East-West Link Needs Assessment Environment and Heritage Study

PART A AND B

- Final
- 20 March 2008

Preface: East West Needs Assessment – Environment and Heritage Study

This Working Paper presents the findings of the Environment and Heritage Study conducted for East West Needs Assessment. The study has been undertaken by Sinclair Knight Merz-Maunsell to provide environment and heritage advice to the Department of Infrastructure (DoI) study team supporting Sir Rod Eddington.

The purpose of the Environment and Heritage Study is to carry out a strategic evaluation of the natural environmental and heritage issues associated with a range of options under consideration to enhance east-west transport linkages in Melbourne.

Part A of this report identifies environment and heritage constraints and opportunities relevant to the analysis of possible transport initiatives, including sustainability drivers for the study and an environmental sustainability framework.

Part B of the report provides a high level analysis of four nominated transport options, comprising different combinations of public transport and road network development initiatives. The options are assessed against the environmental sustainability framework, using the study team's strategic merit test.

It is noted that the overall project is being delivered as a collaborative approach between a number of specialist teams engaged by DoI, including:

- Environment and Heritage Study : Sinclair Knight Merz- Maunsell
- Economic Analysis – Meyrick and Associates
- Demographics, Social and Land Use Effect Analysis – SGS Economics and Planning
- Transport Planning and Costing – Sinclair Knight Merz-Maunsell
- Transport Modelling- Veitch Lister Consulting.

It may be necessary to review sections of the above reports to gain a more complete understanding of the information presented in this working paper.

East-West Link Needs Assessment Environment and Heritage Study

Part A – Issues Paper

- Final
- 2 August 2007. Updated 25 March 2008

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List of abbreviations

Abbreviation	Expanded Term or Title
AAQFS	Australian Air Quality Forecasting System
ARD	Acid Rock Drainage
ASS	Acid sulphate soils
AusCID	Australian Council for Infrastructure Development
CAMBA	China-Australia Migratory Bird Agreement
CHMP	Cultural Heritage Management Plan
CO	Carbon monoxide
CO2	Carbon dioxide
dBA	Decibels
DEH	Department of Environment and Heritage (now DEWR)
DEWR	Department of the Environment and Water Resources
DoI	Department of Infrastructure
DSE	Department of sustainability and Environment
EETM	Emission Estimation Technique Manual
EPAV	Environment Protection Authority Victoria
ESD	Ecologically Sustainable Development
EVCs	Ecological Vegetation Communities
EWLNA	East-West Needs Assessment
FFG Act	Flora and Fauna Guarantee Act
GDE	Groundwater Dependent Ecosystem
JAMBA	Japan-Australia Migratory Bird Agreement
MCA	Multi Criteria Analysis
MTAG	Maribyrnong Truck Action Group
µm	micron; a unit size equivalent to one thousandth of a millimetre
$\mu g/m^3$	micrograms per cubic metre; a unit mass concentration
L_{A01}	The A-weighted sound pressure level that is exceeded for 1% of the time for which the given sound is measured. L_{A01} is sometimes used as a measure of the typical maximum noise level.
L_{A10}	The A-weighted sound pressure level that is exceeded for 10% of the time for which the given sound is measured. L_{A10} is commonly referred to as the average maximum noise level.
$L_{A10,1hr}$	The L_{A10} level measured over a 1 hour period.
$L_{A10(18hr)}$	The arithmetic average of the $L_{A10,1h}$ levels for the 18 hour period between 6am and 12 midnight on a normal working day.
L_{A90}	The A-weighted sound pressure level that is exceeded for 90% of the time. The L_{A90} is commonly referred to as the background noise level.
L_{Aeq}	Equivalent sound pressure level – the steady sound level that, over a specified period of time, has the same sound energy as the fluctuating noise actually occurring. LAeq is often referred to as the average noise level.
$L_{Aeq,1hr}$	The L_{Aeq} noise level for a one-hour period.
$L_{Aeq,9hr}$	The L_{Aeq} noise level for the period 10pm to 7am.
$L_{Aeq,15hr}$	The L_{Aeq} noise level for the period 7am to 10pm.
$L_{Aeq,24hr}$	The L_{Aeq} during a 24 hour period from midnight to midnight.
LDN	This is the same as the $L_{Aeq,24h}$, but with a 10dB penalty added to the nighttime hours between 10.00pm-7.00am.

LDEN	The LAeq,24h with a 10dB penalty added to the night-time hours between 10.00pm-7.00am, and a 5dB penalty added to the evening hours between 7.00pm-10.00pm.
L_{Amax}	The maximum noise level which occurs during any noisy event during the measurement period
NCCC	Northern Central City Corridor Study
NEIP	Stony Creek Neighbourhood Environment Improvement Plan
NEPM	National Environment Protection (Ambient Air Quality) Measure
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen; *i.e.*, comprising fractions of NO_2 and NO
NPI	National Pollution Inventory
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbon
PM	Particulate Matter
PPB	Parts Per Billion
PPM	Parts Per Million
SEPP	State Environment Protection Policy
SO_2	Sulfur dioxide
TBL	Triple Bottom Line
VOC	Volatile Organic Compound

Glossary

Term	Explanation
Acid sulphate soils	Soils that contain significant amounts of iron sulfides, which when exposed to water and air react to produce acid and can have major environmental, economic, engineering and health impacts
Acid Rock	Rocks that contain sulphide minerals that when exposed to water and air react to produce acid and can have major environmental, economic, engineering and health impacts.
Acid Rock Drainage	ARD occurs when rocks or soils with high sulphide content are oxidised by exposure to the atmosphere after excavation.
Beneficial Use	The uses and values of the water environment that the community and government want to protect
Biodiversity	Biodiversity is the variety of all living things; the different plants, animals and micro organisms, the genetic information they contain and the ecosystems they form.
Ecological Vegetation Classes	EVCs are the basic mapping units used for biodiversity planning and conservation assessment at landscape, regional and broader scales in Victoria. They are derived from large-scale forest type and plant community mapping.
Groundwater	Water that exists beneath the earth's surface in underground streams and aquifers
Groundwater Dependent Ecosystem	An ecosystem that relies on groundwater for some, or all, of their water requirements.
Hydrogeology	The science dealing with the occurrence and distribution of subsurface water
Particulate Matter	Particulate Matter (PM) is a laboratory term for small (inhalable) particles; *e.g.*, PM_{10} refers to particles with diameters less than 10 microns; and $PM_{2.5}$ refers to particles with diameters less than 2.5 microns). A micron (μm) is size measurement equal to one thousandth of a millimetre
Scarred trees	Scarred trees are trees which have had bark removed by indigenous Australians for the creation of canoes, shelters, shields and containers.
Sustainability	The ability to maintain something over time whether it is infrastructure, the environment, ecosystems, healthy communities or prosperous economy
TBL	Measuring and reporting performance against economic, social and environmental parameters.

Executive Summary

The Victorian Department of Infrastructure (DoI) has commissioned Sinclair Knight Merz-Maunsell to undertake the Environment and Heritage Study for the East-West Needs Assessment (EWNA). The purpose of the Environment and Heritage Study is to carry out a strategic evaluation of the physical and natural environmental and heritage constraints and opportunities for a range of options for a possible additional east-west transport link. The findings will assist the DoI Study Team with providing an assessment of the need for and feasibility of an additional link.

This Environment and Heritage Issues Paper represents the first stage of the assessment program. This paper has been developed to assist in both generating transport options for a new East-West link and in formulating criteria for the assessment framework that will be used to compare and contrast the options developed. Based on the options generated, a range of further specialist investigations will be undertaken during subsequent phases to develop a more detailed understanding of potential environmental opportunities and constraints.

Below is a brief overview of the potential key environment and heritage headline issues for the project.

Air Quality

Air quality monitoring conducted by the Environment Protection Authority Victoria (EPAV) shows the key air pollutant for the Melbourne Airshed, (in 2005 at least), was particulate matter. The air quality assessment for the EWLN Study should be based on the following air pollution indicators; for each traffic corridor scenario, estimates for concentrations expected for:

- Particulate Matter (as PM_{10} and $PM_{2.5}$); NO_2; and VOCs.

The identification of air pollution 'hot spots' is expected to be strongly dependent on traffic density 'hot spots' (to be determined by spatial analysis only), and only weakly dependent on the results of air dispersion modeling.

Flora and fauna

Although the study area is largely urbanised, a number of natural values remain in the area, largely defined by existing parks and reserves and drainage lines. Key flora and fauna features such as parks, reserves, riparian vegetation are described in Section 3.1.3 and have been highlighted in Figure 3-4.

A review of DSE databases, including the Atlas of Victorian Wildlife and Flora Information System database, identified the presence or potential presence for:

- Three flora species and four fauna species listed under the EPBC Act;

- Four flora species and 15 fauna species listed under the FFG Act; and
- 16 flora species and 27 fauna species listed on the Victorian Rare or Threatened (VROT) species advisory list, which is maintained by DSE.

The locations of recorded all threatened flora and fauna species in shown in Figure 3-4.

In investigating an additional East-West link the potential exists for possible 'opportunities', whereby specific ecological improvement options can also be included for further consideration. This may take the form of specific revegetation programs relating to waterway protection, screening or general amenity plantings.

Cultural heritage

A number of Aboriginal Heritage places have been identified through a review of existing reports. These locations are listed in Section 3.1.4 and are highlighted in Figure 3-5.

The study area is heavily disturbed through urbanisation and development, therefore there is generally a low potential for Aboriginal archaeological sites or sub-surface deposits.

Areas where there is a greater potential for sites to occur include areas within the vicinity of waterways such as rivers, creeks and swamps and elevated areas overlooking these waterways. Any areas of remnant native vegetation may also contain sites. Site types most likely to occur in the area are small, sparse artefact scatters and scarred trees. Areas where there is a greater potential for sites to occur have been mapped and are shown in Figure 3-5.

Total post-contact non-Indigenous heritage sites encompasses over a thousand places. Most of the study area is subject to Heritage Overlay controls in local planning schemes as shown in Figure 3-5.

Based on spatial datasets provided by Heritage Victoria, the study area contains:

- 538 heritage places listed on the Victorian Heritage Register (state-wide significance).
- Approximately 1300 sites listed on the Heritage Inventory. Most of these sites, approximately 1200, are located within the Melbourne CBD. There are 109 sites recorded outside the CBD.

Victorian Heritage Register Properties and sites listed on the Heritage inventory are shown in Figure 3-5 and key sites of importance have been specifically highlighted.

Aboriginal and European heritage places are often much more than what is currently identified and protected, and not all areas and themes have been assessed. The identification of heritage is an ongoing process, undertaken through the planning system, additions to the Victorian Heritage Register and community processes, in light of changing perspectives about what is important.

Preservation of the strong and highly significant heritage features of the area should be regarded as a potentially significant constraint to be considered in the development of an additional East-West link. However, opportunities may exist for transport infrastructure to incorporate and enhance cultural heritage values.

Noise

Of the main transportation modes, road transport causes the greatest noise intrusion in terms of the number of people impacted. A significant proportion of the population in Melbourne and other areas of Victoria are exposed to some degree of road traffic noise, where the proportion of the population exposed to aircraft and railway noise is significantly less, due to the lesser extents of use and infrastructure of these modes. In Victoria, there have been only a small number of community noise impact surveys since 1970, with none been undertaken in the last ten years.

The effects of noise on people are various and often interrelated. For example speech interference can result in annoyance and tiredness, while in turn, tiredness may exacerbate annoyance. There are also relationships between the general state of health of individuals and the various effects of noise. Stress may be introduced by the presence of noise, and stress may then induce changes in the body and general decline in health and well-being.

Some of the existing major transportation corridors in the area include:

Roads

- Alexandra Parade/Princes Street/Brunswick St
- Elliott Ave/MacArthur Rd
- Lygon St/Royal Pde/Sydney Rd/Nicholson St
- Racecourse Rd/Macaulay Rd
- Smithfield Rd/Kensington Rd
- Ballarat Rd/Geelong Rd/Barkley Rd/Sunshine Rd
- Francis St/Millers Rd/Grieve Pde
- Dohertys Rd/Boundary Rd/Fitzgerald Rd
- West Gate Freeway
- Western Highway
- Western Ring Road
- CityLink

Railways

- Epping, Fawkner, Broadmeadows, Footscray, Newport and Altona rail lines
- Railyards at Footscray, Dynon, Tottenham, Sunshine

Hydrology and water quality

The major rivers and creeks within the study area include Moonee Ponds Creek, Yarra River, Maribrynong River, Kororoit Creek, Stony Creek and Merri Creek. The locations of these waterways are shown in Figure 3-11. The quality of water entering these waterways and flowing into Port Phillip Bay is a major environmental concern because of the social and environmental significance of these waterways. Waterway condition of these rivers and creeks is rated from very poor to moderate by Melbourne Water.

Options that may be generated in the East-West Needs Assessment have the potential to impact on water quality and aquatic ecology in a number of ways, such as:

- The redirection of surface and groundwater flows and subsequent ecological impacts;
- The introduction of exotic species;
- Loss of existing floodplain functions. Figure 3-11 shows areas covered by a Land subject to Inundation Overlay;
- Impacts on existing infrastructure. Existing infrastructure is highlighted in Figure 3-11; and
- Water quality impacts from runoff from construction sites and road surfaces.

Preservation and improvement of water quality in the Yarra River, Moonee Ponds Creek, Maribrynong River, Kororoit Creek, Stony Creek and Merri Creek would be a beneficial by-product of any new transport infrastructure and its associated land use improvements.

Land contamination

Construction of a new East-West transport link is expected to involve the excavation and stockpile of large volumes of soil. There is the potential for man-made contamination of soils and potential for naturally occurring contamination of soil and rock. Historic and current industrial operations are a common source of contamination. Given the highly industrialised nature of the study area, the potential for contamination may be a significant issue.

Areas included within an Industrial Zone or an Environmental Audit Overlay of local planning schemes may have a higher potential to cause soil and/or groundwater contamination both on site and in surrounding areas. Figure 3-12 shows areas within this land zoning.

Within the study area there are 20 sites that are listed as EPA Priority Sites. Priority sites are sites for which EPA has issued a clean-up notice or a pollution abatement notice to. Addresses are shown in Table 3-18 and the locations are shown in Figure 3-12. There are likely to be numerous additional sites not investigated or reported.

Rocks or soils with high sulphide content are referred to as acid sulphate soils and rocks. These soils and rocks are oxidised by exposure to the atmosphere after excavation and can have major

environmental, economic, engineering, and health impacts, and can constrain development, construction and other activities in affected areas.

The Department of Primary Industries, acid sulphate soils map, which has been derived from modelling, provides an indicative location for acid sulphate soils. As shown in Figure 3-12, acid sulphate soils are probable around the Port of Melbourne, West Melbourne, Docklands, parts of Yarraville, Kensignton and Flemington and along land surrounding the Maribrynong River, Yarra River and Moonee Ponds Creek.

The East-West Needs Assessment provides an opportunity to contain and allow cleaning-up of contamination in areas adjoining proposed transport infrastructure.

Hydrogeology

In many major transport and infrastructure projects, especially those which involve tunnelling or embankments, the hydrogeological processes can have a significant influence on possible transport options and routes and hence on the project cost and construction methods adopted. Hence it is expected that the hydrogeology of the project area will be one of a small number of issues that will have a significant influence on the selection of the final transport options and proposed route alignments.

The existing hydrogeological conditions within Melbourne's inner north are shown in Table 3-19.

Potential hydrogeological impacts are generally caused by the need to manage groundwater inflows into the site, impacts include:

- Redirection of flow from waterways and wetlands;
- Impacts to Groundwater Dependant Ecosystems (GDE's) such as dying off of groundwater dependent vegetation;
- Maintenance of base flows to streams;
- Potential need to extract and treat groundwater;
- Land subsidence causing problems with urban infrastructure such as roads, buildings, pipelines etc; and
- Excessive inflows into cuttings/tunnels causing construction delays.

Further phases of assessment will include a more detailed review of hydrogeology of the study area.

1. Introduction

The Victorian Government has requested Sir Rod Eddington to lead a study into the need for an East-West Link. The East-West Link Study Team supporting Sir Rod has commissioned Sinclair Knight Merz- Maunsell to undertake the Environment and Heritage Study for the East-West Link Needs Assessment (EWLNA). The purpose of the Environment and Heritage Study is to carry out a strategic evaluation of the physical and natural environmental and heritage constraints and opportunities for a range of options for a possible additional east-west transport link. The findings will assist the Sir Rod and the Study Team with providing an assessment of the need for and feasibility of an additional link.

The overall project is being delivered as a collaborative approach between a range of specialist teams for DoI including:

- Environment and heritage analysis (Sinclair Knight Merz - Maunsell);
- Transport planning and costing (Sinclair Knight Merz - Maunsell);
- Economic analysis (Meyrick and Associates);
- Demographics, social and land use effect analysis (SGS Economics and Planning);
- Commercial and Financial analysis (Ernst & Young);
- Legal (Clayton Utz) and
- Transport modelling (Veitch Lister Consulting).

1.1 Study overview

The East-West Needs Assessment is an independent examination of the long term transport requirements of an additional east-west corridor across Melbourne. The assessment will investigate and make recommendations to the Government on a wide range of options to meet future demand. Matters that the investigation will consider include:

- Public transport opportunities
- Enhanced freight access
- Urban amenity
- Environment and sustainability issues
- Road network connectivity
- Benefits to the Victorian economy
- Traffic congestion
- Costs and funding options.

Whilst the growing congestion on our roads and public transportation networks is an important starting point for this Needs Assessment, the study is concerned with developing a sustainable transport system which:

- Supports economic growth and prosperity
- Addresses key environmental sustainability imperatives, including reducing greenhouse gas emissions and maintaining ecological functioning
- Contributes to the advancement of community well-being.

The indicative study area for the East-West Needs Assessment extends from the Western Ring Road at the Deer Park Bypass to east of Hoddle Street at the Eastern Freeway, see Figure 1-1.

- **Figure 1-1 Indicative study area**

The overall project is based on three Phases of Assessment as shown in Table 1-1 below:

- **Table 1-1 Phases of assessment**

Phase 1	Overview of strategic drivers, key issues and development of an assessment framework that will be used to assess the need for and performance of transport options.
Phase 2	Generation of initial options and assessment of those options against an assessment framework.
Phase 3	Final option assessment against the assessment framework.

1.2 Purpose of this document

The purpose of this Environment and Heritage Issues Report is to provide the following:

- Overview of the sustainability drivers applying to the study
- Outline of key environment and heritage headline issues
- A set of proposed environmental sustainability criteria for incorporation into the project's assessment framework that will be used to assess the performance of transport options generated.

Specific issues covered by the Environment and Heritage team include:

- Sustainability and climate change
- Air quality
- Greenhouse gas emissions
- Flora and fauna
- Cultural heritage
- Noise
- Hydrology and water quality
- Land contamination and
- Hydrogeology

1.3 Structure of this report

- **Section 2** identifies the key sustainability drivers applying to the project and includes an overview of current government sustainability policy at a state, federal and international level.
- **Section 3** summarises key environment and heritage issues for the study based on a literature review of existing reports, maps and other relevant information.
- **Section 4** provides an overview of the environmental sustainability criteria proposed to assess the performance of options generated.
- **Section 5** Conclusion.
- **Appendix A** outlines a number of sustainability policy drivers applying to the project.
- **Appendix B** provides suggestions for how the project's overall assessment framework could be based on sustainability principles, including a suggested Multi-Criteria Analysis approach.
- **Appendix C** provides an overview of railway noise criteria used in other Australian states.
- **Appendix D** comprises the VicRoads Noise Reduction Policy, February 2005.

2. Sustainability drivers for the study

2.1 Introduction

This section of the report examines the terms *Sustainable Development* and *Sustainable Transport*, the links between transport and greenhouse gas emissions and identifies sustainability issues that will be considered in both the generation and assessment of options for this study.

A particular focus for the Environment and Heritage study team is *Environmental Sustainability*, and environmental sustainability criteria proposed for the project's overall assessment framework are identified in Section 4.1. Economic and social criteria are being developed through the Economic Analysis (Meyrick and Associates) and the Demographics, Social and Land Use Effect Analysis (SGS Economics and Planning) respectively. Economic and social criteria will be combined with the environmental criteria to form an overall sustainability framework for the study

Suggestions on how the project's overall assessment framework could be based on sustainability principles of economic prosperity, environmental sustainability and community well-being are outlined in Appendix B, including a suggested Multi-Criteria Analysis approach.

This section provides a preliminary appraisal of sustainability issues and will be followed up with more detailed investigation during the development of the options.

2.2 What is sustainable development?

The concept of sustainable development was originally defined in 1987 by The World Commission on Environment and Development as *'development that meets the needs of others without compromising the ability of future generations to meet its own needs'*.

Within Australia, the Federal Government in 1992 further defined the concept of sustainability through three core objectives contained within the *National Strategy for Ecologically Sustainable Development*. These objectives are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

A systems-based approach to sustainability focuses on the interaction between human systems and the natural ecosystems that support us. Natural ecosystems provide us with a variety of resources

(such as potable water, clean air, a stable climate) and services[1] (such as water filtration, dispersion of air pollutants, and groundwater recharge). Human systems (economies and communities) generate a variety of products and wastes. In relation to these systems, there are two principal objectives:

- to maximise the productive capacity of natural and human systems
- to minimise the negative affects of one system on another.

There is a need to maximise the productive capacity of natural systems to provide the resources to support human systems. In addition, the productive capacity of natural ecosystems must not fall below an ecosystem-specific threshold beyond which its services and assimilative capacity diminish and its restoration cannot be feasibly achieved (i.e. its survival is threatened). In many cases, human interventions are now required to maintain and restore (where possible) the productive capacity of ecosystems.

The East–West Link Needs Assessment will apply sustainability principles to major transport strategy formulation for the study area and its surrounds. The key drivers for applying the principles of sustainability to the project are the significant range of government legislation and policies (as well as some anticipated new ones) which are underpinned by strong community expectations for increasingly sustainable transport infrastructure outcomes. A selection of sustainability policy drivers are outlined in Appendix A.

2.3 How is sustainable development assessed?

Strategies and evaluation methods for sustainable development need to combine the concepts of *triple bottom line* and the systems approach described above to yield the planning framework shown in Figure 2-1.

This approach supports performance-based development that meets agreed sustainability goals (such as economic prosperity, environmental sustainability and community well-being), rather than focussing on an approach which seeks to minimise adverse impacts.

[1] For further information on ecosystem services, refer to www.ecosystemservicesproject.org or Reid et al (2002)

Figure 2-1 Using the triple bottom line for planning purposes

	Environment	Society	Economy
Sustainability ('maintaining')	What would it take to **sustain** those aspects of the economy, society or natural environment that we value?		
Genuine progress ('improving')	What needs to be **changed** so that people's quality of life can be improved, both locally and globally?		
No major trade-offs (essential)	What would it take to ensure that any particular initiative does not have a **major impact** on *Sustainability* and *Genuine Progress*?		
Win-win outcomes (desirable)	How can a range of initiatives combine to provide **net benefits** (or offset impacts) to the economy, society and environment without a major impact in any area?		
Complete portfolio (complementary)	What would it take for any particular initiative to **contribute simultaneously** to *Sustainability* and *Genuine Progress*?		

Source: after Sutton (2003)

The Melbourne Principles on Sustainable Cities were adopted at the World Summit on Sustainable Development held in Johannesburg in 2002. Principle 9 is to '*Promote sustainable production and consumption, through appropriate use of environmentally sound technologies and effective demand management.*'

Other reference documents are summarised in Appendix A, including:

- The Australian Council for Infrastructure Development (AusCID) produced a handbook *Sustainability Framework for the Future of Australia's Infrastructure (2003)* that establishes a number of guiding principles for Australian infrastructure projects
- The Victorian Government's *Sustainability Action Statement (2006)* sets out a comprehensive set of environmental sustainability objectives including efficient transport systems, less waste and increased resource efficiency and reduced climate impact.

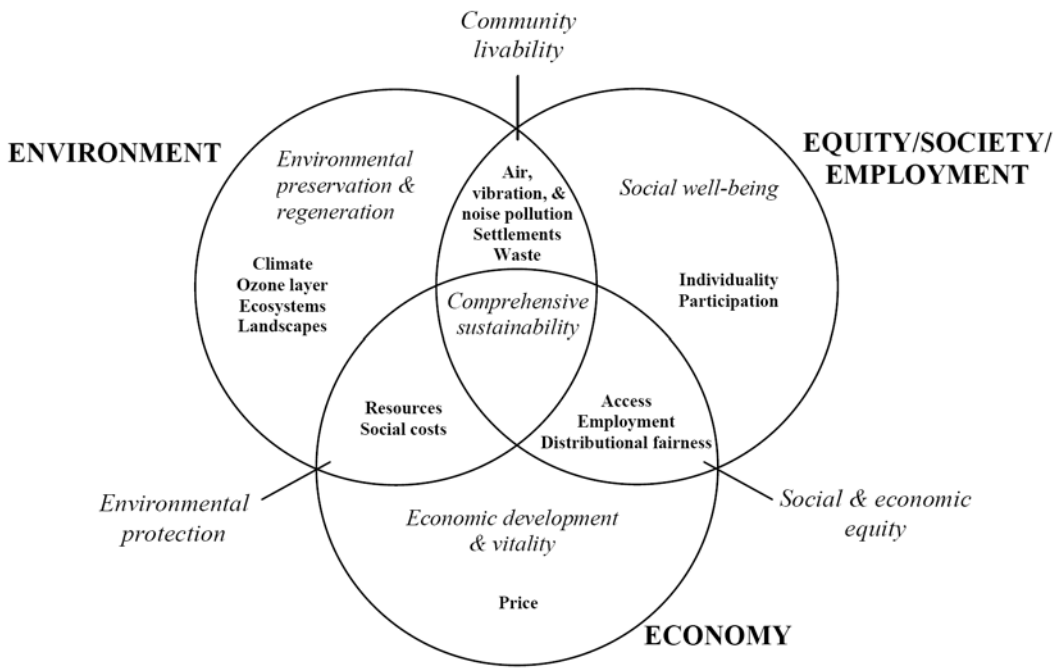
Our proposed approach to development of an overall Sustainability Assessment Framework for the study is outlined in Appendix B.

2.4 Sustainable transport

Following the 1992 Rio Conference, there have been numerous attempts to incorporate the core principles of sustainable development in conceptualisations of sustainable transport, also referred to as sustainable mobility.

The Massachusetts Institute of Technology [2] has articulated sustainable transportation using the TBL approach of environment, economy and equity/society/employment, as indicated in Figure 2-2.

- **Figure 2-2 Visualisation of the 3 Es of sustainable transportation**



Source: Hall & Sussman, 2006

One early and often cited definition of sustainable transport offered by the Organisation for Economic Cooperation and Development (OECD) is '*Transportation that does not endanger public health or ecosystems and meets mobility needs consistent with:*

- *Use of renewable resources at below the rates below their rates of regeneration; and*
- *Use of non-renewable resources at below the rates of development of renewable substitutes.*'

A more comprehensive definition provided by the New Zealand Ministry for the Environment:

'*Sustainable transport is about finding ways to move people, goods and information in ways that reduce its impact on the environment, the economy, and society. Some options include:*

- *Using transport modes that use energy more efficiently, such as walking or cycling and public transport;*
- *Improving transport choice by increasing the quality of public transport, cycling and walking facilities, services and environments;*

- *Improving the efficiency of our car use, such as using more fuel efficient vehicles, driving more efficiently, avoiding cold starts, and car pooling;*
- *Using cleaner fuels and technologies;*
- *Using telecommunications to reduce or replace physical travel, such as tele-working or tele-shopping; and*
- *Planning the layout of our cities to bring people and their needs closer together, and to make cities more vibrant and walkable.*'

The Warren Centre for Advanced Engineering at the University of Sydney completed a major study '*Sustainable Transport in Sustainable Cities*' in July 2002. The study identified strategies required to improve both accessibility and sustainability of Sydney's transport system. These results will be analysed further in Phase 2.

The automotive and energy industries increasingly use the term 'Sustainable Mobility' to describe and promote their technology developments, primarily in the areas of new motive and engine technologies and advances. For example, the World Business Council for Sustainable Development initiated the Sustainable Mobility Project (SMP) in 2000 to consider how global mobility patterns might evolve in the period to 2030 and beyond. The Mobility 2030 report concluded that the way people and goods are transported today is not sustainable if the present trends continue. The study proposed seven goals that, if achieved, would improve the prospects for sustainable mobility:

- Reduce conventional emissions from transport so that they do not constitute a significant public health concern anywhere in the world
- Limit GHG emissions from transport to sustainable levels
- Reduce significantly the number of transport-related deaths and injuries worldwide
- Reduce transport-related noise
- Mitigate traffic congestion
- Narrow 'mobility divides' that exist within all countries and between the richest and poorest countries
- Improve mobility opportunities for the general population in developed and developing societies.

Elements of sustainable transport systems (as identified above) will be analysed in more detail during later phases of the study, with specific reference to the East-West Corridor, including consideration of the following matters:

- Peak oil – many observers have concluded that the world is close to reaching the point at which global oil production will peak and start to decline. Anticipated consequential increases in the price of oil could have significant impacts on transport in Australia, as nearly all private

transport currently runs on oil, and 75% of Australian oil consumption is accounted for by transport

- Substitute fuels – potential substitute fuels include LPG, ethanol, biodiesel and fuel cells/ hydrogen. Potential penetration of these fuels will be examined, with reference to current Government programs such as the Compressed Natural Gas Infrastructure Program, the Alternative Fuels Conversion Program and the Environmental Strategy for the Motor Vehicle Industry.
- Improving fuel efficiency - lighter vehicles, hybrid engines, Australian Design Rules changes etc
- Demand management – analysis of non-infrastructure demand management initiatives such as car pooling schemes backed up by computerised booking systems, telecommuting
- Modal split - enhancement of the portion of the transport task taken by public transport through adoption of integrated transport and land-use strategies
- Economic instruments - the potential use of economic measures to moderate traffic demand.

2.5 Environmental sustainability and this study

The Environment and Heritage component of the EWLNA has a focus on the *environmental sustainability* aspect of sustainability. Economic and social aspects are being developed through the Economic Analysis (Meyrick and Associates) and the Demographics, Social and Land Use Effect Analysis (SGS Economics and Planning) respectively. Economic and social criteria will be combined with the environmental criteria to form an overall sustainability framework for the study

Environmental sustainability is concerned with ensuring that the accumulative impact of human activity does not adversely impact on the health and stability of the environment and ecosystem services that society and the economy depend upon such as stable climate conditions, materials, potable water and food production.

As highlighted previously, environmental sustainability values need to be considered as one element of the project's Triple Bottom Line objectives, during both option generation and assessment.

Key environmental sustainability issues for the study comprise:

- Impact on or opportunities to enhance or connect existing areas of natural ecosystems / assets
- Potential to enhance efficiency of the total transport system through improved connectivity (road, public transport, cycling and pedestrians)
- Potential to reduce energy use and greenhouse gas emissions over the corridor

- Impact on or opportunities to enhance air quality in the corridor
- Impact on or opportunities to enhance the acoustic environment in the corridor
- Impact on surface and ground water flows
- Impact on or opportunities to enhance water quality
- Potential for exposure to contamination and opportunities to manage impacts.
- Impact on or opportunities to preserve or enhance sites of cultural significance

Further explanation of the greenhouse imperative is provided below.

2.6 Greenhouse gas emissions and transport

2.6.1 Current policy drivers

Current policy drivers for action on climate change and greenhouse gas abatement are the National Greenhouse Strategy, the Victorian Greenhouse Strategy and the Victorian Greenhouse Gas Protocol.

National Greenhouse Strategy

The National Greenhouse Strategy was developed in 1998 and is the primary mechanism through which Australia's international commitments under the United Nations Framework Convention on Climate Change (and at the time of development the potential requirements of the Kyoto Protocol). Within the Strategy a number of modules were identified to manage and monitor Australia's greenhouse gas emissions.

Module 5 – Efficient Transport and Sustainable Urban Planning highlighted that, under business as usual assumptions, domestic transport emissions would increase by 42%, on 1994 levels, by 2015 and proposed the following measures:

- Integrating land use and transport planning
- Travel demand and traffic management
- Encouraging greater use of public transport, walking and cycling
- Improving fuel efficiency and fuel technologies
- Freight and logistics systems.

Specific transport actions included TravelSmart, a program designed to get people to change the way they travel, and car sharing programs.

The Australian government's decision to ratify the Kyoto Protocol in late 2007 means that Australia now accepts its objectives and obligations under international law. The new Government has announced (February 2008) that Australia's climate change policy is built on:

- Reducing Australia's greenhouse gas emissions

- Adapting to climate change that we can't avoid
- Helping to shape a global solution.

The Government has confirmed its commitment to a target of reducing emissions by 60% of 2000 levels by 2050, as well as its commitment to setting a medium term target.

Victorian Greenhouse Strategy

The Victorian Greenhouse Strategy 2002 recognised transport as a significant contributor to Victoria's greenhouse gas emissions and that greenhouse gas emissions from the road sector are projected to grow significantly over the next decade.

Key areas for action were identified as:

- Promotion of integrated cross-modal transport solutions
- A reduction in the need for motorised travel through integrated land use/ transport planning strategies
- Promotion of modal shift through delivery of a high quality public transport system
- Improving the fuel economy and emissions performance of motor vehicles
- Influencing travel choices and driver behaviour
- Improving the efficiency and effectiveness of the freight sector.

Our Environment Our Future

The Victorian Government's Sustainability Action Statement 2006 - Our Environment Our Future - identifies a range of actions to encourage sustainable transport in Victoria, including:

- More transport choice- a $135 million expansion of the TravelSmart Program
- Alternative fuels- a requirement for government vehicles to use ethanol blended petrol where available, and $100,000 for a Biofuels Action Plan
- Hybrid bus trial- $500,000 to trial hybrid buses in Melbourne
- Greening the Victorian automotive industry- $300,000 to work with the automotive manufacturing industry to develop fuel efficient and low greenhouse gas emissions technologies in locally-produced vehicles.

State Environmental Protection Policy (Air Quality Management)

The main thrust of the SEPP (AQM) requirements in relation to management of greenhouse gases is:

- Generators of emissions of greenhouse gases must manage their emissions by:
    - Avoiding and minimising emissions;
    - Assessing, monitoring, controlling, reducing or prohibiting emissions for improvements to air quality; and
    - Pursuing continuous improvement in environmental management practices and environmental performance and applying best practices to air emissions management.
- A generator of a new or substantially modified source of emissions must apply best practice to the management of those emissions.
- Any protocols for environmental management relating to greenhouse gas emissions developed by the (EPAV) in accordance with (the SEPP) will be consistent with any measures developed by the Government of Victoria for the management of greenhouse gases and energy efficiency.
- The (EPAV) will apply these protocols to generators of emissions subject to works approvals and licences, and in assessing the potential impacts of other development proposals.

Victorian Government Climate Change Policy

In November 2006, the Victorian Government committed to legislating for a long term target to reduce greenhouse gas emissions by 60% by 2050 compared to 2000 levels.

A (confidential) study by the Victorian Department of Premier and Cabinet is underway (July 2007) to identify potential greenhouse gas abatement initiatives across each sector of the Victorian economy, including transport, as an input to policy measures required to achieve the long term target.

Proposed National Emissions Trading Scheme

On 3 June 2007, the Prime Minister announced that he had accepted the recommendations of the Prime Ministerial Task Group on Emissions Trading. The Australian emissions trading model recommended by the Task Force is to be based on a 'cap and trade' model with the following features:

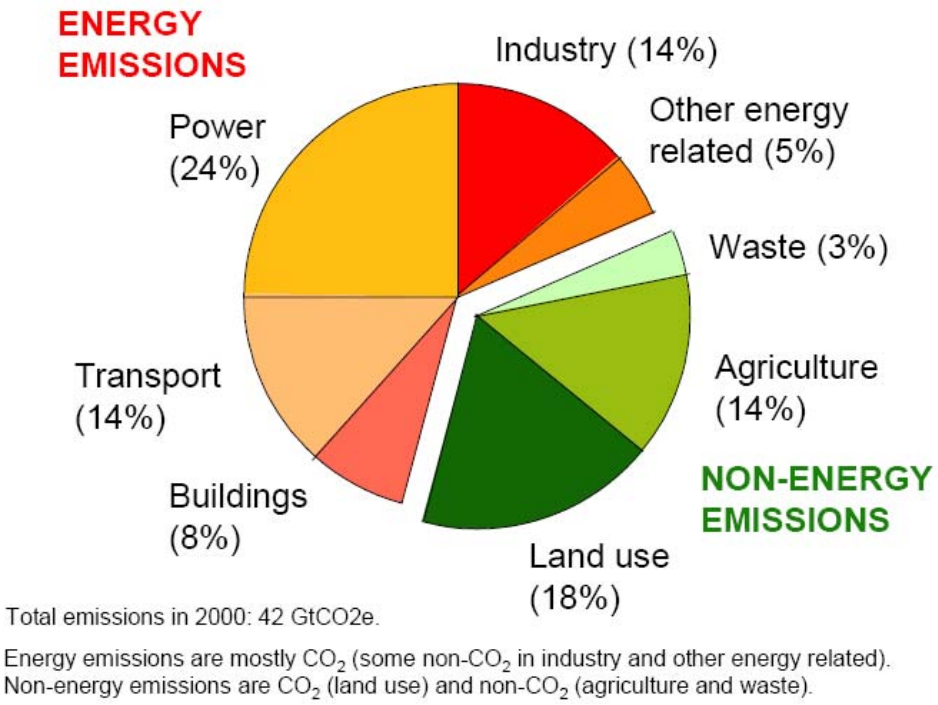
- A long term aspirational emissions abatement goal and associated pathway;
- An overall emissions reduction trajectory that commences moderately, progressively stabilises and then results in deeper emissions reductions over time; and
- Maximum practical coverage of all sources and sinks, and of all greenhouse gases.

The new Australian government has announced its intention to introduce an emission trading scheme by 2010, taking into account findings of the Garnaut review and Treasury modelling.

2.6.2 Greenhouse gas emissions from the transport sector

The transport sector is responsible for a significant proportion of greenhouse gas emissions. Figure 2-3 shows the proportion of greenhouse gases generated globally by the major sectors in 2000. Transport accounted for about 14% of all greenhouse gas emissions worldwide.

- **Figure 2-3 Proportion of global energy emissions by sector**



Source: The Stern Review – The Economics of Climate Change, 2006 (data from World Resources Institute)

The following sections provide some background on greenhouse gas emissions from transport and the rate of growth in transport emissions in Australia, the United Kingdom and the United States of America.

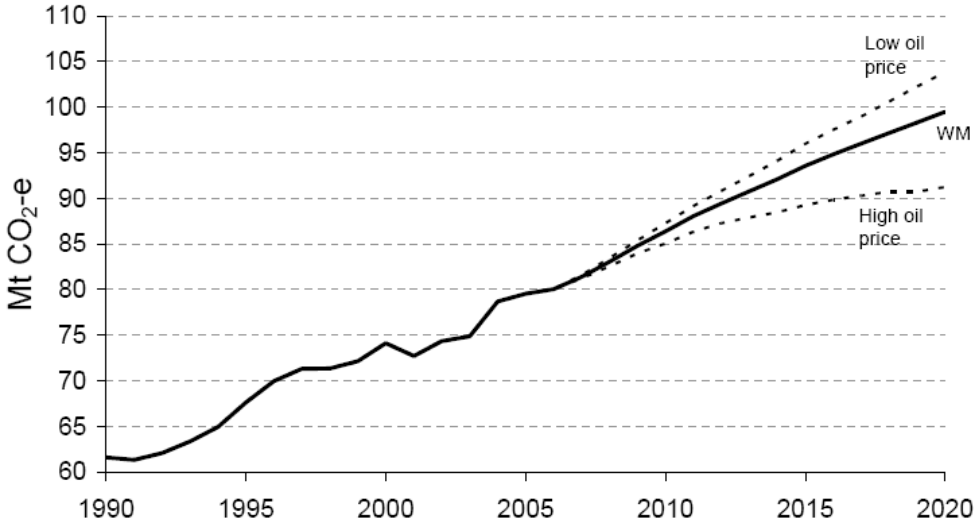
2.6.3 Australia

In 2004, 15% of all greenhouse gas emissions in Australia were from the transport sector. 88.6% of these emissions were from road transport (AGO, 2006a).

