discussed in Section 3.3 of report No. 01136rev1, there are a number of ways of assessing noise exposure when evaluating risk of sleep disturbance. For this initial appraisal, the most useful way of assessing exposure is the rule of thumb provided by Dr Ragnar Rylander:

> *"Sleep is likely to be disturbed with a rather low number of passes of 10-15 heavy vehicles at about 55dBA* [measured indoors, per night]*."*

Summary

When viewed in combination, the sort of studies discussed above indicate that there are several aspects of the noise environment that apparently contribute to community effects such as annoyance and sleep disturbance. In particular, it may be useful to characterise community noise exposure in terms of the frequency of noisy events, as well as in terms of noise levels.

2.2 Assessment of transport scenarios

The effect of the various scenarios on traffic noise was assessed by looking at the change in traffic volume on selected links within the study area. The links assessed are detailed in Appendix A.

Change in traffic volume was considered to be a useful measure of change in noise exposure because:

- As shown in Figure 2, the change in traffic volume can be directly related to change in community annoyance for sudden changes in noise exposure.

- Change in traffic volume can be directly related to change in average noise levels. For example, a change in traffic volume of 25% will result in a change in average noise level of approximately 1dBA.

Table 2, two levels of change in the traffic volume were considered. Also shown are the associated change in noise level and change in community annoyance, based on Figures 1 and 2.

Table 2
Changes in traffic volume considered

Change in traffic volume	Equivalent change in noise level	Change in annoyance	
		Gradual	Sudden
15%	Less than 1dBA	1%	5%
30%	1-2dBA	2%	10%

It can be seen that if changes in traffic volume in this magnitude occur gradually the change in community annoyance is not significant.

As shown in Table 1, the strategy elements under consideration result in scenarios that would consist primarily of gradual changes (such as the "Do nothing" scenario), and scenarios which consist of very visible projects which would result in relatively sudden changes (such as Scenario G). Most scenarios consist of a combination of gradual and sudden changes. Thus, the community response might lay somewhere between the figures shown in Table 2.

Note that both positive changes (decreases in traffic volume) and negative changes (increased in traffic volume) have been considered.

For convenience, the term "noticeable" has been applied to a change in traffic volume of at least 15% and the term "significant" has been applied to a change in traffic volume of at least 30%. Note that the "significant" range is included in the "noticeable" range. This means that any road link that experiences a "significant" change in traffic volume will also register as experiencing a "noticeable" change.

For each of the road links in Appendix A, the number of residences was estimated. Then, the number of residences exposed to "noticeable" or "significant" changes in traffic volume were determined by adding up the number of residences over the whole study area adjacent to links on which ”noticeable” or “significant” changes in traffic volume occurred. The number of residences has not been reported here as it is only a very approximate estimate based on the extent of residential and mixed use land adjacent to the given road links. Hence, the proportion of residences exposed to noticeable or significant changes in traffic volume has been reported as a percentage of the total number of residences adjacent to the selected links.

Some members of the CRG have expressed concern that certain specific effects such as vibration due to heavy vehicles be considered in this assessment. By using a simple “broad brush” approach such as that outlined above, all community effects are, to an extent, implicitly considered, as all such effects contribute to community annoyance.

Note that, for some scenarios, it may be possible for one of the major effects to be a redistribution of traffic, so that some areas experience improvements in noise environment while other areas experience degradations.

The effect on the community of noise due to additional trams or light-rail vehicles has not been considered at this stage. However, the effect is likely to be small because as shown in figure 1, community response to noise from rail based vehicles is considerably less than for road traffic.

2.3 Changes in heavy vehicle numbers

As discussed in Section 3.1, noise from heavy vehicles is considered to be an important factor attributing to community annoyance. While heavy vehicle modelling was undertaken by Veitch Lister Consulting, the results are not considered to be sufficiently accurate to allow a quantitative assessment of changes on particular road links. A qualitative assessment only was undertaken at this stage. Of particular interest were the links (if any) where truck volumes were reduced to less than 1,000 trucks per day. As shown in Figure 3, it appears that long-term reductions in community annoyance with heavy vehicle noise can only be achieved if the number of trucks per day is reduced to less than 1,000.

3.0 ASSESSMENT OF MODELLED SCENARIOS

3.1 Changes relative to existing situation

Table 3 shows the proportion of residences affected by noticeable or significant changes in traffic noise exposure compared to the existing situation. This is based on a comparison of the modelled traffic volumes for the various scenarios and the modelled traffic volumes for 2001.

Table 3
Proportion of residences affected compared with existing situation

	Do nothing	A	B	D	F	F2	G	G1	G2
Significant improvement	0%	2%	19%	19%	19%	19%	28%	23%	23%
Noticeable improvement	0%	2%	22%	22%	22%	22%	34%	29%	27%

Noticeable degradation	71%	36%	51%	44%	42%	41%	24%	19%	41%
Significant degradation	23%	14%	19%	19%	19%	19%	10%	10%	15%

Whichever scenario is adopted, 10-23% of residences adjacent to the selected links will experience a significant degradation of their traffic noise exposure. However, as the cumulative effects of the various scenarios build up toward Scenario G the extent of degradation becomes more limited.

The proportion of residences experiencing a significant improvement shows more markedly the benefit of the various scenarios compared to "Do nothing". Scenarios B to F2 show 19% of residences experiencing a significant improvement. This is due to the heavy restrictions on traffic volumes on certain links in Scenario B (see Section 3.3). Scenario G also appears to provide a worthwhile improvement, with 28% of residences experiencing a significant improvement.

3.2 Changes relative to "Do nothing" scenario

Table 4 shows the proportion of residences affected compared with the "Do nothing" scenario.

Table 4
Proportion of residences affected compared with "Do nothing" scenario

	A	B	D	F	F2	G	G1	G2
Significant improvement	5%	22%	22%	24%	24%	32%	29%	28%
Noticeable improvement	13%	31%	31%	27%	31%	51%	51%	41%
Noticeable degradation	0%	11%	1%	2%	2%	1%	1%	4%
Significant degradation	0%	0%	0%	0%	0%	1%	0%	0%

Compared to the "Do nothing" scenario, none of the scenarios show more than 1% of residences exposed to a significant degradation in traffic noise exposure. However, the proportion of residences experiencing a significant improvement in noise exposure reaches 22% by Scenario B and 32% by Scenario G.

3.3 Changes relative to previous scenario

As discussed in Section 1.0, the scenarios are cumulative - that is, each scenario includes the traffic management measures incorporated in the previous scenario. So, to determine the additional benefit of the measures in each scenario that do not form part of the previous scenarios the traffic volumes for each scenario were compared with those for the previous scenario. Table 5 shows the proportion of residences affected compared with the previous scenario.

Table 5
Proportion of residences affected compared with previous scenario

	A	B	D	F	F2	G	G1	G2
Significant improvement	5%	20%	3%	1%	3%	14%	2%	2%
Noticeable improvement	13%	21%	4%	4%	4%	27%	2%	3%
Noticeable degradation	0%	25%	0%	2%	2%	3%	10%	27%
Significant degradation	0%	1%	0%	2%	0%	3%	3%	8%

The greatest improvement was achieved by Scenario B. This was due to the spectacular traffic volume reductions on the links where free speed was downgraded to 10km/hr.

Scenario G also achieved a high level of improvement, although one third of the improvement was on links already significantly improved by Scenario B. The other two thirds of the improvement (or about 9% of the total) was due to significant traffic volume reductions on McArthur Road, Princes Street, Alexander Parade and even Brunswick Road between Sydney Road and Nicholson Street.

The benefits achieved by Scenario G were not realised in G1 and G2. In fact, the highest proportion of residences experiencing a significant degradation (8%) was achieved by Scenario G2.

4.0 ASSESSMENT OF ESTIMATED SCENARIOS

Not all of the scenarios listed in Table 1 were modelled by Veitch Lister Consulting. Those not modelled are:

- Scenario C – cycling and walking strategies.
- Scenario D2 – TravelSMART.
- Scenario E – local land use strategies.

Table 13 provides a qualitative assessment of these three scenarios.

Table 13
Qualitative assessment of Scenarios C, D2 & E

Scenario	Assessment
C	Road traffic volume decreases due to mode shift to walking and cycling are likely to be unnoticeable.
D2	According to the summary figures provided by the DoI, the TravelSMART program will provide an estimated 9% decrease in the number of car trips within the study area. It is not clear whether longer or shorter trips will be more or less affected, but assuming that a 9% decrease in car trips will produce a decrease in traffic volumes of about 9%, this is still somewhat less than the 15% nominated in Section 2.2 as "noticeable". So, in general, the improvements will tend to be minor. However, it is possible that, when traffic volume decreases occur, the through trips on smaller local roads will shift to major roads and there may be traffic volume decreases on local roads greater than 15%.
E	A range of land use management options has been prepared and discussed by Maunsell Australia. The effect of these strategies on the number of trips (in particular car-based trips) is not estimated. However, according to the Maunsell Australia report, significant population growth is expected in the study area without significant changes in the proportion of the population who own cars. Maunsell Australia provide a number of strategies for limiting carparking in an effort to reduce the rates of car ownership. However, it is not clear whether such measures will sufficiently negate any increase in traffic volumes due to population increase. Changes in traffic noise exposure as a consequence of these strategies is likely to be unnoticeable.