There was a 28.4% growth in greenhouse gases from transport in Australia between 1990 and 2004[3]. It is currently estimated that the growth of greenhouse gases from transport from 1990 to 2010 will be 40.2% and from 1999 to 2020 will be 60.5% (AGO, 2006b). This is higher than estimated population growth and the estimated growth of total greenhouse gases in Australia.

Past and projected future growth of greenhouse gas emissions from the transport sector are shown in Figure 2-4.

- **Figure 2-4 Greenhouse gas emissions for the transport sector (high and low oil price scenarios**

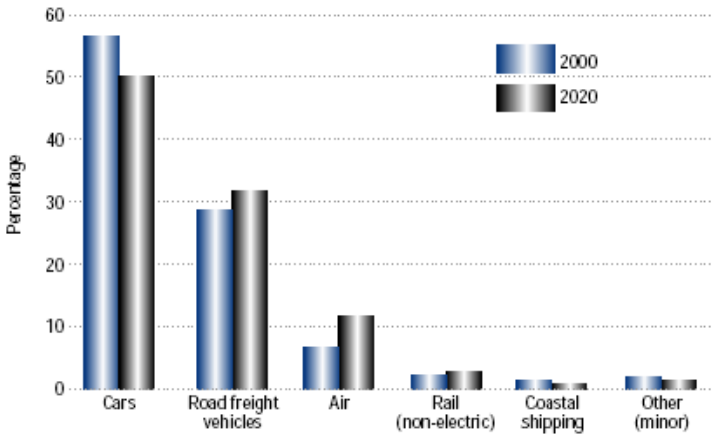


Note: High oil price scenario reaches US$90 by 2020. Low scenario falls to US$35 by 2020.
Source: ACG 2005; BTRE 2005; BTRE 2006; AGO analysis.

Source: AGO, 2006b

Currently in Australia cars emit more than half of transport greenhouse emissions. Figure 2-5 shows that by 2020 cars will still be the highest contributor but it is predicted that the proportion of emissions will have reduced from around 57% (in 2000) to about 50%. Conversely, the proportion of emissions contributed by road freight vehicles and air transport will have increased.

- **Figure 2-5 Distribution of transport emissions by vehicle type**



Source: Greenhouse Policy Options for Transport: Report 105 btre (2002)

2.6.4 International comparisons

The following comparisons shown in Table 2-1 compare greenhouse gas emissions per person in Australia, the UK and the USA.

- **Table 2-1 Comparison of greenhouse gases emissions per person**

	AUSTRALIA	UK	USA
Population	20.1 million	60.3 million	296.4 million
Total Greenhouse Gas Emissions (CO_2 equivalent)	565 mt/yr	656 mt/yr	7147 mt/yr
Total Greenhouse Gas Emissions per person	28.1 t/yr 100%	10.9 t/yr 39%	24.1 t/yr 86%
Greenhouse Gas Emissions from Transport (CO_2 equivalent)	76 mt/yr	125.3 mt/yr	2000.3 mt/yr
Greenhouse Gas Emissions from Transport per person	3.8t/yr 100%	2.1 t/yr 55%	6.75 t/yr 178%
Greenhouse Gas Emissions from Cars (CO_2 equivalent)	41.7 mt/yr	62.8 mt/yr	1170.5 mt/yr
Greenhouse Gas from Cars* per person	2.07 t/yr 100%	1.04 t/yr 50%	3.95 t/yr 191%

Analysis of data supplied under UN Framework on Climate Change, 2004

* Definitions of cars vary and include light trucks and 4WDs/SUVs in the United States

2.6.5 Implications for this study

As noted previously, the Commonwealth and Victorian Government's greenhouse gas reduction targets, combined with the Prime Minister's commitment to the introduction of an emissions trading scheme by 2010, indicate that it is likely that greenhouse gas reduction targets will be set for the Victorian transport sector at some point in the future.

This highlights the importance for the study to consider climate change and greenhouse issues in a rigorous and integrated way. A key environmental criterion for the assessment of strategy options will be greenhouse gas emissions associated with each option, and assessed against the Base Case. Comparisons with the Base Case need to consider the context of the Victorian Government's 2050 target, as described above.

Government has not yet set a specific target for the transport sector. However, given the large increase in greenhouse gas emissions from transport that has occurred since 1990 (refer earlier graphs) a stabilisation target to 1990 levels in the near future is clearly not be achievable in Australia. However, a long term target of the order of 60% reduction by 2050 could be used as a basis for the development of intermediate targets, and could be used as a benchmark against which strategy options could be assessed.

3. Key environment and heritage issues

3.1 Introduction

This section describes the existing environment and heritage values of the study area identifying key environment and heritage headlines issues and potential constraints and opportunities.

Information provided in this section has been drawn from existing literature, reports and maps and the expert knowledge of specialists. It is not an exhaustive review and provides only an indication of potential issues and sensitivities within the study area. This desktop review does not preclude the potential existence of unrecorded sites/species of significance or areas of potential constraint.There are likely to be additional constraints and opportunities within the study area. Further investigation is required to provide an accurate assessment of issues.

3.1.1 Air quality

Introduction

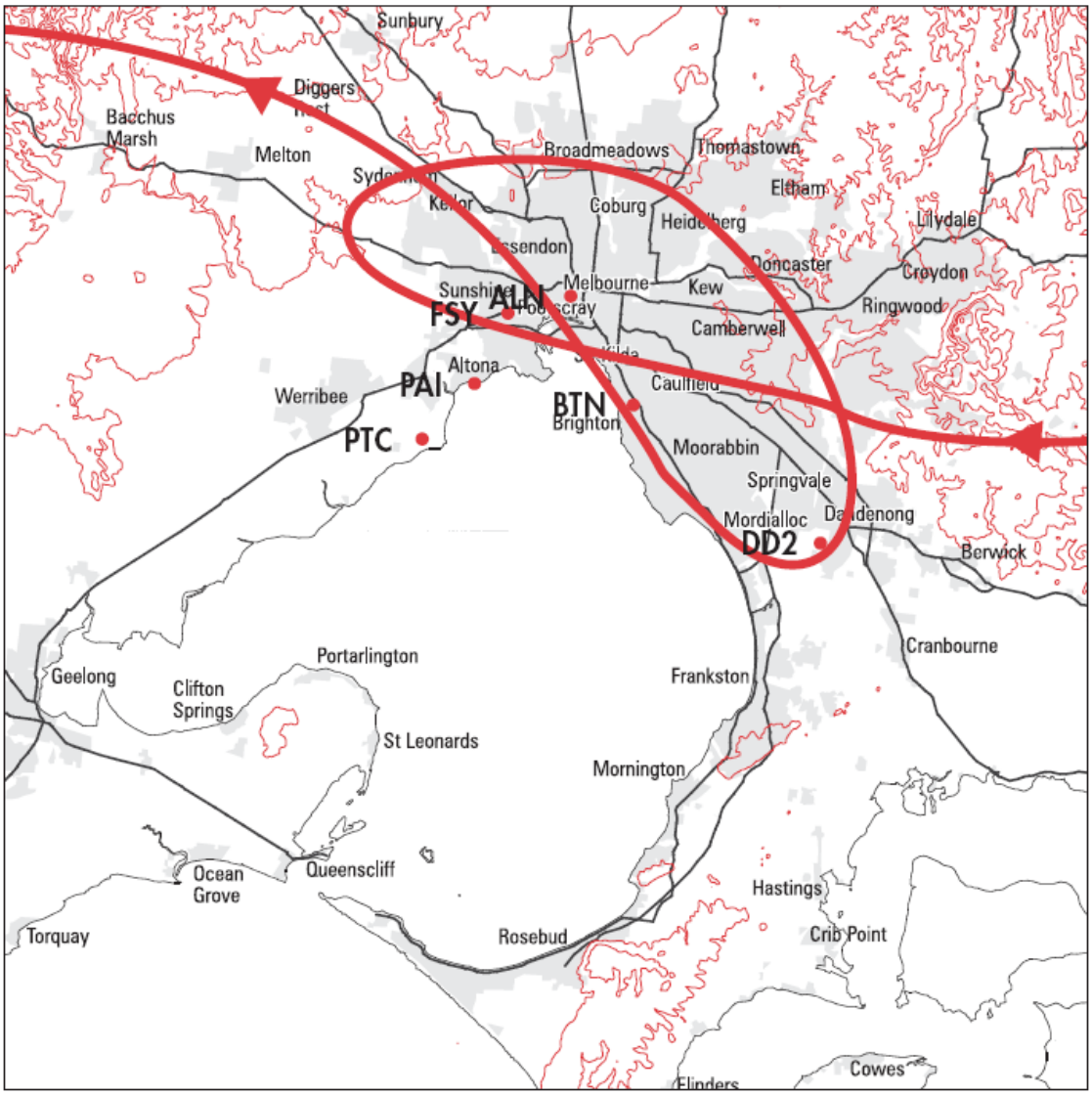
The air quality and greenhouse gas assessment component for Phase 1 of the EWLNA project is a preliminary review of the characteristics of Melbourne's air pollution and traffic environment. In this phase we provide only a qualitative understanding of the impacts from existing transport corridors on Melbourne's ambient air quality and greenhouse gas emissions. This includes the identification of sensitive areas and the strategic air quality and greenhouse gas drivers applying to the project.

The 'Melbourne Airshed'

Throughout this project reference will be made to the 'Melbourne Airshed'. This is a commonly used term to describe a study area that includes the locations of key air pollution sources and key air quality impacts within the wider Melbourne metropolitan area.

An example showing the Melbourne Airshed boundaries is provided in the extract from the urban air pollution study undertaken by the Australian Academy of Technological Sciences and Engineering (AATSE, 1997); refer to Figure 3-1. The figure shows a typical (predicted) air pollutant circulation pattern within the Melbourne Airshed and the locations of air pollution monitoring stations that existed at the time of the report.

- **Figure 3-1 Typical Melbourne Airshed study area (AATSE, 1997)**



Air pollution monitoring in Melbourne

The Environment Protection Authority Victoria (EPAV) conducts air quality monitoring within the Melbourne Airshed for air quality reporting and also to build our longer-term knowledge about changes in Melbourne's air pollution environment.

The current and primary EPAV air quality monitoring stations within the Airshed are indicated by the air pollution summary for 2005 provided in Figure 3-2. (extract from EPAV, 2006b).

- **Figure 3-2 EPAV Summary of air pollution monitoring for Victoria 2005**

Region		Station	Particles			Ozone		NO_2	CO	SO_2
			Visibility	PM_{10}	$PM_{2.5}$	1h	4h			
MELBOURNE	City	Richmond		1				0	0	
		RMIT	5	0		0	0	0	0	0
	East	Alphington	19	0	3	0	0	0	0	0
		Box Hill	10*	10		0	0	0	0	0
		Brighton	12	0		0	0	0		
		Dandenong	11	0		0	0	0		
		Eltham		6	9*	0*	0*	0*	0*	
		Moorooduc			.	0	0			
		Mooroolbark		9		0	0	0	0	
	West	Footscray	3*	0	2	0	0	0	0	0
		Melton				0	0			
		Paisley	7	3*		0	0	0		0
		Pt. Cook	2*			0	1	0		
Geelong		Geelong South	7	7		0	0	0	0	0
		Pt. Henry				0	0			
Latrobe Valley		Moe	11	0		0	0	0		0
		Traralgon	18*	0*		0*	0*	0*		0*
Other Rural		Ballarat	5	0*		0*	0*	0*	0*	
		Bendigo	1*	2*		0*	0*	0*	0*	
		Mildura		24*						

0	Objectives and Goal met on all days.		Exceeded the objective but met the Goal.		Goal not met.

Abbreviation	Expanded Term or Title
CO	Carbon monoxide
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen; *i.e.*, comprising fractions of NO_2 and NO
O_3	Ozone
SO_2	Sulfur dioxide

Inspection of this summary shows that the key air pollutant for the Melbourne Airshed, (in 2005 at least), was particulate matter. An EPAV map showing the locations of these air quality stations may be obtained from the website, www.epa.vic.gov.au; refer to Figure 3-3.

- **Figure 3-3 Locations of Melbourne Airshed air quality monitoring stations (EPAV)**

Source: http://www.epa.vic.gov.au/air/bulletins/airmonlc.asp

Road vehicle emissions and the air environment

Background

Significant air pollution events in Melbourne are due to elevated particulate matter levels (*e.g.* in winter) and photochemical smog (*e.g.* in summer). Photochemical smog is caused by oxides of nitrogen (NO_x) and Volatile Organic Compound (VOC) emissions reacting in sunlight with ambient air molecules to form ozone (O_3) and other secondary pollutants.

The combustion of petroleum fuels leads to emissions of NO_x, Particulate Matter (PM), VOCs, carbon monoxide (CO) and sulfur dioxide (SO_2). In Melbourne's Airshed, the primary source of NO_x and CO is road vehicles (EPAV, 2006a & 2006b).

Many scientific air dispersion modelling studies have been undertaken for the Melbourne Airshed and some of these include the effects of air emissions from road vehicles. For example, the Hurley *et al.* (2005) examination of air dispersion model performance for estimating impacts from NO_2, O_3 and PM is one such study.

EPAV studies of air quality and roadways

The EPAV operates the Australian Air Quality Forecasting System (AAQFS[2]) for the Melbourne Airshed with a 1km^2 resolution air emissions inventory that includes road vehicle emissions.

The EPAV has reviewed the data from various air monitoring stations in combination with roadside air pollution measurements in EPAV (2006a). The salient issues from this paper (and other studies of Melbourne's air pollution) are:

- Road vehicles, (not industry), are the primary sources of CO and NO_x in the Melbourne Airshed.
- Road vehicles are significant contributors to the PM and VOC emissions totals in Melbourne's Airshed.
- Although road vehicle use is increasing, Melbourne's air quality is gradually improving; *i.e.*, since the mid-1980s levels of CO, NO_2 and O_3 have been decreasing.
- Improving air quality is due to improving vehicle emissions technology and fuel quality.
- Particulate matter levels have not improved since the mid-1980s and this is due to emissions from diesel-fuelled vehicles. It is noted that the EPAV expected this to improve in 2006 due to improved diesel fuel quality.
- EPAV has identified benzene and Polycyclic Aromatic Hydrocarbons (PAHs) needing more study due to their relatively high airborne concentrations in relation to corresponding ambient air quality standards. Benzo[a]pyrene is used as an indicator for the PAH group of substances.
- Significant air quality impacts (exceedences of ambient air quality standards) occur within approximately 100 metres of main roadways – at distances approximately greater than that air pollutant emissions from main transport corridors are difficult to detect in the background.
- With the introduction of UnLeaded Petrol (ULP), lead has ceased to be an air pollution issue to the extent that EPAV ceased air monitoring for this substance in 2005.

Although EPAV (2006a) has provided some valuable observations of air pollutants on several main roadways, it is doubtful whether the air quality impacts can be compared between these sites. This is due to sampling deficiencies: (a) The samples are taken at different distances from the main roadways; (b) The traffic volumes are highly variable; and (c) the results are no doubt confused by background pollution levels.

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[2] AAQFS: The current message from EPAV website is, "*Notice: Due to technical issues the forecasts are not available. Forecasting is expected to resume in early 2007*" (accessed 28th May, 2007).

To detect 'hot spots' for this project, it is recommended that a 'hot spot' is defined simply by its (short) distance to (any) high traffic-flow roadway. That is, 'hot spots' would be identified only by spatial analysis of traffic densities.

A note on mitigation measures for road vehicle air emissions

The Department of Environment and Water Resources provides National initiatives to reduce the impact of road transport on air quality, urban amenity and human health; the strategies are:

- Improving the emissions performance of the Australian vehicle fleet, by:
  - Improving fuel quality;
  - Reducing in-service vehicle emissions; and
  - Encouraging fuel efficient and environmentally friendly vehicles and technologies;
- Addressing the nature and growth of vehicle travel by:
  - Improving sustainable transport, including through encouraging high occupancy vehicle use and promoting walking, cycling and public transport;
  - Integrating land use and transport planning; and
  - Promoting uptake of intelligent transport systems.
- Managing and promoting the *Product Stewardship for Oil Program*, which provides incentives to increase used-oil recycling in the Australian community and ensures the environmentally sustainable management of used engine oil.

Source: DEWR (2007)

Simple quantitative assessment of the relative risks

For this report, a brief quantitative assessment has been undertaken of the important air pollutant species from road vehicle emissions using the air emission factor data provided in the National Pollution Inventory (NPI) Emission Estimation Technique Manual (EETM) for Combustion Engines V.2.3 (DEH, 2003).

In this undertaking the risks from each of the pollutants listed in the previous section, (specifically with respect to air emissions from road vehicles), may be determined simply by comparing the ratios between typical air emissions for each species and their corresponding criteria. The conclusion from this analysis conforms that the key air pollutants near roadways are NO_2, particles, benzene and VOCs. This corresponds well with the findings of EPAV (2006a).

The EWLNA (Air Quality) should be based on the following air pollution indicators; for each traffic corridor scenario, estimates for concentrations expected for:

- Particulate Matter (as PM_{10} and $PM_{2.5}$); NO_2; and VOCs.

- The identification of air pollution 'hot spots' is expected to be strongly dependent on traffic density to be determined by spatial analysis only, and only weakly dependent on the results of air dispersion modelling.

Criteria for EWLNA sustainability framework

The nation's key ambient air quality standards are provided in the National Environment Protection (Ambient Air Quality) Measure (shortened here to 'NEPM'). Victoria's ambient air quality standards are provided in the State Environment Protection Policy (Air Quality Management) (shortened here to 'SEPP').

The Victorian air quality standards are on a par with the ambient air quality guidelines provided in the NEPM. As such for simplification and as the EWLNA is a Victorian project, the Victorian standards only are considered for use as criteria for EWLNA.

The most relevant studies are provided in Table 3-1 (Design Criteria, for stack emissions), and Table 3-2 (Intervention Levels). Intervention Levels are used in the assessment of local or neighbourhood air monitoring data, and as such are relevant for examining air pollutant concentrations that may be detected by monitoring near roadways and residences.

- **Table 3-1 SEPP design criteria for relevant stack emissions**

Pollutant	Standard / statistic	Value
NO_2 (1-hour)	Class 1 Design Criterion; maximum hourly average	0.19 mg/m^3
PM_{10} (1-hour)	Class 1 Design Criterion; maximum hourly average	80 µg/m^3
$PM_{2.5}$ (1-hour)	Class 2 Design Criterion; maximum hourly average	50 µg/m^3

All the SEPP Intervention Levels are listed in Table 3-2 and reasons given for their inclusion/exclusion as indicators for the EWLNA.

- **Table 3-2 SEPP intervention levels for local air quality**

Pollutant	Comments:	Intervention Level
1,3-butadiene	Lower risk according to calculations.	n/a
Benzene	Included due higher risk VOC	0.075 mg/m^3
Formaldehyde	Not flagged as an issue for road vehicles.	n/a
Nitrogen dioxide	Included due higher risk air pollutant.	0.14 ppm
Carbon monoxide	Excluded due low risk.	n/a

Pollutant	Comments:	Intervention Level
PAHs	Included due higher risk.	0.0005 mg/m^3
$PM_{2.5}$	Particles higher risk.	0.036 mg/m^3
PM_{10}	Particles higher risk.	0.060 mg/m^3
Sulfur dioxide	Excluded due lower risk.	n/a
Toluene	Included for consideration as VOCs flagged as higher risk.	1.88 mg/m^3
Xylenes	Included for consideration as VOCs flagged as higher risk.	2.08 mg/m^3

3.1.2 Greenhouse gas emissions

This section sets out the methodology for greenhouse gas projections for the options assessment, including information requirements that will be required from others during later investigations; *e.g.*, corridor and Melbourne-wide traffic projections, air quality and greenhouse emissions for the Base Case and options under consideration.

The method will comprise review of the 2006, 2021 and 2031 Base Case transport modelling projections of greenhouse gas emissions and establish a benchmark against which strategy options will be assessed from VLC modelling results. Greenhouse gas emissions of strategy options will be assessed by calculating GHG amounts for each scenario based on outputs from VLC modelling.

3.1.3 Flora and fauna

Introduction

Although the study area is largely urbanised, a number of natural values remain in the area, largely defined by existing parks and reserves and drainage lines.

The Victorian Biodiversity Strategy (1997) notes that urban and urban fringe areas often have small remnants of habitat, which are highly valued by the local community. The biodiversity values remaining in these areas can be particularly important for providing unique examples of pre-existing flora and fauna, for protecting sites of biological significance and as seed sources for revegetation with indigenous species. Importantly, those areas provide local and other urban dwellers with a direct link to the natural heritage of a locale, contributing to a sense of place in urban environments (Lumb *et al*, 2000).

Victoria's Native Vegetation Management: A Framework for Action (the framework) is the relevant state-wide policy for native vegetation management. The Framework sets out goals for native vegetation management. The main goal is to achieve a reversal, across the entire landscape of the long-term decline in the extent and quality of native vegetation, leading to a 'net gain'. Net gain is

where overall gains in native vegetation are greater than overall losses and where individual losses are avoided where possible. If native vegetation removal is proposed, a three step approach, as outlined in the Framework, must be applied as follows:

1) To avoid adverse impacts, particularly through vegetation clearance.
2) If impacts cannot be avoided, to minimise impacts through appropriate consideration in planning processes and expert input to project design or management.
3) Identify appropriate offset options.

Strategic planning for inner Melbourne recognises that although Melbourne is highly urbanised and developed, actions can be taken to protect and enhance biodiversity values such as preserving remnant vegetation and connecting fragmented patches of habitat. Many local councils have developed biodiversity plans and strategies and have undertaken work programs to better develop biodiversity characteristics within specific municipalities.

Existing strategies and plans that seek to improve environmental performance, amenity and liveability of the Melbourne through biodiversity protection and enhancement include:

- City Plan 2010, Towards a thriving and sustainable city, City of Melbourne (2005).
- Maribyrnong River Valley Vision & Design Guidelines, Department of Sustainability and Environment (2006)
- The Yarra Environment Strategy, City of Yarra (2000)
- Yarra River Action Plan (2006)
- Kororit Creek Regional Strategy (2006)

These overarching documents are supported by a range of local level park management plans and biodiversity enhancement projects and programs.

Existing conditions

Before European settlement, the study area was covered by approximately 13 ecological vegetation communities (EVCs). The dominant ECVs were the Plains Grassland, Plains Grassland/Plains Grassy Woodland Mosaic and Plains Grassy Woodland. Others included Riparian Woodland, Brackish Grassland, Swamp Scrub, Swampy Woodland, Escarpment Shrubland, Damp Sands Herb-rich Woodland, Plains Grassy Wetland, Aquatic Herbland, Box Ironbark Forest and Coastal Saltmarsh. Today, few remnants of the native vegetation remain apart from those within the Derrimut Grasslands Reserve, Yarra Bend Park, Royal Park and in patches along rivers and creeks. In addition, the loss of terrestrial habitat has had a dramatic impact on the number of animal species that Melbourne now supports. The small and localised nature of these remaining areas of vegetation and fauna habitat means that the impacts of any developments need to be recognised and considered.

Key flora and fauna features within the study area include the following:

- *Derrimut Grasslands Striped Legless Lizard* - The Derrimut Grasslands are located approximately 15 km to the west of Melbourne and is approximately 152 hectares in area. Under the *Crown Land (Reserves) Act* 1978, Derrimut Grassland Reserve was made a permanent reserve in 1989. The Derrimut Grasslands provides the only conservation reserve known to support a population of *D. impar (Striped Legless Lizard)* and is therefore central to the efforts which are being made to aid in the survival of this species (DSE, 2003). The Striped Legless Lizard is listed under the *Environment Protection and Biodiversity Conservation Act 1999* and listed as threatened under the *Victorian Flora and Fauna Guarantee Act 1988*. The lizard's habitat includes grasslands and grassy woodlands where they are generally encountered under rocks, in deep cracks in soil and grass tussocks.
- *Royal Park* - Royal Park is the largest of Melbourne's parks, covering 188 hectares. Designed as native bushland, Royal Park contains remnants of the area's indigenous vegetation, with an abundance of eucalyptus and casuarina trees. (City of Melbourne web site). Royal Park is Crown land, permanently reserved for use as a public park, and the City of Melbourne holds responsibility for its management.
- The remnant River Red Gum stands in Royal Park are of high local to regional significance, depending on their condition, which is highly variable. (NCCS)
- *Pipemakers Park* - Pipemakers Park is home to the Growling Grass Frog (*Litoria raniformis)*, listed as vulnerable under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and listed under the *Victorian Flora and Fauna Guarantee Act 1988*. Other wildlife includes the White-faced Heron, Black Duck and Swamp and Sacred Ibis. (parkweb.vic.gov.au)
- Pipemakers Park has a wide range of native plants. River Red Gums, sheoaks, wattles trees and a number of eucalypt varieties may be seen and also Cumbungi (native reeds) in the wetlands and Kangaroo Grass and Poa Grass. (parkweb.vic.gov.au)
- *Royal Botanic Gardens* - The Royal Botanic Gardens are home to more than 51,000 individual plants, representing over 12,000 different species, and have become a natural sanctuary for native wild life including black swans, bell birds, cockatoos and kookaburras (rbg.vic.gov.au). One of the fundamental roles of the Royal Botanic Gardens is furthering knowledge about, and fostering the conservation of, Australia's plant biodiversity, through research in taxonomy, systematics and ecology.
- *Yarra Bend Park* - Yarra Bend Park is Crown land managed by the Yarra Bend Park Trust under the *Kew and Heidelberg Lands Act 1933*. Since April 1997, Parks Victoria has managed the day to day operation of the Park in partnership with the Trust. A total of 185 indigenous native fauna species have been recorded within Yarra Bend Park, including 125 bird, 10 mammal, 19 reptile, 15 butterfly, 5 amphibian and 11 freshwater fish. The Park contains 13 of

Victorian's 178 threatened fauna species including seven endangered and four vulnerable species.

Yarra Bend Park contains some of the last stands of original bushland in inner Melbourne, with approximately half of the park covered by indigenous vegetation. The Park supports a high diversity of indigenous plants (approximately 292) and is defined by two broad vegetation groups, these being Plains Grassy Woodland and Valley Grassy Forest. Yarra Bend Park contains 7 of the state's threatened flora species, one endangered, three vulnerable and three species suspected of being endangered, vulnerable or rare. In addition, 117 flora species are recognised as being important in the Melbourne Region.

A relocation project was undertaken in October 2003 to relocate a colony of Grey-headed Flying Foxes from the Royal Botanic Gardens to Yarra Bend Park. The Grey-headed Flying-fox is listed as threatened under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* and is also listed as a threatened species under the *Victorian Flora and Fauna Guarantee Act 1988*. This species is potentially at risk of extinction. This is due to a slow reproductive rate (one young per year), the relatively long time for males to become sexually mature (in the wild the average age for sexual maturity is 30 months, the average life span is 4 years) and the high rate of infant mortality (dse.vic.gov.au).

- *Newells Paddock Wetlands* - Identified as a regionally significant flora and fauna site in the *Maribyrnong City Council 2005 Municipal Strategic Statement – Detailed Issues Paper*. It provides important wetland habitat for migratory birds.
- *Fitzroy Gardens* - The Fitzroy Gardens is Crown land permanently reserved as public gardens and was listed on the Heritage Victoria Register in 2000. A creek bed extends north-south through the centre of the gardens, bordered by fern trees and native plants. The remainder of the gardens includes large avenues of trees, shrubs and expansive lawns.
- *Riparian Vegetation and Habitat* – The condition of riparian vegetation and habitat along river and creek within the study area is described in Table 3-3 below:

Table 3-3 Condition of riparian vegetation and habitat

River / Creek	Condition of Riparian Vegetation and Habitat
Yarra River	Vegetation and habitat of local to regional significance, depending on its condition, which is highly variable (DoI, 2001).
Merri Creek	Vegetation and habitat of local to regional significance, depending on its condition, which is highly variable (DoI, 2001).
Maribyrnong River	Along the Maribyrnong River there is a mix of active and passive open spaces and conservation areas including Fairbairn Park, the Riverside golf course and driving range, Pipemakers Park, Footscray Park and Newells Paddock Wetlands. Sites in the upper lengths of the valley support greater areas of remnant vegetation and fauna, compared with the more urbanised areas within the study area. Native grasslands, escarpment shrublands and riparian woodlands are a few of the vegetation types to be found (Townsend et al, 2006). The Maribyrnong River is significant in supporting a range of fauna species.
Moonee Ponds Creek	Much of the Moonee Ponds Creek lower has been heavily modified as part of extensive development of the lower floodplain. Works in recent years have focused on enhancing habitat

River / Creek	Condition of Riparian Vegetation and Habitat
	and stabilising, reshaping and replanting the banks of the creek
Kororoit Creek	The native vegetation of the Kororoit Creek corridor is highly degraded and retains little pre-European vegetation and fauna habitat. However, the coastal salt-marsh areas in Altona near Cherry Lake and at Altona Coastal Park are home to thousands of water birds and waders that migrate annually to the inter-tidal flats at the mouth of the Creek. These birds are recognised by international treaties (Land Design Partnership et al, 2006).
Stony Creek	Stony Creek has been rated as one of Melbourne's poorest in terms of water quality and on the basis of biological monitoring (Maribyrnong City Council, 2004). The White Mangroves (*Avicennia marina*) found in Stony Creek backwash are threatened by poor water quality and smothering by litter. The most significant water birds that visit the site are the Royal Spoonbill (*Platalea regia*) and the Great Egret (*Ardea alba*) (Maribryning City Council, 2004). Great Egrets are listed as a threatened species under the Flora and Fauna Guarantee Act (1988) and are listed on both the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA).

Threatened flora and fauna

Table 3-4 lists threatened flora and fauna species previously recorded within the study area. The species have been identified from the Department of Sustainability and Environment databases, including the Atlas of Victorian Wildlife and Flora Information System database. These databases provide comprehensive information on plant and animal distribution which is constantly being updated. The database review does not preclude the potential existence of unrecorded sites/species of ecological significance. Targeted field surveys for these species and their habitats should be considered in future flora and fauna assessments.

Table 3-4 Threatened flora and fauna species previously recorded within the study area

Common Name	Scientific Name	EPBC	FFG	VROTS
Fauna				
Australasian Shoveler	*Anas rhynchotis*			*Vulnerable*
Azure Kingfisher	*Alcedo azurea*			*Rare*
Baillon's Crake	*Porzana pusilla*		*Listed*	*Vulnerable*
Barking Owl	*Ninox connivens*		*Listed*	*Endangered*
Caspian Tern	*Sterna caspia*		*Listed*	*Rare*
Common Sandpiper	*Actitis hypoleucos*			*Vulnerable*
Fat-tailed Dunnart	*Sminthopsis crassicaudata*			*Rare*
Great Egret	*Ardea alba*		*Listed*	*Vulnerable*
Grey Goshawk	*Accipiter novaehollandiae*		*Listed*	*Vulnerable*
Grey-headed Flying-fox	*Pteropus poliocephalus*	*Vulnerable*	*Listed*	*Vulnerable*
Growling Grass Frog	*Litoria raniformis*	*Vulnerable*	*Listed*	*Endangered*
Hardhead	*Aythya australis*			*Vulnerable*
Intermediate Egret	*Ardea intermedia*		*Listed*	*Endangered*
Latham's Snipe	*Gallinago hardwickii*			*Rare*
Lewin's Rail	*Rallus pectoralis*		*Listed*	*Vulnerable*
Little Egret	*Egretta garzetta*		*Listed*	*Endangered*
Magpie Goose	*Anseranas semipalmata*		*Listed*	*Vulnerable*
Nankeen Night Heron	*Nycticorax caledonicus*			*Rare*
Pacific Gull	*Larus pacificus*			*Rare*

Common Name	Scientific Name	EPBC	FFG	VROTS
Pied Cormorant	*Phalacrocorax varius*			*Rare*
Powerful Owl	*Ninox strenua*		*Listed*	*Vulnerable*
Red-backed Kingfisher	*Todiramphus pyrrhopygia*			*Rare*
Regent Honeyeater	*Xanthomyza phrygia*	*Endangered*	*Listed*	*Endangered*
Royal Spoonbill	*Platalea regia*			*Vulnerable*
Southern Myotis	*Myotis macropus*			*Rare*
Striped Legless Lizard	*Delma impar*	*Vulnerable*	*Listed*	*Endangered*
Whiskered Tern	*Chlidonias hybridus*			*Rare*
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris*		*Listed*	
Flora				
Austral Tobacco	*Nicotiana suaveolens*			*Rare*
Australian Broomrape	*Orobanche cernua var. australiana*			*Vulnerable*
Basalt Peppercress	*Lepidium hyssopifolium*	*Endangered*	*Listed*	*Endangered*
Brown Beetle-grass	*Leptochloa fusca subsp. fusca*			*Rare*
Bushy Hedgehog-grass	*Echinopogon caespitosus var. caespitosus*			*Endangered*
Giant Honey-myrtle	*Melaleuca armillaris subsp. armillaris*			*Rare*
Melbourne Yellow-gum	*Eucalyptus leucoxylon subsp. connata*			*Vulnerable*
Pale Swamp Everlasting	*Helichrysum aff. rutidolepis (Lowland Swamps)*			*Vulnerable*
Small Burr-grass	*Tragus australianus*			*Rare*
Small Golden Moths	*Diuris sp. aff. chryseopsis (Basalt Plains)*	*Endangered*	*Listed*	*Vulnerable*
Small Milkwort	*Comesperma polygaloides*		*Listed*	*Vulnerable*
Spiny Rice-flower	*Pimelea spinescens subsp. spinescens*	*Critically Endangered*		*Vulnerable*
Spotted Gum	*Corymbia maculata*			*Vulnerable*
Studley Park Gum	*Eucalyptus X studleyensis*			*Endangered*
Rye Beetle-grass	*Tripogon loliiformis*			*Rare*
Tough Scurf-pea	*Cullen tenax*		*Listed*	*Endangered*

EPBC – Commonwealth Environment Protection and Biodiversity Conservation Act 1999
FFG- Victorian Flora and Fauna Guarantee Act 1988.
VROTS – Victorian Rare or Threatened Species - This is an advisory list and is not the same as the statutory list of threatened taxa established under the Victorian FFG Act or the Commonwealth EPBC Act. There are no legal requirements or consequences that flow from inclusion of a species in this advisory list.

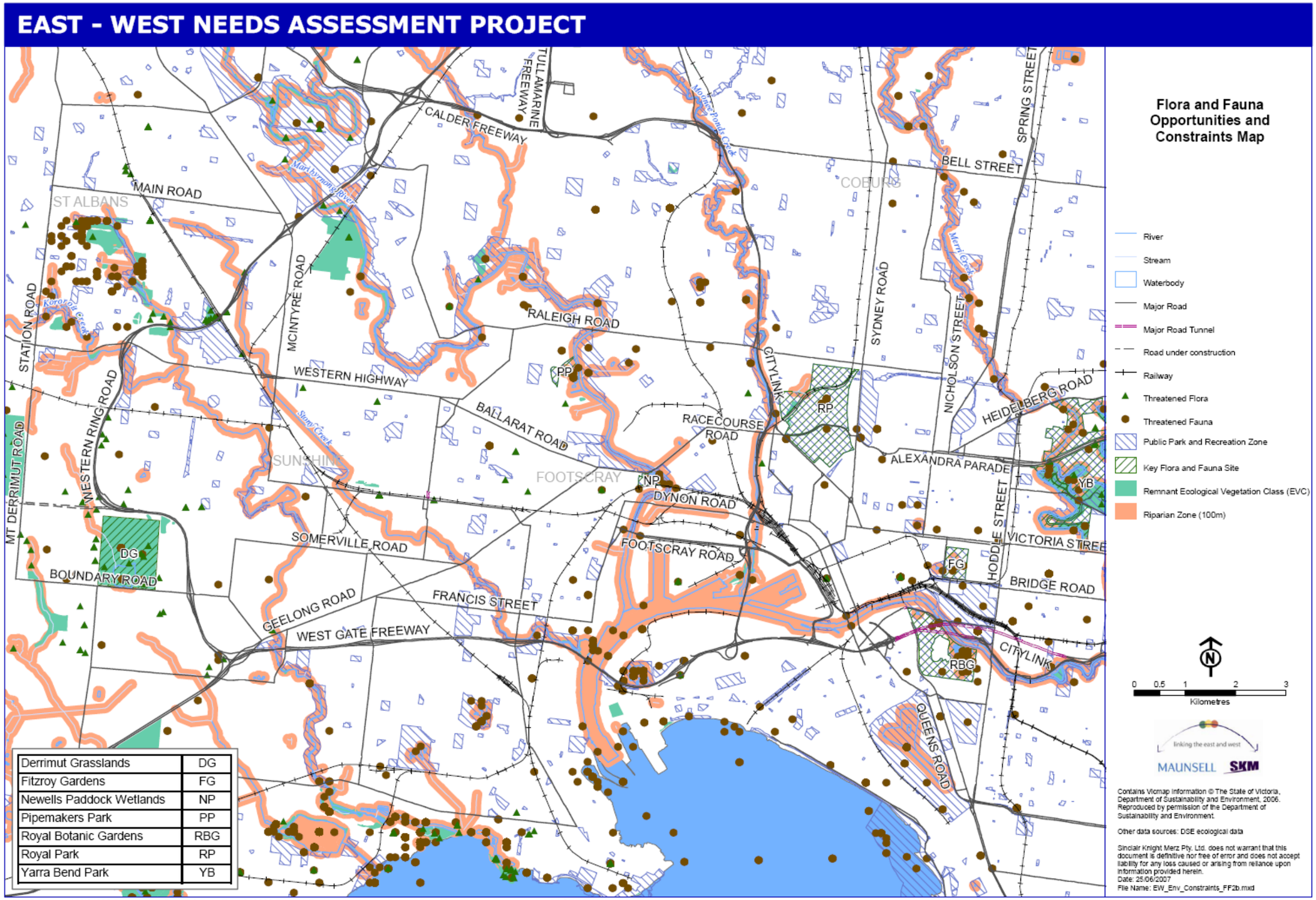
Opportunities / Constraints

In investigating an additional East-West link the potential exists for possible 'opportunities', whereby specific ecological improvement options can also be included for further consideration. This may take the form of specific revegetation programs relating to waterway protection, screening or general amenity plantings.

With the inclusion of sustainability outcomes within the project, the opportunity exists for strategic programs to improve the current state of biodiversity characteristics within the study area, whilst meeting the required offset options for any impacts associated with removal of native vegetation.

Figure 3-4 provides a visual representation of potential flora and fauna opportunities and constraints within the study area.

- **Figure 3-4 Summary of flora and fauna opportunities and constraints**



3.1.4 Cultural heritage

Introduction

Melbourne was used by Aboriginal people for many thousands of years prior to European settlement. The City of Melbourne is of traditional significance to the *Woi wurrung*, *Boon wurrung*, *Dja Dja Wurrung*, *Wathaurong* and the *Taungerong* peoples. Together, these 5 groups comprise the Kulin Nation. The Traditional Owners of the City of Melbourne are today represented by the Wurundjeri Tribe Land Compensation and Cultural Heritage Council. In addition, Melbourne has a significant heritage of buildings, street patterns and open spaces that reveal its nineteenth-century colonial origins and its development into one of the world's great Victorian-era commercial cities.

There are many sites of Aboriginal significance in the study area that are protected and the total post-contact non- Indigenous heritage inventory encompasses over a thousand places. Most of the study area is subject to Heritage Overlay controls in local planning schemes. Councils are committed to heritage conservation through their Municipal Strategic Statements, local policies and heritage related studies.

Heritage places are often much more than what is currently identified and protected, and not all areas and themes have been assessed. The identification of heritage is an ongoing process, undertaken through the planning system, additions to the Victorian Heritage Register and community processes, in light of changing perspectives about what is important.

Aboriginal cultural heritage in Victoria is protected under both State and Commonwealth legislation. The two key Acts are the *Victorian Archaeological and Aboriginal Relics Preservations Act 1972*, and the Commonwealth *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*. In addition, local government has a responsibility under the *Planning and Environment Act 1987* to identify and conserve heritage, including Aboriginal heritage.

In May 2006 the Victorian Parliament passed the *Aboriginal Heritage Act 2006*, which came into operation the 28 May 2007. The new Act establishes regulations to specify:

- when a cultural heritage management plan is required;
- standards for the preparation of cultural heritage management plan;
- standards for any maps included in a cultural heritage agreement;
- fees for evaluation of reports, cultural heritage permits and applications to the Secretary for advice regarding site records.

Division 1 of the regulations (Regulation 6) prescribe that a Cultural Heritage Management Plan (CHMP) is required for an activity if:

- all or part of that activity area is defined as an area of cultural heritage sensitivity; and

- all or part of the activity is a high impact activity.

A CHMP will be required for works within 200 m of a waterway or within 50 m of any registered Aboriginal site. If the project is subject to an Environment Effects Statement under the *Environment Effects Act 1978*, a CHMP will be required regardless of location.

Existing conditions

Key heritage places identified in the literature review are included below.

Aboriginal heritage places

The study area is heavily disturbed through urbanisation and development therefore there is generally a low potential for Aboriginal archaeological sites or sub-surface deposits. Areas where there is a greater potential for sites to occur include areas within the vicinity waterways such as rivers, creeks and swamps and high rises overlooking these areas. Any areas of remnant native vegetation are also more likely to contain sites. Site types most likely to occur in the area are small, sparse artefact scatters.

A number of Aboriginal heritage places are protected through the Melbourne Planning Scheme. They include:

- *Yarra Park* - Two scarred trees.
- *Fitzroy Gardens* - One scarred tree
- *Kings Domain Resting Place* - After being repatriated from the Museum of Victoria, the remains of 38 Victorian Aboriginal people were buried in Kings Domain in1985. A granite boulder and plaque marks the site (Eidelson 1997: 9).

A range of other Aboriginal Heritage places have been identified in the Draft Indigenous Culture and Heritage Framework 2006-2009 (City of Melbourne, 2006) and other literature. These sites include the following listed in Table 3-5 below:

- **Table 3-5 Aboriginal heritage places**

Place	Description
Williams Street Falls	The falls provided a place where people could cross the river by foot and were associated with regular gatherings of Aboriginal people (Eidelson 1997: 6).
Government House / Tromgin	A battle between Aboriginal people was witnessed in 1839 near the present day site of Government House. This area has also been described as *Tromgin*, a favoured camping place for the Kulin Nations (Eidelson 1997: 10, Clark and Heydon 2004: 29).
Langhorne's Mission	An Aboriginal school and mission operated on the south bank of the Yarra River in what is now the Royal Botanic Gardens between 1837 – 1839 (Eidelson 1997: 12). *Yarra Park / MCG* - The Yarra Park was the site of the Police Paddocks Reserve which housed the Native Police Corps in the late 1830s.
Former West Melbourne Swamp and Moonee Ponds Creek	A resource rich area favoured by Aboriginal people and now within the Docklands Area (Presland 1995: 11- 12).
Queen Victoria Market	Council has entered into an Aboriginal Cultural Heritage Agreement/Section 173 Agreement on 11 November 1986 with the Wurundjeri Tribe Land Compensation and Cultural Heritage Council Incorporated and Robert Maclellan, Minister for Planning in relation to redevelopment

	that may have disturbed burials within the area of the former cemetery designated for Aboriginal burials. This site is also an important Aboriginal heritage place.
Royal Park	Royal Park was an important Aboriginal camping ground and fell within the territory of the Wurundjeri people
Maribyrnong River	The Maribyrnong River has played a major role in the occupation and development of western Victoria. Aboriginal tribes have frequented its banks for at least 40,000 years. Some of Australia's most important Aboriginal archaeological sites are located in the Maribyrnong River Valley, such as a 30,000 year old human skeleton at Keilor.
Kororoit Creek	Kororoit Creek has significant archaeological material, particularly lithic (stone artefact) scatters. Less than 15% of the creek corridor has been investigated for Indigenous archaeological material. Aboriginal Affairs Victoria has recorded 171 sites to date and it is expected many more sites are yet to be identified (Land Design Partnership et al, 2006).
Dights Falls	The area around Dights Falls is said to have been an important inter-tribal or inter-clan meeting/ceremony ground including being a Corroboree site. The natural rock falls at Dights Falls were also a river-crossing point and fish trapping location. A burial ground at the confluence of Merri and the Yarra is also said to have existed.

European heritage places

The Victorian Heritage Register lists the State's most significant heritage places and objects. The Victorian Heritage Register is established under the *Victorian Heritage Act 1995* and provides the highest level of protection for heritage places and objects in Victoria. Based on spatial datasets provided by Heritage Victoria, 538 heritage places have been recorded within the study area.

European heritage site types can include including buildings, gardens, trees, archaeological sites, shipwrecks, precincts, land and protected zones.

Heritage Victoria also maintains the Heritage Inventory, which lists all known places and objects in Victoria that possess archaeological value or archaeological potential. Unlike places on the Victorian Heritage Register, Heritage Inventory places do not have to be of 'State-wide' significance to be listed, however they are still protected under the *Victorian Heritage Act 1995.* Based on spatial datasets provided by Heritage Victoria there are approximately 1300 sites within the study area. Most of these sites, approximately 1200, are located within the Melbourne CBD. There are 109 sites recorded outside the CBD.

Below in Table 3-6 are some of the key European heritage places identified in the literature review:

- **Table 3-6 European heritage places**

Place	Description
Royal Exhibition Building and Carlton Gardens	The Royal Exhibition Building in Carlton Gardens is the only non-Aboriginal cultural site and only building in Australia to have been awarded World Heritage listing.
Royal Agricultural show grounds	The Royal Agricultural Showgrounds were added to the Victorian Heritage Register in 1997. The Showgrounds are Victoria's largest agricultural complex. They have been home to the Royal Melbourne Show since 1883. They have also been the base for the Royal Agricultural Society of Victoria.
Royal Park	Royal Park has a rich history. The first agricultural farm of about 35 hectares was established at Royal Park in 1858. In 1860 Burke and Wills set out from Royal Park to cross the continent from south to north and the Park was used for the stationing of troops in both the First and Second World Wars (City of Melbourne, 2007).
Pipemakers Park	Pipemakers Park is a historic pipemaking industrial site which has been transformed into a park and wetlands.

Footscray Park	Footscray Park is included on the Victorian Heritage Register. It is the largest and most intact example of an Edwardian period public garden in Victoria.
Maribyrnong River	The Maribyrnong River has played a major role in the occupation and development of western Victoria. There are numerous important maritime, industrial and farming archaeological sites along the river.
Fitzroy Gardens	The Gardens have a long history of over 150 years. The Fitzroy Gardens were listed on the Heritage Victoria register in 2000. Several buildings of historical significance can be found in the Fitzroy Gardens, including: - Cooks' Cottage; - the Conservatory; - Sinclair's Cottage; - the carved Fairies' Tree; - stunning avenues of English elms; - the model Tudor Village of miniature buildings; - ornamental follies - the Temple of the Winds Rotunda and the old Bandstand.
Other sites:	■ Massey Ferguson Complex ■ Dights Mill site, Abbotsford ■ Shot Tower, Clifton Hill ■ Cambridge Terrace, Carlton North ■ Melbourne General Cemetery ■ Melbourne University and the Colleges ■ Royal Melbourne Zoological Gardens

Opportunities / Constraints

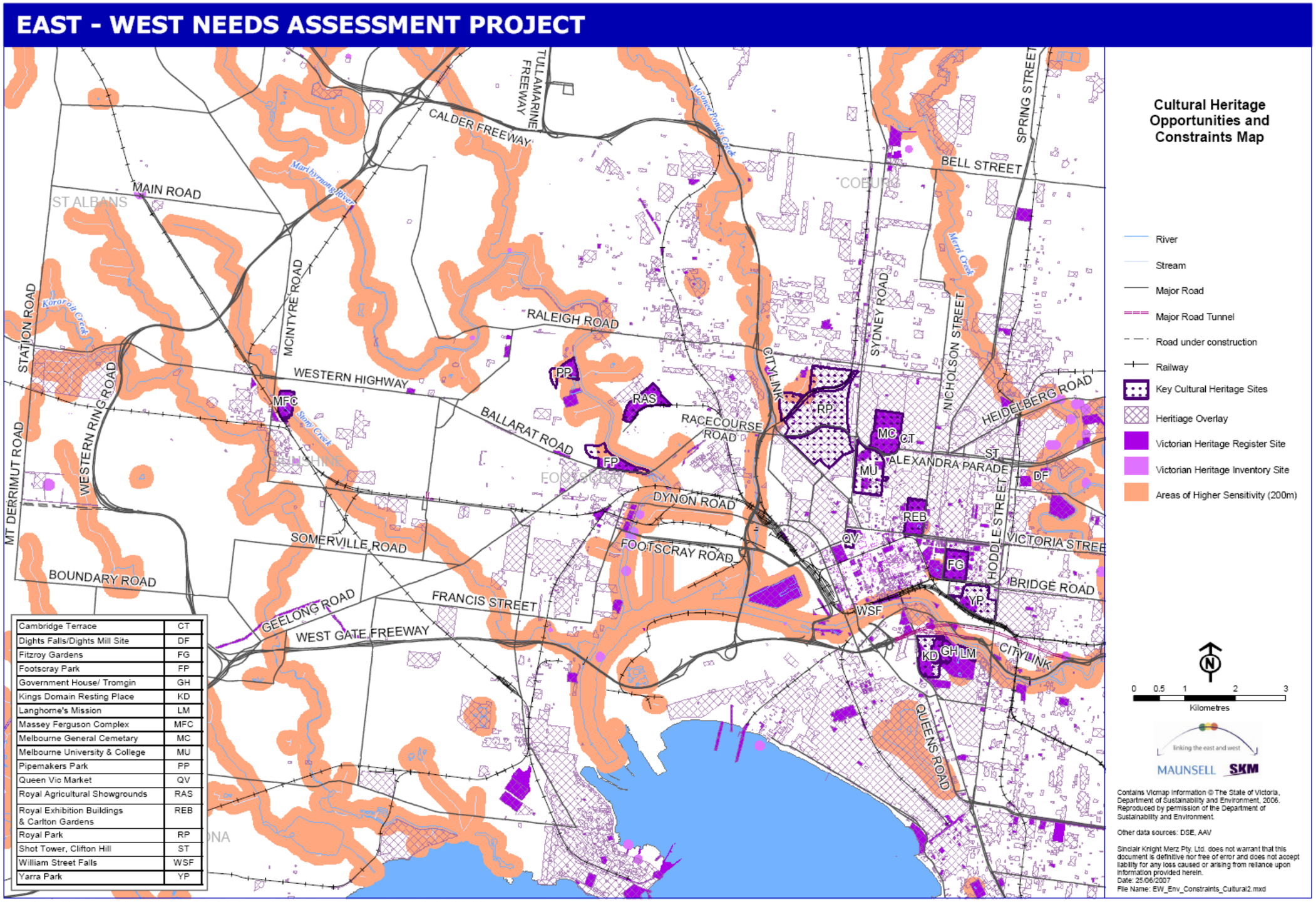
The study area comprises significant Indigenous and non-Indigenous cultural heritage values. Given the essentially urban nature of the study area landscape, most cultural heritage values relate to European settlement and predominantly comprise built structures, streetscapes and open spaces such as parklands and cemeteries. Indigenous heritage values are not highly preserved in the urban landscape but can be present along the rivers, creeks and less disturbed open spaces.

Preservation of the strong and highly significant heritage features of the area should be regarded as a potentially significant issue to be considered in the development of an additional East-West link. However, opportunities may exist for transport infrastructure to incorporate and enhance cultural heritage values. Direct and indirect impacts on cultural heritage values, such as subsidence and vibration will need to be assessed. For example, a tunnel under the historic Melbourne Cemetery may have the potential to result in disturbance to features such as fences and headstones.

While open space may be seen to provide opportunities for transport infrastructure, they may comprise cultural heritage values, and it should be remembered that archaeological sites are a non-renewable resource in the landscape and should be preserved wherever possible. Indigenous historical values also need to be considered and these may relate to a landscape place or feature (e.g. Yarra Bend) rather than specific archaeological sites. Therefore, whilst the construction of transport infrastructure through an open space might not have any Indigenous archaeological sites, it may well impact on the social and contemporary values of an Aboriginal place of significance.

Figure 3-5 provides a visual representation of potential cultural heritage opportunities and constraints within the study area.

- **Figure 3-5 Summary of cultural heritage opportunities and constraints**



3.1.5 Noise

Introduction

Transportation noise impacts large sections of populated areas in Australia. Extensive investigations have been carried out over the past 30 years in Victoria.

As part of Phase 1 of the East-West corridor needs assessment – (Environment and Heritage), Transportation Noise criteria and assessment techniques were developed.

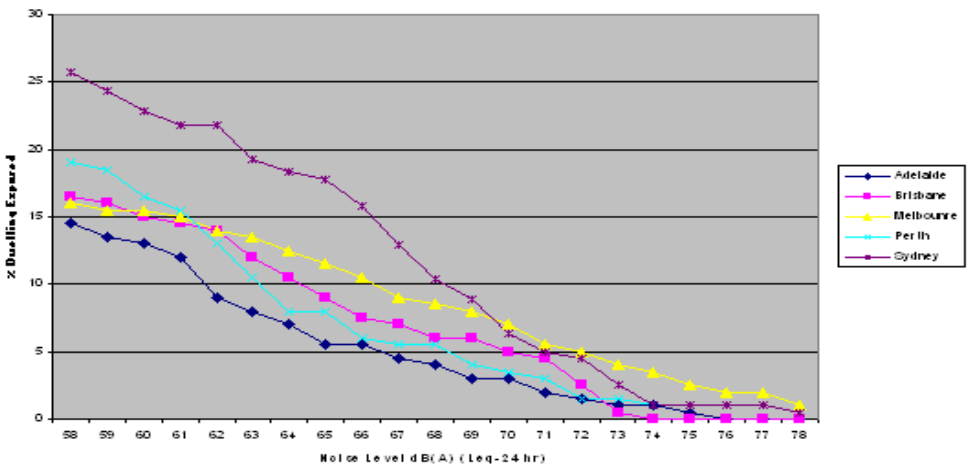
Transportation noise

Road traffic noise and exposure

There can be little doubt that of the main transportation modes, road transport causes the greatest noise intrusion in terms of the number of people actually impacted. A significant proportion of the population in Melbourne and Victoria are exposed to some degree of road traffic noise, where as the proportion of the population exposed to aircraft and railway noise is significantly less, due to the lesser extent of this mode use and infrastructure. In Victoria, there have been only a small number of community noise impact surveys since 1970, with none been undertaken in the last ten years.

In documents prepared by the EPA supporting the development of a State Protection Policy for Road Traffic Noise, (SEPP-RTN) the number of dwellings exposed to different noise levels in various capital cities are provided, and presented in Figure 3-6 below. The figure shows that 12% of Melbourne's homes are exposed to road traffic noise of Leq (24 hr) 65 dBA. At higher levels of noise (> Leq (24 hr) 70 dBA), as a proportion, more Melbourne homes are exposed to highly excessive traffic noise levels than that experienced in other Australian capital cities. (EPA June 2001).

- **Figure 3-6 Traffic Noise Exposure Leq (24 hr)- All Roads in 1996/971**



The abovementioned study was undertaken in 1996/97. Since then there has been a significant increase in road transportation use, which would imply that the percentage of the population exposed to high traffic noise levels is likely to also have increased significantly. Road use increases due to increases in car traffic of 1% per annum and in truck traffic of 3 to 4% per annum. The total freight task is forecast to double in the next 20 years, with the bulk of this task being road freight.

Road traffic noise levels are increasing despite the improvements obtained through reductions is noise emissions of individual vehicles or through specific noise mitigation measures such as noise barriers on Freeways. However given the relationship, that for each doubling of traffic volume there will be an increase in traffic noise levels of 3 dB(A), the real increase in noise levels will be relatively small.

Railway noise and exposure

Contrasting the growth in other modes of transportation, railways have not grown at such a rate. However, railway noise does have a significant impact on nearby communities. Railway noise is generally a function of a number of different factors including the interaction of wheels and rails, engines in diesel locomotives, auxiliary equipment, noise radiating from vibrating structures, train speed, warning devices, etc. Diesel locomotives are the loudest sources of noise at about 90-95 dB(A) when moving. Wheel/rail noise and specifically wheel flange squeal whilst it is relatively loud, very tonal and annoying.

Transportation noise impacts

Increasing public awareness of environmental pollution in all its forms has been increasing since the mid 1900's. For example, poor air quality in a number of large European cities lead to public concern about effects of poor air quality and the associated increase in mortality. Environmental awareness did not come about solely as a result of public opinion to environmental pollution (noise, air quality, water quality, etc) but rather as a result of a combination of increased public awareness of the need to conserve environmental quality, conditioned by the rapid growth in transportation, transportation systems and urbanization.

The effects of noise on people are various and often interrelated. For example speech interference can result in annoyance and tiredness, while in turn, tiredness may exacerbate annoyance. There are also relationships between the general state of health of individuals and the various effects of noise. Stress may be introduced by the presence of noise, and stress may then induce changes in the body and general decline in health and well-being.

Since the early 1970's there have been an increasing number of studies undertaken to determine the population exposure to all types of transportation noise (road traffic, rail and aircraft) and to develop criteria to manage the exposure to noise. There has also been the development of models to predict noise impacts.

Health effects

It is well known that long-term exposure to high noise levels can result in permanent hearing loss. Exposure to noise levels of more than 140 dB(A) over relatively short periods of time, will cause some permanent hearing loss. Exposure to occupational noise levels of 85 dB(A) L_{eq} for 8 hours a day over a period of 20 years, that is over a working lifetime exposure, is very likely to cause some degree of permanent hearing loss. Longer periods of exposure to lower noise levels can also lead to the increased risk of some permanent hearing damage. However, the risk of hearing damage at noise levels associated with transportation noise in the community is much less than the risk associated with exposure to occupational noise, to the extent that transportation noise should not cause measurable hearing loss.

Noise and its effects on other aspects parts of the human physiology have been studied extensively. Noise can induce a range of reactions such as an increase in blood pressure, heart rate and breathing, the degree of change depending on the circumstances. These changes do not occur solely due to noisy events such as continuous high level noise or noisy single events but may also occur due to noise levels commonly experienced whilst exposed to noisy environments such as busy streets.

Effects on sleep

Of all the effects of noise, interference with sleep is probably the least tolerated. Sleep impacts depend mainly on the type and level of noise and on the time during the sleep pattern when the noise is produced. The effects of noise during sleep will then cause different outcomes. Sleep disturbance can lead to accumulated sleep deficit, tiredness during the following day with associated impaired work performance, increase in medication use to aid the sleep capacity of affected people, and an increase in annoyance due to the noise source.

Sleep disturbance can be associated with noise from railways as well as from road traffic. Some apparent habituation seems to occur for exposure to low levels of noise, however, there seems to be very little or no adaptation to noise levels above L_{max} 60 dB(A) indoors. The noise levels do not need to be sustained over long periods, numerous peaks of noise greater than L_{max} 60 dB(A) will have a similar impact on sleep as continuous similar levels of noise. With windows to the bedrooms of houses closed, the equivalent outdoors noise level would be about L_{max} 80 dB(A). With windows open the equivalent outdoors noise level would be about L_{max} 70 dB(A). At this noise level, trains using horns or trucks using engine brakes at distances of about 100 metres from the residence, could disturb sleep.

Effects on communication

Interference with communication is an easily defined effect of transportation noise. The noise level that interferes with communication does not vary greatly from person to person. Communication interference is a straightforward issue of masking of the desired sounds. If communication is impaired, then this may create both annoyance and loss of information.

Loss of information caused by noise interference can be dangerous in the work situation where warning systems are important. Noise interference can also reduce the quality of teaching and affect the ability of children to learn. Transportation noise can significantly affect communication depending on the distance between the noise source and the receiver. Peak noise due to rail noise can lead to short periods where speech can be totally obscured for persons located close to the rail line. Road traffic can have longer effects as the intensity of continuous noise makes communication difficult, with short peak noise totally obscuring communications. As an example, at noise levels of $L_{Aeq,1\ min}$ 65 dB(A) people can communicate at a separation distance of 1 metre with out forcing their speech. A car passby at 2 metres distance would result in a noise level of the order of $L_{Aeq,\ 1\ min}$ 65 – 70 dBA.

Annoyance effects

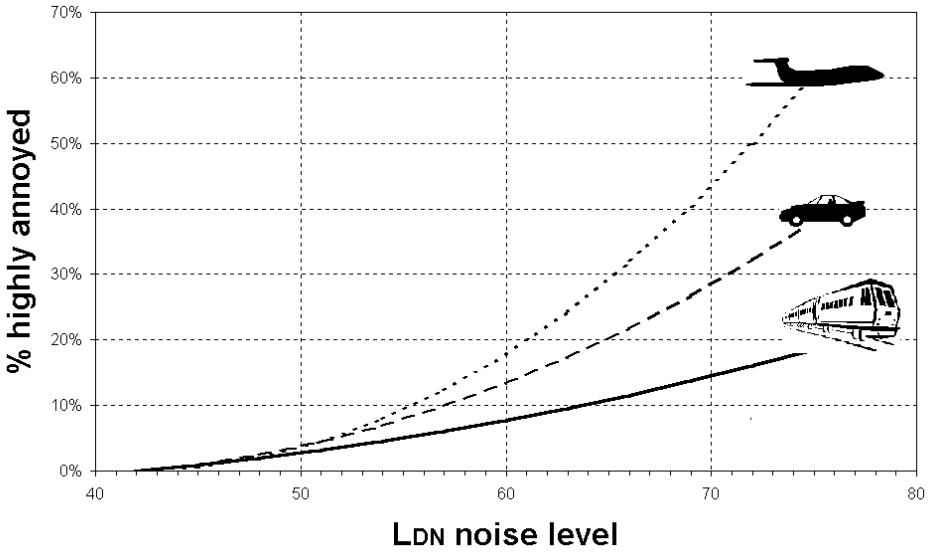
In addition to the direct effects of noise (sleep disturbance and communication loss) there is the effect of annoyance, which is related to the way we feel about the noise. The range of responses to noise is considerable; some people won't have a significant response to rail noise, but may be highly annoyed by aircraft noise. Also the response to the intensity of the noise levels may vary considerable depending upon the type of noise. Situational, biological and psychological factors can also play a role in annoyance.

Annoyance to noise varies considerably among observers, however researchers have been able to determine a measurement process that ranks large populations of residents exposed to transportation noise; the concept of community annoyance. It is from this basis that policy decisions are made to ameliorate noise exposure for people who describe their reaction to prevailing noise as annoying or highly annoying.

A great number of studies have been undertaken over past decades into the relationship between environmental noise levels and community annoyance. Figure 3-7 below shows the collation of many studies and demonstrates the relationship between noise levels and community annoyance for three common transportation modes, (Austroads 2003).

It can be seen, in Figure 3-7, that few people are found to be highly annoyed at a level of 45 dB(A) L_{DN} (Day – Night). However, as the outdoor noise level rises above 60 dB(A) L_{DN}, the proportion increases, so that at a level of 65 dB(A) L_{DN}, about 25% of the population exposed will be highly annoyed.

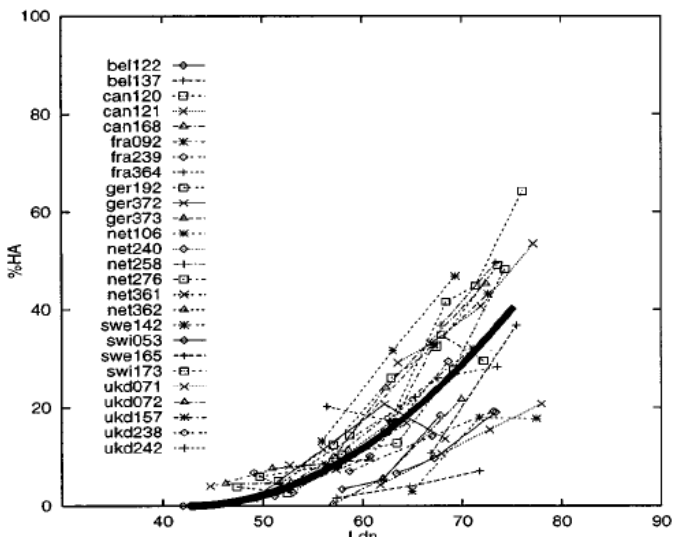
- **Figure 3-7 Relationship between average noise level and community annoyance**



The LDN descriptor has a 10 dB(A) penalty for night-time noise.

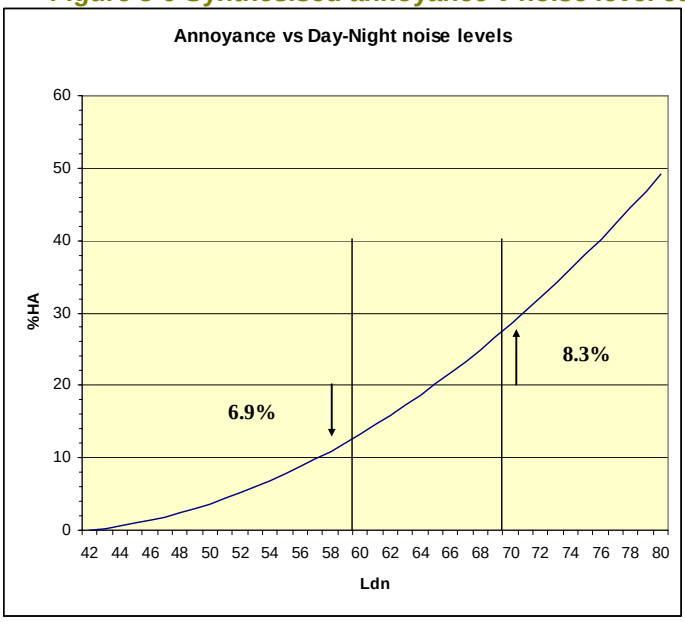
The relationship between noise level and annoyance was reviewed by Miedema and Vos, (J. Acoust. Soc Amer., 1998). The authors synthesised 26 road traffic/annoyance databases, to a single % HA v LDN curve, where HA is Highly Annoyed. Figure 3-8 below shows the curve and the outcomes of the 26 databases.

- **Figure 3-8 % Highly annoyed v LDN (Miedema and Vos)**



The synthesised road traffic noise curve is a quadratic equation where % HA = 0.24(LDN-42) + 0.0277(LDN-42)^2. The curve is reproduced below, Figure 3-9. A characteristic of a quadratic equation is that each incremental increase in the LDN level will result in the % HA larger than the previous incremental increase in LDN. For example, The 5 dB(A) noise increase from 60 to 65 dB(A) resulted in an increase in the % HA of 6.9%, (from 13.1% to 20%). The 5 dB(A) noise increase from 65 to 70 dB(A) resulted in an increase in the % HA of 8.3%, (from 20% to 28.3%).

- **Figure 3-9 Synthesised annoyance v noise level curve**



Another way of looking at this relationship would be comparing the same increase and decrease form a central point. For example at 65 dB(A) LDN a 5 dB(A) increase results in a 8.3% increase in %HA. That is the % of Highly Annoyed residents exposed to the traffic noise impacts increases from 20% to 28.3%. A 5 dB(A) decrease results in a smaller decrease of 6.9% HA, where the % of residents highly annoyed decreases from 20% to 13.1%.

It is important to put changes of traffic volume in context with noise level changes and % of residents highly annoyed. A doubling or halving of the traffic volume will change the road traffic noise levels by 3 dB(A) and a change of traffic noise levels by 3 dB(A) is unnoticeable. Also, a decrease in the traffic volume of 30% will decrease the noise levels by 1 dB(A). If the existing noise levels is 65 dB(A), then a 30% traffic volume decrease will potentially reduce the noise levels by 1 dB(A) to 64 dB(A). If this reduction is applied to the LDN curve in Figure 3-9, then there will be a potential 1.3% reduction in the percentage of local residents who are highly annoyed. Whilst there is a reduction in the percentage of residents who are highly annoyed, the noise levels will remain unchanged to most of the residents.

There may be other factors that apply to the removal of traffic noise exposure from a community that may lead to a lesser response in the %HA. For example the removal of heavy vehicles from residential streets would significantly reduce the percentage of residents highly annoyed by the traffic.

The impacts of trucks in residential streets are many and varied. The responses to truck noise clearly shows how disturbing and annoying heavy vehicle traffic can be. For example, truck curfews apply to several streets in suburban Melbourne specifically to remove the potential for significant impacts within local communities. The annoyance response of communities to heavy vehicle noise is well researched, however it is not detailed in the report.

Transportation Noise Criteria

Traffic noise descriptors

Noise descriptors are specific, commonly-used noise indices which are used to express noise levels during particular times of day, such as daytime or night-time, or entire 24-hour periods. The following descriptors (Austroads 2005) are commonly used for describing road traffic noise exposure:

L_{A10} (18 hour) The arithmetic average of each of the LA10,1 hour levels for the 18 hour period between 6.00am and 12.00 midnight on a normal working day.
L_{Aeq} (9 hour) - The LAeq noise level for the period 10.00pm -7.00am.
L_{Aeq} (8 hour) - The LAeq noise level for the period 10.00pm -6.00am.
L_{Aeq} (15 hour) - The LAeq noise level for the period 7.00am-10.00pm.
L_{Aeq} (16 hour) - The LAeq noise level for the period 6.00am-10.00pm.
L_{Aeq} (24 hour) - The equivalent continuous noise level during a 24 hour period, usually from midnight to midnight.
L_{DN} - The day/night equivalent sound level is the 24 hour LAeq inverse logarithmic average of hourly LAeq values, with a + 10dB penalty applied to noise levels during the night period (10.00pm-7.00am).
L_{DEN} - The LAeq 24 hour with a + 10dB penalty added to the night-time hours between 10.00pm-7.00am and a + 5dB penalty added to the evening hours between 7.00pm-10.00pm.
Further discussion of terms and symbols is provided in Appendix A.

Attainment Criteria

There are several terms used in defining the application of noise levels to identify a policy or guideline outcome. Table 3-7 lists the six preferred terms, together with some comments on how they are commonly used.

- **Table 3-7 Common usage of various terms (Austroads 2005)**

Term	Comments
Goals	Of the various terms used to obtain environmental outcomes, “goals” has probably got the most consistently-used meaning. Goals are long-term objectives based on current knowledge of health impacts and set without regard for the practicality of achieving them. They provide a useful background against which to derive practical criteria.

Term	Comments
Guidelines	Guidelines provide assistance and direction relating to principles, standards and recommendations associated with performance based objectives and desired outcomes.
Criteria	The term "criteria" is often used to refer to practical, (mostly) achievable noise level objectives against which noise impacts can be assessed or which can be used as noise limits when setting policy. The term "performance criteria" can be used almost interchangeably with "limits".
Limits	The term "noise limits" generally refers to criteria defined in noise policy. Limits are often, but not necessarily, mandatory.
Objectives	The term "objectives" can be used as a term to refer generally to goals, criteria and limits. Note that it is often used to refer to non-mandatory noise limits.
Trigger level	A "trigger level" is a noise level that, if exceeded, causes some action to be taken. The action may be a review, a noise measurement or some other action, and need not necessarily be provision of noise control. It is not necessarily an objective in the sense of a level that must be aimed for.

Road traffic noise

In Australia there are several traffic noise criteria in use, whilst the number of railway noise criteria is limited to two sets, South Australia and Queensland. Table 3-8, shows current noise descriptors used in Australia and Internationally. For the various descriptors, jurisdictions have adopted a range of assessment periods. The adoption of traffic noise criteria is influenced by many requirements, such as measurement database, modelling capabilities, road authority's/EPA's preference, political and community requirements, etc. In some circumstances, there may appear to be no obvious reason that a specific assessment time was adopted.

- **Table 3-8 Comparisons of traffic noise descriptors currently in use internationally**

Noise descriptor	Typical assessment time period (T)	Country/ Australian State in use	Advantages/ disadvantages
$L_{Aeq,T}$	24 hour period 15 hour day period (7.00am-10.00pm); 16 hour day period (6.00am-10.00pm); 8 hour night period (10.00pm-6.00am); 9 hour night period (10.00pm-7.00am) 1 hour period (peak hour)	Australia (NSW, SA, Tas, Austroads), Australian Standard AS3671; New Zealand; Canada (Ontario); European Union; France; Germany; Greece; Italy; Spain; Switzerland; The Netherlands; USA; OECD & WHO	noise descriptor used by most countries to describe traffic noise many noise calculation methods calculate L_{Aeq} descriptors well correlated with L_{A10} for freely flowing traffic(approx. 3dB lower) used by researchers in studies relating noise exposure to health effects takes greater account of the high energy levels of trucks appropriate measure of sleep arousal for continuous traffic noise conditions, but not for intermittent traffic noise easy to calculate de-emphasises occasional noisy events does not provide an adequate measure of sleep disturbance produced by noise.
L_{DN}, L_{DEN}	24 hour	USA; European Union	more sensitive to night-time noise level variations than $L_{Aeq,24hr}$ used by researchers in studies relating noise exposure to health effects.
L_{Amax}	(night)	Australia (Qld); New Zealand; OECD; WHO	Maximum noise levels tend to correlate with sleep arousal, but it may be the emergence of an event above the background, rather than the absolute value, that correlates with sleep disturbance. best used in conjunction with L_{Aeq} to predict potential disturbance to sleep.
L_{Aeq}	60 seconds	Australian Standard 2107-2000	internal noise level that can be measured over a short period suitable only where traffic noise is fairly steady in level.
L_{A1}	60 seconds (night)	NSW EPA Environmental Noise Control Manual	represents the higher noise levels experienced and takes some account of number of events dependent on other factors (eg duration) which do not correlate with sleep arousal difficult to predict using standard noise prediction methodologies.

Noise descriptor	Typical assessment time period (T)	Country/ Australian State in use	Advantages/ disadvantages
L_{A10}	16 hour day period (6.00am-10.00pm); 8 hour night period (10.00pm-6.00am); 18 hour day period (6.00am-12.00am) 12 hour day period (6.00am-6.00pm) 1 hour period (peak hour)	Australia (ACT, Qld, NT, Tas, Vic, WA, Austroads); Hong Kong; United Kingdom; (WHO)	well correlated with L_{Aeq} (approx. 3dB higher) insensitive to high level noise events where they occur for less than 10% of the time Used in UK 'Calculation of Road Traffic Noise' traffic noise prediction method.
L_{A50}		Japan (previously); Portugal	correlates reasonably with $L_{Aeq.}$

Most of the descriptors are generally well correlated. Table 3-9 shows the relationship between the descriptors in terms an arithmetic factor to be added. Note that the factors shown in the Table are based on data collected at sites which were mostly adjacent to limited-access roads with relatively high traffic volumes. Therefore, the conversion factors may not apply in situations significantly different from this. For example, conversion between the night-time descriptor LAeq,9hr and other descriptors will be dependent on whether the road under consideration is a major freight route, (Austroads 2005).

- **Table 3-9 Factors for simple conversion between road traffic noise descriptors (Austroads 2005)**

	$L_{Aeq,16hr}$	$L_{Aeq,8hr}$	$L_{Aeq,15hr}$	$L_{Aeq,9hr}$	$L_{Aeq,24hr}$	Highest $L_{Aeq,1hr}$	L_{DN}	L_{DEN}
$L_{A10(18hr)}$	2.0	6.3	2.2	5.1	3.0	0	-1.9	-2.2
$L_{Aeq,16hr}$		4.3	0	3.1	1.0	-2.5	-3.9	-4.3
$L_{Aeq,8hr}$			-4.1	-1.2	-3.3	-6.7	-8.2	-8.6
$L_{Aeq,15hr}$				2.9	0.8	-2.6	-4.1	-4.4
$L_{Aeq,9hr}$					-2.1	-5.5	-7.0	-7.4
$L_{Aeq,24hr}$						-3.4	-4.9	-5.3
Highest $L_{Aeq,1hr}$							-1.5	-1.8
L_{DN}								0

The factors shown should be added to the descriptor in the header row to estimate the descriptor in the right hand column. For example:

$$L_{A10(18hr)} = L_{Aeq,15hr} + 2.2dB(A)$$

Existing road traffic noise criteria

The following table, Table 3-10, summarises the LA10 traffic noise criteria in use in Australia (in 2005) by Government Road Authorities. Most toll roads have similar criteria.

- **Table 3-10 Simplified summary of daytime residential LA10 traffic noise objective levels, (Austroads 2005)**

Agency		Residential Noise Objective			
		New roads	Upgraded roads	Existing roads (no roadworks)	Averaging period (hours)
ACT	Planning and Land Management Authority	63	63	-	18
NSW	RTA & EPA	58 *	63 *		15
QLD	Department of Main Roads	63	68	68	18
	Environment Protection Authority	63 – 68 **	63 – 68 **	63 – 68 **	18
SA	Transport South Australia	58 – 63 *	58 – 68 *	-	15
TAS	Department of Infrastructure, Energy and Resources	63	63	-	18
VIC	VicRoads	63	63	68	18
WA	Main Roads Western Australia	63	63	-	18
NZ	Transit New Zealand	65 *	65 *	-	24

* Figure converted from L_{Aeq} to L_{A10} by applying a +3dB correction
** 68 dB for a state-controlled road and 63 dB for any other public road

In Victoria, traffic noise criteria are all based on the VicRoads Traffic Noise Reduction Policy.

The CityLink and EastLink Requirements use the $L_{A10\ (18\ hour)}$ traffic noise metric and contain some to nearly all of the VicRoads Policy requirements. The following sections will examine briefly the VicRoads Traffic Noise Reduction Policy.

VicRoads Traffic Noise Reduction Policy

VicRoads has had a traffic noise policy of some form since the late 1970's. The current Traffic Noise Reduction Policy was developed and adopted in January 2005 and is included in Appendix D. The noise descriptor is L_{A10} and the averaging periods are 18 and 12 hours. The application of the policy is to most noise-sensitive buildings, with exceptions to non-conforming uses and developments that were initiated after the preliminary investigations for a road corridor. Until recently VicRoads used Road Design Note 6-1a "Interpretation and application of VicRoads Traffic Noise Reduction Policy 2005" as a guide for the policy use.

Some of the main limitations of the VicRoads policy are:

- The criteria do not address nighttime traffic noise impacts,
- The criteria do not apply to habitable levels of buildings above the lowest impacted by a road project,
- The criteria do not apply to the upgrade of existing non-freeway roads unless the road reservation is significantly altered,
- The Policy does not apply retrofitting to existing non-freeway roads.