5.0 CHANGES IN HEAVY VEHICLE NUMBERS

None of the scenarios includes measures to specifically reduce impacts due to heavy vehicle traffic, however, there is likely to be some changes in heavy vehicle numbers, especially for Scenario B. Table 3 provides a qualitative assessment of the various scenarios.

Table 3
Qualitative assessment of changes in heavy vehicle numbers

Scenario	Assessment
A	This scenario will apparently lead to some minor increases in congestion on major roads. This may deflect a small number of heavy vehicle trips from the study area. For example, the daily truck volume in Gertrude Street was reduced to less than 1,000.
B	This scenario will remove heavy vehicles almost entirely from the roads downgraded to a 10km/hr free speed. Daily truck volumes were reduced to less than 1,000 in Abbotsford Street, Arden Street, Errol Street, Gatehouse Street west of Royal Parade, Gertrude Street, Grattan Street, Queensberry Street, Smith Street, Wellington Street and Wreckyn Street. Other roads apparently will suffer significant increases in congestion which could deflect some heavy vehicle trips from the study area.
C	The enhanced pedestrian and cyclist facilities will apparently include a greater number of pedestrian and cycle crossings on major roads. This may lead to a greater number of occurrences of braking and accelerating by heavy vehicles. This may noticeably change the character of the noise environment which could be a source of annoyance for some individuals.
D	Neither the CBD parking price increase nor the TravelSMART program are likely to affect truck volumes.
E	Unlikely to affect truck volumes.
F, F1, F2	None of the variations on this scenario are likely to affect heavy vehicle numbers, even with a toll on Eastern Freeway. It is our understanding that the toll on City Link does not discourage use of the route by heavy vehicles.
G, G1, G2	It is our understanding that the tunnel is likely to have a big effect on heavy vehicle numbers on some of the existing roads in the study area. However, only two of the links unaffected by Scenario B achieved a daily truck volume of less than 1,000, namely Elliott Avenue and Macarthur Road.

6.0 CONCLUSIONS

Of the various traffic management strategies assessed, the greatest benefit was achieved by the significant downgrading of certain roads (Scenario B) and the east-west tunnel with intermediate interchanges (Scenario G). This is illustrated in Figure 4, which shows the proportion of residences experiencing a significant degradation or improvement in traffic noise exposure compared to the previous scenario.

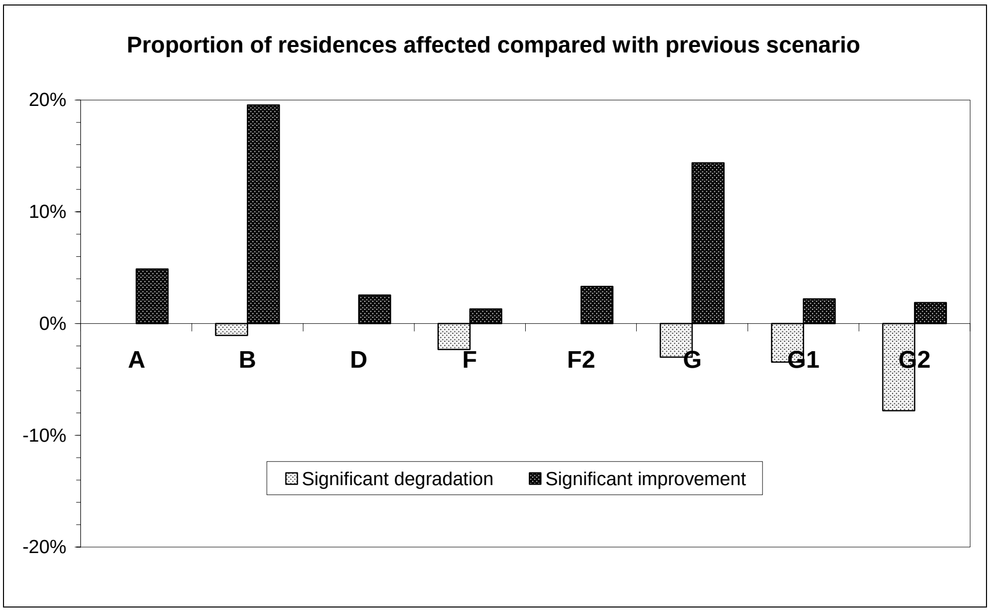

Figure 4 -Proportion of residences significantly affected

Scenario B and G – or similar scenarios – are recommended for further evaluation.

It is also recommended that there be some evaluation of measures to specifically reduce impacts due to heavy vehicle traffic. For example, the use of night-time truck bans on particular routes is likely to have benefits. The selection of routes would, of course, depend on a number of factors including the diversion of trucks onto other routes.

APPENDIX A

LINKS INCLUDED IN NOISE ASSESSMENT

	Road	From	To
1	Abbotsford St	Victoria St	Arden St
2	Abbotsford St	Arden St	Hanes St
3	Abbotsford St	Hanes St	Flemington Rd
5	Errol St	Arden St	Victoria St
7	Dryburgh Rd	Victoria St	Arden St
8	Queensberry St	Lygon St	Swanston St
9	Queensberry St	Lygon St	Rathdowne St
10	Queensberry St	Swanston St	Peel St
11	Gatehouse St	Royal Pde	College Cr
12	Gatehouse St	Bayles St	Royal Pde
13	Gatehouse St	Bayles St	Flemington Rd
14	Grattan St	Rathdowne St	Swanston St
15	Grattan St	Elizabeth St	Flemington Rd
16	Arden St	Citylink	Macauly Rd
17	Arden St	Curzon St	Courtney St
18	Arden St	Macauly Rd	Curzon St
19	Macauly Rd	Boundary Rd	City Link
20	Wreckyn St	Courtney St	Flemington Rd
21	Elgin St	Swanston St	Nicholson St
22	Curzon St	Victoria St	Hanes St
23	Harker St	Hanes St	Flemington Rd
24	Brunswick St	Victoria St	Gertrude St
25	Brunswick St	Gertrude St	Moor St
26	Brunswick St	Moor St	Johnson St
27	Brunswick St	Johnson St	Alexandra Pde
28	Brunswick St	Alexandra Pde	St Georges Rd
29	St Georges Rd	Brunswick St	Holden St

	Road	From	To
30	Smith St	Victoria St	Johnson St
31	Smith St	Johnson St	Keele St
32	Smith St	Keele St	Alexandra Pde
33	Smith St	Alexandra Pde	Queens Pde
34	Lygon St	Grattan St	Queensberry St
35	Lygon St	Queensberry St	Victoria St
36	Swanston St	Cemetary Rd West	Elgin St
37	Swanston St	Grattan St	Elgin St
38	Swanston St	Victoria St	Grattan St
39	Wellington St	Victoria St	Johnson St
40	Wellington St	Johnson St	Alexandra Pde
41	Gertrude St	Nicholson St	Brunswick St
42	Gertrude St	Brunswick St	Smith St
43	Lygon St	Elgin St	Queensberry St
45	Victoria St	Curzon St	Dryburgh St
46	Rathdowne St	Princes St	Newry St
47	Boundary Rd	Macauly Rd	Racecourse Rd
48	Grattan St	Swanston St	Royal Pde
49	Cemetary Rd West	Swanston St	Royal Pde
50	Rathdowne St	Princes St	Victoria St
51	Johnson St	Nicholson St	Brunswick St
52	Johnson St	Brunswick St	Smith St
53	Johnson St	Smith St	Wellington St
54	Johnson St	Wellington St	Hoddle St
55	Johnson St	Hoddle St	Masons Lane
56	Macauly Rd	Hanes St	Arden St
57	Macauly Rd	Hanes St	Boundary Rd
58	Racecourse Rd	Flemington Rd	Stubbs St
59	Elliot Ave	Flemington Rd	Macarthur Rd

	Road	From	To
60	Macarthur Rd	Elliot Ave	Royal Pde
61	Nicholson St	Alexandra Pde	Johnson St
62	Nicholson St	Newry St	Brunswick Rd
63	Nicholson St	Alexandra Pde	Newry St
64	Nicholson St	Johnson St	Victoria St
65	Royal Pde	Gatehouse St	Grattan St
66	Royal Pde	Gatehouse St	Brunswick Rd
67	Elizabeth St	Flemington Rd	Victoria St
68	Elizabeth St	Grattan St	Flemington Rd
69	Lygon St	Princes St	Brunswick Rd
70	Lygon St	Elgin St	Princes St
71	High St	Queens Pde	Westgarth St
72	Queens Pde	Heidelberg Rd	High St
73	Flemington Rd	Elizabeth St	Grattan St
74	Victoria St	Hoddle St	Lithgow St
75	Peel St	Flemington Rd	Victoria St
76	Hoddle St	Queens Pde	Alexandra Pde
77	Hoddle St	Johnson St	Langridge St
78	Hoddle St	Langridge St	Victoria St
79	Queens Pde	Alexandra Pde	Heidelberg Rd
80	Princes St	Nicholson St	Rathdowne St
81	Princes St	Rathdowne St	Lygon St
82	Cemetary Rd East	Lygon St	Swanston St
83	Alexandra Pde	Brunswick St	Nicholson St
84	Flemington Rd	Grattan St	Gatehouse St
85	Flemington Rd	Gatehouse St	Abbotsford St
86	Flemington	Abbotsford	Elliot Av