However, the VicRoads Policy does allow off-road noise amelioration treatments if this is a practical option to expensive on-road noise barriers.

State Environment Protection Policy – Road Traffic Noise

The EPA of Victoria has been developing a SEPP-RTN for a few years, and currently are finalising the SEPP content and policy impact assessment documents. If this SEPP is accepted, then its criteria would be adopted by VicRoads. However, as the noise criteria for CityLink and EastLink are a significant part of the concession to operate the roads, it is unlikely that the criteria for these roads will be changed.

The content and approach of the SEPP-RTN is not known, however, as an indication, the leading practices adopted in other States will probably form the basis of the SEPP criteria. Thus it is reasonable to assume that:

- the noise descriptor will be L_{Aeq},
- there will be daytime and nighttime criteria,
- the daytime/nighttime averaging periods will be 16 hour/8 hour or 15 hour/9 hour,
- there would be a requirement to address new roads (freeways and arterial roads) as well as up-graded roads (freeways and arterial roads),

As the SEPP-RTN will not be released in the near future, it will have no influence on this project at this stage of the assessment.

Proposed Road Traffic Noise Criteria

The guiding principles for the development of the East-West corridor assessment criteria are:

- that they provide a reasonable protection for the local community;
- that they reflect current leading practice in Australia;
- that they are achievable and practical in application; and

- that they align with the general principles of new road project criteria already in practice in Victoria.

To achieve these principles the Project Team decided to use VicRoads Traffic Noise Reduction Policy Criteria. The reasons for adopting these Criteria are:

- That the Criteria reflect the current and accepted practise by CityLink, EastLink and VicRoads as well as other states in Australia,
- That the Criteria that will apply for the Assessment, however, the actual Project Criteria have not been determined, and,
- That the Criteria used in this assessment are for rating each Option equally against the other Options.

The Criteria are:

	New Freeways and arterial roads and up-graded existing roads	
Existing noise levels	≤ 61 dB(A) L_{10}(18 hour)	> 61 dB(A) L_{10}(18 hour)
Criteria	63 dB(A) L_{10}(18 hour)	Limit increase to 2 dB(A) L_{10}(18 hour)

Consideration should be given to limiting the increase of noise levels to 12 dB(A), where the existing noise level is less than 50 dB(A) $L_{10\ (18\ hour)}$.

Railway Noise

There are a limited number of railway noise policies in place in Australia. The EPA of Victoria SEPP N-1, controlling noise from industrial, commercial or trade premises in Victoria, exempts railways, light rail and tramways from noise criteria (except marshalling yards and maintenance depots). Guidance from other jurisdictions was used to develop the proposed railway noise criteria.

An overview of criteria used in other states is provided in Appendix C.

Proposed Rail Traffic Noise Criteria

- **Table 3-11 Proposed rail traffic noise criteria**

Noise descriptor	Proposed levels, dB(A)
Leq, 24 hr	65
Lmax	85

It should be noted that these proposed criteria are for assessment purposes only and don't reflect developments by Victorian Government Departments in this area.

Transportation Noise Assessment

Environment Noise Impacts

The Transportation Noise impact assessment will be based on the change in existing noise levels.

With respect to road traffic noise, changes will be:

- positive or an environmental benefit when some traffic is removed from a road and the existing noise levels are predicted to decrease,
- positive or an environmental benefit when the existing noise levels are predicted to decrease due to changes in the existing road infrastructure,
- negative or an environmental disbenefit when new infrastructure leads to an increase in noise levels,
- negative or an environmental disbenefit when changes to existing road infrastructure leads to a increase in the existing noise levels,
- negative or an environmental disbenefit when additional traffic results in an increase in traffic noise levels.

The degree of the impact of the road infrastructure and traffic volume changes will be determined by the change in dB(A) after attenuation requirements have been applied as determined by the Road Traffic Noise Criteria in Table 3-10. Initially it is assumed that attenuation requirements will be applied to all corridor options where road works increase the existing noise levels and trigger the Noise Criteria. Also that all properties requiring attenuation will be attenuated.

This approach will enable corridor options to be compared equally. In reality, the final option will need to be subjected to practicability testing; that is, what is the feasible and reasonable approach to attenuating properties for the increase in noise levels.

Table 3-12 gives an example of how an option assessment and comparison may be performed.

Table 3-12 Example of Road Traffic Noise Assessment

Option	Location	Existing noise level, dB(A) L10 (18 hour)	Predicted future unattenuated noise levels dB(A) L10 (18 hour)	Predicted future attenuated noise levels dB(A) L10 (18 hour)	Change in noise level after attenuation dB(A) L10 (18 hour)	Total option noise level change dB(A) L10 (18 hour)
Option 1	Residence 1	48	60	55	7	7
	Residence 2	53	57	55	2	
	Motel	65	68	67	1	
	School	60	57		-3	
Option 2	Residence 10	50	60	55	5	1
	Residence 11	57	52		-5	
	Residence 12	62	68	64	2	
	Residence 20	70	69		-1	

There may need to be some weighting applied to the properties impacted by the options, depending upon their usage. For example in Table 3-12, there is a mix of uses that are covered by the Noise Criteria. Option 1 will impact residences as well as a Motel and a School, whilst Option 2 only impacts residences. There should be some consideration for the increased noise levels for the Motel (albeit small) and the decrease in noise levels at the school, because, at these sites there are potentially greater number of people exposed to the predicted changes in noise level.

It is proposed that railway noise assessment would be treated in a similar way to that of road traffic noise impacts. It is likely the assessment will involve increases in noise from new railways and changes to existing infrastructure, however, there may be potential decreases to existing railway noise levels due to changes in existing infrastructure.

Furthermore, there will be an assessment of the number of train passby. It is recognised that the maximum noise level of a train passby may be disturbing. The number of train passbys will also be significant for residences near a well trafficked rail line. The number of maximum passby events in a period of time is a well developed technique in road traffic noise, and this technique may be considered when a change in the rail network may lead to more train noise vents.

Buildings to be protected

The VicRoads Traffic Noise Reduction Policy considers the following types of buildings:

- ***Category A**: - For residential dwellings, aged persons homes, hospitals, motels, caravan parks and other buildings of a residential nature, the external noise level objective will be **63 dB(A) L10 (18hr)** measured between 6 am and midnight,*

- ***Category B**: - For schools, kindergartens libraries and other noise-sensitive community buildings the external noise level objective will be **63 dB(A)L10 (12hr)** measured between 6 am and 6 pm,*

The NSW Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects considers residential and non-residential uses (schools, educational institutions, places of worship, hospitals, passive recreational and active recreational (eg golf course).

For the assessment the following uses will be considered:

Residential uses

residential dwellings, aged persons homes, hospitals, motels, caravan parks and other buildings of a residential nature,

Institutional uses

schools, kindergartens, places of worship, libraries, and other noise-sensitive community buildings

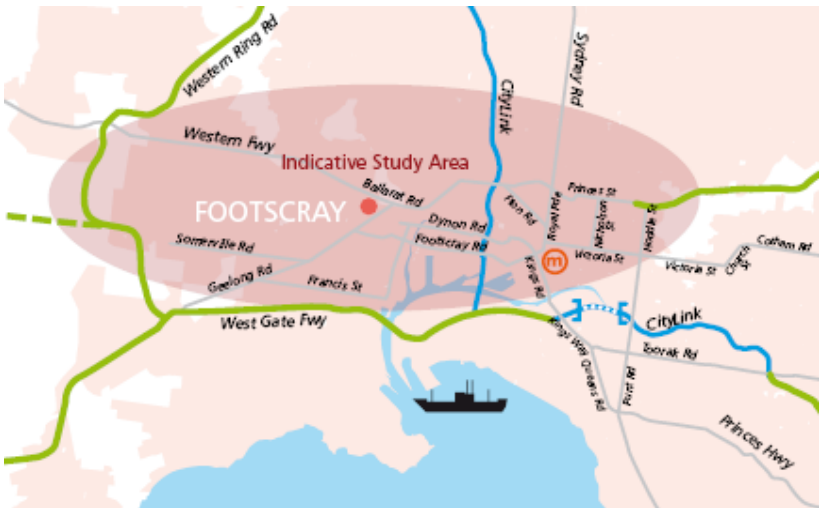
Recreational uses

passive recreational

Existing noisy road and railways in the corridor investigation area

The definition of the East-West Corridor study area is shown in the figure 4.1 below.

- **Figure 3-10 East-West corridor study area**



Some of the existing major transportation corridors in the area include:

Roads

- Alexandra Parade/Princes Street/Brunswick St
- Elliott Ave/MacArthur Rd
- Lygon St/Royal Pde/Sydney Rd/Nicholson St
- Racecourse Rd/Macaulay Rd
- Smithfield Rd/Kensington Rd
- Ballarat Rd/Geelong Rd/Barkley Rd/Sunshine Rd
- Francis St/Millers Rd/Grieve Pde
- Dohertys Rd/Boundary Rd/Fitzgerald Rd
- West Gate Freeway
- Western Highway
- Western Ring Road
- CityLink

Railways

- Epping, Fawkner, Broadmeadows, Footscray, Newport and Altona rail lines
- Railyards at Footscray, Dynon, Tottenham, Sunshine

3.1.6 Hydrology and water quality

Introduction

The major rivers and creeks within the study area include Moonee Ponds Creek, Yarra River, Maribrynong River, Kororoit Creek, Stony Creek and Merri Creek. The quality of water entering these waterways and flowing into Port Phillip Bay is a major environmental concern because of the social and environmental significance of these waterways.

The importance of the quality of water in Melbourne's waterways and streams was identified in *Environmental Issues and their Impact on Metropolitan Strategy, Technical Report 1, Lumb et al 2000*. In summary, the key drivers for protecting the quality of water in waterways and streams are as follows:

- Melbourne's waterways and bays are highly significant elements of urban biodiversity and provide opportunities to enhance biodiversity capacity in urban areas;
- These waterways are used for a diverse range of water-based recreational pursuits for which high water quality is necessary; and
- The quality of water flowing to Port Phillip Bay will determine it's ecological and economic future. Nutrient cycling, mainly nitrogen, has been identified as the major factor in maintaining the health of Port Philip Bay (CSIRO, 1996).

The characteristics of an Ecologically Healthy River as used in the *Victorian River Health Strategy, DNRE 2002b*, are identified as follows:

An ecologically healthy river will have flow regimes, water quality and channel characteristics such that:

- in the river and riparian zone, the majority of plant and animal species are native and the presence of exotic species is not a significant threat to the ecological integrity of the system;
- natural ecosystem processes are maintained;
- major natural habitat features are represented and are maintained over time;
- native riparian vegetation communities exist sustainably for the majority of the river's length;
- native fish and other fauna can move and migrate up and down the river;
- linkages between river and floodplain and associated wetlands are able to maintain ecological processes;
- natural linkages with the sea or terminal lakes are maintained; and
- associated estuaries and terminal lake systems are productive ecosystems.

Melbourne Water is responsible for drainage, waterway and floodplain management for the Port Phillip and Westernport catchment. The objectives for water quality of the rivers, streams and Bays are established through State Environment Protection Policies (SEPPs), prepared by the EPA as statutory instruments under the *Environment Protection Act 1970*. The *State environment protection policy (Waters of Victoria)* is the state-wide SEPP that covers the management of Victorian waterways and other urban waters. Specific schedules to SEPP (Waters of Victoria) deal with specific individual catchments and have more detailed requirements that apply within the catchments in question. *Schedule F6 (Waters of Port Phillip Bay)* and *Schedule F7 (Waters of the Yarra Catchment)* are of relevance to the study area and describe the environmental quality objectives and indicators of relevance to Port Philip Bay and the Yarra Catchment.

The *Urban Stormwater Best Practice Environmental Management Guidelines, CSIRO, 1999* also provides guidance regarding the protection of stormwater quality and identifies the following principles for the management of storm water runoff:

- **preservation**: preserve existing valuable elements of the stormwater system, such as natural channels, wetlands and stream-side vegetation;
- **source control** : limit changes to the quantity and quality of stormwater at or near the source; and
- **structural control** : use structural measures, such as treatment techniques or detention basins, to improve water quality and control streamflow discharges.

Existing conditions

Maribyrnong River

The Maribyrnong River valley changes dramatically in character as it flows from the Organ Pipes to its confluence with the Yarra River. Within the study area the river valley is characterized by floodplain and flats – wide, open flats prone to flooding and changing channel location. In these areas the valley slopes are some distance from the river (Townsend et al, 2006). The condition of Maribyrnong River is rated as moderate by Melbourne Water (refer to Table 3-13).

The Maribyrnong has a history of flooding dating back to the 1880s. The largest flood on record occurred in 1906 (Townsend et al, 2006). Much of the land surrounding the Maribyrnong River is covered by a Land Subject to Inundation Overlay (LSIO), which delineates the area affected by a 1 in 100 year flood as identified by the floodplain management authority.

- **Table 3-13 Waterway condition: Maribyrnong River**

Maribyrnong River: Moderate					
	Water quality	Aquatic life	Habitat & stability	Vegetation	Flow
Excellent					
Good	✘		✘		
Moderate		✘			
Poor				✘	✘
Very Poor					

(Source: Melbourne Water, 2007)

Kororoit Creek

The water quality of Kororoit Creek through the urban area from Deer Park to Altona is considered to be in fair condition with most water quality parameters generally within the bounds of State Environment Protection Policy (SEPP) objectives (EPA, 1988 cited in Land Design Partnership et al, 2006).

The aquatic fauna of Kororoit Creek is described in the *Korooit Creek Regional Strategy 2005-2030* as generally moderate to good with sites located in the mid to upper catchment scoring higher ('healthier') ranks than sites in the lower catchment (refer to Table 3-14). Growling Grass Frogs have long been recognised as a key species of the riparian zone of Kororoit Creek. Their presence along Kororoit Creek has been recorded in a survey commissioned by Melbourne Water from sites as far apart as Racecourse Road in Altona to Beattys Road in Rockbank, as well as numerous sites in between (Land Design Partnership et al, 2006).

- **Table 3-14 Waterway condition: Kororoit Creek**

Kororoit Creek: Moderate					
	Water quality	Aquatic life	Habitat & stability	Vegetation	Flow
Excellent					
Good			✘		
Moderate	✘	✘			✘
Poor					
Very Poor				✘	

(Source: Melbourne Water, 2007)

Merri Creek

Merri Creek originates on the slopes of the Great Dividing Range and flows to its confluence with the Yarra River near Dights Falls in Abbotsford. In the Merri Creek lower/urban area water quality is considered to be poor but variable along its length (refer to Table 3-15). Heavy metal contamination, elevated nutrient concentrations and gross litter continue to be issues of concern for Merri Creek, its tributaries and the subsequent impact on the lower Yarra River (MW, 2003 cited in Parks Vic, 2006). Flows within Merri Creek vary according to seasonal rainfall and flooding occurs periodically.

- **Table 3-15 Waterway condition: Merri Creek (urban sections)**

Merri Creek (Urban Sections): Very Poor					
	Water quality	**Aquatic life**	**Habitat & stability**	**Vegetation**	**Flow**
Excellent					
Good					
Moderate			✘		
Poor		✘			✘
Very Poor	✘			✘	

(Source: Melbourne Water, 2007)

Yarra River

Water quality in the lower reaches of Yarra River is moderate to poor (refer to Table 3-16) with urban stormwater being the most significant source of pollution containing pollutants, waste, nutrients and litter (Melbourne Water, 2006). The *Yarra River Action Plan* supports the Government's Our Water Our Future Plan and outlines projects that will meet the challenge of managing water quality in the Yarra River over the long-term.

- **Table 3-16 Waterway condition: Middle and lower Yarra River**

Middle and Lower Yarra River: Poor					
	Water quality	**Aquatic life**	**Habitat & stability**	**Vegetation**	**Flow**
Excellent					
Good					
Moderate	✘		✘		
Poor		✘		✘	✘
Very Poor					

(Source: Melbourne Water, 2007)

Moonee Ponds Creek

The Moonee Ponds Creek flows from Yuroke in Melbourne's north-western suburbs past Melbourne Airport through the municipalities of Hume, Moreland, Moonee Valley and Melbourne, along the Tullamarine Freeway, through the Docklands and into the Yarra River to Port Phillip Bay. The overall condition of Moonee Ponds Creek is very poor (refer to Table 3-17). However, there are small areas in better condition (Melbourne Water, 2007).

- **Table 3-17 Waterway condition: Moonee Ponds Creek**

Moonee Ponds Creek: Very Poor					
	Water quality	**Aquatic life**	**Habitat & stability**	**Vegetation**	**Flow**
Excellent					
Good			✘		
Moderate					
Poor	✘	✘			✘
Very Poor				✘	

(Source: Melbourne Water, 2007)

Stony Creek

Stony Creek begins in Sunshine and crosses inner western industrial and residential areas before entering the Yarra River near where the Yarra and the Maribyrnong River merge. The *Stony Creek Neighbourhood Environment Improvement Plan (NEIP), 2004* identifies the main issue of concern with respect to the Creek as water quality.

Opportunities / Constraints

Potential hydrological impacts from new infrastructure are generally caused by the need to manage the increase or decrease in surface water flows (for natural assets) or increased underground flows (for man made assets including stormwater drainage pipelines).

Impacts include:

- Redirection of flows from natural assets, such as waterways and wetlands, resulting in:
  - loss of major natural habitat features.
  - loss of native riparian vegetation communities.
  - limits to the movement and passage of native fish and other fauna.
  - disruption to natural ecosystem processes that maintain the linkages between river and floodplain and associated wetlands.
- Impacts to the ecological integrity of the ecosystem, such as the introduction of exotic species;

- Loss of existing floodplain functions, such as loos of floodplain storage;
- Constriction of waterway openings which could potentially lead to increased local flood levels;
- Diversion of groundwater flows (baseflows) which would otherwise flow into streams, which would cause a reduction in stream flow; and
- Impacts on existing infrastructure, in particular the capacity of underground drainage to accommodate additional flows.

These impacts and the potential to identify avoidance, management and/or mitigation options all need to be considered at the preliminary planning stage of any new transport infrastructure.

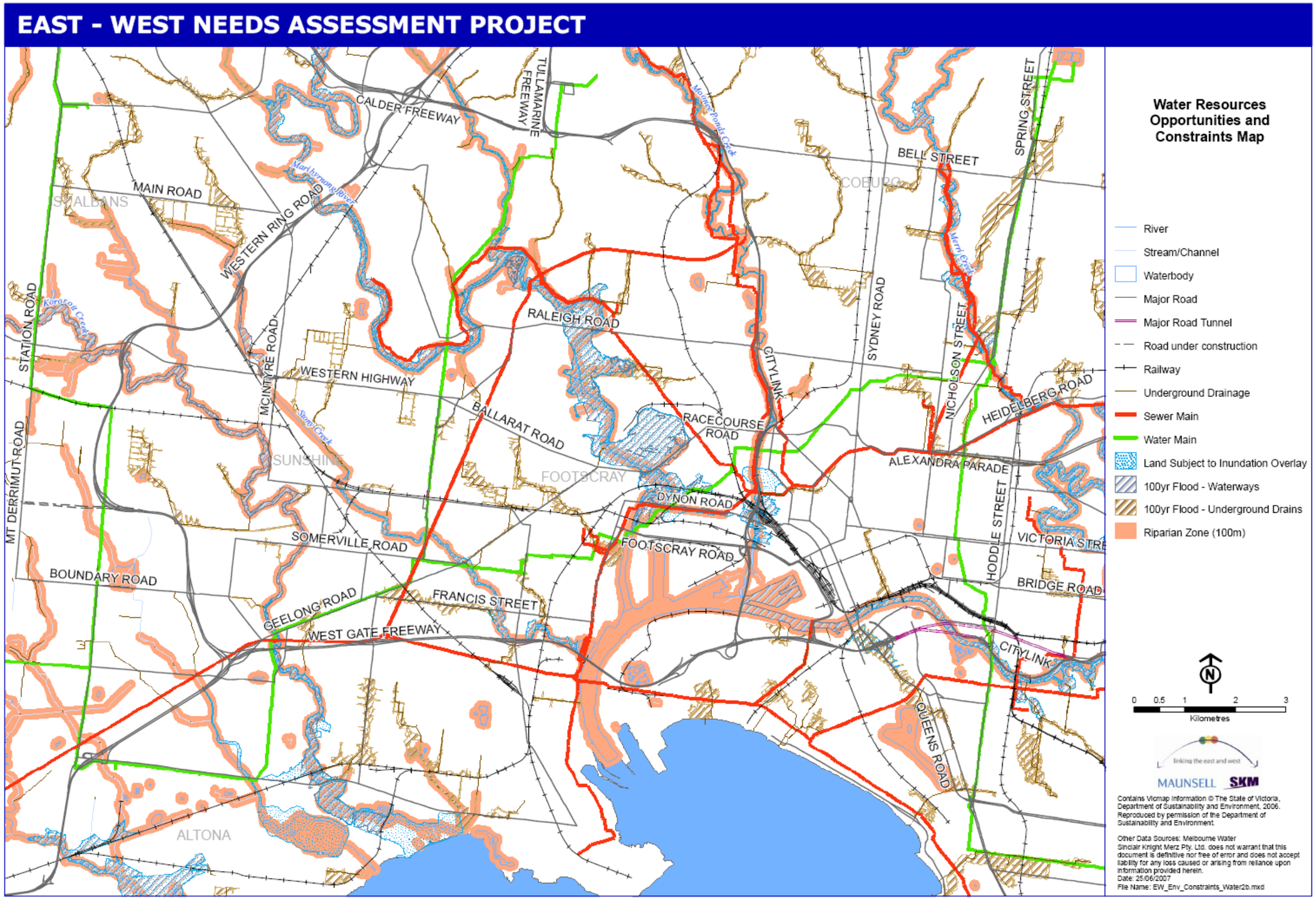
Options that may be generated in the East-West Needs Assessment have the potential to impact on water quality and aquatic ecology in a number of ways. Surface carriageways can have impacts during construction and operation. Runoff from construction sites and road surfaces that can enter waterways have the potential to carry sediment, hydrocarbons and heavy metals. These pollutants are known to cause degradation in stream water quality which can have consequences for aquatic biota and ecological processes. Water quality impacts should be appropriately managed through water sensitive construction techniques that minimise sediment generation and runoff by directing all surface runoff away from waterways for either recycling or treatment prior to discharge.

Tunnel options can also impact on aquatic ecology, for example, if tunnel operations intercept groundwater there can be a diversion of groundwater flows (baseflows) which would otherwise flow into streams, which would cause a reduction in stream flow in adjacent waterways. Reduction in stream flow can have implications for aquatic ecosystems. Water quality impacts should be appropriately managed through appropriate tunnelling techniques and linings that minimise groundwater seepage.

Preservation and improvement of water quality in the Yarra River, Moonee Ponds Creek, Maribrynong River, Kororoit Creek, Stony Creek and Merri Creek would be a beneficial by-product of any new transport infrastructure and its associated land use improvements.

Figure 3-11, provides a visual representation of potential water resource opportunities and constraints within the study area.

- **Figure 3-11 Summary of water resources opportunities and constraints**



3.1.7 Land contamination

Introduction

Contamination is defined in the National Environment Protection (Assessment of Site Contamination) Measure as:

'…where any chemical substance or waste has been added at above the background level and represents, or potentially represents, an adverse health or environmental impact' (NEPM, Assessment of Site Contamination 1999)

Construction of a new East-West transport link is expected to involve the excavation and stockpile of large volumes of soil. There is the potential for man-made contamination of soils and potential for naturally occurring contamination of soil and rock. Historic and current industrial operations are a common source of contamination. Given the highly industrialised nature of the study area, the potential for contamination may be a significant issue.

The St*ate environment protection policy (Prevention and Management of Contamination of Land) [SEPP (PMCL)]* provides a statutory framework for protecting people and the environment from the effects of land contamination. The policy sets in place measures to prevent and manage contamination. The SEPP (PMCL) aims to maintain and where appropriate and practicable improve the condition of land to protect current and future uses from contamination. (EPA, 2002)

The Northern Central City Corridor Study - Issues and Trends Paper, DoI 2001 provides a useful overview of potential sources of soil and groundwater contamination that would be typically associated with current and previous industrial activities undertaken in the study area, including:

- heavy metal contamination associated with industrial activities such as dye works;
- polychlorinated biphenyl (PCB) contamination associated with electricity supply systems and electrical equipment maintenance depots;
- asbestos contamination associated with industrial and residential structures, and transport activities (eg. brake pads in vehicles);
- organochlorine contamination due to pesticide and herbicide use around industrial, residential and recreational areas;
- paint, oil and grease contamination from current transport and industrial activity;
- hydrocarbon contamination from fuel storage tanks (eg at service stations);
- uncontrolled dumping on derelict sites; and
- potential contamination in imported fills.

Existing conditions

Areas included within an Industrial Zone or an Environmental Audit Overlay of local planning schemes may have a higher potential to cause soil and/or groundwater contamination both on site and in surrounding areas. Based on a review of local planning schemes, the major industrial areas of the study area are located within the following areas:

- Port Melbourne (including the Port of Melbourne and Fishermans Bend)
- West Melbourne Industrial area
- Parts of Kensington
- Parts of North and West Melbourne
- Geelong St, West Footscray
- Sunshine Road, West Footscray / Tottenham
- Sommerville Rd, Tottenham, Brooklyn
- Industrial precinct of Whitehall Street, Yarraville

As a broad screen assessment a review of EPA priority sites was undertaken. There are 20 sites within the study area that are listed as EPA Priority Sites. Priority sites are sites for which EPA has issued a clean-up notice pursuant to section 62A or a pollution abatement notice pursuant to section 31A or 31B (relevant to land and/or groundwater) of the *Environment Protection Act* 1970. Typically these are sites where pollution of land and/or groundwater presents an unacceptable risk to human health or to the environment (EPA. 2007).

The condition of these sites is not compatible with the current or approved use of the site without active management to reduce the risk to human health and the environment. Such management can include clean-up, monitoring and/or institutional controls. Sites are removed from the Priority Sites Register once all conditions of a notice have been complied with.

Sites within the study area that are currently listed on the EPA Priority Sites Register (current to 30 March 2007) are list in Table 3-18 below. The list is not exhaustive and provides an indication of contaminated sites. There are likely to be numerous additional sites not investigated or reported. Further study is required to develop a fuller picture.

- **Table 3-18 EPA Priority Sites within the study area**

Address	Suburb	Municipality
1-21 Kent St & 10-24 Buckingham St	RICHMOND	Yarra City Council
1-3 High St	YARRAVILLE	Maribyrnong City Council
186 St Georges Rd	FITZROY NORTH	Yarra City Council
221a & 221b Whitehall St	YARRAVILLE	Maribyrnong City Council
225 Barkly St	BRUNSWICK	Moreland City Council

Address	Suburb	Municipality
227 Barkly St	BRUNSWICK	Moreland City Council
23 Central Av	SUNSHINE	Brimbank City Council
281-295 Whitehall St	YARRAVILLE	Maribyrnong City Council
295 Whitehall St	YARRAVILLE	Maribyrnong City Council
40-60 Mcdonald Rd	BROOKLYN	Brimbank City Council
47 Mcintyre Rd	SUNSHINE	Brimbank City Council
501 Swanston St	MELBOURNE	Melbourne City Council
594 Geelong Rd (Corner Mcdonald Rd)	BROOKLYN	Brimbank City Council
Bunting Rd	BROOKLYN	Brimbank City Council
Carrington Dr Reserve North & South Of The Western Ring Rd	SUNSHINE	Brimbank City Council
Duke St	SUNSHINE NORTH	Brimbank City Council
Farnsworth Av	FOOTSCRAY	Maribyrnong City Council
Former James Hardie Landfill, Hardie Rd	BROOKLYN	Maribyrnong City Council
Former Melton Shire Landfill, Ferris Rd	MELTON	Melton Shire Council
Somerville Rd	FOOTSCRAY WEST	Brimbank City Council

(Source: EPA, 2007)

Acid sulfate soil and acid rock potential

Soils that contain significant amounts of iron sulfides are referred to as acid sulphate soils. Acid sulfate soils can have major environmental, economic, engineering, and health impacts, and can constrain development, construction and other activities in affected areas.

Waste acid sulfate soils must be managed in accordance with the requirements of the *Industrial Waste Management Policy (Waste Acid Sulfate Soils).* Acid sulfate soils excavated as part of works would require appropriate management and disposal, leading to increased cost for the development. In addition, acid sulfate soils may preclude the adoption of certain foundation types.

A review of the likely impact of acid sulfate soils was undertaken for the study area based on the Department of Primary Industries, on-line acid sulphate soils map. (http://www.dpi.vic.gov.au/dpi/vro/maps.nsf/pages/acid_sulfate_soils?Opendocument), (DNRE, 2002).The map is indicative only and has been derived from modelling. It does not provide an accurate representation of the location of acid sulphate soils but can be used as a guide.

Acid sulphate soils are probable around the Port of Melbourne, West Melbourne, Docklands, parts of Yarraville, Kensignton and Flemington and along land surrounding the Maribrynong River, Yarra River and Moonee Ponds Creek.

The excavation of certain rock types around Melbourne can result in Acid Rock Drainage (ARD). ARD occurs when rocks or soils with high sulphide content are oxidised by exposure to the atmosphere after excavation. The acid producing potential of a rock depends on the relative quantities of sulphidic minerals and carbonate minerals in the material. Sampling and laboratory

testing can characterise the likely volume of acid a soil or rock will produce as well as the time frame acid production will take. Treatment or appropriate disposal of excavated material is required to prevent potentially damaging ARD to the environment. Management of ARD is outlined in the EPA publication 655 'Acid Sulfate Soil and Rock' and is likely to require characterisation, treatment or landfill disposal and on-going communication with the EPA.

Opportunities / Constraints

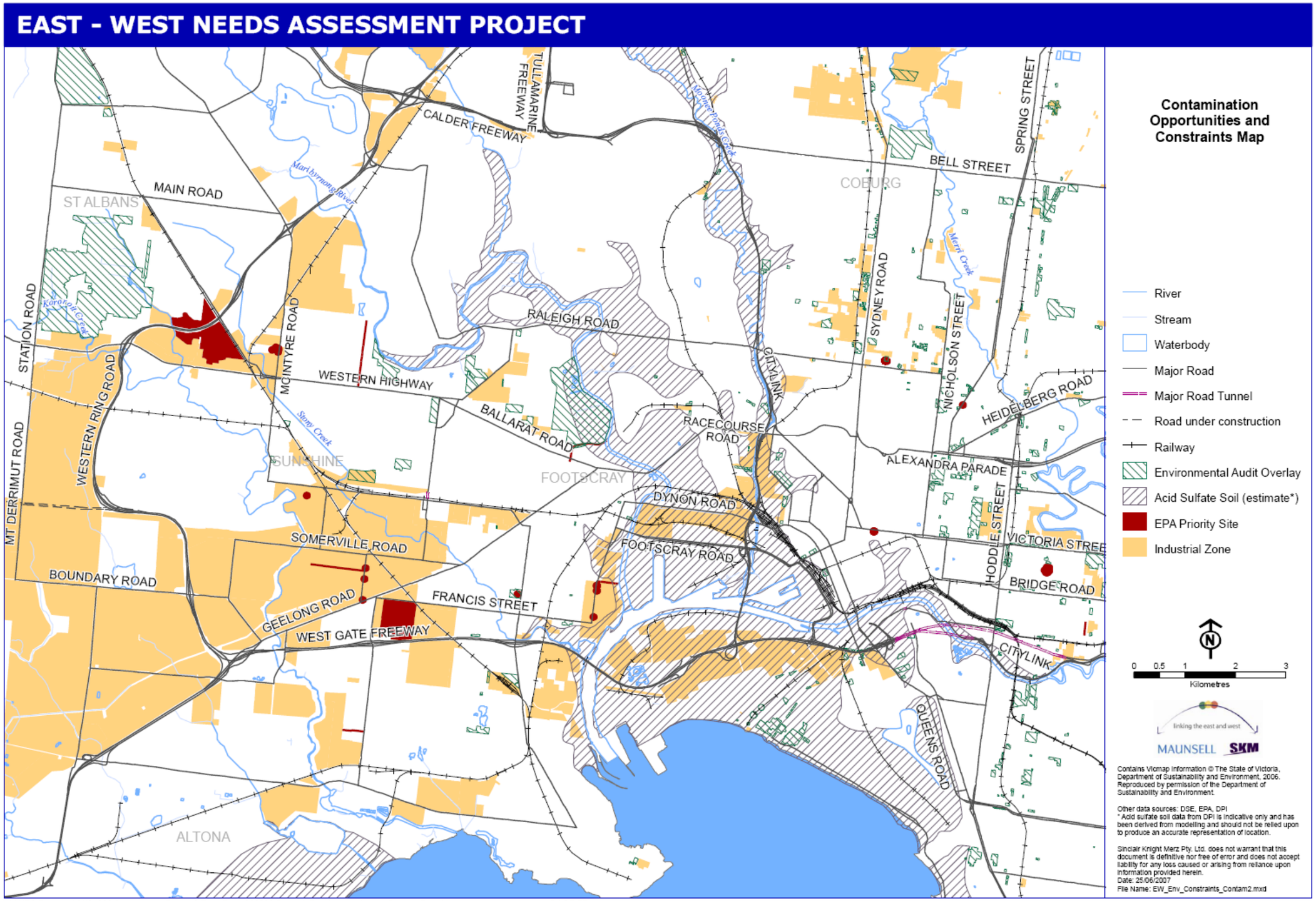
Contamination of soil and groundwater has the potential to increase costs and time required to complete the development of an option. Specifically causes include:

- Regulatory approval for development on a contaminated site (particularly where a statutory environmental audit is required);
- Assessment and remediation of contaminated soil may require significant time and expense;
- Additional costs of construction associated with management and/or disposal of contaminated soil/groundwater;
- Increase in generation of waste; and
- Potential for increased due diligence requirements as part of prospective land purchase in order to minimise issues associated with inherited contamination.

The East-West Needs Assessment provides an opportunity to contain and allow cleaning-up of contamination in areas adjoining proposed transport infrastructure.

Figure 3-12, provides a visual representation of potential land contamination opportunities and constraints within the study area.

- **Figure 3-12 Summary of land contamination opportunities and constraints**



3.1.8 Hydrogeology

Introduction

In many major transport and infrastructure projects, especially those which involve tunnelling or embankments, the hydrogeological processes can have a significant influence on possible transport options and routes and hence on the project cost and construction methods adopted. Hence it is expected that the hydrogeology of the project area will be one of a small number of issues that will have a significant influence on the selection of the final transport options and proposed route alignments.

Existing conditions

A study conducted for the *Northern Central City Corridor Study (NCCC)* (DoI, 2001) documented the existing hydrogeological conditions within Melbourne's inner north. Table 3-19 outlines the general stratigraphy of the NCCC study area.

- **Table 3-19 Stratigraphy of the NCCC study area**

Age	General Geological Type	Code	Name	Description
Silurian	Mudstone and sandstone	Sla	Deep Creek Formation	Massive mudstone interbedded with thin sandstone and shale
		Sud	Dargile Formation	Sandstone interbedded with minor interbeds of mudstone and shale
Lower Tertiary	Alluvials	Tew*	Werribee Formation	Sand, sandy and silty clay
	Volcanics	Tvo	Older Volcanics	Basalt, often deeply weathered to clay
Upper Tertiary	Alluvials	Tpb	Brighton Group	Sand, sandy clay, silt and gravel
Quaternary	Volcanics	Qvn	Newer Volcanics	Basalt, scoria, minor tuff and sand, clay
	Alluvials	Qrp*	Moray St Gravels	Gravel and sand, minor silt, clay and carbonaceous clay
		Qpf*	Fishermens Bend Silt	Silty Clay, minor sandy clay and silt
		Qp	Coode Island Silt	Silt, silty clay, sandy clay, minor peat and shell beds
		Qrd	Port Melbourne Sands	Shelly sand, minor silty or clayey sand
		Qrc	Alluvial Fan Deposits	Gravel, sand, minor silt
		Qra	River Alluvium	Sand, silt, clay, minor gravel

The East-West Needs Assessment study area is situated predominantly on Newer Volcanics. The regional flow system within the Newer Volcanic aquifer is directed south easterly towards discharge areas in the Port Phillip Bay, with variations due to highly variable thickness and permeability of the aquifer.

Available data suggests that groundwater beneficial use is highly variable but is of high salinity. Beneficial use maps indicate groundwater salinity of the watertable aquifer for the study area is between 1,000mg/L and 13,000mg/L.

The water table within the NCCC Study area was around 3.5 to 13 metres deep from available information, being closest to the surface in the south western parts of the area, and deeper over the rest where ground elevations are higher (DoI, 2001).

Opportunities / Constraints

Groundwater processes fundamentally control the design of most civil engineering structures. Potential hydrogeological impacts are generally caused by the need to manage groundwater inflows into the site, impacts include:

- Redirection of flow from waterways and wetlands;
- Impacts to Groundwater Dependant Ecosystems (GDE's) such as dying off of groundwater dependent vegetation;
- Maintenance of base flows to streams;
- Potential need to extract and treat groundwater;
- Land subsidence causing problems with urban infrastructure such as roads, buildings, pipelines etc; and
- Excessive inflows into cuttings/tunnels causing construction delays.

The potential for contamination of groundwater also exists. Exposure to groundwater contamination during construction activities can result in potential environmental and human health impacts. There may also be implications for contaminated water disposal should this be required.

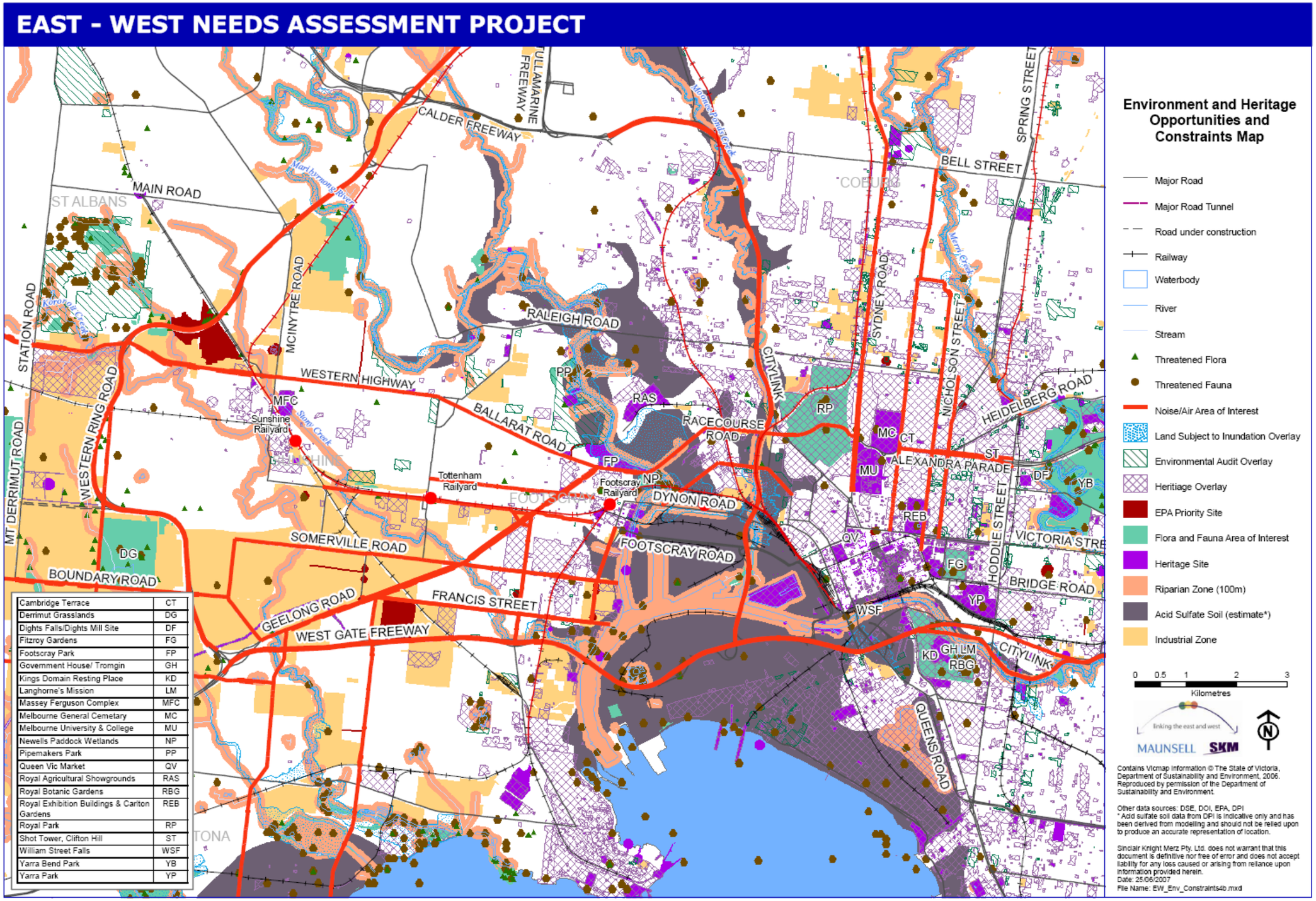
These impacts and also avoidance, management and/or mitigation options all need to be considered at the preliminary planning stage.