	Road	From	To
	Rd	St	
87	Victoria St	Hoddle St	Rokeby St
88	Victoria St	Rokeby St	Cambridge St
89	Victoria St	Brunswick St	Nicholson St
90	Victoria St	Nicholson St	Rathdowne St
91	Alexandra Pde	Gold St	Smith St
92	Alexandra Pde	Smith St	Brunswick St
93	Eastern Fwy	Yarra Bend	Gold St
94	Eastern Fwy	Gold St	Yarra Bend
95	Citylink	Brunswick Rd	Dynon St
96	Citylink	Dynon St	Brunswick Rd
97	Victoria St	Hawke St	Errol St
98	Victoria St	Errol St	Elizabeth St
99	Victoria St	Elizabeth St	Rathdowne St
100	Brunswick Rd	Tullamarine Fwy	Grantham St
101	Brunswick Rd	Grantham St	Sydney Rd
102	Brunswick Rd	Sydney Rd	Lygon St
103	Brunswick Rd	Lygon St	Nicholson St
104	Holden St	Nicholson St	St Georges Rd

Appendix B ERM Air Quality and Greenhouse Gas Appraisal Report

FIRST DRAFT REPORT

Maunsell Australia Pty Ltd

Northern Central City Corridor Study - Appraisal of Transit Strategy Elements

Air Quality & Greenhouse Gas Assessment

September 2002

Environmental Resources Management Australia
151 Clarendon Street,
South Melbourne VIC 3206
Telephone +61 3 9696 8011
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FIRST DRAFT REPORT

Maunsell Australia Pty Ltd

Northern Central City Corridor Study - Appraisal of Transit Strategy Elements

Air quality & Greenhouse Gas Assessment

September 2002

Reference: 80101087rp1

For and on behalf of Environmental Resources Management Australia
Approved by: ______________________
Signed: ______________________
Position: ______________________
Date ______________________

CONTENTS

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

Maunsell Australia Pty Ltd (Maunsell) has commissioned Environmental Resources Management Australia Pty Ltd (ERM) to detail the air quality and greenhouse gas impacts of the proposed transport strategy in Melbourne's inner north. This report forms part of the Maunsell Environmental report, which has been commissioned by the Department of Infrastructure (DOI).

The Northern Central City Corridor Study (NCCCS) is investigating transport and land-use issues in Melbourne's inner north, covering the areas of:

- Abbotsford
- Carlton
- Carlton north
- Clifton Hill
- Collingwood
- Fitzroy
- Fitzroy North
- North Melbourne
- Parkville
- Princes Hill

The study will develop an integrated strategy with proposals for improving transport in these areas, including facilities and services for walking, cycling, public transport, freight and private car use now and in the future.

The strategy will cover the area's needs over at least the next 20 years and should anticipate and guide the type of development and activity growth that will occur in this timeframe, to provide a more sustainable future.

1.1.1 *Strategy Elements*

This report has been prepared as an air quality and greenhouse gas appraisal of the proposed transport strategy scenarios.

To develop an integrated strategy, the Department of Infrastructure has suggested a number of initiatives, the possible initiatives have been grouped into a set of scenarios, detailed in *Table 1.1*.

Table 1.1 Scenarios for Testing

Types of Initiative	Base Case 2021	Scenarios for testing						
		A	B	C	D	E	F	G
Significant Improvements to bus, tram and rail routes/services		ã	ã	ã	ã	ã	ã	ã
Measures to remove traffic from local streets and reduce community severance effects			ã	ã	ã	ã	ã	ã
Improvement to bicycle and pedestrian networks, encouragement of cycling and walking				ã	ã	ã	ã	ã
Measures to reduce car use, such as parking, pricing, policy and behavioural initiatives					ã	ã	ã	ã
Land use-related measures to accommodate growth and reduce or minimise the need for travel						ã	ã	ã
Doncaster area rapid transit system							ã	ã
Options within the inner north to improve the efficiency of the arterial network								ã

1. Source – Northern Central City Corridor Study – Study Goals, Assessment Framework and Strategy Elements Discussion Paper.

The 'Base Case' is a forward projection of expected travel and lands use trends in the year 2021, with currently committed or highly likely transport infrastructure included. It is the benchmark against which strategy elements will be compared.

The initiatives have been proposed to detail what can be done to **attract** people onto public transport and non-motorised modes, to **induce** them to travel and/or use cars less, and whether, after all this is done, **major infrastructure initiatives** are still needed to achieve the desired changes in transport, land use and amenity.

The initiatives are listed with a set of strategy scenarios, the scenarios are built incrementally to gauge the possible effects of a range of components.

To assist the appraisal, scenarios A, B, C, F and G have been modelled using the Melbourne wide Zenith transport model. This provides an indication of likely transport effects of the strategies, in particular mode share, AM Peak and Daily average trips within the study area.

1.2 SUMMARY RESULTS

2 VEHICLE EMISSIONS

The quantification of emissions for the NCCCS has been conducted based on the traffic projections from the Zenith model and an analysis of vehicle emission rates that accounts for the improvements in fuel consumption and emission control technology that are expected to occur between now and 2021.

2.1 MODELLED VEHICLE USE SCENARIOS

Traffic levels were obtained from the Zenith Model for each of the NCCCS scenarios. Vehicle categorisations supplied in the data were for private vehicles, commercial vehicles, and buses. The vehicle kilometres travelled (VKT) for vehicle types at a higher resolution were determined by splitting the modelled categories into individual vehicle types utilising data from the Fuel Quality Review Analysis (Environment Australia, 2000). The resulting change in vehicle travel as a percentage of the 2001 case is presented in Table 2.1. The scenarios developed for the NCCCS are sequentially cumulative so the reported outcome of strategy B also includes the impacts of Strategy A. For this reason it is not possible to determine the impact of say, the DART light rail in isolation as Strategy F also includes the impacts of strategies A, B and D.

Table 2.1 Scenario Vehicle Travel Melbourne Metropolitan Area

Vehicle Kilometres (Million/year)	Year 2001 Road Network Calibrated	Year 2021 Base	Year 2021 Strategy A (PT)	Year 2021 Strategy B (Loc Streets)	Year 2021 Strategy D (City Park'g)	Year 2021 Strategy F (DART) - Light Rail
Cars	100%	134%	130%	130%	129%	129%
Light Trucks	100%	136%	136%	136%	136%	136%
Medium Trucks	100%	91%	90%	91%	91%	91%
Heavy Trucks	100%	215%	214%	215%	215%	215%
Buses	100%	101%	119%	119%	119%	108%
Motorcycles	100%	288%	279%	278%	277%	277%
Trams	100%	105%	167%	167%	167%	186%
Trains	100%	100%	155%	155%	155%	155%
Total	100%	134%	131%	131%	131%	130%

Vehicle Kilometres (Million/year)	Year 2021 Strategy G (Art. Roads)	(Sens) Strategy F1 (DART): E Fwy Tolls	Strategy G1 (Art. Roads) no Royal/Nicholson Ramps	Strategy G2 (Art. Roads) E.Fwy to CBD Tunnel	Year 2021 Strategy F2 (DART) - Heavy Rail
Cars	129%	129%	129%	129%	129%
Light Trucks	136%	136%	136%	136%	136%
Medium Trucks	91%	91%	91%	91%	91%
Heavy Trucks	215%	215%	215%	215%	215%
Buses	108%	108%	108%	108%	108%
Motorcycles	277%	277%	277%	277%	277%
Trams	186%	186%	186%	186%	167%
Trains	155%	155%	155%	155%	175%
Total	130%	130%	130%	130%	130%

The data in *Table 2.1* show that total vehicle travel in Melbourne increases significantly between 2001 and 2021, amounting to a 34% increase on the 2001 level. The impacts of the traffic reduction scenarios are in general, significantly less than the increase in traffic over the period. However, the vehicle travel data is only available for the entire Melbourne region and does not show the localised impacts that would be felt as a result of some of the strategies. However, in many of the scenarios the impacts are focussed on the NCCCS region, resulting in larger percentage changes in this region than are indicated for the metropolitan region as a whole. For example the use of traffic calming in local streets would significantly reduce the traffic on those streets, but the overall impact on metro-wide vehicle travel would be minimal.

The public transport improvements in Strategy A offer the largest reduction in vehicle travel compared to the 2021 base case, accounting for a 2.1% reduction in traffic. The reduction in private vehicle travel is partly offset by increased bus travel as a result of this strategy.

2.2 VEHICLE EMISSION FACTORS

Projections of vehicle emission factors have been based on assumptions consistent with those in the Fuel Quality Review (Environment Australia, 2000). These projections assume that fuel consumption of new light duty vehicles improves at 1% per year till 2010 and 1.5% to 2020, according to the proposed National Average Fuel Consumption Targets. Emission control legislation is expected to continue on its current path with the introduction of the Euro 3 and Euro 4 requirements being introduced in 2007. These emission standards will result in significant reductions in emissions of NOx, CO, SOx and particles from both petrol and diesel fuelled vehicles. The reduction of diesel fuel sulfur content in 2006 will in addition, result in significant reduction in particle emissions from all diesel fuelled vehicles.

Overall, the fleet average emission rates for most pollutants will reduce to approximately a third of current levels, from the combined effects of fuel consumption, emission control and fleet turnover.