Further phases of assessment will include development of a Conceptual Model of the hydrogeology of the study area. This would be a comprehensive summary of hydrogeology in the region and an indication of the likely behaviour of groundwater in the project area, including groundwater elevation, seasonal groundwater level fluctuations, recharge and discharge mechanisms, groundwater flow direction, groundwater chemistry characteristics and receptors of groundwater.

3.2 Summary of opportunities and constraints

Figure 3-13, provides a visual representation of potential opportunities and constraints within the study area.

Figure 3-13 Environment and heritage opportunities and constraints



4. Environmental sustainability framework

Drawing from the discussion of environmental sustainability in Section 2 of this report, an evaluation method is proposed that combines a triple bottom line framework of goals, objectives and criteria with the systems approach shown in Figure 3 of this document:

- An environmental sustainability framework is proposed in Section 4.1
- Performance of an option would also be assessed against the following sustainability tests:
  - Will the option sustain valued aspects of the economy, society or the natural environment?
  - Will the option result in genuine progress?
  - Are major trade-offs involved?
  - Are there positive synergies associated with the option?
  - Does the option contain complementary elements that enhance net benefits?

This approach supports performance-based development that meets agreed triple bottom line/ sustainability goals, rather than focussing on an approach that merely seeks to minimise adverse impacts.

As discussed earlier, the framework included in Section 4.1 focuses on the environmental issues that are the subject of the Environment and Heritage study. An overall assessment framework will need to also incorporate relevant economic and social criteria.

4.1 Draft goals, objectives and criteria

Principle: Environmental Sustainability

Goals	Objectives	Criteria	Factors to be considered
Ecological Sustainability	Protect the functioning of natural ecosystems and biological diversity.	■ Area of natural vegetation or fauna habitat depleted (ha) ■ Potential impact on areas of high or moderate conservation value ■ Potential fragmentation of existing wildlife corridors	■ Number of species that are rare and/or threatened at the National, State, Regional or local level potentially removed ■ Quality / level of significance (i.e. state, regional or local) of vegetation. ■ Ability to meet the required offset options for any impacts associated with removal of native vegetation ■ Potential effects on natural habitats, wildlife corridors and wetlands.
	Maintain or improve the quality of existing natural habitat	■ Opportunity to restore areas that are currently degraded or alienated ■ Opportunities for enhancement of wildlife corridors/connecting reserves	■ Compatibility with existing biodiversity master plans and strategies ■ Opportunities for specific ecological improvements such as specific revegetation programs relating to waterway protection, screening or general amenity plantings.
Preserve indigenous and non-indigenous heritage values	Maintain and enhance sites of cultural heritage significance.	■ Potential interactions with known locations of significant heritage sites requiring preservation in situ ■ (Predictive modelling of cultural heritage sensitivity based on sensitivity of landforms (Aboriginal) and historic themes (European).	■ Sites identified though Heritage Victoria register and inventory, AAV Register, Heritage Overlays, Natural Trust of Victoria listed places, Register of the National Estate ■ Significance of known Aboriginal archaeological sites on the basis of rarity, integrity, education value and research value. ■ Likelihood of finding sites of heritage significance based on predictive modelling. ■ Nature and disturbance of the options.
Contribute to target of containing climate change impacts	Efficient Use of Resources	■ Reduced congestion within study area ■ Increases in the use of walking and cycling ■ Increases in the public transport mode share	■ Connectivity of the road network and the degree to which the transport system encourages different transport modes.
	Reduce energy use and greenhouse gas emissions	■ Reduced consumption of fossil fuels ■ Estimated CO2 emissions by mode of transport over the study area	■ Increase accessibility of employment and residential areas to public transport and pedestrians/cyclists. ■ Level of congestion of the transport network – travel time ■ The extent to which vehicle kilometres travelled would increase or decrease with development of the transport strategy – KM travelled, fuel use.

Maintain surface and groundwater resources of appropriate quality and quantity to provide for community and environmental needs	Maintain existing surface water flows and levels	■ Continued ability of waterways to carry floodwaters ■ Maintain base flows and surface water flows of streams	■ Floodplain functions, potential constriction of waterway openings. ■ Potential diversion of groundwater flows (baseflows) causing a reduction in stream flow. ■ Potential redirection of flows from waterways and wetlands impacting on natural habitat features, native riparian vegetation communities, movement and passage of native fish and other fauna and natural ecosystem processes.
	Maintain or improve existing water quality	■ Environmental sensitivity of the catchment ■ Ability to effectively treat stormwater runoff, prior to discharge to steams	■ Runoff has the potential to carry sediment, hydrocarbons and heavy metals, which are known to cause degradation in stream water quality which can have consequences for aquatic biota and ecological processes.
	Conserve the quantity and quality of groundwater in the study area.	■ Potential need to extract and treat groundwater ■ Potential impacts on groundwater quality ■ depth to watertable ■ Potential impacts on groundwater dependent ecosystems	■ Impacts to GDE's such as dying off of groundwater dependent vegetation. ■ Maintenance of base flows to streams. ■ Excessive inflows into cuttings/tunnels causing construction delays.
	Maintain existing capacities of underground infrastructure	■ Effects on existing infrastructure, such as underground drainage	■ Land subsidence causing problems with urban infrastructure such as roads, buildings, pipelines etc; and ■ Capacity of underground drainage to accommodate increased volumes of water.
Protect and enhance existing environmental amenity over the corridor	Improve amenity and quality of life	■ Compliance with proposed noise guidelines ■ Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches. ■ Potential enhancement of acoustic environment due to reduction in traffic ■ Reduction in traffic volumes on local streets ■ Concentration of air pollutants at relevant sites according to adopted standards	■ The Victorian air quality standards are on a par with the ambient air quality guidelines provided in the NEPM. As such for simplification and as the EWLNA is a Victorian project, the Victorian standards only are considered for use as criteria for EWLNA. ■ Proposed Road Traffic Noise Criteria for the East-West corridor for a new freeway and arterial road: ` - Daytime: 55 dB(A) $L_{eq\ (16\ hour)}$ ` - Night-time: 50 dB(A)$L_{eq\ (8\ hour)}$
Protect human and environmental health	Minimise the risk to human heath and the environment from exposure to contaminated soil or groundwater	■ Manage any potentially contaminated land to avoid surface or groundwater impacts and to safeguard human health. ■ Opportunities to contain and allow cleaning-up of contamination in areas adjoining new transport infrastructure. ■ Opportunities to create buffer zones between contamination sources and receptors in areas adjoining new infrastructure.	■ Level of risk to human health ■ Types of contamination encountered. ■ Remediation opportunities based on the type of contamination. ■ Management options to increase re-use without detrimentally affecting the ability to achieve other objectives.

5. Conclusion

A number of potential opportunities and constraints have been identified in this Preliminary Environment and Heritage Issues Working Paper. Specific issues covered in this paper included:

- Environmental sustainability;
- Air quality;
- Greenhouse gas emissions;
- Flora and fauna;
- Cultural heritage;
- Noise;
- Hydrology and water quality;
- Land contamination; and
- Hydrogeology.

The intention of this paper is to assist the study team in understanding the sustainability drivers applying to the study and the potential key environment and heritage headline issues. Understanding these issues will assist in both developing transport options for a new East-West link and in formulating criteria for the assessment framework that will be used to compare and contrast the options developed. Based on the options generated, a range of further specialist investigations will be undertaken during development of the options to develop a more detailed understanding of potential environmental opportunities and constraints.

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Appendix A Policy and external drivers

The key sustainability policy drivers for EWLNA are provided in Table 6-1 below but several snapshots of other external drivers or indicators of global developments are also included.

Table 6-1 Policy and external drivers for consideration

International	Policy Drivers
United Nations Framework Convention on Climate Change	The ultimate objective of the convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human-induced interference with the climate system.
City of Groningen - Permanent Measures for Sustainable Transport	The city of Groningen has implemented a number of permanent measures in favour of sustainable transport modes: • re-allocation of road space: plan 'Binnenstad Beter' (better inner city) which consists of the redesign of the inner city reserving more space for slow traffic and pedestrians, • on-street parking regulations: implementation of parking garages to limit on-street parking, • improvement of public transport: introduction of quick express lines to important commuter destinations, • improvement of the bicycle network and extension of guarded bicycle parking facilities.
Sustainable Development Commission Submission - The Eddington Transport Study – UK, Jan 2006	An evaluation of the contribution that transport makes to the UK's economic growth, productivity and stability must include the external costs that it imposes on the environment, society and other areas of the economy.
Sustainable Transportation Practices in Europe – Nov 2001	In the United States, the transportation community has shown an increasing interest in sustainable transportation and its linkages to land use and urban development patterns, economic growth, environmental impacts, and social equity. Sweden, Germany, the Netherlands, and the United Kingdom were identified as nations that have been actively addressing sustainable transportation issues for several years.
Federal	**Policy Drivers**
Greenhouse Gas Abatement Programme Projects	The transport sector is one of the fastest growing emissions sectors in Australia and as such provides significant opportunities for greenhouse gas abatement. The Australian Government is seeking to reduce emissions in this sector through: • informing consumer choices • working with industry to improve vehicle efficiency • exploring and developing the use of alternative fuels where there is a greenhouse benefit.
Travel Demand Management Initiative (TDM)	The Australian Greenhouse Office, in the Department of the Environment and Water Resources, is engaging with States, Territories and local governments and communities to support various approaches to reduce greenhouse gas emissions from passenger transport, particularly in urban centres.
Environmental Strategy for the motor Vehicle Industry	The Environmental Strategy for the Motor Vehicle Industry aims to significantly enhance the environmental performance of the automotive industry through measures including consumer information programmes and fuel consumption targets.
TravelSmart Australia	TravelSmart is about reducing our reliance on cars and making smart choices about other forms of transport.
National Travel Behaviour Change (NTBC)	The National Travel Behaviour Change Project involves Queensland, Victoria, South Australia and the Australian Capital Territory as well as the Australian Government, and aims to reduce impacts of car use. • This will be achieved by utilising a variety of measures to facilitate a

	voluntary change in behaviour towards more sustainable modes of travel such as walking, cycling, public transport and ride-sharing. • Project activities primarily focus on metropolitan areas and a small number of regional centers, with particular focus on work places, communities and households, schools and major destinations such as shopping centres and hospitals. • A national coordinator undertakes national initiatives in communication, evaluation, monitoring and review processes, best practice tools, award events and national conferences, and assists in coordinating the programme.
Alternative Fuels Programme	As part of Australia's response to climate change the Australian Government's alternative fuels programmes are designed to reduce greenhouse gases and other vehicular emissions from Australia's road transport sector.
Australian Council for Infrastructure Development (AusCID) - *Sustainability Framework for the Future of Australia's Infrastructure (2003).*	The handbook establishes the following guiding principles for Australian infrastructure projects: • The infrastructure industry recognises economic development is most acceptable where benefits outweigh costs, including the social and environmental costs and where social, environmental and economic capital are used efficiently • The infrastructure industry recognises it must care for the environment, which includes preserving ecological integrity, making prudent use of common natural resources (especially non-renewable resources) and enhancing environmental capital, where possible • The infrastructure industry operates as part of the community, so that stakeholders participate and influence planning, social capital is enhanced, human rights are respected and local economies benefit through employment opportunities and local purchasing • The infrastructure industry recognises the need for innovation to make projects more efficient and reduce their social and environmental impact and adopt whole-of-life cycle decision-making.
Victorian	**Policy Drivers**
Our Environment, Our Future – *Environmental Sustainability Action Statement (2006)*	This statement sets out a comprehensive set of environmental sustainability objectives, including: ■ Efficient transport systems ■ Liveable cities and towns ■ Less waste and increased resource efficiency ■ Reduced climate impact.
Victoria Government Departments' Environmental Policies - Encouraging cycle friendly workplaces	Encouraging staff to cycle improves staff health, reducing impact on the environment and can provide a number of financial benefits including: • Healthier staff—less sick days • Higher morale and increased staff productivity • Reduced need for carparking Indicative of an expected broader impact on car travel demand from increase cycle facilities at destination.

Appendix B Sustainability assessment framework

Sustainability framework approach

A proposed approach to the overall study is for the strategy options to be assessed from a sustainability perspective through the development of a TBL Assessment Framework. This will enable an integrated comparison of the alternatives on the basis of economic prosperity, liveability and environmental sustainability performance.

It is proposed that the Sustainability Assessment Framework be established with the following hierarchy:

- Principle - defines the area of sustainability being considered, e.g. environmental sustainability
- Goal - defines the element of the principle being considered and the overarching aim of the project for that component, e.g. contribute to target of containing climate change impacts
- Objective - describes the principal means by which the goal can be achieved
- Criteria - defines a specific and measurable (either quantitatively or qualitatively) means by which to systematically evaluate the extent to which a particular objective is likely to be achieved.

Chapter 4 of this document presents our proposed framework for the Environmental Sustainability component. If adopted, similar frameworks would need to be prepared for the Economic Prosperity and Community Well Being components of the TBL.

Multi criteria analysis technique

MCA is a systematic, semi-quantitative approach to decision making through the application of numerical weightings to a set of principles, goals and objectives to enable the net advantages and disadvantages of each option to be assessed.

This technique is a proven means of simplifying complex decision-making tasks, serving both as a process and a tool to aid the identification of a preferred solution from a range of alternatives. It is also an important means by which the structure and transparency can be achieved in the decision-making process. Other benefits include:

- It is an outcome-oriented process
- It accommodates the selective comparison of dissimilar criteria and consideration of potential trade-offs between alternatives
- It helps to focus investigations on the things that matter (i.e. the performance criteria)
- Qualitative data can be incorporated into the decision-making process without resorting to estimations of the monetary value of costs and benefits

- The use of weights reflects the relative importance of the assessment criteria

There is flexibility and scope for sensitivity analysis, by testing the impact of varied weightings.

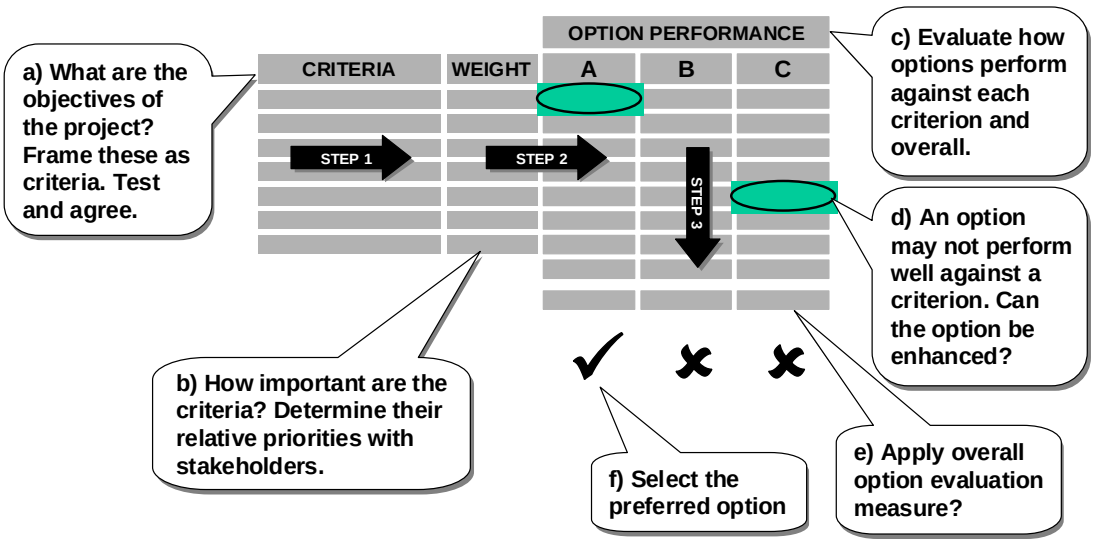
In previous SKM projects, numerical values, referred to as a weighting, have been assigned to certain principles, goals and objectives to enable a greater emphasis to be placed on them over others. Our normal approach is to initially allocate 100 points between each of the principles (i.e. 33 points each). The points allocated to specific principles are then further distributed between the supporting goals and then objectives, allowing emphasis to be placed on those goals and objectives viewed as more significant.

The inputs required for the MCA process are summarised as:

- A set of criteria against which to evaluate the alternatives
- The preferences or weights the stakeholders assign to the various criteria
- The performance of alternatives against the agreed criteria
- An aggregation procedure by which the alternatives are ranked.

Each of these steps is illustrated in

- **Figure 6-1 Conventional steps and information structure in MCA decision making**



The performance of each alternative against the agreed criteria will be assessed by relevant specialist team members, in collaboration with the study team and other key stakeholders. For each alternative the following values will be assigned to each of the criteria.

- Low consistency (1);
- Medium consistency(3); or

- High consistency (5)

Where a criterion is rated as 'High' it indicates that the alternative under consideration is consistent with the objective. Where possible, numeric information will be used to assign the values. If this is not available, the professional judgement of the project team will be drawn on. Where the alternatives cannot be differentiated for a particular criterion a 'Medium - 3' value will applied to each.

Key steps

Key steps to be undertaken are:

- Identify range of relevant issues and strategic drivers.
- Formulate the Sustainability Assessment Framework by grouping the identified issues into the three broad sustainability principles of prosperity, liveability and environmental sustainability and identify goals and objectives within each principle, with reference to existing and emerging government policies, strategies and planning scheme requirements. The agreed framework would then be utilised by specialist study team members in their analysis of the performance of each of the options during phase 2 and 3 assessments. The assessment will be undertaken by comparing the performance of each of the options against the base cases i.e. the 'do-nothing option' for 2021 and 2031.
- Consider the objectives of each principle and undertake an analysis of the degree (rating) to which the option is consistent with the identified objective. The consistency of each option with each objective is usually assessed on a five or three point scale
- Assess overall performance by assigning values or weightings to the over-riding principles and their objectives and combining with the identified ratings
- Sensitivity testing using varied weightings.

Appendix C Railway noise criteria used in other States

NSW EPA criteria

The NSW Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects establishes trigger levels for residential and non-residential uses. The noise trigger levels address:

- An increase in rail noise due to rail infrastructure projects
- Absolute levels of rail noise.

For residential receivers the noise trigger levels for absolute levels of rail noise have two components, L_{Aeq} and L_{Amax}. This combination addresses both the average level of noise (L_{Aeq}) over the day or night period and the maximum noise level (L_{Amax}) from passby events. The application of the L_{Amax} descriptor for residential land uses recognises that rail events are not adequately described solely by the L_{Aeq} descriptor when preservation of residential amenity and wellbeing are considered.

For other noise-sensitive land uses, only L_{Aeq} is applied, as the focus is on speech interference and providing adequate acoustic protection to conduct the activities associated with those land uses. An increase in both rail noise and the absolute level of rail noise at the trigger values in Table 6-2 and Table 6-3 must be met to initiate an assessment of rail noise impacts. The increases in rail noise trigger levels for L_{Aeq} and L_{Amax} are set at levels where an increase in rail noise may become perceptible.

Table 6-2 Airborne rail traffic noise trigger levels for residential land uses

	Noise trigger levels dB(A)		
	Day (7 am – 10 pm)	Night (10 pm – 7 am)	Comments
New rail line development	Development increases existing rail noise levels and resulting rail noise levels exceed:		These numbers represent external levels of noise that trigger the need for an assessment of the potential noise impacts from a rail infrastructure project. An 'increase' in existing rail noise levels is taken to be an increase of 2 dB(A) or more in L_{Aeq} in any hour or an increase of 3 dB(A) or more in L_{Amax}.
	60 $L_{Aeq\ (15\ hour)}$ 80 L_{Amax}	55 $L_{Aeq\ (9\ hour)}$ 80 L_{Amax}	
Redevelopment of existing rail line	Development increases existing rail noise levels and resulting rail noise levels exceed:		
	65 $L_{Aeq\ (15\ hour)}$ 85 L_{Amax}	60 $L_{Aeq\ (9\ hour)}$ 85 L_{Amax}	

Table 6-3 Airborne rail traffic noise trigger levels for sensitive land uses other than residential

	Noise trigger levels dB(A)	
Sensitive land use	New rail line development	Redevelopment of existing rail line
	Development increases existing rail noise levels by 2 dB(A) or more in L_{Aeq} in any hour and resulting rail noise levels exceed:	
Schools, educational institutions – internal	40 $L_{Aeq\ (1\ hour)}$	45 $L_{Aeq\ (1\ hour)}$
Places of worship – internal	40 $L_{Aeq\ (1\ hour)}$	45 $L_{Aeq\ (1\ hour)}$
Hospitals	60 $L_{Aeq\ (1\ hour)}$	60 $L_{Aeq\ (1\ hour)}$
Hospitals – internals	35 $L_{Aeq\ (1\ hour)}$	35 $L_{Aeq\ (1\ hour)}$
Passive recreational	L_{Aeq} as per residential noise level values in Tables 1 (does not include maximum noise level component)	
Active recreational (eg golf course)	65 $L_{Aeq\ (24\ hour)}$	65 $L_{Aeq\ (24\ hour)}$

South Australia Railway Noise Criteria

In South Australia, the EPA regulates rail transport noise and currently uses the NSW Rail Traffic Noise Guidelines as a basis for its noise criteria for residential receivers. The noise descriptors are:

$L_{Aeq,\ 24\ hr}$ - an equivalent noise level over a full day (24 hours)

L_{Amax} - a maximum pass-by level.

The criteria are in Table 6-4 below.

Table 6-4 Rail Traffic Noise Guidelines applied in SA

Noise descriptor	Planning levels dB(A)	Maximum levels dB(A)
$L_{eq,\ 24\ hr}$	55	60
L_{max}	80	85

Queensland Railway Noise Criteria

The following criteria are from the Queensland Rail, Code of Practice, Railway Noise Management.

Table 6-5 Queensland railway noise criteria

Noise descriptor	Planning levels dB(A)	Interim levels dB(A)
$L_{eq,\ 24\ hr}$	65	70
L_{max}	87	95

Appendix D VicRoads Noise Reduction Policy

VicRoads Traffic Noise Reduction Policy

February 2005

Statement of Policy:

Road traffic noise is a significant environmental problem, particularly in residential areas. VicRoads is committed to taking whatever steps it can to reduce the overall level of traffic noise, and to limit the effect of traffic noise on nearby residents when new or improved roads are opened to traffic. It will achieve this by:

- seeking to reduce noise emitted by vehicles and road surfaces;
- encouraging compatible land use next to major roads;
- limiting traffic noise from new arterial roads and roads upgraded to carry significantly more traffic;
- retrofitting noise barriers on older freeways.

Detailed Requirements and Performance Standards:

Reducing noise emissions at source:

VicRoads will seek to reduce noise emitted by vehicles and road surfaces by:

- supporting more stringent noise standards in Australian Design Rules for motor vehicles;
- using quieter pavement surfaces, where practicable on freeways and major arterial roads through residential areas;
- promoting and supporting measures that reduce engine brake noise.

Encouraging compatible land use:

VicRoads will encourage compatible land use next to major roads by:

- working with Planning Authorities to ensure that wherever possible, permitted land use beside busy roads is relatively insensitive to noise;
- encouraging the development of building regulations which will take into account both the noise level outside and the type of activity proposed inside the building.

Limiting noise next to new or improved roads:

Where arterial roads and freeways are built on new alignments, or where existing arterial roads or freeways are widened by two or more lanes and buildings previously protected from traffic noise are exposed by removal of buildings required for widening, the traffic noise level will be limited to the objectives set out below or the level that would have prevailed if the road improvements had not occurred, whichever is the greater.

- **Category A**: - For residential dwellings, aged persons homes, hospitals, motels, caravan parks and other buildings of a residential nature, the external noise level objective will be **63 dB(A) L_{10} (18hr)** measured between 6 am and midnight,

- **Category B**: - For schools, kindergartens libraries and other noise-sensitive community buildings the external noise level objective will be **63 dB(A)L_{10} (12hr)** measured between 6 am and 6 pm,

- Where the noise level adjacent to **Category A or B** buildings prior to road improvements is less than **50 dB(A)L_{10} (18hr)**, consideration will be given to limiting the external noise level increase to **12 dB(A).**

VicRoads will endeavour to comply with these noise level objectives using the most cost effective technology. The approach taken to controlling noise will include but not be limited to:

- the "whole of life" attenuation performance and the practicability of the measures,
- a combination of noise barriers and other measures such as open graded asphalt, barriers on bridge parapets and crash barriers, etc.,
- off-reservation attenuation measures to be undertaken, subject to practicability testing, and agreement with key stakeholders.

In addition, VicRoads will:

- consult with Councils and affected local communities on the need for and type of protection (if necessary) for small areas of passive open space;
- implement appropriate traffic management measures, if necessary, to ensure that night time noise levels are not excessively high.

Noise abatement program - Retrofitting

The principle of this part of the Policy is that all eligible projects under the policy are to be included within the noise retrofitting program and acceptable treatment methods are to ensure that the most cost effective approach over the life cycle of the project is considered.

The following key elements to the Noise Abatement Program – Retrofitting apply:

- VicRoads will continue to retrofit barriers to freeways and arterial roads that have previously been eligible for noise attenuation works,
- The retrofitting program will apply through out Victoria,
- The trigger for considering retrofitting will be when the traffic noise levels exceed **68 dB(A)L10 (18hr)**,
- A target noise level of less than **68 dB(A)L10 (18hr)** should be maintained after the attenuation works,
- When determining what measures can be employed to achieve the retrofitting target noise objective, consideration should be given to the "whole of life" attenuation performance and the practicability of the measures,
- The noise reduction may be achieved by a combination of noise barriers and other measures such as open graded asphalt, barriers on bridge parapets and crash barriers, etc.,
- Off-reservation attenuation measures may be undertaken, subject to practicability testing, and agreement with key stakeholders,
- Noise retrofitting works will be undertaken as funds permit, and will only apply to **Category A and B** buildings.

Exceptions to this Policy

There are a limited number of situations where expenditure of public monies on noise attenuation is not considered to be justified. Accordingly, VicRoads will not take action to protect existing or future development in the following circumstances:

- **Category A** or **Category B** buildings, as defined above, where such land use is defined as a non-conforming use in the relevant planning scheme.
- new buildings or subdivisions abutting any existing road under the control of VicRoads.
- new buildings or subdivisions abutting any road zone shown on any planning scheme for a new road or a road widening.

- buildings or subdivisions abutting any proposed road zone where the planning approval for the subdivision, was obtained after the commencement of the exhibition period to set aside land for a future road in the relevant planning scheme.

Definitions of terms used to describe traffic noise

Due to its nature traffic noise varies from instant to instant. Statistical terms have evolved to describe its level using a single number value.

dB: This is the abbreviation used for decibel which is the measure of sound pressure level.

dB(A): The (A) denotes that the sound pressure level has been "A" weighted so that the scale approximates the response of the human ear. The ear is less sensitive to high and low frequency sounds than it is to sounds in the midrange. Most community noise is measured in "A" weighted decibels.

L_{10}dB(A): This is the noise level in dB(A) exceeded for 10% of a specified time period. For a one hour period the level would be exceeded for 6 minutes but would be less for the remaining 54 minutes.

L_{10} (18hr)dB(A): This is the standard traffic noise descriptor used in Australia. It is the arithmetic average of the hourly L_{10} levels between 6 am and 12 midnight.

Key Responsibilities:

Manager - Environmental Services:

Preparation of information to advise the public of VicRoads practices with respect to traffic noise.

Ensure that VicRoads standard specifications and design practices are consistent with these guidelines.

Regional Managers and Project Managers:

Implementation of this policy

Related Technical Guidelines, Standard Specifications and Codes of Practice:

The guidelines for the measurement of traffic noise are located in the Road/Road Use, Policy/Standards Database in the Standards section. Other guidelines and works instructions are located in the Environmental Information Systems database.

Specific references:

VicRoads Traffic Noise Measurement Requirements for Acoustic Consultants – November 2005

Road Design Note 6-1a Interpretation and application of VicRoads Traffic Noise Reduction Policy 2005

Amended and approved 30th January 2005

East-West Link Needs Assessment Environment and Heritage Study

Part B – Options Appraisal

- Final
- 26 March 2008

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List of abbreviations

Abbreviation	Expanded Term or Title
ARD	Acid Rock Drainage
ASS	Acid sulphate soils
CHMP	Cultural Heritage Management Plan
CO	Carbon monoxide
CO_2	Carbon dioxide
dBA	Decibels
DoI	Department of Infrastructure
EPAV	Environment Protection Authority Victoria
ESD	Ecologically Sustainable Development
EVCs	Ecological Vegetation Communities
EWLNA	East-West Needs Assessment
GDE	Groundwater Dependent Ecosystem
GHG	Greenhouse gas
NEPM	National Environment Protection (Ambient Air Quality) Measure
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen; *i.e.*, comprising fractions of NO_2 and NO
O_3	Ozone
PM	Particulate Matter
SEPP	State Environment Protection Policy
SO_2	Sulfur dioxide
TBL	Triple Bottom Line
VHR	Victorian Heritage Register
VKT	Vehicle kilometres travelled
VLC	Veitch Lister Consulting
VOC	Volatile Organic Compound

Glossary

Term	Explanation
Acid sulphate soils	Soils that contain significant amounts of iron sulfides, which when exposed to water and air react to produce acid and can have major environmental, economic, engineering and health impacts
Acid Rock	Rocks that contain sulphide minerals that when exposed to water and air react to produce acid and can have major environmental, economic, engineering and health impacts.
Acid Rock Drainage	ARD occurs when rocks or soils with high sulphide content are oxidised by exposure to the atmosphere after excavation.
Beneficial Use	The uses and values of the water environment that the community and government want to protect
Biodiversity	Biodiversity is the variety of all living things; the different plants, animals and micro organisms, the genetic information they contain and the ecosystems they form.
BioSite	A BioSite is a physical area of land or water containing biological assets with particular attributes, such as the presence of rare or threatened flora, fauna or habitat required for their survival and/or rare or threatened vegetation communities.
Ecological Vegetation Classes	EVCs are the basic mapping units used for biodiversity planning and conservation assessment at landscape, regional and broader scales in Victoria. They are derived from large-scale forest type and plant community mapping.
Groundwater	Water that exists beneath the earth's surface in underground streams and aquifers
Groundwater Dependent Ecosystem	An ecosystem that relies on groundwater for some, or all, of their water requirements.
Hydraulic Head	The force per unit area exerted by a column of liquid at a height above a depth (and pressure) of interest
Hydrogeology	The science dealing with the occurrence and distribution of subsurface water
Particulate Matter	Particulate Matter (PM) is a laboratory term for small (inhalable) particles; *e.g.*, PM_{10} refers to particles with diameters less than 10 microns; and $PM_{2.5}$ refers to particles with diameters less than 2.5 microns). A micron (μm) is size measurement equal to one thousandth of a millimetre
Scarred trees	Scarred trees are trees which have had bark removed by indigenous Australians for the creation of canoes, shelters, shields and containers.
Sustainability	The ability to maintain something over time whether it is infrastructure, the environment, ecosystems, healthy communities or prosperous economy
TBL	Measuring and reporting performance against economic, social and environmental parameters.

1. Introduction

The Victorian Government has requested Sir Rod Eddington to lead a study into the need for an East-West Link. The East-West Link Study Team supporting Sir Rod has commissioned Sinclair Knight Merz- Maunsell to undertake the Environment and Heritage Study for the East-West Link Needs Assessment (EWLNA). The purpose of the Environment and Heritage Study is to carry out a strategic appraisal of the physical and natural environmental and heritage constraints and opportunities associated with a range of options for a possible additional east-west transport link. The findings will assist Sir Rod and the Study Team with providing an assessment of the need for, and feasibility of, an additional link.

The overall project is based on three Phases of Assessment as shown in Table 1-1 below:

- **Table 1-1 Phases of assessment**

Phase 1	Overview of strategic drivers, key issues and development of an assessment framework that will be used to assess the need for and performance of transport options.
Phase 2	Generation of initial options and preliminary appraisal of those options against an assessment framework.
Phase 3	Appraisal of final options against the assessment framework.

This report presents the outcomes of the final options appraisal.

The intention of the Options Appraisal is to undertake a rapid appraisal of the final list of potential transport options to inform the decision making process for determining a preferred transport scheme.

The main features of the four transport options assessed in this phase are detailed below.

OPTION A

Public Transport initiatives:

- CBD rail tunnel from Tottenham rail yards (Sydenham Line) to Caulfield Station (Dandenong line).
- Doncaster Rapid Transport – upgrade of the DART bus services to incorporate bus only exit and entry from / to Eastern Freeway, bus interchange at Victoria Park Station and upgrading of Johnson St to a Strasbourg-style bus lanes and reduction of Johnson St traffic to one lane in the east bound direction only. An alternative is to allocate a lane each way on Alexandra Parade.
- Tarneit Rail – connection of V/Line Services from west of Werribee to Deer Park. Provides for additional capacity to accommodate future growth on the Werribee line by the removal of V/Line Services from this line.

Road Network Development initiatives:

- East-West Road connection from Eastern Fwy to West Gate Fwy (east of Williamstown Rd), including tunnels between the Eastern Freeway and Kensington and an elevated road between Kensington and the Westgate Freeway. The new road link would have connections to the existing network at Hoddle St/Alexandra Pde, Queens Pde, CityLink, the Port (Dynon Road) and Williamstown Rd. In the longer term, this would involve upgrading of Western Ring Rd (Deer Park bypass to West Gate Fwy) and West Gate Fwy (Williamstown Rd to WRR).
- Freight network connectivity enhancements, comprising:
  - Widening of Ballarat Rd to six lanes between Ashley St and Geelong Rd
  - Upgrading Ashley St / Paramount Rd to two lanes each direction from Geelong Rd to Ballarat Rd.
  - Connection of Ashley St to West Gate Fwy via Cemetery Rd upgrade
  - Connection from Hyde St to West Gate Fwy
  - Connection from Dynon Rd to Smithfield Rd

OPTION B

Public Transport initiatives:

- As for Option A

Road Network Development initiatives:

- East-West Road connection from Eastern Fwy to the Western Ring Road, including tunnels between the Eastern Freeway and Kensington (as for Option A), a tunnel under the Maribyrnong River and Footscray and a new surface road between Footscray and the Western Ring Road. The new road link would have connections to the existing road network at Hoddle St/Alexandra Pde, Queens Pde, CityLink, the Port and Sunshine Rd/Geelong Rd, Market Rd and WRR.
- Freight network connectivity enhancements, comprising:
  - Upgrading Ashley St / Paramount Rd to two lanes each direction between Geelong Rd and Ballarat Rd.
  - Connection from Hyde St to West Gate Freeway
  - Direct connection from Princes Hwy west to the Western Ring Rd and upgrade of WRR (between Deer Park bypass and West Gate Fwy)

OPTION C

Public Transport initiatives:

- As for Option A

Road Network Development initiatives:

- Upgrade of the existing road system from Eastern Freeway to Smithfield Road, comprising widening of Alexandra Parade, Cemetery Roadd to Royal Park; Tunnel from Royal Park to Smithfield Rd, and widening of Ballarat Road to six lanes between Ashley Street and Geelong Road
- Freight network connectivity, comprising:
  - Upgrading Ashley St / Paramount Rd to two lanes each direction between Geelong Rd and Ballarat Rd.
  - Connection of Ashley St to West Gate Fwy via Cemetery Rd upgrade
  - Connection from Hyde St to West Gate Freeway
  - Connection from Dynon Rd to Smithfield Rd

OPTION D

Public Transport initiatives:

- As for Option A

Road Network Development initiatives:

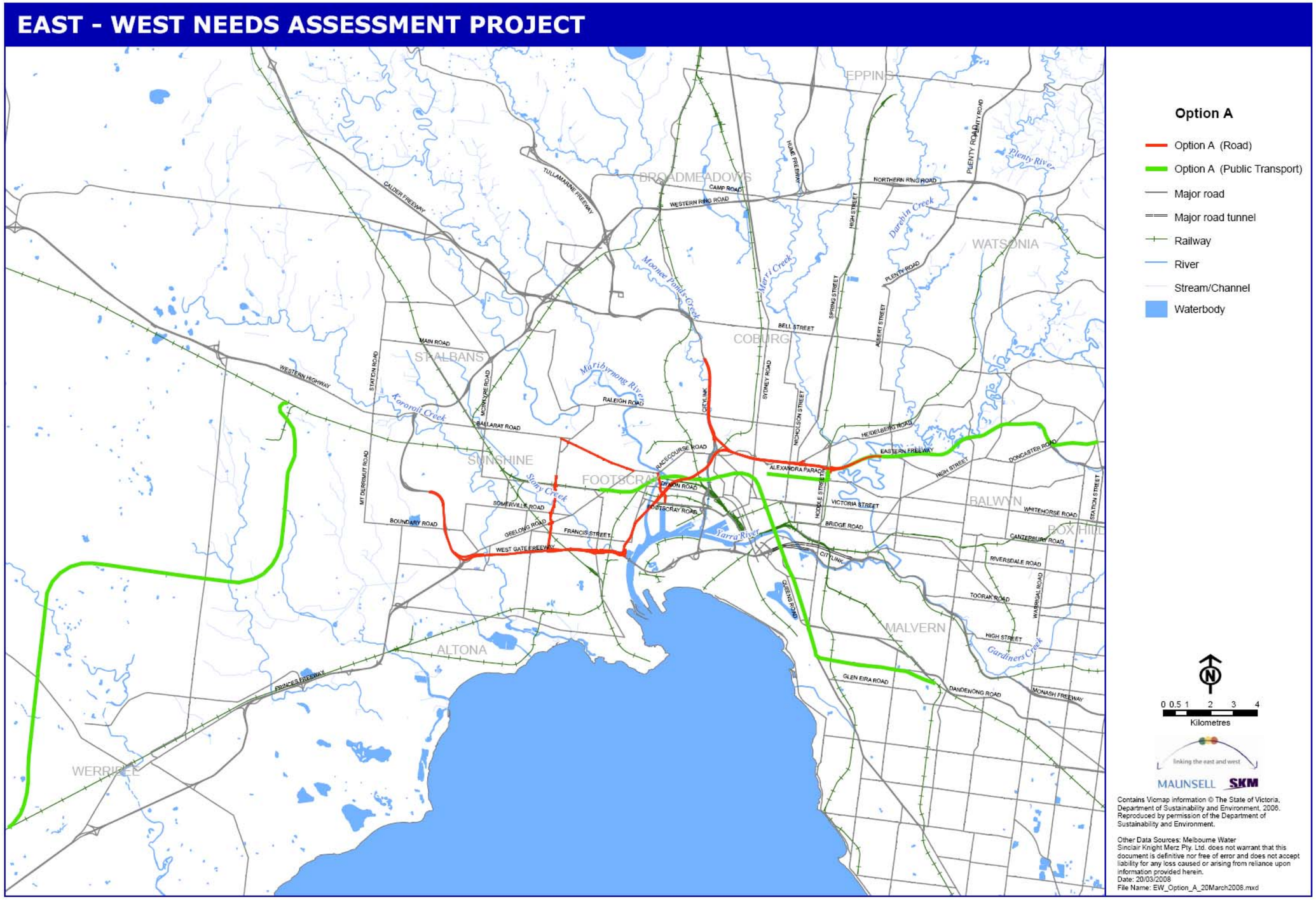
- Nil

Figure 1-1 provides an overview map of the four short-listed options.