The analysis of emission factors for this study has not considered the impacts of significant technological advances that could impact on these emission rates. We have not included significant uptake of hybrid vehicles or fuel cell vehicles. If either of these technologies achieve significant penetration into the market we would expect further reductions in emissions to occur.

2.3 VEHICLE EMISSIONS

Emissions of the criteria pollutants reduce significantly over the period 2001 to 2021 despite a significant increase in vehicle travel. The reduction is a result of increasingly stringent vehicle emission requirements, new fuel standards and increased fuel efficiency.

Table 2.2 Total Vehicle Emissions (percent of 2001 value)

	2001	Base	A	B	D	F
Criteria Pollutants						
NOx	100.0%	30.3%	30.2%	30.2%	30.1%	29.7%
NMVOC	100.0%	36.6%	36.0%	35.9%	35.8%	35.6%
SOx	100.0%	27.5%	27.6%	27.6%	27.5%	27.1%
CO	100.0%	24.8%	24.2%	24.2%	24.1%	24.0%
PM10	100.0%	57.5%	58.5%	58.4%	58.3%	57.0%
Greenhouse Gases						
CO_2	100.0%	103.1%	103.1%	103.1%	102.7%	101.2%
CH_4	100.0%	89.3%	87.1%	87.0%	86.6%	86.3%
N_2O	100.0%	127.4%	125.1%	125.0%	124.5%	123.7%
CO_2E	100.0%	103.4%	103.4%	103.3%	103.0%	101.5%
Total VKT	100.0%	134.1%	131.3%	131.2%	130.6%	130.0%

	G	F1	G1	G2	F2
Criteria Pollutants					
NOx	29.7%	29.7%	29.7%	29.7%	29.7%
NMVOC	35.6%	35.5%	35.6%	35.6%	35.5%
SOx	27.1%	27.1%	27.1%	27.1%	27.1%
CO	24.0%	24.0%	24.0%	24.0%	24.0%
PM10	57.0%	57.0%	57.0%	57.0%	57.0%
Greenhouse Gases					
CO_2	101.2%	101.2%	101.2%	101.2%	101.2%
CH_4	86.4%	86.3%	86.3%	86.4%	86.3%
N_2O	123.7%	123.6%	123.7%	123.7%	123.6%
CO_2E	101.5%	101.4%	101.5%	101.5%	101.5%
Total VKT	130.0%	129.9%	130.0%	130.1%	129.9%

Figure 2.1 ***Emissions of NOx, Particles and CO_2-e as a Percent of 2001 Emissions (note: scenario results are additive and include all previous scenarios)***

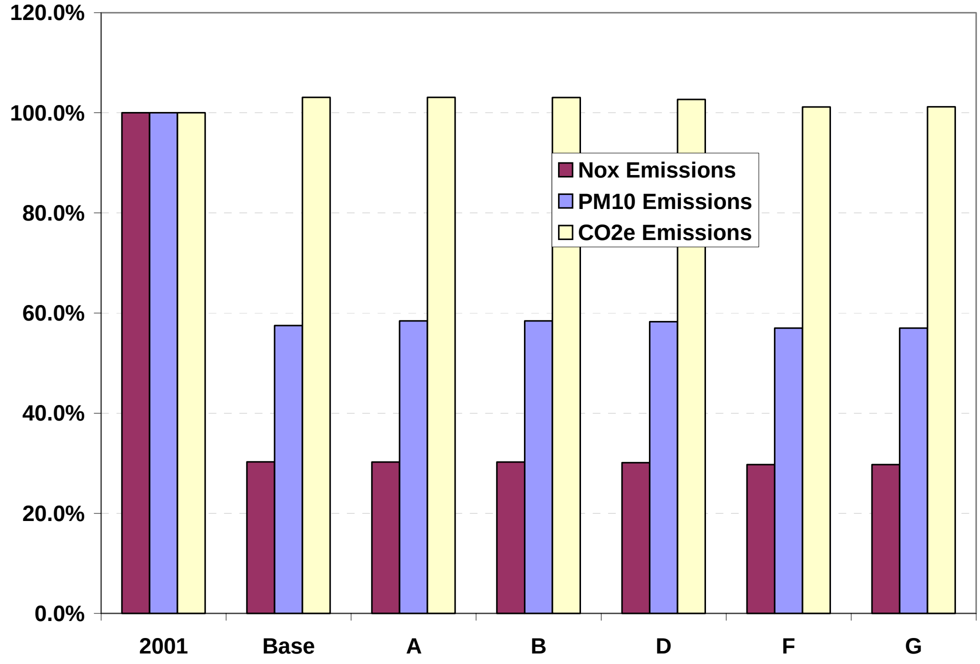
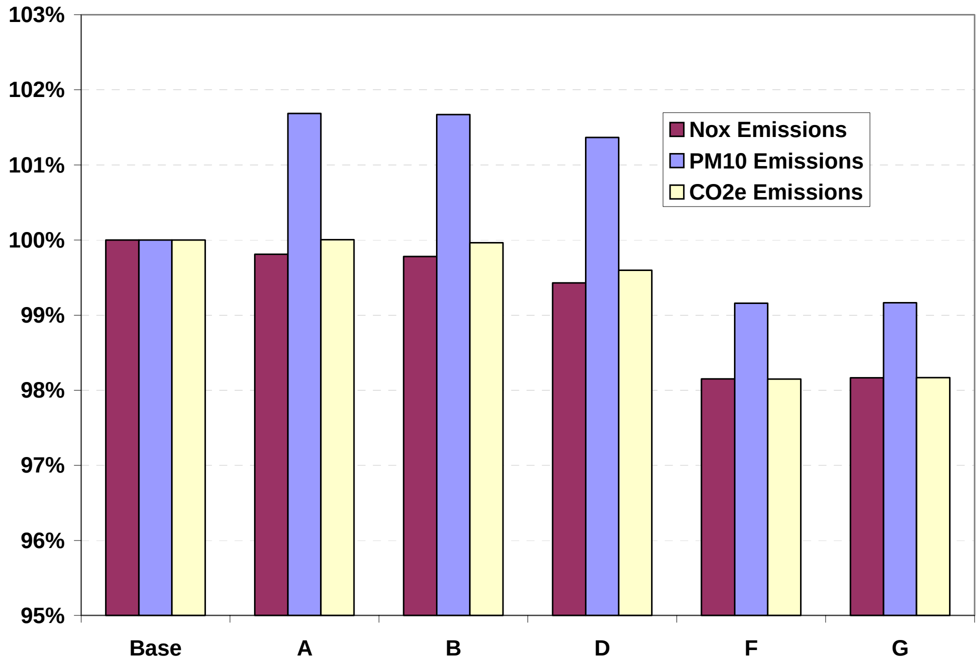


Figure 2.2 ***Emissions of NOx, Particles and CO_2-e as a Percent of Base 2021 Emissions (note: scenario results are additive and include all previous scenarios)***



Note: Figures 2.1 and 2.2 utilise significantly different scales.

Figure 2.1 & *Figure 2.2* show a number of interesting trends in the vehicle emissions. Compared to the 2001 levels emissions of NOx and PM10 drop significantly to the 2021 base case, but following this the strategies have little impact in reducing the level of emissions. Greenhouse gas emissions increase by about 2% from 2001 to 2021 despite the improvements in fuel consumption. However, the modelled scenarios go some way to reducing these emissions particularly when the DART is introduced because of its impact on reducing road transport in general. In Strategy A and B much of the reduction in private traffic is picked up in bus travel, therefore not resulting in a large reduction in emissions. This transfer to bus transport also has the effect of increasing particle emissions in Strategies A, B and D.

Overall the air quality response to each of the strategies is relatively minor, and most of the impacts are a result of national programs aimed at reducing air emissions and greenhouse gas emissions. The air quality impacts of a strategy will only be a significant decision variable if large localised impacts can be identified.

3 APPRAISAL METHODOLOGY

3.1 EXISTING ENVIRONMENT

The existing environment in the NCCCS and Melbourne area is described in the Department of Infrastructure NCCCS Issues and Trends Report, September 2001. Further information regarding air quality and greenhouse gas issues are detailed in the ERM Existing conditions Air Quality and Greenhouse Gas Reports.

3.1.1 Scenario Appraisal

The Department of Infrastructure and the NCCCS Technical Reference Group have developed study goals and an assessment framework, which incorporate a triple bottom line assessment methodology. The goals and indicators relevant to air quality and greenhouse gas issues are detailed in *Table 2.1*.

Table 3.1 Air Quality and Greenhouse Gas Study Goals and Indicators

Goal	Indicator
Significantly reducing the impacts of noise and **air pollution from transport**	Concentration of air pollutants at relevant sites according to adopted standards
Ensuring a contribution to overall reductions in greenhouse gas emissions	Estimated total greenhouse gas emissions (by mode of transport) – both metropolitan-wide and for travel to, from within and through the inner north

1. Source – Northern Central City Corridor Study – Study Goals, Assessment Framework and Strategy Elements Discussion Paper.

All scenarios have been appraised using the following qualitative framework:

- Comparison to the Base Case 2021
- Opportunities and constraints
- Impacts on NCCCS area
- Impact on externalities

In addition, estimation of anticipated total emission loads has been undertaken for Scenarios that have been modelled using the Zenith transport model.

4 BASE CASE 2021

4.1 SUMMARY

The Base Case 2021 includes all projects that are currently committed, with little or no changes to the transport system beyond these. Most projects are located in the middle and outer suburbs and will not have a significant bearing on traffic demands and patterns in the NCCCS Study Area. The Victorian population is anticipated to increase by 22 percent.

Significant Base Case 2021 Road Projects include:

- Eastern Freeway Extension to Ringwood
- Scoresby Freeway

Significant 2021 Base Case Public Transport Projects include:

- All tram and train services have a 20% higher frequency
- Smartbus Routes along Springvale Road (existing routes 888 & 889) and Blackburn Road (existing route 703)
- Cranbourne East Rail Extension

The mode share estimate for Base Case Scenario (2000) and Base Case Scenario (2021) is detailed in *Table 3.1*.

Table 4.1 Zenith Model Estimates of Travel for Base Case Scenarios Melbourne Metropolitan Area

	2000 Base Case		2021 Base Case		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	9,325	77.5	11,745	77.7	2,419	25.9
Transit	784	6.5	1,028	6.8	244	31.2
Walk / Cycle	1,918	16.0	2,332	15.4	414	21.6
Total	12,028	100	15,107	100	3,078	25.6

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 4.2 Zenith Model Estimates of Travel for Base Case Scenarios to/from, within and through the NCCCS Area

	2000 Base Case		2021 Base Case		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	645	63.7	755	61.9	110	17.1
Transit	196	19.4	265	21.8	69	35.2
Walk / Cycle	171	16.9	198	16.3	27	15.8
Total	1,012	100	1,219	100	207	20.5

1. Source – NCCCS Strategy Elements
2. Trip numbers rounded to the nearest thousand
3. Walk / Cycle excludes intrazonal walking and cycling

As indicated in the Department of Infrastructure NCCCS Issues and Trends Report, emissions from private motor vehicles are the major source of air quality pollutants in the study area, and have been identified as the most significant contributor to Melbourne's air pollution.

Emissions from motor vehicles have been estimated using the vehicle kilometres travelled for each of the vehicle classes derived from the transport model. The VKT were combined with the emission rates per kilometre for each pollutant and vehicle type considered. Emission rates have been developed based on previous Australian studies that have utilised the database of new and in-service vehicle testing results held by the EPAs of NSW and Victoria and estimations of the composition of the future vehicle fleet. We have derived emission rates for the vehicle fleet in 2021 utilising an analysis of the likely emission characteristics of individual vehicles. The future characteristics of the future vehicle fleet have been assessed based on proposed new emission regulations, new fuel standards, emission standards from overseas and likely rates of new technology adoption. Further details on the derivation of these figures are presented in Annex A.

Greenhouse emissions from transport within the region have been based on the average fuel consumption of vehicles in the region and assumed fuel efficiency improvements over the period to 2021.

The emission rates developed from this analysis for 2001 and 2021 are presented in *Table 4.3* and *Table 4.4*.

Table 4.3 Vehicle Emission Rates 2001(g/km)

Vehicle Category	Pollutant					Greenhouse		
	NOx	NMVOC	SOx	CO	PM10	CO2	CH4	N2O
Cars	g/km	g/km	g/km	g/km	g/km	g/km	g/km	g/km
ULP Post 1986	1.113	1.412	0.022	7.063	0.05	232.4	0.090	0.023
Leaded Pre 1986	1.589	3.185	0.052	27.048	0.05	257.0	0.140	0.003
Diesel	0.943	1.446	0.385	0.989	0.15	319.6	0.010	0.010
LPG	1.800	2.528	0.031	20.038	0.05	232.7	0.080	0.008
Light Trucks								
Petrol	1.760	2.930	0.049	23.580	0.05	306.1	0.140	0.012
Diesel	1.180	1.490	0.394	1.109	0.22	327.6	0.010	0.014
LPG	1.981	2.680	0.035	21.990	0.05	255.4	0.090	0.008
Medium Trucks								
Petrol	4.649	5.090	0.093	57.800	0.09	473.7	0.174	0.006
Diesel	3.101	1.950	0.634	1.820	0.88	527.4	0.020	0.018
LPG	2.820	3.421	0.051	24.001	0.31	364.2	0.130	0.012
Heavy Trucks								
Petrol	4.661	7.049	0.151	121.301	0.09	768.7	0.210	0.010
Diesel	15.291	3.741	1.413	7.862	0.88	1198.6	0.072	0.027
LPG	4.828	5.168	0.087	23.999	0.31	624.2	0.219	0.021
Buses								
Petrol	3.955	4.468	0.079	49.156	0.05	402.2	0.151	0.005
Diesel	4.540	2.405	0.928	2.667	0.62	769.8	0.029	0.023
LPG/LNG	2.642	2.307	0.047	22.982	0.11	341.6	0.115	0.011

Table 4.4 Vehicle Emission Rates 2021 (g/km)

Vehicle Category	Pollutant					Greenhouse		
	NOx	NMVOC	SOx	CO	PM10	CO2	CH4	N2O
Cars	g/km	g/km	g/km	g/km	g/km	g/km	g/km	g/km
ULP Post 1986	0.267	0.480	0.017	1.978	0.03	176.533	0.069	0.017
Leaded Pre 1986	0.381	1.083	0.041	7.573	0.03	201.114	0.110	0.003
Diesel	0.226	0.492	0.029	0.277	0.04	253.033	0.008	0.008
LPG	0.432	0.859	0.026	5.611	0.02	194.958	0.067	0.006
Light Trucks								
Petrol	0.423	0.996	0.040	6.603	0.03	250.275	0.114	0.010
Diesel	0.283	0.507	0.029	0.311	0.04	261.023	0.008	0.011
LPG	0.475	0.911	0.030	6.157	0.02	217.627	0.076	0.007
Medium Trucks								
Petrol	1.116	1.731	0.082	16.184	0.05	417.870	0.153	0.006
Diesel	0.744	0.663	0.052	0.509	0.34	460.786	0.017	0.016
LPG	0.677	1.163	0.045	6.720	0.12	326.441	0.117	0.011
Heavy Trucks								
Petrol	1.119	2.397	0.140	33.964	0.05	712.837	0.195	0.010
Diesel	3.670	1.272	0.128	2.201	0.34	1131.988	0.068	0.026
LPG	1.159	1.757	0.081	6.720	0.13	586.384	0.206	0.019
Buses								
Petrol	0.949	1.519	0.068	13.764	0.03	346.363	0.130	0.005
Diesel	1.090	0.818	0.079	0.747	0.24	703.164	0.026	0.021
LPG/LNG	0.634	0.785	0.042	6.435	0.05	303.771	0.103	0.010

Table 4.5 Air Emissions from the Base Case Within the Metropolitan Area

Pollutant	2000 Base Case Emission (tonne)	2021 Base Case Emission (tonne)	Change (%)
Nitrogen Oxides	43,169	13,076	-69.7%
Volatile Organic Compounds	55,792	20,394	-63.4%
Sulfur Dioxide	3,011	830	-72.5%
Carbon Monoxide	347,217	86,056	-75.2%
PM10	2,738	1,574	-42.5%
Carbon Dioxide Equivalents (Gg / year)	7,966	8,239	3.4%

4.2 OPPORTUNITIES AND CONSTRAINTS

The development of low emission cars represents an opportunity to minimise the air quality and greenhouse gas impacts of the proposed increase in vehicle trips.

There are a number of plausible technology mix scenarios for the introduction of low emission vehicles. The most likely major technology changes that may begin to be seen on our roads within the next 20 years are;

- Significant improvements in fuel efficiency above and beyond that expected
- Market share increase of commercial hybrid vehicles, such as the Toyota Prius and Honda Insight released here last year
- Introduction to the Australian market of commercial fuel cell and hydrogen powered vehicles, these may be available around 2010 but without significant technology and price breakthroughs will not reach large numbers in the study period

While it is likely that some or all of these technologies will be introduced over the next twenty years, it is anticipated that these will have a minimal impact on the emission characteristics of the vehicle fleet as a whole.

Unless the Government introduces a paradigm shift in policy direction, it is likely that low emission vehicles will represent a maximum of 5 to 10% of the new vehicles entering the market.

New motor vehicle emission limits are implemented at a commonwealth level through the Australian Design Rules (ADRs). These standards set levels of NOx, CO, VOC and Particles that may be emitted from vehicle exhausts. The standards have been regularly reviewed and tightened since their introduction and we expect that this process will continue through the period to 2020. Currently, the ADRs are in the process of attaining harmonisation with the European emission standards, which are more stringent than our current controls. In general, Australian limits are approximately 5 years behind the introduction of similar limits in Europe and US. As the standards apply only to new vehicles their impact is delayed substantially by the turnover of the fleet. In Australia the fleet turnover is relatively slow and effectively means that it would take about 10 years for half the fleet to be covered by a new ADR.

The modelled vehicle emission rates only take into account the harmonisation of Australian Standards with the Euro 3 and Euro 4 standards until 2006. No further emission requirements are modelled past this date because of the great uncertainty in determining what the changes may be. Vehicle fuel consumption is assumed to improve annually throughout the period to 2021, but no further tightening of fuel consumption targets are modelled. These assumptions represent quite a conservative (ie high) estimate of future vehicle emission rates.