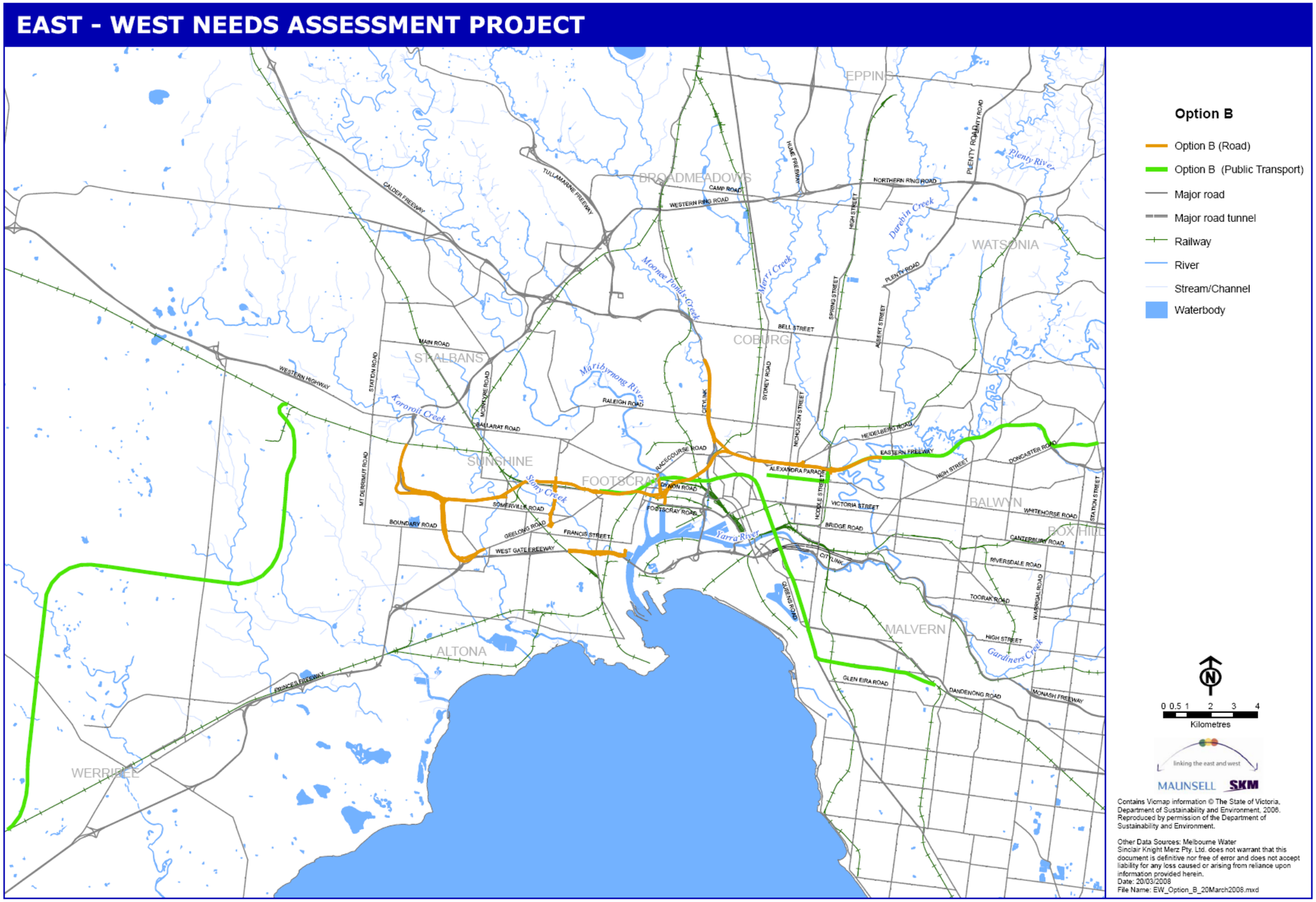
Specific categories of issues covered by the Environment and Heritage team in this report comprise:

- Hydrogeology;
- Hydrology**,** water quality and aquatic ecology;
- Contaminated land;
- Flora and fauna (terrestrial)**;**
- Cultural heritage;
- Air quality and Greenhouse gas emissions;
- Noise; and
- Environmental Sustainability.

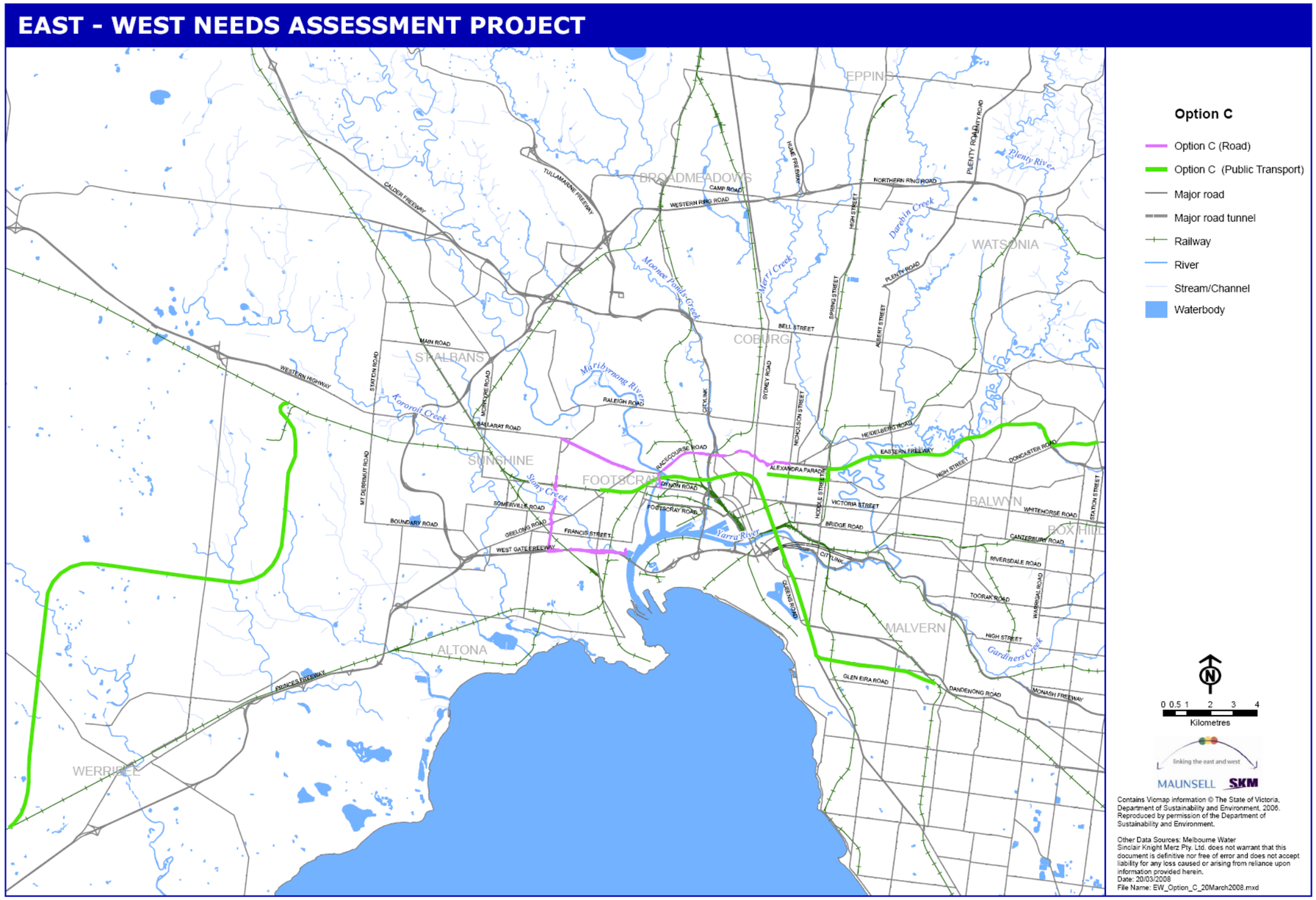
- **Figure 1-1 Option A Overview Map**



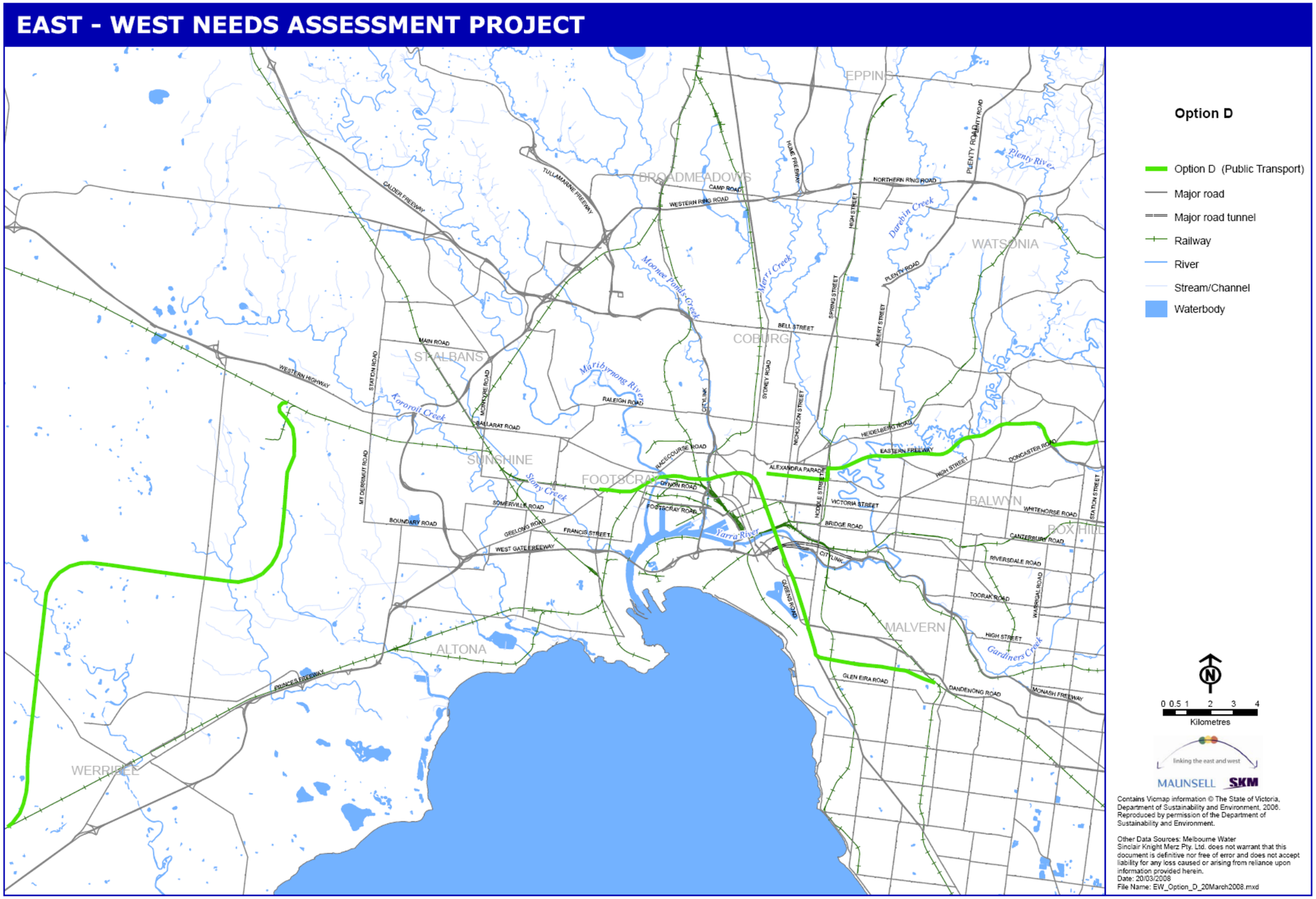
- **Figure 1-2 Option B Overview Map**



- **Figure 1-3 Option C Overview Map**



- **Figure 1-4 Option D Overview Map**



All transport options have been appraised against the assessment framework developed in Phase 1 and in relation to issues and constraints identified in the Preliminary Environment and Heritage Issues Report.

The appraisals are preliminary in nature, based on the initial concepts available in early December 2007 and already published information, without site reconnaissance or detailed surveys. They are based on the judgements of experienced practitioners in each of the specialist fields listed above. As such, the appraisals identify potential interactions that could be associated with the nominated options and should not be interpreted as constituting an environmental impact assessment. Potential interactions are identified to alert the study team to issues that will require further investigation during more detailed feasibility and environmental assessments and to provide input to the comparative assessment of the nominated options.

For each option a Summary Appraisal Table has been completed (see Appendix A), which outlines the following information:

- **Impacts -** Potential interactions between each option and the environmental assessment criteria developed in Phase 1
- **Qualitative Description** – A description of the nature of the interaction and the significance of the interaction
- **Quantitative Measure** – Identification of the number of potential interactions, e.g., number of cultural sites, number of waterways crossed etc
- **Assessment** – An assessment score between -3 and +3 using the Strategic Merit Test rating system (See Appendix B). Assessment scores were determined by comparing each option to the 2031 Base Case (do nothing) option
- **Confidence -** A score (High/Medium/Low) to identify the level of confidence with respect to the accuracy of the assessment and an explanation of the basis for that score
- **Risks** – Identification of the likelihood / confidence of potential unidentified interactions
- **Weighting –** assessment of the relative importance of the criterion under consideration, with the sum of criteria within each issue category totalling 100%
- **Rating –** the performance of each option against the objective under consideration, determined by multiplying the assessment score by the weighting. An overall rating for each option was determined by summing the ratings of the option for each objective.

An overview of each specialist assessment is provided in Section 3. The compiled assessments for each option are included in Section 4 and Appendix A contains the detailed assessments.

2. Assessment methodology

2.1 Overview

An assessment framework consisting of goals, objectives and criteria was developed in Phase 1 of the EWLNA. This assessment framework has been reviewed and refined and the final assessment framework is shown below in Table 2-1. The assessment framework has been applied to each of the nominated transport options and the performance of each option has been rated against the Base Case using the Study Team's Strategic Merit Test (see Appendix B).

The Base Case is as previously defined, comprising the existing transport system, combined with transport initiatives already planned or committed to by the Victorian Government.

The ratings determined in this report focus on environment and heritage issues, and are to be incorporated into the overall assessment framework that also includes relevant economic and social criteria.

All appraisals are based on available information and judgements of personnel experienced in their specialist field. The appraisals are intended to provide an indication of potential interactions associated with each option, as defined in December 2007, and updated in March 2008.

This report is based on transport modelling of the options against a Reference Case based on 'steady as she goes' land use, population and transport assumptions. As part of a separate process, the Reference Case results will be compared with a range of other future scenarios, including high and low population scenarios, as well as a Carbon Constrained Future scenario.

2.2 Key Assumptions

As indicated above, this appraisal comprises a preliminary identification of potential interactions associated with each of the options, based on the initial design concepts available at December 2007 and review of available information.

Key assumptions for this assessment are outlined below. Any variations to these key assumptions will affect the assessment results.

- For all options involving the construction of a tunnel it is assumed that the tunnel will be a tank tunnel, hence, no groundwater inflows have been assumed during operation. Potential interactions during the construction phase have been identified to assist with the comparison of options. However, it is anticipated that advanced tunnelling techniques will be adopted that will effectively manage the identified interactions.
- Tunnel size – A road tunnel (two lane) is assumed to be approximately 11.5m external diameter for each tunnel (two required from CityLink to the west). A road tunnel (three lane) is assumed to be

approximately 15m external diameter for each tunnel (two required from Eastern Fwy to CityLink) A single rail tunnel is assumed to be approximately 7m external diameter.

- Tunnel depth – the road tunnels are assumed to be relatively shallow (10-22 metres), while it is anticipated that the CBD rail tunnels could be up to 50m in depth, in order to avoid existing infrastructure.
- No "clogging" of tunnel drainage system.

It is expected that potential environmental interactions identified in this report can be mitigated or managed and do not represent a fatal flaw to the construction of any of the options. Some of these management measures will influence the cost of construction and this is being taken into consideration in the development of the cost estimates for each of the options. Potential mitigation measures that could eliminate or minimise potential environmental interactions are described below. For the purposes of this appraisal, it is assumed that these measures will be adopted and specialists have rated the options considering the likely effectiveness of the proposed measures.

Detailed assessments and development of management and mitigation measures will be required for the adopted transport option but the overview below provides a broad indication of how potential issues could be managed with enhanced environmental outcomes.

Hydrology, Water Quality and Aquatic Ecology

- It is assumed that stormwater runoff will be treated to best practice and construction impacts will be capable of being effectively mitigated. Where potential limitations to effective treatment exist, such as a lack of open space for water quality treatment, this has been highlighted in the assessment.
- It has been assumed that impacts on the hydraulic capacity of waterways can be engineered out to mitigate any potential impacts.

Contaminated Soil

- Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately. Appropriate assessment and management will ensure that adverse impacts are managed. The management and disposal of contaminated and acid sulphate soil and rock will increase the volume of waste material produced as a result of the project and the cost associated with spoil disposal / treatment is being taken into account in the development of cost estimates for each of the options.

Hydrogeology

- The major environmental interaction associated with hydrogeology is the potential impact on stream flows and Groundwater Dependant Ecosystems (GDEs) during construction (assumed to be fully controlled in operation). Pumping to lower groundwater levels and groundwater inflows to tunnels have the potential to result in reduced river/stream base flows. The lowering of the water table may impact on GDEs by impacting on vegetation health and reducing water levels in wetlands. This potential interaction has been recorded in the *Hydrology and Water Quality* assessment.
- Other hydrogeology issues associated with geology type, tunnel size and tunnel depth can be managed but have the potential to significantly influence construction costs. Cost implications are being incorporated into the capital cost estimates being prepared for each of the options.
- Hydrogeological impacts have only been assessed for options with tunnelling components.

Flora and Fauna

- Modification or removal of threatened flora and fauna, their habitat or introduction of movement barriers will impact on flora and fauna values. Areas of sensitivity around each transport option were identified in the assessment. Impacts to sensitive areas should be capable of being avoided or minimised through refinements to the alignments and appropriate mitigation measures. Where impacts cannot be avoided, the quality / level of significance of the flora and fauna will be an important factor in determining the level of constraint.

Cultural Heritage

- Destruction or disturbance to Aboriginal Heritage sites and places is a significant issue. However, potential impacts to sensitive areas should be capable of being avoided or minimised through refinements to the alignments and appropriate mitigation measures. Where impacts cannot be avoided, this may result in a significant constraint.

Air Quality

- Potential air quality impacts have been assessed on the basis of potential impacts due to anticipated changes (increases and reductions) in traffic flows in residential areas and the possibility air quality issues associated with emissions from road tunnel stacks. With respect to the latter, this possibility has been given a low weighting as it has been assumed that such interactions would be investigated in detail during detailed planning and the findings incorporated into the tunnel design and ventilation system.

Greenhouse Gas Emissions

- The appraisal of greenhouse gas emission issues associated with the Base Case and each of the options has focussed on relative effects rather than the absolute level of emissions as it is understood that the transport modelling undertaken for the Phase 3 assessments do not incorporate anticipated improvements in vehicle efficiency and the likelihood of substantially reduced emissions from vehicles in the future. Recent analysis has indicated that a 30% improvement in fuel efficiency could be achieved between 2010 and 2022, increasing to 60% through to 2034. These improvements are anticipated by more fuel efficient internal combustion engines, reductions in vehicle weight through the use of new materials and increased market penetration of petrol/electric hybrid vehicles, use of biofuels, clean diesel and hydrogen powered vehicles.

Environmental Sustainability

- The Phase 3 options feature a range of approaches to achieving an integrated transport system involving both public transport system enhancements and road network developments. The Environmental Sustainability appraisal undertaken in this report is limited due to the scope being focussed on environment and heritage matters, with other relevant Economic and Social Appraisals being undertaken by others. The appraisal includes suggestions of non-infrastructure related initiatives and sequencing that would enhance the environmental sustainability performance of the options under consideration. These suggestions will be considered further during subsequent planning and investigation phases.

Table 2-1 Assessment Framework

Goals	Objectives	Criteria	Factors to be considered
Ecological Sustainability	Protect the functioning of natural ecosystems and biological diversity.	▪ Potential impact on mapped EVCs ▪ Potential impact on mapped biosites ▪ Potential interactions with threatened flora and fauna	▪ Number of species that are rare and/or threatened at the National, State, Regional or local level potentially removed ▪ Quality / level of significance (i.e. state, regional or local) of vegetation. ▪ Ability to meet the required offset options for any impacts associated with removal of native vegetation ▪ Potential effects on natural habitats, wildlife corridors and wetlands.
Preserve indigenous and non-indigenous heritage values	Maintain and enhance sites of cultural heritage significance.	▪ Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance ▪ Potential interactions with known locations of non-Indigenous sites/places and heritage overlays ▪ Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity ▪ Impacts to social significance of cultural heritage sites	▪ Sites identified though Heritage Victoria register and inventory, AAV Register, Heritage Overlays, Natural Trust of Victoria listed places, Register of the National Estate ▪ Significance of known Aboriginal archaeological sites on the basis of rarity, integrity, education value and research value. ▪ Likelihood of finding sites of heritage significance based on predictive modelling. ▪ Nature and disturbance of the options.
Contribute to target of containing climate change impacts and promoting sustainable transport	Efficient Use of Resources	▪ Enhanced transport system efficiency ▪ Increased mode shift to public transport, walking and cycling ▪ Consistency with travel demand management initiatives	▪ Connectivity of the road network and the degree to which the transport system encourages different transport modes. ▪ Reduced congestion over the study area and reduced travel times ▪ The extent to which vehicle kilometres travelled would increase or decrease with development of the transport strategy – VKT, fuel use.
	Reduce energy use and greenhouse gas emissions	▪ Reduced consumption of fossil fuels ▪ Reduced CO2 emissions of transport over the study area	▪ Consistency with the above factors would be expected to result in reduced consumption of fossil fuels and reduced greenhouse gas emissions from transport. Additional factors are listed below ▪ Improved fuel efficiency of car use by using more fuel efficient vehicles ▪ Using cleaner fuels and technologies ▪ Reducing and managing travel demand through improved telecommunications technology ▪ Increased accessibility of employment and residential areas to public transport and pedestrians/cyclists

Maintain surface and groundwater flows & protect water quality	Maintain existing surface water flows and levels	■ Continued ability of waterways to carry floodwaters ■ Maintain base flows and surface water flows of streams ■ Potential impacts on groundwater dependent ecosystems	■ Floodplain functions, potential constriction of waterway openings. ■ Potential diversion of groundwater flows (baseflows) causing a reduction in stream flow. ■ Potential redirection of flows from waterways and wetlands impacting on natural habitat features, native riparian vegetation communities, movement and passage of native fish and other fauna and natural ecosystem processes. ■ Impacts to GDE's such as dying off of groundwater dependent vegetation. ■ Maintenance of base flows to streams.
	Maintain or improve existing water quality	■ Environmental sensitivity of the catchment ■ Ability to effectively treat stormwater runoff, prior to discharge to steams	■ Runoff has the potential to carry sediment, hydrocarbons and heavy metals, which are known to cause degradation in stream water quality which can have consequences for aquatic biota and ecological processes.
	Conserve the quantity and quality of groundwater in the study area.	■ ■ Potential need to extract and treat groundwater ■ Potential impacts on groundwater quality ■ Depth to watertable	■ Excessive inflows into cuttings/tunnels causing lowering of watertable
	Maintain existing capacities of underground infrastructure	■ Effects on existing infrastructure, such as underground drainage	■ Land subsidence causing problems with urban infrastructure such as roads, buildings, pipelines etc; and ■ Capacity of underground drainage to accommodate increased volumes of water.
Protect and enhance existing environmental amenity over the corridor	Improve amenity and quality of life	■ Compliance with VicRoads noise guidelines ■ Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches. ■ Potential enhancement of acoustic environment due to reduction in traffic ■ Reduction in traffic volumes on local streets ■ Concentration of air pollution emissions based on the trigger pollutant NOx. ■ Reduced congestion (area specific) ■ Length of tunnels and stacks	■ The Victorian air quality standards are on a par with the ambient air quality guidelines provided in the NEPM. As such for simplification and as the EWLNA is a Victorian project, the Victorian standards only are considered for use as criteria for EWLNA. ■ The VicRoads' Traffic Noise Guidelines have been adopted for the purposes of this appraisal as they reflect current and accepted practices by VicRoads, EastLink and CityLInk, as well as other Australian states. The guidelines require: ■ 63dB(A) L10(18hr) where existing noise levels are less than or equal to 61dB(A) ■ Limit increase to 2dB(A) L10 (18hr) ■ Adopted rail traffic noise guidelines are: ■ Leq, 24 hr 65dB(A) ■ L max 856dB(A)Construction Noise ■ Traffic modelling volumes
Protect human and environmental health	Minimise the risk to human heath and the environment from exposure to	■ Construction issues associated with management and disposal of acid sulphate soil and acid rock ■ Construction issues associated with disposal of contaminated spoil	■ Level of risk to human health ■ Types of contamination encountered. ■ Remediation opportunities based on the type of contamination.

	contaminated soil or groundwater	■ Manage any potentially contaminated land to avoid surface or groundwater impacts and to safeguard human health. ■ Opportunities to contain and allow cleaning-up of contamination in areas adjoining new transport infrastructure. ■ Construction issues associated with inflow of contaminated groundwater and required treatment during construction and operation	■ Management options to increase re-use without detrimentally affecting the ability to achieve other objectives.

3. Summary of Potential Interactions

This chapter provides a summary of potential interactions associated with each of the four nominated options. The summary is derived from the more detailed input from specialist team members included in Appendix A of this document.

3.1 Hydrogeological

In major transport and infrastructure projects, especially those which involve tunnelling or embankments, the hydrogeological processes can present a range of issues requiring detailed investigation.

Three key factors to differentiate the options from a hydrogeological perspective were identified as:

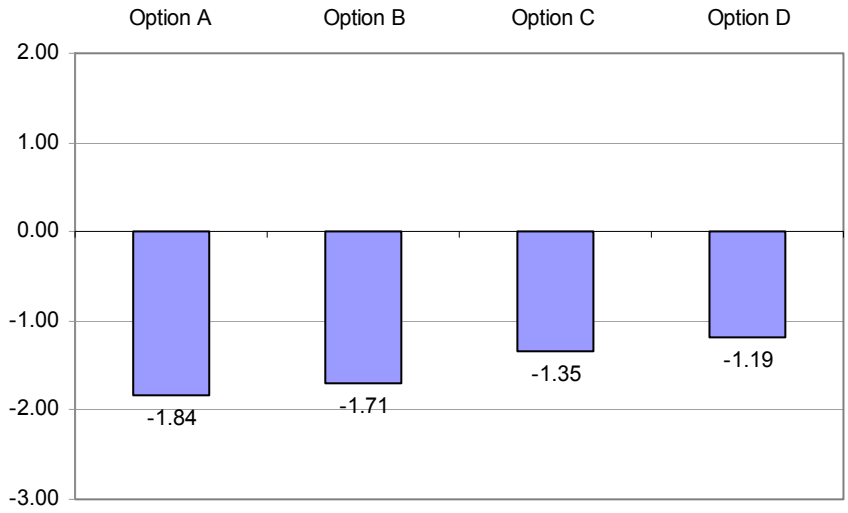
- *The length of tunnel to be constructed in Yarra Delta sediments* - Yarra Delta sediments are made up of a number of continually varying and porous geology types, which can result in drilling complications and the potential for increased groundwater inflows into the tunnel during construction. Where the tunnel intersects either basalt or sandstone siltstone aquifers, the tunnelling is likely to be more straight-forward.
- *The potential for acid sulphate groundwater* – There is a higher potential for the generation of acid sulphate groundwater resulting from drilling through the Yarra Delta sediments. Where groundwater is lost from locations containing acid sulphate soils there is a potential requirement for contaminated groundwater disposal. Furthermore, the occurrence of acid sulphate groundwater would lower the pH of the groundwater and may lead to the remobilisation of contaminants and the generation of a contaminated groundwater plume. Whilst measure can be taken to minimise this impact during construction, longer term monitoring and remediation may be required during the operation phase, if acid sulphate groundwater has been generated.
- *Tunnel Size* – The greater the tunnel size the greater the potential issues to be managed. This is because, as the size of the tunnel increases, the tunnel diameter increases significantly and hence the surface area of the tunnel increases. This results in a greater potential for increased groundwater inflow into the tunnel during construction, potentially leading to greater costs involved in disposing of intercepted groundwater, reduced stream flows and impacts on GDEs.
- *Depth of Tunnel* – The greater the tunnel depth the greater the potential issues to be managed. This is because, as the depth of the tunnel increases, the hydraulic head increases and hence the groundwater inflow rate increases linearly. Again, this has the potential to lead to increased tunnelling costs, reduced stream flows and impacts on GDEs.

Of the three key differentiating factors identified above, the most significant issue is considered to be the length of tunnel in Yarra Delta Sediments. While tunnelling techniques are available to minimise groundwater infiltration during construction, this issue has been raised in this preliminary appraisal as an important issue requiring further investigation during subsequent planning phases. Groundwater infiltration, and subsequent lowering of the watertable, in areas of Yarra Delta Sediments can also result in impacts on base flows and surface water flows of streams and impact on GDEs, as examined

in Section 3.2. Design and construction techniques to minimise groundwater infiltration have been provided for in the costing of the options.

A range of additional interactions have been considered in the Summary Appraisal Tables prepared for the hydrogeological assessment, including acid sulphate soils and land subsidence, with the results as summarised in the Table 3-1 below:

- **Table 3-1 Hydrogeological ratings**



Options A and B are rated as having a moderately-negative scores due to the combined effects of the East West road and CBD rail tunnels, with both tunnels potentially passing through areas comprising Yarra Delta sediments. While Option A has a slightly longer length of tunnel in Yarra Delta sediments, Option B includes a cut and cover tunnel at the Maribyrnong River crossing. In addition, the rail tunnel is likely to be a relatively deep tunnel (up to 50 metres below surface level) in order to avoid existing infrastructure and inferior geological conditions.

By comparison, Options C and D show a lower negative rating due to the reduced length of road tunnelling involved and shorter lengths of Yarra Delta sediments likely to be encountered.

3.2 Hydrology, Water Quality and Aquatic Ecology

Criteria used to assess potential hydrological, water quality and aquatic ecological issues associated with the options include:

- Continued ability of waterways to carry floodwaters without afflux effects
- Maintenance of base flows and surface water flows of streams
- Maintenance of terrestrial and aquatic ecological values
- Maintenance of water quality through effective treatment of stormwater runoff.

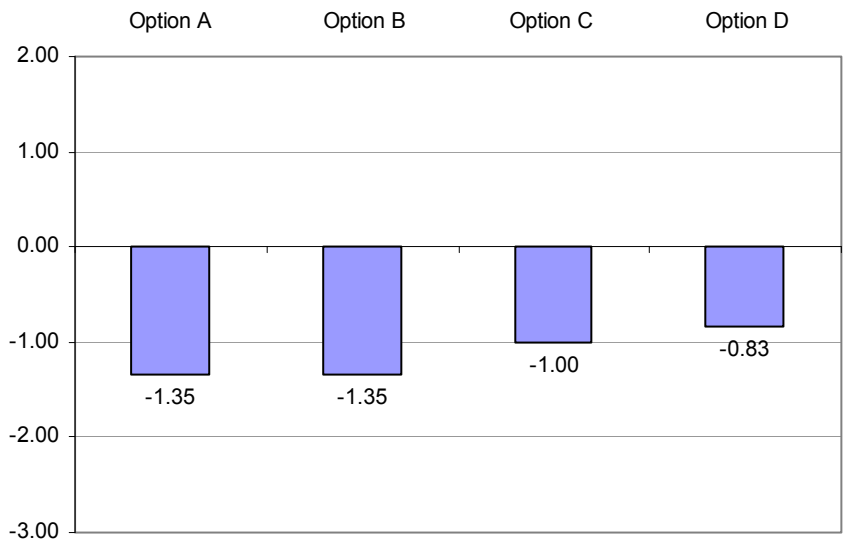
The options have the potential to impact on water quality and aquatic ecology in a number of ways. Runoff from construction sites and road surfaces that can enter waterways have the potential to carry sediment, hydrocarbons and heavy metals. These pollutants are known to cause degradation in stream

water quality which can have consequences for aquatic biota and ecological processes. Any new works will require best practice treatment to manage water quality impacts, which will include water sensitive construction techniques that minimise sediment generation and runoff by directing all surface runoff away from waterways for either recycling or treatment prior to discharge. A potential constraint with some of the options is the lack of open space to effectively treat stormwater runoff prior to discharge.

Potential impacts associated with tunnel elements include the infiltration of groundwater flows (base flows) into the tunnel, which would otherwise flow into streams, causing a reduction in stream flow in adjacent waterways. Reduction in stream flow can have implications for aquatic ecosystems. With the use of advanced tunnelling techniques and linings that avoid or minimise groundwater seepage, the likely impact on stream flows and GDEs is likely to be very minor, particularly as the proposed tunnels are generally aligned at 90° to streams and watercourses.

All options have been assessed to fall in the range of minor to moderate potential hydrological, water quality and aquatic ecology interactions, as identified in Table 3-2 below:

- **Table 3-2 Hydrology, water quality and aquatic ecology ratings**



Options A and B record moderately-negative rating scores due to the number of watercourses that the above-ground elements of the options intersect with (associated with the East West road connection proposals and the Tarneit Rail proposal), potential impacts on surface water flows and GDEs (associated with the East West road connection options and the CBD rail proposal) and the environmental sensitivity of potentially-impacted catchments.

Option C records a minor negative rating due to potential surface water interactions associated with the road network upgrade proposals (including the short length of road tunnel proposed), the CBD rail tunnel initiative and the Tarneit rail proposal.

Option D records the lowest negative rating due to the absence of road upgrade initiatives in this package. Potential interactions are associated with the CBD rail tunnel initiative and the Tarneit Rail proposal.

3.3 Contaminated Land

Key criteria in assessing the options for land contamination related issues are:

- Disposal of acid sulphate soils; and
- Disposal of contaminated soil.

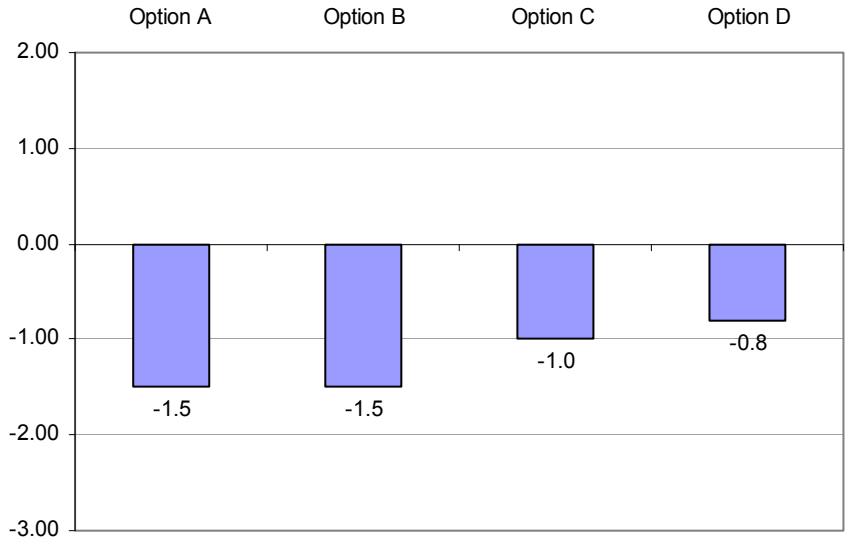
Construction of a new East West transport link is expected to involve the excavation and stockpile of large volumes of soil. There is the potential for man-made contamination of soils and potential for naturally occurring contamination of soil and rock. Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately. Appropriate assessment and management will ensure that adverse impacts are managed. The management and disposal of contaminated and acid sulphate soil and rock will increase the volume of waste material produced as a result of the project and the cost associated with spoil disposal / treatment is being taken into consideration in the development of cost estimates of the options.

The length of tunnel (volume of spoil) within areas of acid sulphate soil and contaminated soil are the critical factors in identifying potential interactions. Tunnels through areas of potentially contaminated soil and within the likely depth of soil contamination (approximately 0-10m) are likely to present an issue. Tunnels at greater depth or within bedrock are less likely to present an issue. Tunnels within areas of Yarra Delta Sediments will also present an issue as Yarra Delta Sediments have a high likelihood of being acid sulphate soil and Silurian Bedrock has some possibility of exhibiting acid rock characteristics. Yarra Delta Sediments also have a greater potential for groundwater inflow as opposed to New Volcanics and Silurian and will increase project costs associated with inflow of contaminated groundwater and required treatment of infiltrating water during construction and operation.

Construction of the transport options would also provide an opportunity to contain and allow clean up of contamination in areas adjoining new transport infrastructure, resulting in a reduction in extent of contaminated material in-situ and reduction in disposed and imported soil during construction.

Ratings of the options with respect to potential contaminated land interactions are summarised in Table 3-3 below.

- **Table 3-3 Contamination assessment scores**



Options A and B record moderately-negative ratings due to the potential for acid sulphate soils associated with Yarra Delta sediments and acid rocks associated with Silurian bedrock. These conditions are likely to be encountered for both the East West road tunnel options and the CBD rail tunnel.

A minor-negative score was recorded for both Options C and D due to the reduced length of tunnelling through areas comprising Yarra Delta sediments and Silurian bedrock and consequently reduced volumes of contaminated soil requiring removal, treatment and disposal.