In contrast to the delayed impact of ADRs, the Australian fuel standards to be introduced for diesel fuel will have an immediate impact on the level of particulate matter emissions from diesel vehicles because of the sulfur content reductions that will be mandated. These standards also allow the use of more advanced emission control technologies and therefore enable the tighter emission limits.

The principle constraint of the Base Case 2021 is that the NCCCS area is predicted to receive an additional 110,000 trips in private vehicles in an area which the community residents group have expressed dissatisfaction with traffic and related problems, namely pollution, congestion, truck volumes, traffic noise and parking facilities.

4.3 *IMPACTS ON NCCCS AREA*

The predicted traffic volumes for Base Case 2021 indicate a significant increase of trips in the NCCCS area. This is likely to have an increased impact on air quality in the local area, which may be partially offset through new vehicle engine and pollution control technologies.

Further congestion on the roads in the NCCCS area will reduce the average speed of roads and therefore increase emissions per vehicle kilometre. This is due to the characteristic increase in emissions with reducing speed and the increase in stop / start driving.

4.4 *IMPACT ON EXTERNALITIES*

Greater traffic volumes are also expected across all of Melbourne. This is likely to have a significant impact on greenhouse gases, and the transport sector is likely to remain one of the key greenhouse gas emitters. Air Quality impacts are likely to be less pronounced in the lower density areas of Melbourne.

5 SCENARIO A: PUBLIC TRANSPORT IMPROVEMENTS

5.1 SUMMARY

Scenario A includes all of the improvements in the Base Case 2021 scenario. The aim of this scenario is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

Significant initiatives include:

- Train frequency increase of 50% or more on the Upfield, Ringwood, Northern, Epping & Hurstbridge lines

- Improvements to bus and tram access to railway stations to reflect interchange service coordination

- Increase of 50% for all study area tram services

- Bus frequency increases for the Eastern Freeway, Johnston St & Northern groups to achieve a frequency of 10 minutes during peak and double the present frequencies in the off peak

- Increased spatial cover for city end Bus routes for the Eastern Freeway and Johnston Street groups.

The mode share estimate for the Base Case Scenario (2021) and Scenario A is detailed in *Table 4.1.*

Table 5.1 Zenith Model Estimates of Travel for Scenario A and Base Case Scenarios Melbourne Metropolitan Area

	2021 Base Case		Scenario A		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	11,745	77.7	11,500	56	-245	-2.1
Transit	1,028	6.8	1,356	30	327	31.8
Walk / Cycle	2,332	15.4	2,250	14	-82	-3.4
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 5.2 ***Zenith Model Estimates of Travel for Scenario A and Base to/from, within and through the NCCCS Area***

	2021 Base Case		Scenario A		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	755	61.9	680	55.8	-75	-9.9
Transit	265	21.8	364	29.9	99	37.4
Walk / Cycle	198	16.3	174	14.3	-24	-12.1
Total	1,219	100	1,219	100	0	

1. Source – NCCCS Strategy Elements
2. Trip numbers rounded to the nearest thousand
3. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from Scenario A are compared with the 2021 Base Case in *Table 5.3*. These show a small decrease in NOx, CO and VOC emissions, a 1.7% increase in particle emissions resulting from increasing use of diesel fuelled buses. It must be remembered that these data represent emissions from the entire network. Due to the spatial distribution of public transport systems we would expect that much of these changes would occur in the inner Melbourne region. As such the percentage changes in the NCCCS area would be significantly higher.

Table 5.3 ***Air Emissions from Scenario A Within the Metropolitan Area***

Pollutant	2021 Base Case Emission (tonne)	Scenario A Emission (tonne)	Change (%)
Nitrogen Oxides	13,076	13,051	-0.2%
Volatile Organic Compounds	20,394	20,067	-1.6%
Sulfur Dioxide	830	830	0.0%
Carbon Monoxide	86,056	84,022	-2.4%
PM10	1,574	1,600	1.7%
Carbon Dioxide Equivalents (Gg / year)	8,239	8,235	0.0%

5.2 OPPORTUNITIES AND CONSTRAINTS

The improvement of public transport systems has the potential to reduce the amenity of private vehicle use, though additional tram and bus traffic, that could increase public transport use further. Increased vehicle congestion would however increase the emission rates in affected areas.

With increasing public transport and walk / cycle use we would expect that the health of travellers would be improved by reductions in emissions and through the additional exercise being undertaken. These health improvements would flow through to reduced public and private health costs.

Increased buses on residential roads are likely to lead to a reduction in amenity, and potentially localised air quality impacts particularly in the vicinity of stops, resulting from brake noise and diesel exhaust plumes. These impacts will be reduced by future emission legislation and significantly improved fuel economy. The air quality impacts could be reduced if LNG fuelled buses are widely introduced.

5.3 IMPACTS ON NCCCS AREA

The main impact on the NCCCS area is that private car trips reduce by approximately 10% compared to the 2021 base case. We would also expect that the air pollution emissions from this source would reduce by a similar amount. A secondary impact from the reduction in private vehicle use would be that the lower levels of congestion expected would result in lower emission rates per kilometre travelled.

If we assume that private cars remain predominantly petrol fuelled and buses remain predominantly diesel fuelled, the reduction in car use and increase in bus use would result in reduction of CO, VOC and NOx, but an increase in particle emissions and sulfur dioxide emissions compared to the 2021 base case.

5.4 IMPACT ON EXTERNALITIES

Comparative migration of private vehicle trips to public transport across the metropolitan region would lead to significant reduction in greenhouse emissions, and corresponding pollutant emissions. However, increased bus use would result in some increases in NOx and particle emissions.

6 SCENARIO B: LOCAL STREET MANAGEMENT

6.1 SUMMARY

Scenario B includes all of the improvements in Scenario A. The aim of Scenario B is to significantly improve public transport services in order to increase public transport usage and to reduce road congestion levels.

Significant initiatives include:

- Lower free flow speeds assumed on specified local streets in the NCCCS area
- Removal of through traffic from local roads

The mode share estimate for the Base Case Scenario (2021) and Scenario A is detailed in *Table 5.1.*

Table 6.1 Zenith Model Estimates of Travel for Base Case and Scenario B Melbourne Metropolitan Area

	2021 Base Case		Scenario B		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	11,745	77.7	11,486	76.0	-259	-2.2
Transit	1,029	6.8	1,367	9.1	339	32.9
Walk / Cycle	2,333	15.4	2,253	14.9	-79	-3.4
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 6.2 Zenith Model Estimates of Travel for Base Case and Scenario B to/from, within and through the NCCCS Area

	2021 Base Case		Scenario B		Change	
Mode	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**	**Person Trips ('000)**	**%**
Private Car	755	61.9	672	55.1	-83	-11.0,
Transit	265	21.8	371	30.4	160	40.0
Walk / Cycle	198	16.3	176	14.4	-22	-11.1
Total	1,219	100	1,219	100.0	0	

4. Source – NCCCS Strategy Elements
5. Trip numbers rounded to the nearest thousand
6. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from Scenario B are compared with the 2021 Base Case in *Table 6.3*. These show a very small decrease in NOx, CO, PM10, SO_2 and VOC emissions, these reductions are all less than 0.1% over that achieved in Scenario A. In this scenario the strategies are specific to the NCCCS region and would result in the displacement of some traffic to regions outside the region, because of this the percentage changes in the NCCCS area would be significantly higher.

Table 6.3 Air Emissions from Scenario B Within the Metropolitan Area

Pollutant	2021 Base Case Emission (tonne)	Scenario B Emission (tonne)	Cumulative Change (%)
Nitrogen Oxides	13,076	13,047	-0.22%
Volatile Organic Compounds	20,394	20,055	-1.66%
Sulfur Dioxide	830	830	0.06%
Carbon Monoxide	86,056	83,969	-2.43%
PM10	1,574	1,600	1.67%
Carbon Dioxide Equivalents (Gg / year)	8,235	8,232	-0.09%

6.2 OPPORTUNITIES AND CONSTRAINTS

One of the largest advantages of these programs is that the measures impact directly on traffic in the NCCCS region and will likely displace traffic onto roads outside the region.

It is expected that the air quality impacts on affected and surrounding streets would be significant, due to the decrease in traffic flow.

The key constraint on implementation relates to the impact of the measures on residents amenity in the streets affect. The reduction in amenity could arise because of restricted access to homes and other locations and noise resulting from speed humps.

6.3 IMPACTS ON NCCCS AREA

The impact on the region in general will be significant in terms of emissions released in the region. However, this is no guarantee of significantly improved air quality as emissions are transport through the region from other areas as well as those produced locally. There is likely to be increased congestion on some roads in the region and the associated emissions will also increase in these areas.

6.4 IMPACT ON EXTERNALITIES

Nearby regions will likely experience some increased traffic flows, congestion and associated emissions travellers avoid the restricted areas in the NCCCS region.

7 SCENARIO C: CYCLING AND WALKING INITIATIVES

7.1 SUMMARY

General improvements to the facilities available and safety for walking and cycling are likely to increase the number of trips carried out by this mode. Specific actions could include, new bike paths or on road lanes, improved signage, improved lighting, secure parking facilities or shower and change facilities at workplaces.

Table 7.1 Zenith Model Estimates of Travel for Base Case Scenarios Melbourne Metropolitan Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario C Person Trips ('000)	Scenario C %	Change Person Trips ('000)	Change %
Private Car	11,745	77.7	11,462	75.9	-79	-2.4
Transit	1,028	6.8	1,360	9.0	331	32.2
Walk / Cycle	2,332	15.4	2,285	15.1	-48	-2.1
Total	15,107	100	15,107	100.0	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 7.2 Zenith Model Estimates of Travel for Base Case Scenarios to/from, within and through the NCCCS Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario C Person Trips ('000)	Scenario C %	Change Person Trips ('000)	Change %
Private Car	755	61.9	648	53.2	-107	-14.2
Transit	265	21.8	363	29.8	98	37.0
Walk / Cycle	198	16.3	208	17.1	10	5.1
Total	1,219	100	1,219	100	0	

7. Source – NCCCS Strategy Elements
8. Trip numbers rounded to the nearest thousand
9. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from Scenario C have not been determined explicitly because of the difficulty in quantifying the relationship between trips and distance travelled. However the following conclusions can be reached based on the change in the number of trips forecast.

The number of trips made by cycling and walking increases by approximately 5% of the base case value as a result of this scenario, representing an 18% increase over that in the previous Scenario. If we assume that most of these trips are short and occur within the NCCCS region, there will be a measurable reduction in the quantity of emissions released by vehicles within the region.

Trips replaced by walking or cycling are largely passenger vehicle trips, indicating that significant short car trips are removed from the region.

8 SCENARIO D: CBD PARKING PRICE INCREASE

8.1 SUMMARY

This scenario includes the evaluation of the impacts of an increase in the cost for parking in the CBD to reduce the demand for commuter travel by private vehicle. The reduction in trips for the metropolitan and the NCCCS region are shown in *Table 8.1* and *Table 8.2*. These data show a reduction in private car use of approximately 1% over the preceding scenario.

Table 8.1 Zenith Model Estimates of Travel for Scenario D Melbourne Metropolitan Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario D Person Trips ('000)	Scenario D %	Cumulative Change Person Trips ('000)	Cumulative Change %
Private Car	11,745	77.7	11,402	75.5	-79	-2.9
Transit	1,028	6.8	1,397	9.2	368	35.7
Walk / Cycle	2,332	15.4	2,308	15.3	-25	-1.1
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 8.2 Zenith Model Estimates of Travel for Scenario D to/from, within and through the NCCCS Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario D Person Trips ('000)	Scenario D %	Cumulative Change Person Trips ('000)	Cumulative Change %
Private Car	755	61.9	633	51.9	-122	-16.2
Transit	265	21.8	373	30.6	108	40.8
Walk / Cycle	198	16.3	212	17.4	14	7.1
Total	1,219	100	1,218			

10. Source – NCCCS Strategy Elements
11. Trip numbers rounded to the nearest thousand
12. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from this scenario are presented in *Table 8.3* and show an additional reduction in emissions for most pollutants of around 0.5% over the previous scenario.

Table 8.3 Air Emissions from Scenario D Within the Metropolitan Area

Pollutant	2021 Base Case Emission (tonne)	Scenario D Emission (tonne)	Cumulative Change (%)
Nitrogen Oxides	13,076	13,001	-0.57%
Volatile Organic Compounds	20,394	19,971	-2.07%

	2021 Base Case	Scenario D	Cumulative Change
Sulfur Dioxide	830	827	-0.30%
Carbon Monoxide	86,056	83,597	-2.86%
PM10	1,574	1,595	1.37%
Carbon Dioxide Equivalents (Gg / year)	8,235	8,201	-0.46%

8.2 *OPPORTUNITIES AND CONSTRAINTS*

The key opportunity here is that this action removes private car trips from the transport network replacing them with public transport or walking / cycling options. The benefits obtained are limited by political will to implement such measures and a likely reduced impact over time as some travellers decide the convenience of private transport is worth the additional cost.

8.3 *IMPACTS ON NCCCS AREA*

Emissions of major pollutants and greenhouse gas emissions reduce by approximately 0.5% within the metropolitan region. The distribution of these trip reductions is likely to be dispersed over much of this region, resulting in a smaller percentage change in the emissions from the NCCCS.

8.4 *IMPACT ON EXTERNALITIES*

The impact of this mechanism will be distributed over the entire metropolitan region and is not specific to NCCCS. Reductions of traffic and emissions will be felt across the metropolitan region.

9 SCENARIO D2: TRAVELSMART IMPLEMENTATION

9.1 SUMMARY

The TravelSmart program is an education based traffic demand management program that has undergone successful trials in Adelaide and Perth. Trials are currently underway in Melbourne. The results of the trials indicate that it may be possible to reduce private vehicle travel by 7-8%.

The applicability of this option in Melbourne regions is unknown at the current time, as the effectiveness will depend upon the available public transport options and their current patronage.

Table 9.1 Zenith Model Estimates of Travel for Base Scenario D Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario D2		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,348	75.1	-79	-3.4
Transit	1,028	6.8	1,433	9.5	404	39.3
Walk / Cycle	2,332	15.4	2,326	15.4	-7	-.3
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 9.2 Zenith Model Estimates of Travel for Scenario D to/from, within and through the NCCCS Area

Mode	2021 Base Case		Scenario D2		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	755	61.9	578	47.4	-177	-23.4
Transit	265	21.8	410	33.6	145	54.7
Walk / Cycle	198	16.3	230	18.9	32	16.2
Total	1,219	100	1,218			

13. Source – NCCCS Strategy Elements
14. Trip numbers rounded to the nearest thousand
15. Walk / Cycle excludes intrazonal walking and cycling

Emissions have not been estimated from this option because of the difficulty in converting trip reductions to VKT under this scenario.

The main impact from the TravelSmart program is the transfer of private vehicle trips to public transport and walking / cycling. This would result in significant reductions in vehicle emissions both within and external to the NCCCS region. Assuming that the results of the Perth trial could be replicated throughout the metropolitan region significant reductions in emissions could be achieved across the city.

10 SCENARIO F: DONASTER AREA RAPID TRANSIT

10.1 SUMMARY

This scenario considers the implementation of the Doncaster Area Rapid Transit (DART) system that incorporates a high capacity light rail system operating between Doncaster Shoppingtown, NCCCS and the City. The service will operate at high frequency and with high quality priority and stops.

The resulting trip impacts for the scenario are presented in *Table 10.1* and *Table 10.2*.

Table 10.1 Zenith Model Estimates of Travel for Scenario F Melbourne Metropolitan Area

Mode	2021 Base Case		Scenario F		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	11,745	77.7	11,339	75.1	-79	-3.5
Transit	1,028	6.8	1,440	9.5	411	40.0
Walk / Cycle	2,332	15.4	2,328	15.1	-5	-0.2
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 10.2 Zenith Model Estimates of Travel for Scenario F to/from, within and through the NCCCS Area

Mode	2021 Base Case		Scenario F		Change	
	Person Trips ('000)	%	Person Trips ('000)	%	Person Trips ('000)	%
Private Car	755	61.9	572	46.9	-183	-24.0
Transit	265	21.8	414	34.0	147	55.5
Walk / Cycle	198	16.3	232	19.0	34	17.2
Total	1,219	100	1,218			

16. Source – NCCCS Strategy Elements
17. Trip numbers rounded to the nearest thousand
18. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from this scenario are presented in *Table 10.3* and show an additional reduction in emissions for most pollutants of between 0.5% and 1.0 %over the previous scenario. These reductions are the result of significant shifts of travel from private cars and buses to the DART.

Table 10.3 Air Emissions from Scenario F Within the Metropolitan Area

Pollutant	2021 Base Case Emission (tonne)	Scenario F Emission (tonne)	Cumulative Change (%)
Nitrogen Oxides	13,076	12,834	-1.85%
Volatile Organic Compounds	20,394	19,835	-2.74%
Sulfur Dioxide	830	815	-1.75%
Carbon Monoxide	86,056	83,351	-3.14%
PM10	1,574	1,560	-0.84%
Carbon Dioxide Equivalents (Gg / year)	8,235	8,084	-1.88%

10.2 OPPORTUNITIES AND CONSTRAINTS

The DART provides for rapid transport from Doncaster to the city on a dedicated line and will therefore compete with bus traffic on the freeway routes. Significant numbers of trips are expected to be migrated from bus to DART resulting in significantly reduced emissions.

Although the project provides significant benefits these are distributed to one particular area of Melbourne, similar systems to other regions would improve conditions to a greater degree.

10.3 IMPACTS ON NCCCS AREA

Significant reductions in all pollutants including greenhouse gases are expected as a result of the DART. Associated with this are improvements in traffic levels and congestion.

10.4 IMPACT ON EXTERNALITIES

The external regions to NCCCS are expected to get most of the benefits of the DART both in terms of access to use of the system and emission reduction benefits.

11 SCENARIO G: EAST-WEST ROAD TUNNEL

11.1 SUMMARY

The east-west tunnel option provides an underground link between the Eastern Freeway and Flemington Road. This option is the only one considered that is likely to increase travel demand. The modelled trip data for this scenario is presented in *Table 11.1* and *Table 11.2*.