3.4 Terrestrial Flora and Fauna

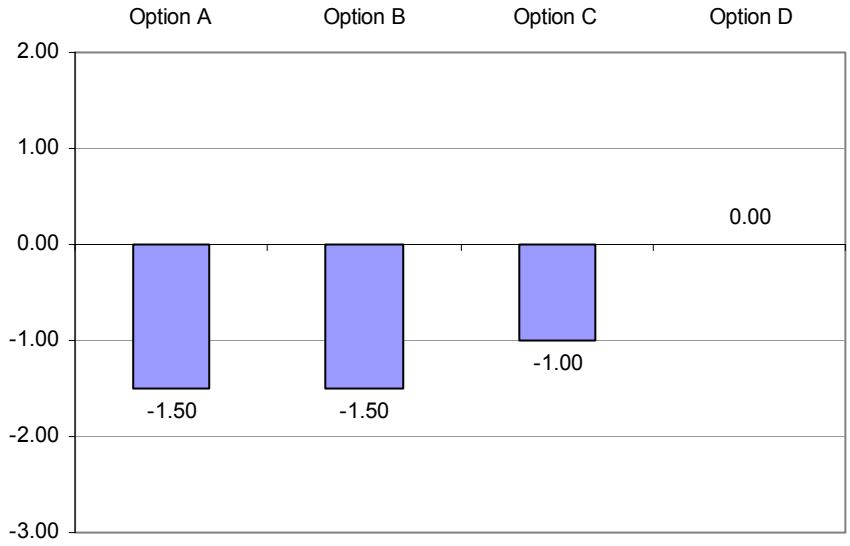
Although the study area is largely urbanised, a number of natural values remain, generally associated with existing parks, reserves and watercourses. Potential impacts from the construction of the options were assessed against the following three key criteria:

- Potential modification or removal of native vegetation;
- Potential modification to biosites; and
- Potential modification removal of threatened flora and fauna, their habitat or introduction of movement barriers.

Potential interactions were assessed through analysis of GIS information to determine areas of sensitivity within 250 m and 25m buffers around each transport option. These sensitivities were quantified where possible into areas (ha) of Ecological Vegetation Classes, Biosites, and number of recorded threatened flora and fauna. Potential interactions with sensitive locations identified should be capable of being avoided or minimised through refinements to the alignments and development of appropriate mitigation measures during the detailed design and environmental assessment process. Where impacts cannot be avoided, the quality / level of significance of the flora and fauna will be an important factor in determining the level of impact.

Ratings of the options with respect to potential flora and fauna interactions are summarised in Table 3-4 below.

- **Table 3-4 Flora and fauna assessment scores**



Options A and B record the highest negative score of the options, although in absolute terms, the score constitutes only a minor to moderately-negative rating. Contributing factors to the score include potential interactions with ecologically-sensitive sites at the Yarra River/Dights Falls environs (Options A and B East West road connection), Stony Creek Backwash (Option A East West road connection), Newells Paddock (Option B East West road connection), Braybrook Rail Reserve (CBD rail proposal) and Royal Park (particularly with Option C road network upgrade proposal).

The rapid appraisal does not include assessment of potential interactions associated with the Tarneit Rail proposal (common to all options), due to the preliminary nature of alignment details that were available at the time of the assessment. The current indicative alignment has the potential to result in impacts on native grasslands adjoining the Derrimut Grasslands and would require further investigation to identify an alignment that minimises or avoids potential impacts.

3.5 Cultural Heritage

Key criteria in assessing potential cultural heritage interactions with each of the options are:

- Potential interactions with known locations of Indigenous cultural heritage places, areas of cultural heritage sensitivity and areas of Aboriginal significance
- Potential interactions with known locations of non-indigenous sites/ places and heritage overlays

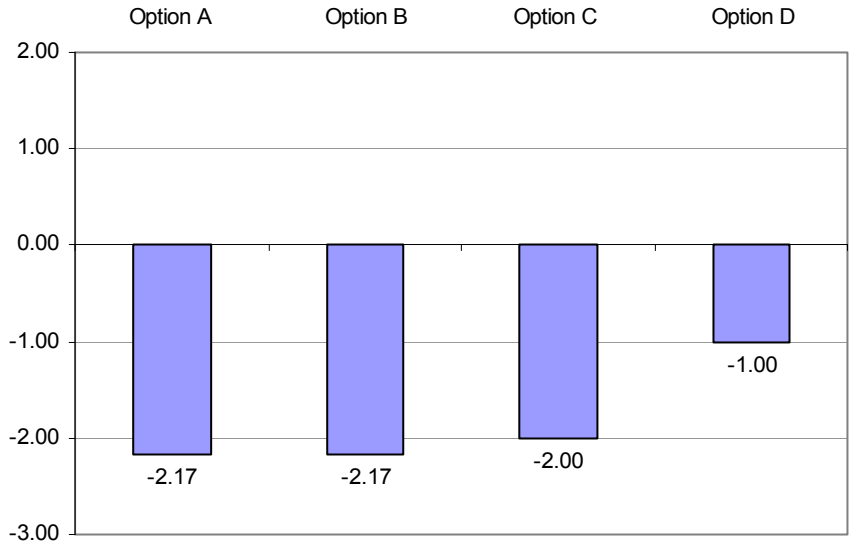
The study area comprises numerous Indigenous and non-Indigenous cultural heritage values. Preservation of these cultural heritage values requires careful consideration in the development of new East West transport infrastructure. Potential interactions between the transport options and cultural heritage sites and Places are generally focused on above ground portions of the option, such as entry and exit portals, and new surface roads and railways. However, impacts from the construction of tunnels such as subsidence and vibration will also need to be assessed, particularly with regard to heritage listed structures.

Some initiatives within the nominated options have the potential to disturb or destroy registered Aboriginal artefact scatters or Victorian Heritage Register sites, which are protected through legislation and should be considered as a significant constraint. In addition, impacts to the social, historical and visual significance of cultural heritage places and areas of cultural heritage significance are also a potentially significant issue and would require consultation with the local community and the Aboriginal community. Several initiatives have the potential to interact with areas subject to Heritage Overlay controls in local planning schemes. Impacts on these areas should be able to be ameliorated by conforming to the Heritage Overlay controls.

It should be noted that options that come within 200 m of the high water mark, within 200 m of a named waterway or within 50 m of any registered Aboriginal Cultural Heritage Place will require a Cultural Heritage Management Plan under the *Aboriginal Heritage Act* 2006 unless it can be proved there has been previous significant ground disturbance. In addition, if the project is subject to an Environment Effects Statement, a Cultural Heritage Management Plan will be required regardless of the alignment.

Ratings of the options with respect to potential cultural heritage interactions are identified in Table 3-5 below.

- **Table 3-5 Cultural Heritage ratings**



Options A, B and C record moderately-negative scores, while Option D is rated as minor negative with respect to cultural heritage.

Contributing factors to the score for Options A, B and C comprise potential interactions with culturally sensitive sites/Places in the Yarra River/ Dights Falls environs, Melbourne Cemetery, Melbourne University, Royal Park, Maribyrnong River environs, Stony Creek/Yarra River confluence, Moonee Ponds Creek, and , Deer Park areas.

Option D has fewer identified interactions due to the absence of road network development initiatives in the option. Identified indigenous heritage interactions are limited to potential disturbance to Aboriginal artefact scatters at Derrimut Road and Deer Park associated with the Tarneit Rail proposal. There are a number of potential non-Indigenous heritage interactions associated with the CBD rail proposal, including proposed stations near Melbourne University and Footscray Railway Station and the proposed bus interchange at Victoria Park.

It should be noted that the ratings for this preliminary appraisal have been made on the basis of known cultural heritage sensitivities in the vicinity of the proposed options. Further investigation and analysis would be undertaken during detailed planning to ensure that potential interactions on cultural heritage values are identified and the transport initiatives refined in order to avoid potential impacts.

3.6 Air Quality and Greenhouse Gas Emissions

3.6.1 Overview

This section provides an overview of the key results of the Phase 3 Assessment for air quality and greenhouse gas emissions. In this section the options have been compared with the 2031 Base Case, (i.e. 'do nothing'), and the 2031 Base Case has also been analysed relative to the present.

The Phase 3 options have been described in detail in Section 1. In summary: The Phase 3 transport corridor options for consideration, A, B, C and D, all include a Central Business District rail tunnel, the Doncaster Rapid Transport enhancement, and the Tarneit Rail proposal, plus combinations of:

- New roads (including new surface roads) and/or improvements to existing roads; e.g., by road widening; and
- Lengths of road tunnel.

3.6.2 Phase 3 Methodology

In this phase of the assessment, with new and more detailed traffic modelling and alignment data being made available for the Options *A-D*, more emphasis has been placed on potential changes to air quality at the local level. Such changes are expected to be caused by changes in traffic flows through residential areas and potential new emissions from road-tunnel stacks. These potential local air quality effects have been given the greatest weight in the assessment.

In Phase 2 of the assessment, air emissions from road tunnel stacks were assumed to be 100% controlled by good stack design leading to good dispersion of air pollutants. However in Phase 3 we have taken a more conservative approach by identifying the possibility of some air quality effects from stack emissions. The effects from stacks will be investigated in detail during the detail design process and design measures identified to avoid or mitigate potential impacts. Some of the design factors to be taken into consideration would include: stack geometries and ventilation systems, and the geography of the surrounding terrain including locations of sensitive receptors. Manins (2007)[1] provides a review of current air quality issues associated with road tunnel stack emissions in Australia.

Veitch Lister Consulting (VLC) provided traffic modelling results including projected fuel use and air emissions for the Base Case for 2006 and 2031, and the options under consideration for 2031. The analysis provided here was based on these model data.

3.6.3 Analysis of road network air emissions: 2031 Base Case versus 2006

First, to provide context to this assessment, relative changes in the key air quality and greenhouse gas emission parameters for the modelled Base Case only, (2031 *versus* 2006), are illustrated in Figure 3-1. Acronyms and molecular formulae used in the figure are listed below:

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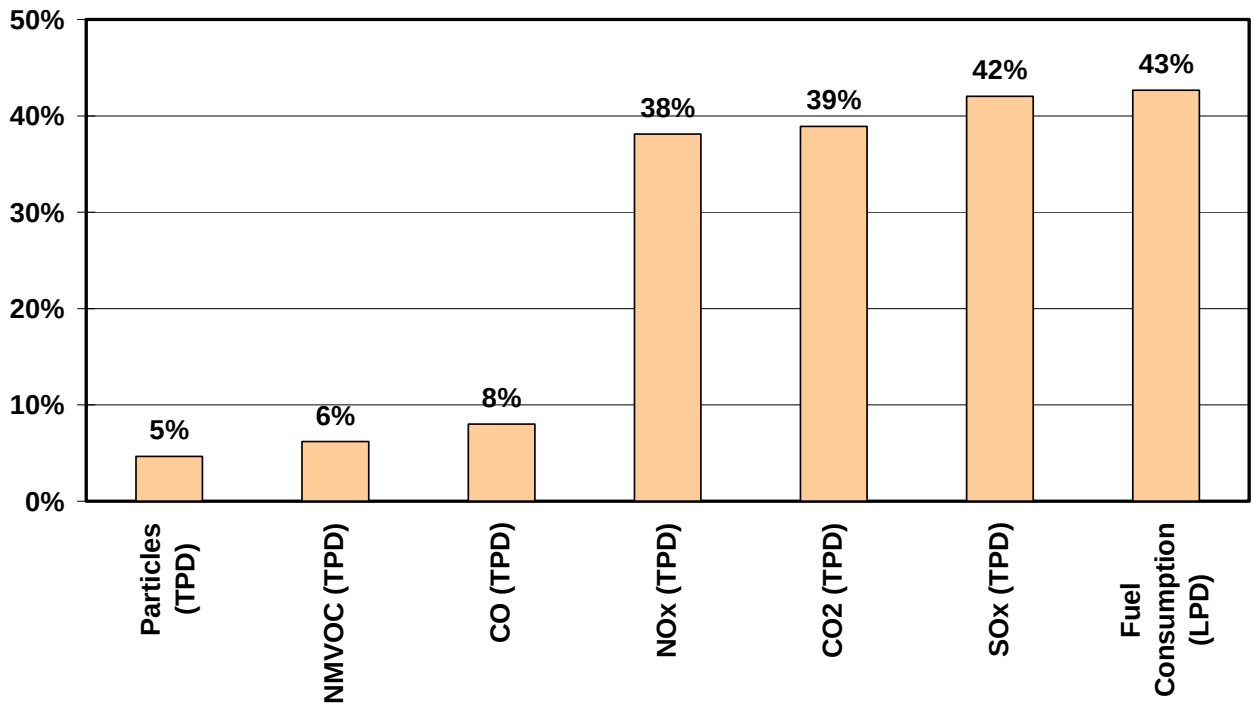
[1] Manins, P. C. (2007), *Air quality as a technical and political issue for Sydney's major tunnels*. 14th IUAPPA World Congress, Clean air partnerships: coming together for clean air: Brisbane 2007: conference proceedings, incorporating the 18th CASANZ Conference hosted by the Clean Air Society of Australia and New Zealand.

- Acronyms: TPD= Tonnes Per Day; LPD = Litres Per Day; NMVOC = Non-Methane Volatile Organic Compounds.
- Molecular formulae: CO = carbon monoxide; NO_x = oxides of nitrogen; CO_2 = carbon dioxide; and SO_x = oxides of sulphur.

- **Figure 3-1: Base Case air emissions and fuel usage: 2031 totals as a percentage of 2006 totals**



These model results are heavily dependent on the predicted 40% increase in vehicle kilometres of travel and 43% increase in fuel usage predicted for the 2031 Base Case (relative to 2006). Improvements to air emissions control technology assumed in the transport model are expected to lead to only relatively small increases in emissions of CO, Volatile Organic Compounds (VOCs) and particulate matter. However, there are marked increases predicted for CO_2 (the primary greenhouse gas), NO_x (which is a higher risk air pollutant in road air emissions) and SO_x. It is emphasised that the transport model has not incorporated other anticipated improvements in vehicle fuel and emission efficiencies.

In summary, the modelling anticipates large increases in two key areas of potential environmental impacts for the 2031 Base Case; i.e., approximately 40% increase in:

- Emissions of some key air pollutants (NO_X, SO_X); and
- Greenhouse gas emissions (CO_2).

The projected increases in total air emission amounts, such as for NO_X, would have a detrimental effect on Melbourne's airshed. If the modelled emissions did eventuate, photochemical smog would be expected to worsen, with an adverse outcome for Melbourne's future air quality environment.

The predicted increase in Greenhouse gas emissions for the 2031 Base Case needs to be considered in the context of current and emerging climate change policy initiatives. Extrapolation of the greenhouse gas projections for the 2031 Base Case, the modelling conducted for this project provides the following estimates for increases in the traffic network's greenhouse gas emissions, relative to 2000:

- Approximately 80% increase in greenhouse gas emissions by 2050; or,
- Approximately 50% increase for 2050 if emissions are held constant from the 2031 figure.

Considering that the Victorian target for overall Greenhouse gas emissions is a 60% reduction by 2050 from 2000, these projected increases in Melbourne transport emissions warrant further consideration by decision-makers.

The modelled greenhouse gas emissions for the options indicate very similar outcomes to the Base Case. As such, all the options have been scored '0' for Greenhouse gas emissions; i.e., no significant change from the Base Case. Greenhouse gas emissions are considered further in the context of broader sustainability objectives in Section 3.8.

3.6.4 Option comparisons versus the 2031 Base Case

The following paragraphs describe the assessment methodology and key results. The qualitative assessment was undertaken by comparing the options versus the Base Case using the following set of criteria: (1) Potential air quality impact on the Melbourne Airshed; (2) Potential air quality effects at the local level, incorporating predicted increases and decreases in traffic flows along specific alignments; and (3) Potential air quality effects from road tunnel stack emissions. These criteria are explained in the following paragraphs.

Air quality impacts on Melbourne Airshed

- A higher risk air pollutant, NO_x, has been selected to assess potential air quality impacts in the Airshed. NO_X contributes to the formation of photochemical smog and is harmful to human health; *e.g.*, refer to EPA Victoria[2]. As such the traffic modelling predictions for the total network's NO_x emissions have been selected to be representative of air quality impacts on the Airshed.

However, note that in the final analysis the raw scores for this criterion have been set to zero, because the traffic modelling results indicate very similar outcomes for the total NO_x emissions from the traffic network (for each Option versus the Base Case).

Air quality effects at the local level

- Increases in traffic flows due to a new or upgraded road may be felt at the local level in two ways:

[2] EPA Victoria, (i) *Ambient Air Pollution and Daily Hospital Admissions in Melbourne 1994 – 1997*, Publication 789, November 2001; and (ii) *Melbourne Mortality Study, Effects of Ambient Air Pollution on Daily Mortality in Melbourne 1991 – 1996.*

- Effects on human health (with health studies confirming increased levels of air pollutants from road vehicle emissions, such as carbon monoxide, oxides of nitrogen and particulate matter) in situations where air pollutant concentrations approach or exceed ambient air quality standards; and
- Effects on amenity such as visible haze and pollution being smelt and felt in the throat and lungs.

Decreased traffic flows of course may improve local air quality and predicted decreases have been taken into account in this assessment.

The raw scores for this criterion are based on an analysis of VLC modelling results for morning peak traffic flows for Options A-D versus the Base Case (year 2031). A basis of the assessment is that changes to high volume, intense (morning peak) traffic flows will have the greatest potential to affect local (near-road) air quality. The predicted effects are potential air quality impacts associated with increased emissions due to increased traffic flows and conversely potentially improved air quality associated with reduced traffic flows. Detailed descriptions of the scoring method and results are provided in Appendix A.6.

The raw score results for this criterion, (local air quality), are:

- Option A = **- 0.2**;
- Option B = **+ 0.1**;
- Option C = **- 0.1**;
- Option D = + **0.4**.

The main contributing factors to Option D having a higher positive rating than Options B or C are:

- Significantly increased traffic flows on the Western Ring Road for Options A and B;
- Reduced traffic flows on the West Gate Freeway for Options B, C and D, but not Option A; and
- Increased traffic flows on Geelong Road (Option B), Ballarat Road (Option A) and Princes Street (Option C).

Although Options A and B would be anticipated to result in substantial reductions in 24 hour traffic volumes on some roads, the transport modelling results for the arterial road network during the morning peak hour period do not reflect this, with the options assessed accordingly. Any air quality benefits resulting from traffic diverting from sub arterial or local roads to the arterial road network are not accounted for in this assessment.

Note that these scores all indicate a minimal level of impact, compared with the Base Case.

Potential air quality impacts from road tunnel stack emissions

This criterion provides a qualitative assessment of potential air quality impacts from road tunnel stack emissions under worst-case emission and meteorological conditions (consistent with what would be required during detailed environmental investigations). It is noted that any air quality impacts that occur would not necessarily occur near the stacks – experience with air dispersion modelling indicates that impacts from stacks may be felt several hundred metres or even several kilometres from the source. To avoid or minimise the risk of plume strikes from stacks, parameters considered during

detailed road tunnel design would include siting of stacks optimally located in the surrounding terrain with respect to sensitive receptor locations; the height of stacks; and the speed of exhaust emissions.

The raw scores for this criterion are based on estimated road tunnel lengths. Simply, a longer road tunnel has been interpreted to lead to increased stack emissions. The raw score for the option with the longest road tunnel (Option B) is judged to be '-2' (i.e., moderate negative impact compared with Base Case). This score is then used to scale the scores of the other options according to their approximate road tunnel lengths. The raw score results for the stack road tunnel criterion are listed below. Note that while the scores for Options A, B and C vary between minimal and moderate, they have yet to be weighted for final assessment:

- Option A = - 1.5;
- Option B = - 2;
- Option C = - 1;
- Option D = 0.

Summary and final assessment

The assessment methodology for Phase 3 is considered to be improved by giving more weight to assessing effects on air quality along specific alignments, and also, by accounting for road tunnel stack emissions.

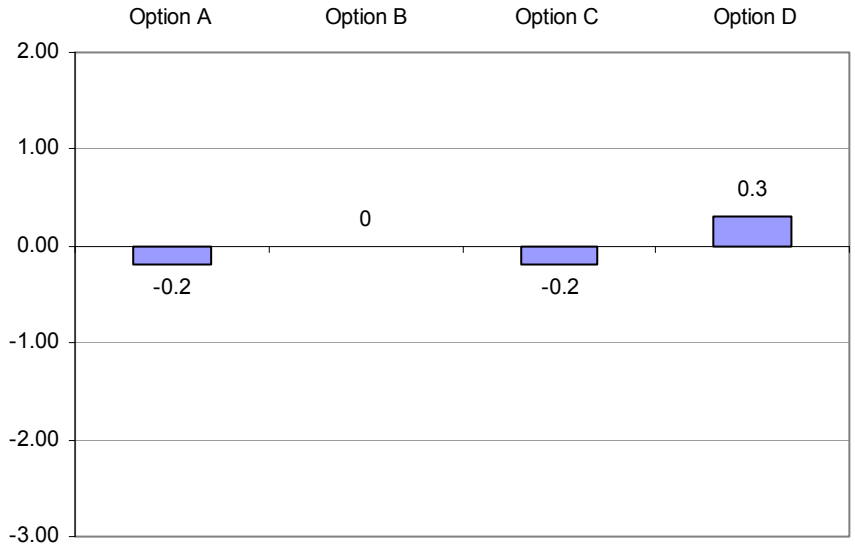
In the final assessment (Options *vs*. the 2031 Base Case), the VLC modelling results indicate similar outcomes for all the options. A summary of the final scores is provided in Table X, derived with weightings of 95% for effects on local (near-road) air quality effects and 5% for effects from road tunnel emissions.

These results indicate that there is not much to distinguish the options with respect to air quality, with all options having a minimal effect.

The calculations for producing these final scores are set out in more detail in Appendix A.6. The confidence scores in the Appraisal Tables are: rated as medium for distinguishing between the options (e.g. Option A *vs*. Option D).

Note that the assessment of air quality effects on the Melbourne Airshed is effectively deleted from the final analysis because the option scores are similar to the Base Case. The assessment of risks from stack emissions is given a small weighting with the assumption that tunnel and stack design would lead to good air emissions control, thereby minimising, (or completely eliminating), air quality impacts. As such the final results provided below are determined primarily by the assessment of potential effects on local (near-road) air quality.

- **Table 3-6 Air Quality ratings**



3.7 Noise

3.7.1 Overview

Potential noise impacts from the operation of each of the nominated Options were assessed against the following key guidelines:

- Compliance with proposed noise criteria;
- Changes in noise exposure on sensitive receivers such as residences, schools, parklands, motels, hospitals and community buildings;
- Potential enhancement of acoustic environment due to reduction in traffic; and
- Reduction in traffic volumes on local streets.

Another important factor to consider is the impact from construction noise. For some Options, construction noise will probably extend over a few years in some locations, and will result in on-going annoyance within the local community.

The first part of the appraisal is to look at the Options based on an objective assessment, identifying issues associated with each of the Options meeting the adopted noise criteria and considering the broader impacts within adjacent areas affected by the traffic changes due to the operation of the Option. Secondly, the appraisal will consider the subjective perceptions associated with traffic changes predicted for each of the Options.

With all the noise assessments there were a number of guiding principles that were used in determining the rating given to an Option. These are discussed below.

3.7.2 Assessment guidelines

Noise Criteria

Rail noise and road traffic noise criteria were developed and agreed to in Phase 1 of this Project.

For road traffic noise the following assessment criteria are proposed:

Noise Criteria	New Freeways and arterial roads and upgraded existing roads	
Existing noise levels	≤ 61 dB(A) $L_{10(18\ hour)}$	> 61 dB(A) $L_{10(18\ hour)}$
Criteria	63 dB(A) $L_{10(18\ hour)}$	Limit increase to 2 dB(A) $L_{10(18\ hour)}$

Consideration should also be given to limiting the increase of noise levels to 12 dB(A), where the existing noise level is less than 50 dB(A) $L_{10\ (18\ hour)}$.

For railway noise the following assessment criteria are proposed:

Noise descriptor	Proposed levels, dB(A)
$L_{eq,\ 24\ hr}$	65
L_{max}	85

For road traffic noise impacts, the noise criteria form part of the assessment, whilst traffic volume changes and the associated community response also assist in the appraisal. As seen in the Phase 1 discussion document, a halving or doubling in traffic volume will result in a change of 3 dB(A) in the traffic noise levels. A change of 3 dB(A) in road traffic noise levels is not perceptible. In other words, significant traffic volume changes will only cause a small increase or decrease in traffic noise levels, which may not be perceptible within the community.

There is a well developed relationship between the road and rail traffic noise and community annoyance. In the Issues report it was demonstrated that large traffic volume changes resulting in small noise level changes will result in small changes in the percentage of the local community highly annoyed by the noise. For example a 30% decrease in traffic volume results in a 1 dB(A) decrease in noise levels with a potential 1.3% reduction in community annoyance.

Where there is a high heavy vehicle content in the traffic volume, then the community annoyance will be a reaction to the number of heavy vehicles. For example, the community in Francis St Yarraville have successfully gained a truck curfew for the street, as a result of high numbers of trucks in the area at nighttimes. Whilst, the relationship between annoyance and the number of heavy vehicles is not discussed, the issue of heavy vehicles in Yarraville is well recognised.

Objective Assessment

- In most circumstances the construction of a new surface road will result in a significant increase in the noise levels above the existing background levels. Whilst major changes in an existing road that leads to a significant change in traffic volumes (both decrease and increase) will only have a small effect on the existing noise levels, refer to the first dot point above.
- Noise is propagated beyond the physical boundaries of new works. Where a new section of road is constructed and generates significant levels of noise, then there is the potential for new or increased noise impacts. For example the removal of buildings for a tunnel ramp or portal will potentially expose previously protected residences to changed levels of traffic noise.
- The application of the noise criteria is based on protecting noise sensitive buildings so that the buildings may continue to be used for their designed purpose.
- Limiting increases in noise levels only apply when the resultant noise level reaches the noise criteria tabulated above. In the current VicRoads Traffic Noise Reduction Policy, consideration is given to limiting the increase of noise levels to 12 dB(A), where the existing noise level is less than 50 dB(A) $L_{10\ (18\ hour)}$.
- The assessment is to compare the Options against the "base case" for the year 2031. The assessment is primarily based on the noise level changes associated with the Options.
- For areas where there is a moderate to high level of traffic noise, the assessment was limited to the impacts at buildings adjacent to the proposed Option. As the potential changes are relatively small in these areas, the changes in noise levels at buildings further away from the Options will be relatively small, due to the shielding offered by the buildings adjacent to the road.
- For areas where there are no existing roads and the noise levels are low, the assessment considered the impacts to properties adjacent to the Option as well as further away from the Option. The zone of interest will be a minimum of 100 metres either side of the road.
- For areas where the traffic volumes are predicted to decrease, the assessment of the impact changes was limited to the buildings adjacent to the affected roads.
- The current development adjacent to the Options was used in the year 2031. For some areas, it is difficult to predict the land usage adjacent the Options for the year 2031. In other areas, for example Dynon Rd area, it was reasonable to assume that the principal activity will remain the same for the foreseeable future.
- Rail noise is sensitive to the peak noise of each train pass by and the duration of the pass by. Significant increases in the number of trains movements will significantly increase the daily noise levels as well as the increase the number of individual noise events. There will be a community reaction to these two outcomes.

Subjective Assessment

- Community reaction to new noise sources is generally greater than the community reaction to an increase in existing noise levels.
- The perceived noise impacts associated with changed traffic volumes is an important factor to consider in the noise assessment. Importantly, the community reaction (perceived impacts) to an increase in traffic volumes is greater compared to the community reaction (perceived benefits) to an equivalent decrease in traffic volume. The appraisal considers this potential effect.

3.7.1 Options summary

The following sections summarize the assumptions and conclusions for each Option, which are detailed in Table A.7 of Appendix A.

3.7.1.1 Option A

Public Transport: Three Public Transport initiatives are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail.

There will be a small increase in the daily exposure ($L_{eq, 24\ hr}$) to rail noise in the existing Werribee and Dandenong rail corridors. There will be a significant increase in the number of rail noise events (L_{max}) in these corridors.

The Doncaster Rapid Transport will generate a small increase in the total traffic noise levels, even though there will be a significant number of buses using the routes. The increase in bus trips will be insignificant when compared to the daily traffic volume using the Eastern Freeway.

The Tarneit Rail Option will generate increases in rail noise in the Werribee and Deer Park corridors as well as new rail noise in the corridor between Werribee and Deer Park, where there are few noise sensitive buildings.

The total rail noise impacts were determined to be minor and rated at -0.08.

Road: New East-West Road Option – from Eastern terminal at Eastern Freeway and Hoddle St to Western terminal at the Westgate Freeway, Laverton. Major interchanges at Western Link at Parkville, Dynon Rd at Footscray and West Gate Freeway at Williamstown Rd.

A significant proportion of the Option is in tunnel through areas with noise sensitive buildings not impacted. However, at the tunnel portals there will be buildings exposed to increases in noise levels due the removal of buildings for the new road alignments. For example in Alexandra Pde, Clifton Hill there will be portals and ramps linking the tunnel to Queens Pde. The changed noise levels are likely to trigger the criteria near the portals and noise sensitive buildings will require protection.

There will be other areas where small pockets of residential areas will be exposed to new sources of traffic noise, for example a small residential area in Hyde St, Yarraville, will be exposed to the proposed elevated structure. Existing road upgrades, for example Ballarat Rd, West Gate Freeway and Paramount Rd/Ashley St will potentially expose residences to increases in noise levels. The criteria in noisy areas, (which are > 61 dB(A)) is to limit the increase to 2 dB(A) above the existing level. The noise assessment rated new sources of road traffic noise at -2.5 and increases in traffic noise on an existing road at -1.5. For the road component of this Option, approximately 750 residences may be exposed to noise levels that could trigger the noise criteria.

Traffic modelling indicates that there are substantial areas where there will be a decrease in traffic volumes. The model indicates wide spread small reductions in traffic in the inner north eastern suburbs (Northcote, Thornbury) whilst there are significant traffic reductions on major roads in the east

(Johnston St and MacArthur Rd) and in the western suburbs (eg, Geelong Rd, Williamstown Rd and Francis St, Yarraville). It is also likely that many local roads will benefit from traffic diverting to the newly linked freeway network created by Option A, as well as reduced freight traffic on roads within Yarraville.

The total road noise impacts were determined to rated at -0.49.

Option A rates -0.66 overall, including construction noise.

3.7.1.2 Option B

Public Transport: Three Public Transport routes are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail. Same as Option A.

This Option is the same as Option A, and has a rating of -0.08.

Road: Full New East-West Option - Eastern terminal at Eastern Freeway and Hoddle St, Western terminal at Western Ring Road at Sunshine West. Major interchanges at City Link at Parkville and Dynon Rd at Footscray.

This Option has a similar tunnel configuration to Option A. A significant proportion of the Option is in tunnel through areas with noise sensitive buildings not impacted. However, at the tunnel ramps and portals there will be buildings exposed to increases in noise levels due the removal of buildings for the new road alignments. This changed noise exposure may trigger the criteria and require protection. Option B is very similar to Option A for the sections between the Maribyrnong River and the Eastern Freeway, and the noise exposure is assumed to be the same.

Option B impacts on residential areas north of Sunshine Rd, Sunshine (south of Rupert St), north of the west end of Sunshine Rd and west of Fairbairn Rd, Sunshine West. This area is nearly fully developed with residential and industrial buildings. The current and future (year 2031 base case) noise levels in these areas will be relatively low, even though there are localised sources such as vehicle movements through the industrial and residential streets. A new link road in this area will add a relatively constant new source of noise with the main impact at night-time when other activities in the area are reduced. The impacts are regarded as new noise and significant increases in the noise levels.

Option B does not include the upgrade of Ballarat Rd. However Option B includes a connection of Hyde St to the West Gate Freeway and the upgrade of Paramount Rd and Ashley St (as for Option A).

The noise assessment rated new sources of road traffic noise at -2.5 and increases in traffic noise on an existing road at -1.5. For the road component of this Option, approximately 685 residences may be exposed to noise levels that could trigger the noise criteria. The number of residence are similar to the number in Option A. Notwithstanding the exposure to changed noise levels, amelioration of these impacts would be undertaken.

Traffic volume modelling indicates that there are substantial areas that will have a decrease in traffic movements. The model indicates widespread small reductions in traffic in the inner north eastern suburbs (Northcote and Thornbury) whilst there are significant traffic reductions on major roads in the east (Johnston St and MacArthur Rd) and in the western suburbs (eg, Geelong Rd, and Francis St,

Yarraville). It is also likely that many local roads will benefit from traffic diverting to the newly linked freeway network created by Option B, as well as reduced freight traffic on roads within Yarraville. The total road noise impacts were determined to rated at -0.53.

Option B rates -0.70 overall, including construction noise.

3.7.1.3 Option C

Public Transport: Three Public Transport routes are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail. Same as Options A and B.

The public transport components of this Option are the same as Option A, and has a rating of -0.08.

Road: Upgrade of the existing road system from Eastern Fwy to Smithfield Rd, comprising widening of Alexandra Pde, Cemetery Rd to Royal Park; Tunnel from Royal Park to Smithfield Rd;

Freight connectivity networking, comprising, upgrading Ashley St / Paramount Rd, connection of Ashley St to West Gate Fwy via Cemetery Rd upgrade, connection from Hyde St to West Gate Fwy and connection from Dynon Rd to Smithfield Rd.

This Option has a limited section of road tunnel compared to Options A and B. The tunnel section between CityLink and Smithfield Road, along the alignment of Racecourse Rd, will have minimum noise impacts at the portals.

At the eastern end of the option, Princess St, Carlton, Cemetery Rd East and West, College Crescent, MacArthur Rd and Elliot Ave., will be widened. The widening of Princes St Carlton will expose previously protected buildings to increases in noise levels, whilst the widening of other roads will not require the removal of buildings. Overall the existing noise levels in the area will increase slightly.

Other road widenings include Ballarat Rd and Paramount Rd/Ashley St. The road widenings may involve the removal of a row of buildings to accommodate the extra lanes. There are new connections from Cemetery Rd and Hyde St to the West Gate Freeway which should not impact noise sensitive buildings.

For the road component of this Option, approximately 595 residences may be exposed to noise levels that could trigger the noise criteria. There will be areas where there is a permitted increase in noise levels, given that for areas where the Base case (2031) noise levels will be > 61 dB(A), the criteria allowance is for an increase of 2 dB(A) before amelioration actions are undertaken. Notwithstanding the exposure to changed noise levels, amelioration of these impacts would be undertaken.

Option C provides less opportunity for traffic reductions in the inner north east and inner west compared with both Options A and B, due to the absence of major new road infrastructure. However, benefits will be felt in roads such as Johnston St, Racecourse Rd, and Francis St. Consistent with all the options, Option C features initiatives to relieve truck traffic conditions in the Yarraville area.

For Option C, the upgrading of existing roads is the main contributor, based on road length and residential impacts. This compares with Options A and B, where new sources of road traffic noise are significant in some areas. The total road noise impacts were determined to rated at -0.3.

The overall rating for Option C is -0.67, including construction noise.

3.7.1.4 Option D

Public Transport: Three Public Transport routes are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail. Same as Option A.

This public transport component of this Option is the same as for Options A, B and C and has a rating of -0.08.

Road: There are no road upgrade initiatives in this Option.

The guiding principle is that all the Options are being considered against the Base Case for the year 2031. The base case will have a rating of zero and other Options will be rated against this. While the base case in 2031 has significant traffic management issues, widespread traffic congestion on a significant amount of the arterial road network within Melbourne is the basis against which the Options are assessed.

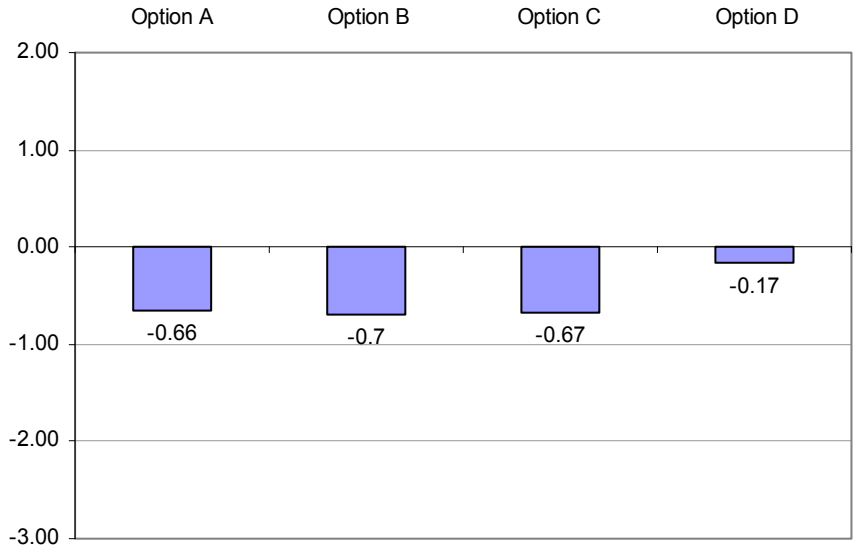
The noise impacts of the degree of congestion cannot be assessed. For example the degree of stop-start traffic flow cannot be assessed from a noise perspective because of the individuality of the vehicle noise in the stop-start traffic flow. Congestion also creates quiet periods, as vehicles are not moving. Severe congestion on road corridors may lead to lengthy and significantly quieter periods during a day that may reduce the overall daily noise levels.

Relieving traffic congestion by diverting travel to another route or mode may only reduce the degree and duration of congestion (stop-start traffic flow). There is no indication in the information given as to the degree of congestion reduction for this Option. Consequently the effect of congestion on traffic noise levels is not assessable in this study.

Diverting some road travel onto the public transport system will reduce the amount of road traffic which in turn will decrease traffic noise levels in parts of the network. However, traffic noise is relatively insensitive to minor changes in traffic volumes, (10% decrease in traffic volume will decrease noise level by 0.3 dB(A)). The assessment of the road component for this Option is not considered significant from a traffic noise perspective.

Potential interactions of each of the Options with respect to noise are summarised in Table 3-7 below.

- **Table 3-7 Noise ratings**



Note, the ratings in Table 3.8 above, account for the increased noise in the Base Case due to increases in traffic volumes in the study area for the year 2031.

Summary

All Options would generate noise impacts from the proposed public transport initiatives, particularly on the surface section of the CBD Rail proposal on the Dandenong line (including locations where the rail corridor would require widening) and the Tarneit Rail proposal where there are increased rail noise beside the Werribee and Deer Park lines, and the area between these lines.

The East West Road Link components of Options A and B would result in increased noise from traffic associated with their surface road elements, including Ballarat Road, West Sunshine, West Footscray and a small area of Yarraville. The noise level changes would be small to significant. Noise benefits would result from diversion of traffic from existing arterial roads and reduced use of local roads in Collingwood, Carlton, Fitzroy, Parkville and Yarraville, but network-wide noise levels are likely to remain high with changes to traffic patterns associated with the introduction of major new road infrastructure.