Table 11.1 Zenith Model Estimates of Travel for Base Case Scenarios Melbourne Metropolitan Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario G Person Trips ('000)	Scenario G %	Change Person Trips ('000)	Change %
Private Car	11,745	77.7	11,341	75.1	-79	-3.4
Transit	1,028	6.8	1,438	9.5	409	39.8
Walk / Cycle	2,332	15.4	2,328	15.4	-5	-0.2
Total	15,107	100	15,107	100	0	0

1. Source – Veitch Lister Consulting – Technical Note 1 NCCCS 2021 Base Case Scenario

Table 11.2 Zenith Model Estimates of Travel for Base Case Scenarios to/from, within and through the NCCCS Area

Mode	2021 Base Case Person Trips ('000)	2021 Base Case %	Scenario G Person Trips ('000)	Scenario G %	Change Person Trips ('000)	Change %
Private Car	755	61.9	573	47.0	-182	-24.1
Transit	265	21.8	413	33.9	148	55.8
Walk / Cycle	198	16.3	232	19.0	34	17.2
Total	1,219	100	1,218			

19. Source – NCCCS Strategy Elements
20. Trip numbers rounded to the nearest thousand
21. Walk / Cycle excludes intrazonal walking and cycling

The resulting emissions from this scenario are presented in *Table 11.3* and show an additional increase in emissions for most pollutants of around 0.1-0.2% over the previous scenario. These increases are the result of shifts of travel to private cars resulting from reduced congestion and travel time.

Table 11.3 Air Emissions from Scenario G Within the Metropolitan Area

Pollutant	2021 Base Case Emission (tonne)	Scenario G Emission (tonne)	Cumulative Change (%)
Nitrogen Oxides	13,076	12,836	-1.84%
Volatile Organic Compounds	20,394	19,840	-2.71%
Sulfur Dioxide	830	815	-1.73%
Carbon Monoxide	86,056	83,376	-3.11%
PM10	1,574	1,561	-0.83%
Carbon Dioxide Equivalents (Gg / year)	8,235	8,086	-1.86%

Table 11.4 Emissions Removed from Surface Roads and Released Through Stack

Pollutant	Emissions to Stack Tonne/year
Nitrogen Oxides	53
Volatile Organic Compounds	83
Sulfur Dioxide	3
Carbon Monoxide	350
PM10	6
Carbon Dioxide Equivalents (Gg / year)	53

The emissions removed from surface level and emitted through the tunnel stack amount to less than 0.5% of total emissions. The impact of the emissions exiting the stack are unlikely to cause discernable impact on local areas providing the stack is effectively designed. The recent report on monitoring of the City Link stacks and surrounding areas has shown that the impact of the stacks cannot be detected above the existing ambient levels.[1]

11.2 OPPORTUNITIES AND CONSTRAINTS

A constraint of this option is that ventilation stacks for the tunnels are likely to be required. The siting of Ventilation stacks has many perceived and a few real issues needing to be resolved.

Ventilation stacks are commonly located near the exit portals of tunnels. This placement conserves the energy required to vent exhausts as the one-way vehicle traffic movement create a ‘piston effect’. Ventilation stacks have been situated in areas other than a portal, however any benefits for doing so would need to be weighed against the additional greenhouse gas emissions resulting from fan operation.

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[1] EPA, 2002, “Annual Review of Air Quality Monitoring Data – CityLink Project”, Publication No. 864, July 2002.

Ventilation stack diameter, height, velocity, treatment would be required to be determined when in depth engineering design has been conducted. Plume dispersion modelling would be required to show that the emissions from any proposed ventilation stacks meet the requirements of the State Environmental Protection Policy (Air Quality Management).

11.3 *IMPACTS ON NCCCS AREA*

Although the emissions generated from road traffic increase in this scenario, the actual impact on air pollution in the NCCCS is difficult to quantify. The difficulty arises because the emissions that generated in the tunnel are effectively removed from the ground level emissions. Air from the tunnel will be emitted from a stack at some height and with some velocity resulting in impacts at ground level that may be lower than that experienced previously. The location, height and exit velocity of the stack will primarily determine the impacts at ground level in the vicinity of the stack.

The NCCCS region will benefit significantly from the reduced travel by through traffic on the roads in the region. The reduced travel through the region results in approximately 0.4% of the ground level emissions from the metropolitan region. As most of this would be removed from within the NCCCS area a significant reduction in emissions at ground level would result.

Quantifying the impacts of the elevated emissions in comparison to the ground level emissions would require additional study including dispersion modelling of emissions from the stack.

11.4 *IMPACT ON EXTERNALITIES*

There are likely to be no significant impacts on air quality in regions outside NCCCS as most of the traffic in the tunnel is removed from within the region. The external regions benefit greatly from the use of the tunnel and the improved travel times resulting.

Annex A

Derivation Of Vehicle Emission Rates

A.1 INTRODUCTION

The derivation of vehicle emission rates has been conducted based on the likely improvements in fuel consumption rates, the impacts of the Fuel Quality Standards, and currently proposed and likely tightening of vehicle emission limits that are administered through the Australian Design Rules (ADR). Emission rates have been determined for different vehicle types and the fuels that they are likely to use.

The timeframe for the analysis is the 20 years from 2001 to 2021 and over this period there is the potential for widespread adoption of hybrid vehicles (such as the recently introduced Toyota Prius and Honda Insight and less widespread adoption of fuel cell vehicles. However, the degree of penetration of these new technology vehicles has not assumed to be great in the current analysis. The emission rates derived can therefore be viewed as conservatively high and could conceivably be significantly lower than reported.

A.2 AUSTRALIAN DESIGN RULE IMPACT ON EMISSIONS

Vehicle emissions are regulated through ADRs that set emission limits on a g/km basis for NOx, CO and hydrocarbons. The standards have been progressively tightened since 1976, including significant tightening in 1985 that required the introduction of unleaded fuel for petrol vehicles to support the introduction of catalyst equipped cars.

There is currently a process underway to harmonise ADRs with international emission regulations. Current ADRs are generally about five years behind the regulations in the US and Europe. The harmonisation will not necessarily remove this lag but will entail adopting similar standards to those operating in Europe. The harmonisation will facilitate the free trade of vehicles as emission limits can be used as a barrier to importation.

The current timetable for introduction of European equivalent emission standards is as follows:

The timetable for the introduction of new emission standards for diesel vehicles will facilitate:

- Euro 2 diesel vehicle emission standards for all new light diesel vehicles in 2002 and for continuing models in 2003.
- Euro 3 diesel vehicle emission standards for all new medium and heavy diesel vehicles in 2002 and for continuing models in 2003: and
- Euro 4 diesel vehicle emission standards for all new diesel vehicles in 2006 and for continuing models in 2007.

And for petrol vehicles:

- Introduction of Euro 2 petrol vehicle emission standards for all new vehicles in 2003 and for continuing models in 2004; and
- Introduction of Euro 3 petrol vehicle emission standards for all new vehicles in 2005 and for continuing models in 2006.

Applying to all new vehicles imported to Australia or manufactured here, the new international standards establish maximum levels for fine particles, nitrogen oxide, carbon monoxide and hydrocarbons agreed by the UN Economic Commission for Europe. For medium to heavy-duty trucks, when compared with current emission standards, emission rates from oxides of nitrogen and particulates will be 40 per cent and 70 per cent lower respectively after 2002; and 50 per cent and 90 per cent lower respectively after 2006.

In deriving the emission rates employed in this study no further tightening of these standards has been assumed to occur.

A.3 FUEL QUALITY STANDARD IMPACT ON EMISSIONS

The introduction of Euro 4 standards for diesel vehicles in 2006 necessitates the availability of low sulfur diesel fuel, which in turn requires significant modifications and investment in refining. The fuel quality for diesel is being mandated through the National Fuel Quality Standards process. Low sulfur diesel will not only allow new vehicles to meet the Euro 4 standard but will also significantly reduce emissions from existing diesel fuelled vehicles.

The introduction of low sulfur diesel will occur over a number of years leading up to 2006, because of the significant investment required by the refineries. A number of states already have diesel fuel on sale that will meet these new standards.

A.4 FUTURE VEHICLE FUEL CONSUMPTION

While it is generally accepted that new vehicle and engine technologies should allow significant reductions in fuel consumption, increase in vehicle mass and increased use of accessory equipment such as air conditioning, this is generally not observed.

The issue of improving fuel economy is being addressed by the Australian Greenhouse Office (AGO) in collaboration with the automotive industry through the development of National Average Fuel Consumption (NAFC) targets. The NAFC targets will form a component of the Environmental Strategy for the Motor Vehicle Industry being developed.

The aim of the targets is to reduce fuel consumption of new vehicles by 15% by 2010. In developing fuel consumption levels for 2021, the increase in fuel efficiency has been linearly extrapolated between 2010 and 2021. This assumes that a similar level of improvement can be achieved over this extended period.

A.5 EMISSION RATES

Emission rates for vehicle types in 2021 have been determined based on:

- Fuel based Emission rates from ARRB
- Derived fuel consumption rates
- The relativity of 2000 and 2020 emission rates presented in the Fuel Quality Review for Scenario 2 (Environment Australia, 2000).

The emission rates derived are consistent with those reported in the Fuel Quality Review.

REFERENCES

ACIL Consulting (1999) **Study on Factors Impacting on Australia's National Average Fuel Consumption Levels to 2010,** A Report to the Australian Greenhouse Office.

Environment Australia (2000) **Review of Fuel Quality Requirements for Australian Transport**