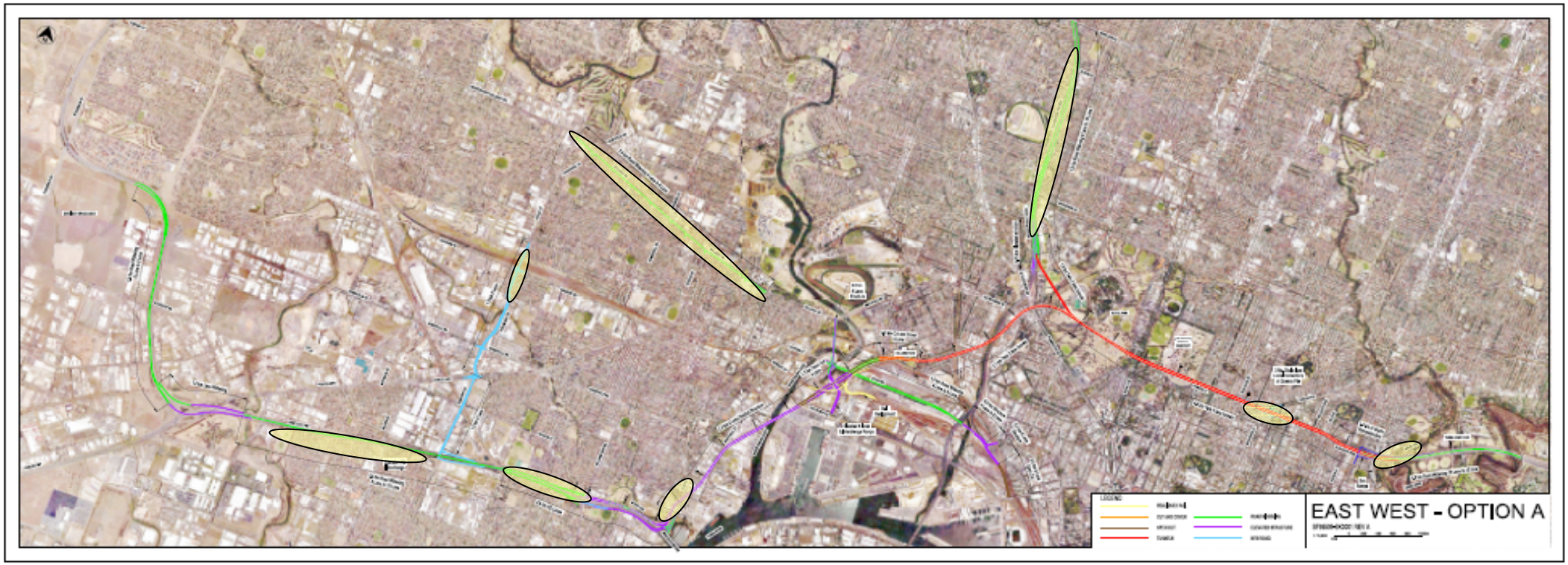
For Options C and D, 2031 Base Case traffic noise levels would remain in many locations in the inner east and inner west. However, consistent with all other options, noise level benefits are expected to be significant in Yarraville due to the targeted freight traffic reductions. The road upgrade elements of Option C will increase noise impacts on existing heavily trafficked arterial roads in Carlton (eg Alexandra Parade, College Crescent) and Parkville (eg Macarthur Road). The enhanced capacity and reduced congestion on these roads should result in some reduction in traffic on local roads in these suburbs, although not to the same extent as Options A and B, due to the absence of major new road infrastructure.

Construction noise impacts are likely to be significant for all Options. Construction noise regulations/guidelines recognise the relative short-term activity and recommend/impose restrictions on

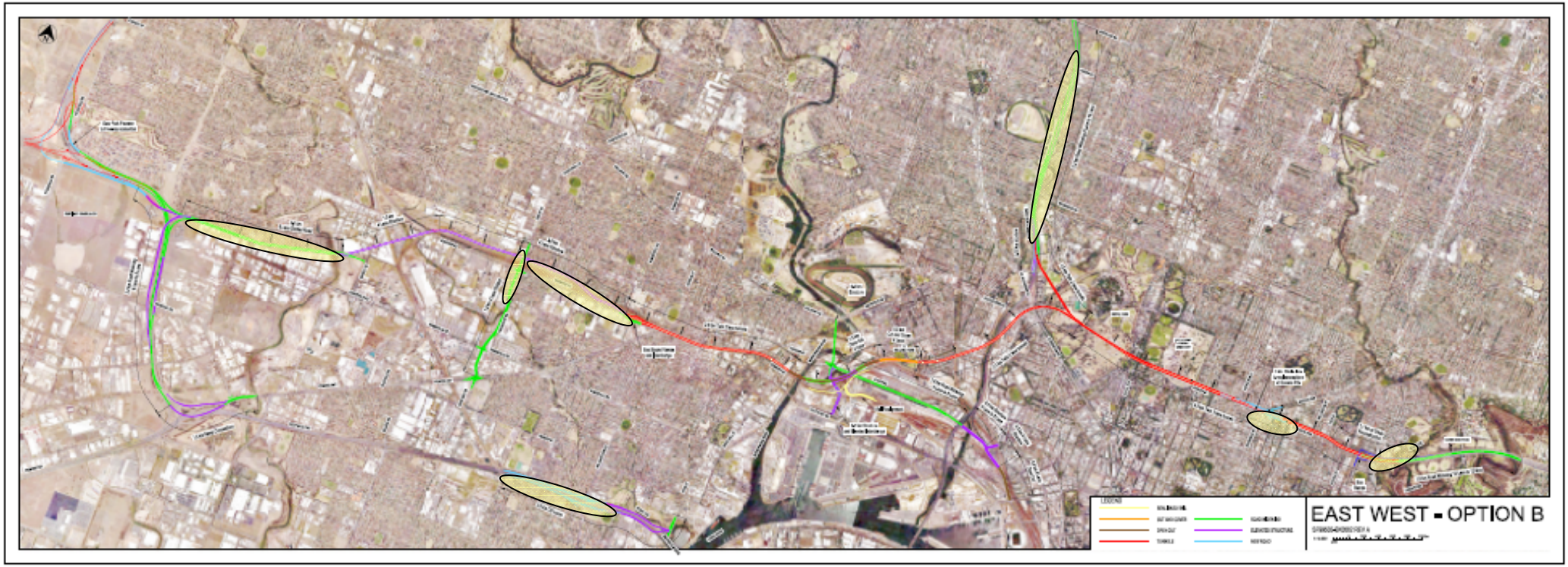
the hours of construction, with no limits on the noise levels during the hours 7am to 10 pm until the activity has been underway for more than 18 months. While construction activities are likely to extend over 18 months, it is unlikely that construction would be ongoing for an extended period (3+ years) in any area.

Overall, Option D performs best for noise, relative to the base case, mainly due to the absence of significant new road infrastructure. However, the noise impacts of each of the options are all rated as minor.

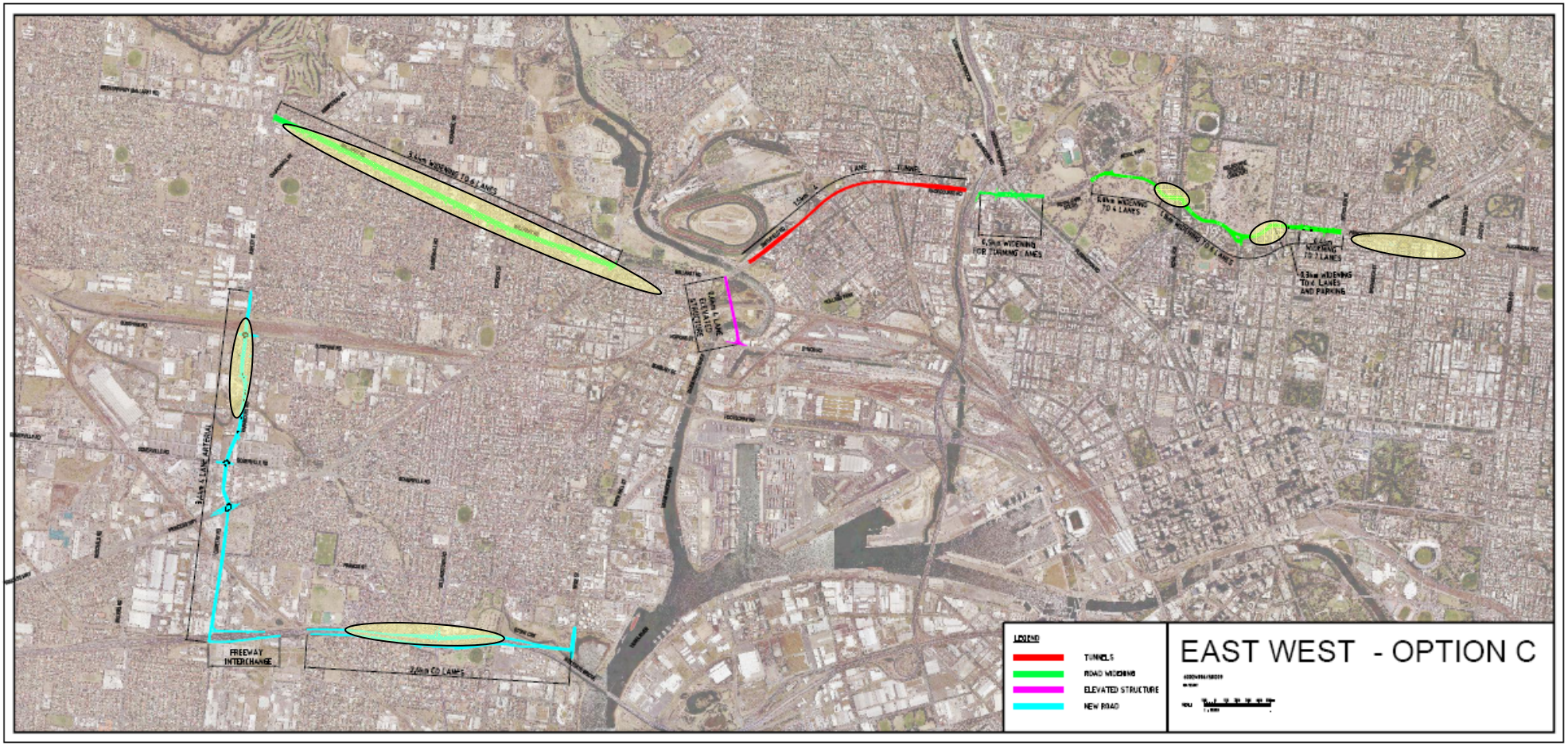
- **Figure 3-2 Option A (Approximate noise impact assessment areas)**



- **Figure 3-3 Option B (Approximate noise impact assessment areas)**



- **Figure 3-4 Option C (Approximate noise impact assessment areas)**



3.8 Environmental Sustainability

3.8.1 Introduction

The preceding assessments have assessed the four nominated transport options against the relevant goals, objectives and criteria of the Environmental Sustainability assessment framework provided in Table 2.1. These assessments focus on the impacts of the proposed transport options on the health and stability of the environment and ecosystem services within the study area, including opportunities to enhance or connect existing areas of natural ecosystems/assets.

The Environmental Sustainability assessment framework also includes the broader goal of '*Contribute to the target of containing climate change impacts and promoting sustainable transport*'and its accompanying objectives of '*efficient use of resource's* and '*reduce energy used and greenhouse gas emissions'*. Criteria for assessing the consistency of the transport options with these goals and objectives, drawn from a review of Government policy initiatives and sustainability transport literature (refer Sections 2.4 and 2.6 of the Issues report) are:

- Enhanced transport system efficiency – relevant factors are the extent to which the option contributes to improved connectivity (road, public transport, cycling and pedestrians) and reduced congestion/stop-start conditions
- Encouragement of mode shift to public transport, walking and cycling – relevant factors are the opportunities provided by the option to improve transport choice by increasing the quality of public transport, cycling and walking facilities and the service they offer
- Consistency with travel demand management initiatives – the extent to which the option is complementary to existing and proposed travel demand management programs.

Consistency with the above criteria would be expected to result in reduced consumption of fossil fuels and reduced greenhouse gas emissions from transport over the affected area.

The Environment and Heritage Issues report (refer Section 2.4) identified the above criteria as key characteristics of sustainable transport, together with the following non-option specific criteria:

- Improving the efficiency of car use by using more fuel efficient vehicles
- Using cleaner fuels and technologies
- Managing travel demand (through improved telecommunications technology, public education etc).

This section analyses the extent to which each of the options is consistent with the first set of criteria for sustainable transport, compared with the 2031 Base Case. Preceding that, to provide the relevant context for the options assessment, the 2031 Base Case is analysed from a sustainable transport perspective. This analysis also identifies those initiatives that hold most potential to move the Base Case to a position more consistent with principles of environmental sustainability.

It is important to recognise that this study, the East West Needs Assessment, is investigating matters relevant to the need for, and feasibility of, a possible additional east-west transport link in one area of Melbourne. It is therefore influenced by existing and likely future transport policy over the entire Melbourne metropolitan area. However, the study findings could also impact on future transport policy and programs.

It should be noted that, under the arrangements for this study, the overall Sustainability Assessment of the options will incorporate other relevant economic and social assessments (being undertaken by others). Therefore, potential social and economic impacts (including social impacts associated with the road widenings proposed for Option C) have not been incorporated into the derived ratings. Assessments being undertaken by the social and economics teams will incorporate these considerations into their assessments.

3.8.2 The 2031 Base Case

The 2031 Base Case comprises the existing transport system and committed transport projects (as detailed in MOTC), set in the context of land use, employment and economic forecast patterns that have previously been developed by government agencies reflecting current Government policy positions. The Base Case also makes 'steady as she goes' assumptions regarding travel behaviour, vehicle efficiency, technology enhancement etc.

The Base Case does not consider the effect that such factors as peak oil, emissions trading and heightened community awareness of the threat posed by climate change may have on changes to travel behaviour, travel demand management and accelerated introduction of substantially more efficient vehicles. These changes will be considered in alternative scenarios currently under investigation by the study team.

Under the Base Case assumptions noted above, transport-related greenhouse gas emissions in Melbourne are predicted to increase by 39% between 2005 and 2031.This predicted increase is of a similar order (refer to Phase 1 report) with AGO projections which estimate the growth of greenhouse gas emissions from transport in Australia from 1999 to 2020 will be 60.5% (AGO, 2006b). It is predicted that by 2020, cars will contribute around 50% of transport greenhouse emissions, with increasing contributions from road freight vehicles and air transport. This scale of greenhouse gas emission increases are predicted to occur in many developed and developing countries, as examined in the '*Mobility 2030: Meeting the challenges to sustainability' report (World Business Council for Sustainable Development, 2004).*

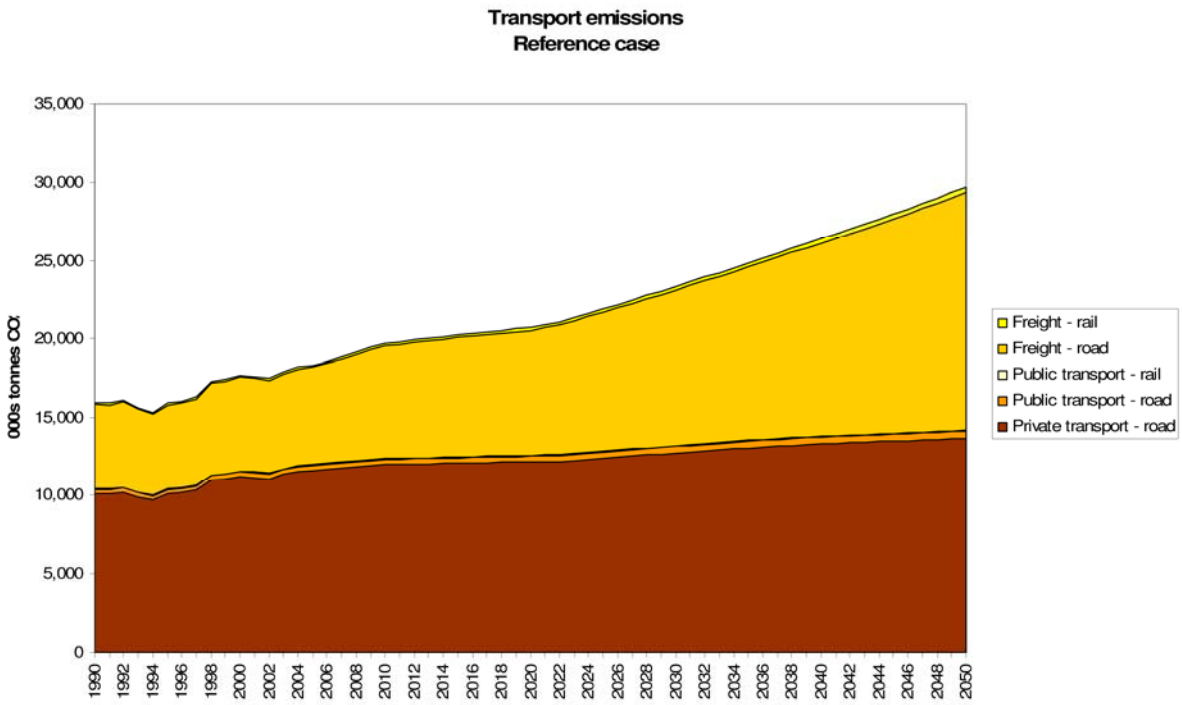
The inconsistency between projected transport-related greenhouse gas emissions and emerging National and State greenhouse gas reduction targets (eg the Victorian (and now Australian) greenhouse gas reduction target of 60% reduction from 2000 to 2050) has been apparent for some time and is the subject of detailed study, not only in Victoria and Australia, but worldwide.

For example, the World Business Council for Sustainable Development initiated the Sustainable Mobility Project (SMP) in 2000 (Issues report). The study concluded that the present system of mobility is not sustainable, and that current trends indicate a worsening of the situation. The report identified seven goals that, if implemented, would improve the prospects for sustainable mobility, including:

- Application of vehicle technologies and transport fuels to be 'building blocks' of sustainable mobility, including hybrid-electric propulsion systems, fuel cells, biofuels, hydrogen, lightweight vehicles and intelligent transport system technologies
- Measures to reduce the total volume of transport activity performed – 'demand channelling' measures were seen as being complementary to technology-based measures
- Alterations to the modal mix of transport activity.

A recent study by the Victorian Government (*Understanding the Potential to Reduce Victoria's Greenhouse Gas Emissions, DPC, April 2008)* has confirmed that the transport sector in Victoria is likely to be a source of significantly increased greenhouse gas emissions, driven largely by population and economic growth, under Reference Case assumptions similar to those made for this study (refer to Figure 3-5).

- **Figure 3-5: Victorian Greenhouse Gas Emissions Reference Case**



The forecasts have been generated from expectations about sector outputs, emissions factors, State GSP growth, State population growth, oil price and assuming that behavioural change is not expected to lead significantly to reductions in emissions through to 2020 ie People are expected to continue favouring private vehicle use, and businesses will use road freight, over alternatives associated with lower emissions.

Contributing factors to the predicted growth in transport emissions are:

- Strong growth in population and economic activity
- Continued strong growth in corridors on Melbourne's fringe, consistent with Melbourne 2030
- Reduced car occupancy rates arising from decreasing average household size
- Growing car ownership
- Increased demand for just-in-time and door-to-door freight services.

Consistent with the findings of the WBCSD SMP study, the initiative likely to have the greatest influence on moderating the predicted increases in transport-related greenhouse gas emissions is improved fuel and vehicle efficiency. Other important initiatives are:

- Travel demand management
- Increased vehicle occupancy
- Mode shift to public transport.

These initiatives are explained below.

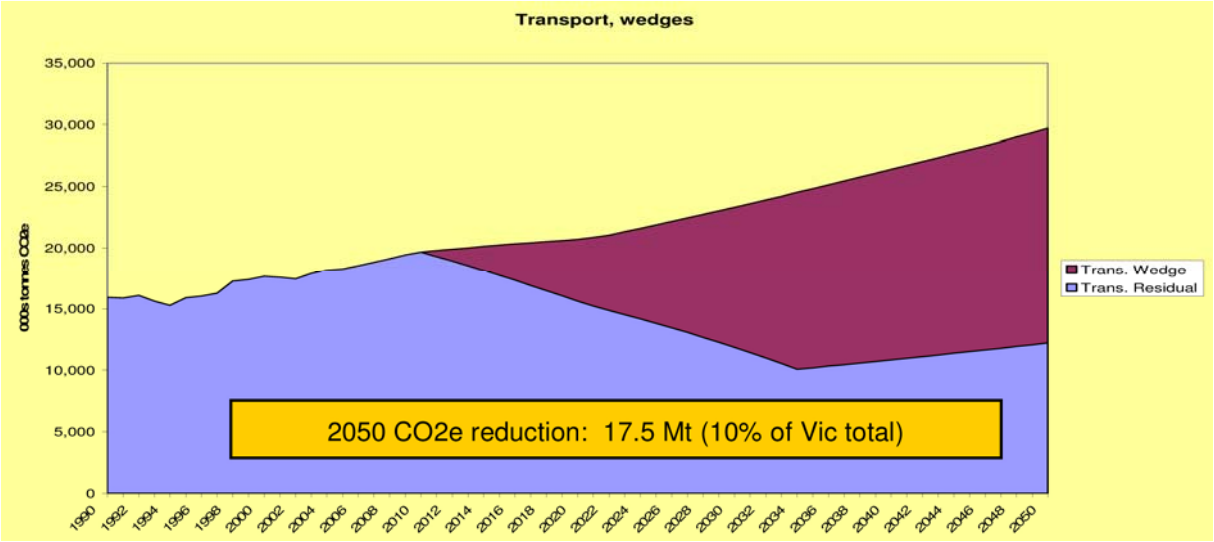
Improved fuel and vehicle efficiency

Improving fuel efficiency has been identified as by far the most effective way to reduce emissions from transport, provided that current barriers to the increased market penetration of fuel efficient vehicles are overcome (eg behaviour change to alter preferences towards more fuel efficient vehicles, FBT and tariff arrangements that favour four wheel drive vehicles and stamp duty arrangements that favour larger vehicles). It has been identified in the DPC study that a 30% improvement in fuel efficiency could be achieved between 2010 and 2022, increasing to 60% through to 2034. These improvements can be achieved by more efficient internal combustion engines, reductions in vehicle weight through the use of new materials and increased market penetration of petrol /electric hybrid vehicles, use of biofuels, clean diesel, and hydrogen powered vehicles. It is noted that more efficient vehicle technology already exists and many European and Japanese cars on the market are currently far more efficient than those manufactured in Australia.

As the price of oil increases with the advent of peak oil conditions, combined with the flow-on effects of a price for carbon, the economic incentive for these technology developments will continue to increase.

It is predicted that the improvements quoted above would lead to a reduction in CO2e emissions in Victoria of 17.5Mt by 2050, representing a saving of 10% of Victoria's projected 2050 greenhouse gas emissions (refer to Figure 3-6).

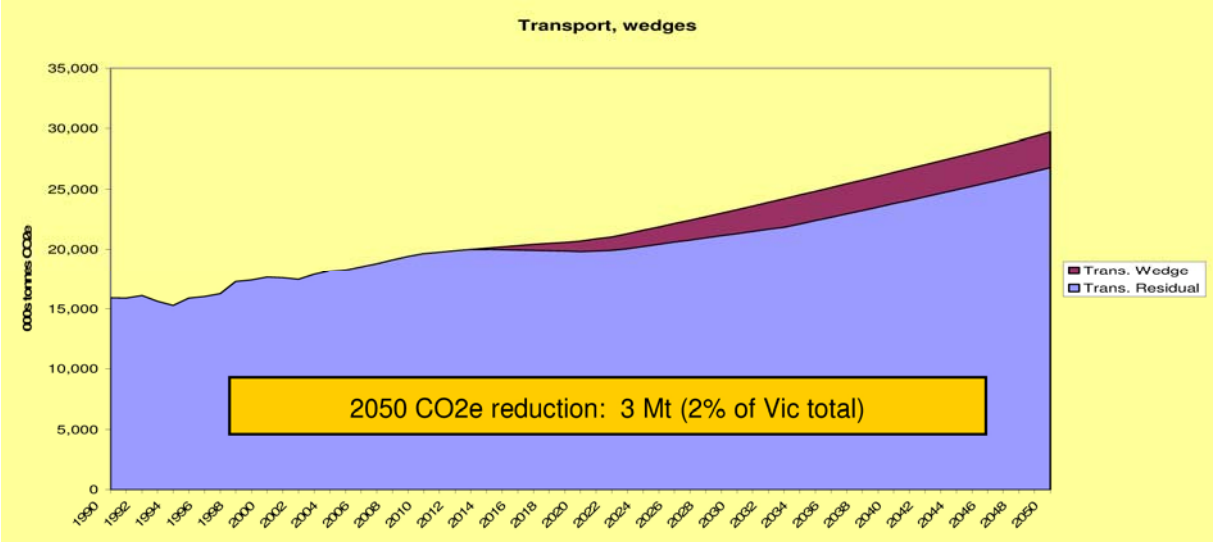
- **Figure 3-6: Improved Fuel and Vehicle Efficiency Wedge**



Travel demand management

Current demand for travel is about 3.7 trips per head of population per weekday. It is estimated that reducing this to 3.2 trips per weekday would achieve a 10% reduction in travel demand over the next 10 years. This would lead to a reduction in CO2e emissions of 3 Mt by 2050, representing a saving of 2% of Victoria's projected greenhouse emissions for 2050 (refer Figure 3-7).

- **Figure 3-7: Travel Demand Management Wedge**



Effective implementation of travel behaviour change programs (eg TravelSmart) is crucial to achieving this reduction. Other initiatives requiring consideration include travel pricing, awareness/education programs and application of technology to freight management, including supply chain management techniques and intelligent vehicle systems.

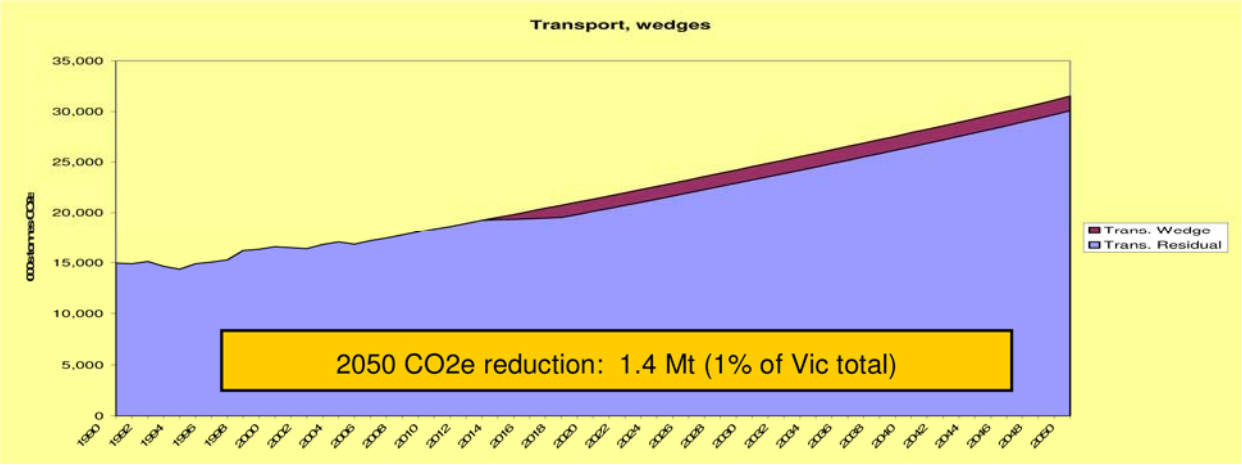
Increased vehicle occupancy

As mentioned earlier, car occupancy has been declining due to such factors as dispersed origins and destinations, reduced house occupancy levels and rising vehicle ownership levels. The opportunity exists to reverse this trend through education and practical measures to promote car pooling. Initiatives include introduction of transit lanes on freeways and major arterial roads and information/education.

It is clear that, given that car occupancy has been declining while congestion has been increasing, substantial challenges exist to achieving the behavioural changes required. However, transport demand management programs conducted recently in Victoria have recorded promising outcomes. The TravelSmart program has been expanded on the basis of pilot projects that have typically reduced car use by up to 15%, mainly by substitution of other means of travel (including walking and cycling) and reduction or reorganisation of discretionary journeys.

If successful, it is estimated that a 10% reduction in private vehicle use could be achieved over the next 10 years. This would translate into a 1.4Mt reduction in greenhouse gas emissions in Victoria by 2050, representing a saving of 1% of Victoria's greenhouse gas emissions (refer Figure 3-8).

- **Figure 3-8: Increased Vehicle Occupancy Wedge**

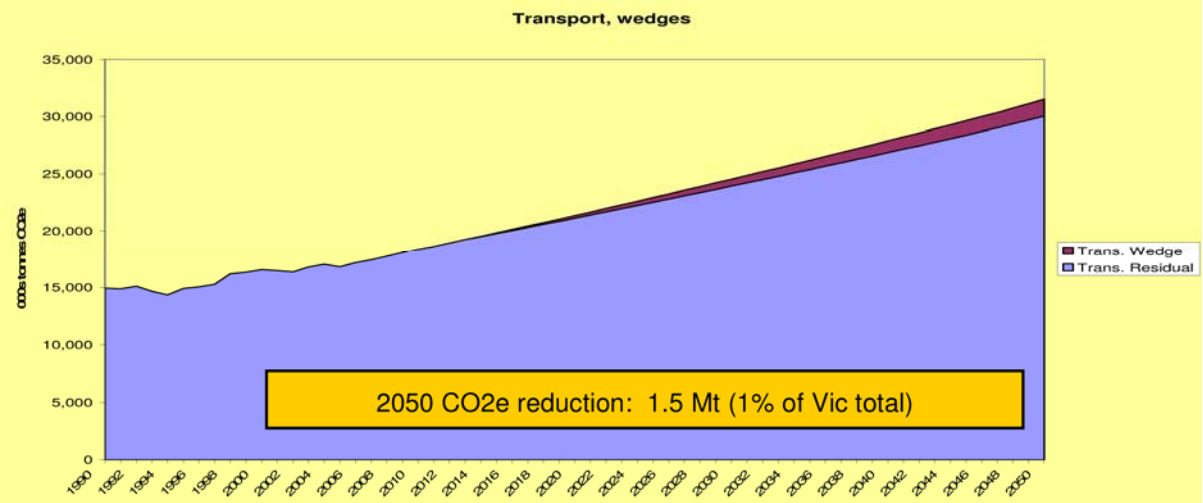


Mode shift to public transport

Although often suggested as a panacea for reducing greenhouse gas emissions from transport, well entrenched cultural barriers suggest that mode shift to public transport represents a relatively small (but still important) opportunity area. The Victorian Government is investing considerable effort in encouraging greater public transport patronage and current predictions are that the $10.5 billion MOTC program will contribute to a noticeable trend towards the Victorian Government's 20/2020 target

Continued heavy investment in public transport infrastructure over the next 40 years will be required to achieve a more modest target of substitution of 10% of private passenger transport to rail, and a 1% shift in road freight to rail. This substitution is estimated to achieve a CO2e reduction of 1.5Mt by 2050, representing 1% of Victoria's greenhouse gas emissions (refer Figure 3-9).

- **Figure 3-9: Mode Shift away from Private Transport Wedge**



It is predicted that implementation of all of these initiatives could reduce Reference/Base Case greenhouse gas emissions by 23.4 Mt by 2050. The net result would be that the predicted increase of greenhouse gas emissions from transport in the period 2005 to 2050 would moderate from 32Mt to 9Mt with the initiatives in place.

In assessing the transport options proposed in this study, the consistency of the options with these initiatives has been analysed. While improved fuel and vehicle efficiency would not be affected by the options, travel demand management, increased vehicle occupancy and mode shift to public transport could all be influenced (to varying degrees) by the options.

The assessment does not include a specific, comparative assessment of predicted greenhouse gas emissions of the options, as the transport modelling results for the Melbourne transport system have shown virtually identical results for each of the options.

The analysis is based on an interpretation of transport modelling results. It includes consideration of a number of contributing factors to potential induced travel arising from the provision of major new road infrastructure, including:

- Route shift – motorists may change the route of their journey to take advantage of the improved travel conditions offered by the new road facility. This can lead to an increase in vehicle kilometres of travel.
- Transport mode shift – travellers may switch from public transport to private vehicle travel
- Change of destination choice – this may lead to an increase in vehicle kilometres of travel

- Newly generated trips – this category comprises trips taken that were previously considered not to be worthwhile (first order effect) and trips generated by changes to land use patterns (second order, longer term effect).

While the potential for induced travel is often claimed to be an automatic and significant adverse effect of building new road transport infrastructure, a proactive approach to capturing the benefits of a more efficient link in the road network can mitigate the adverse aspects of travel behaviour changes.

Specific measures applicable to the road network development options (Options A and B in particular) include allocating 'freed-up' road space to other users, such as on-road public transport (e.g. buses and trams), bicycles and high occupancy vehicles. These types of measures would be considered as part of the design development process in subsequent planning phases and would be implemented during construction of the road network development initiatives.

3.8.3 Options Assessment

Given the preceding discussion, key objectives for the environmental sustainability assessment of the options are confirmed as:

- Enhanced transport system efficiency through improved connectivity and reduced traffic congestion
- Encouragement of mode shift to public transport, walking and cycling
- Consistency with travel demand management initiatives.

Potential interactions between the options under consideration and these objectives are examined in the following paragraphs, with overall ratings summarised in Table 3.8. Appendix A provides a detailed analysis of each of the options.

Enhanced transport system connectivity

All options include significant public transport initiatives (rail and bus) and projected Base Case traffic congestion would be alleviated by the enhanced road network connectivity of Options A and B in particular, and to a lesser extent, the road network upgrades associated with Option C. Options A and B provide specific opportunities to capture 'freed up' road space for enhanced on-road public transport, cycling and pedestrian facilities, as discussed below.

The CBD rail tunnel (all options) is the critical foundation infrastructure for further rail network improvements, including enhanced rail services from Melbourne's western suburbs.

Option A provides the most enhanced road network connectivity by linking of three existing freeways – Eastern Freeway/City Link/Westgate Freeway, as well as:

- Improved access for freight vehicles to the Port of Melbourne
- Upgrading of Ballarat Road, Westgate Freeway and Western Ring Road.

Option B also enhances road network connectivity, linking the Eastern Freeway/City Link/ Sunshine Road/Western Ring Road, and enhanced access to the Port of Melbourne.

Option C comprises an upgrading of the existing road network that is expected to alleviate some Base Case traffic congestion, without the gains in connectivity of either Options A or B.

Option D traffic congestion would be very similar to the Base Case and road network connectivity would not change.

Increased use of public transport, walking and cycling

The public transport enhancements proposed for all options will encourage the use of public transport, and associated walking and cycling activity.

Options A and B also provide significant opportunities to enhance on-road, local public transport (eg trams, buses), as well as improved pedestrian and cycling facilities and linkages in areas where high traffic volumes would be diverted into tunnels. This applies, for example, in areas adjacent to Alexandra Parade, where a proportion of projected traffic would be diverted into a tunnel, with flow-on benefits for both Alexandra Parade and adjoining local roads, providing the opportunity for enhancement of pedestrian and cycling facilities, as well as reduced travel times for north- south tram services. The upgrade of Ballarat Road in Option A also provides an opportunity to enhance this road as a cycle link.

Local benefits to public transport, pedestrians and cyclists provided by Options A and B have the potential to be offset by the effect that the road network development initiatives would have in making driving more competitive against both public transport and cycling, particularly for longer, peak hour commuter journeys. This potential effect would be minimised by additional measures to capture the opportunity presented by ‘freed up’ road space by introducing further public transport, cycling and high occupancy vehicle initiatives.

The absence of significant new road infrastructure in Options C and D means that predicted Base Case traffic congestion levels will remain, maximising the comparative advantage provided by the public transport enhancements (particularly the rail initiatives). However, on-road/local public transport, pedestrian and cycling conditions would be disadvantaged by congestion levels similar to the Base Case, without the prospect of reduced traffic volumes on the existing network.

Consistency with travel demand initiatives

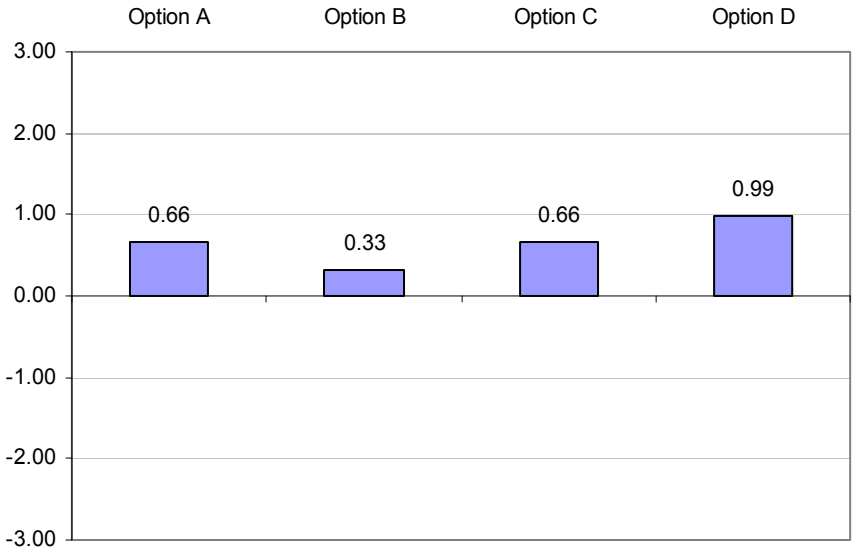
While Options A and B represent a balanced approach to transport system development, the significant road network development initiatives (and to a lesser extent the public transport initiatives) of both options has the potential to increase overall travel, particularly discretionary trips. The extent of likely

generated travel is expected to be relatively minor. Potential increases in travel demand would be moderated by effective implementation of travel behaviour change programs. Such programs have been identified earlier as representing an important initiative in alleviating the currently predicted 2031 Base Case situation.

It is anticipated that Option C would only have a minor effect on travel demands, while travel demand for Option D would be as for the Base Case.

As indicated in the table, all options record a small overall positive rating for environmental sustainability.

- **Table 3-8 Environmental Sustainability ratings**



4. Comparison of Options

4.1 Compilation of Unweighted Ratings

The assessment ratings for each option for each category of issue examined in this study are compiled in Table 4-1. This table shows the actual values and unweighted scores for each environmental component for each transport option. All options have been assessed relative to the 2031 Base Case. These scores are represented graphically in Table 4-1. The detailed Appraisal Tables for each option are contained in Appendix A.

Table 4-1 Comparison of assessment ratings

Option Description	Hydrogeology	Hydrology, WQ & Aquatic Ecology	Contaminated Land	Flora and Fauna (terrestrial)	Cultural Heritage	Air Quality	Noise	Sustainability
Option A	-1.84	-1.35	-1.50	-1.50	-2.17	-0.20	-0.66	+0.66
Option B	-1.71	-1.35	-1.50	-1.50	-2.17	0.00	-0.70	+0.33
Option C	-1.35	-1.00	-1.00	-1.00	-2.00	-0.20	-0.67	+0.66
Option D	-1.19	-0.83	-0.80	0.00	-1.00	+0.30	-0.16	+0.99

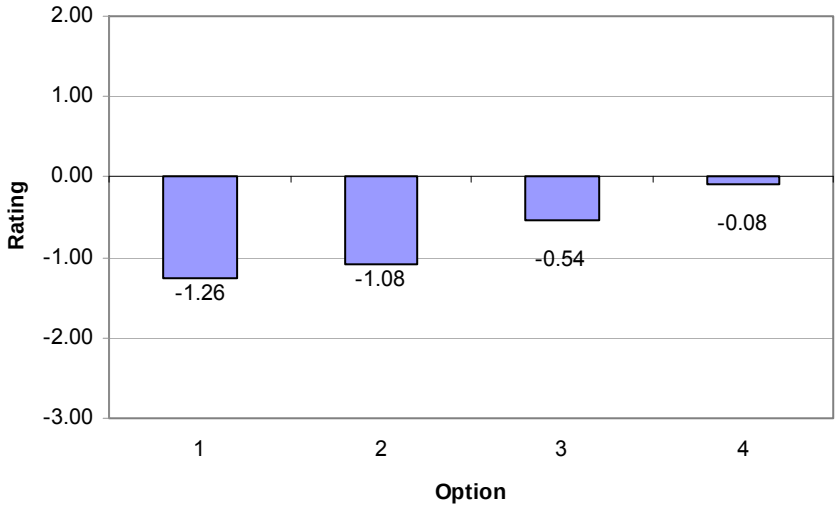
4.2 Weighted Comparison of Options

The unweighted scores have been weighted and the outcomes summed in Table 4-2. This weighted scores place a strong emphasis on air quality, environmental sustainability and noise, with these three factors accounting for 60% of the cumulative rating. These weightings were chosen to highlight the potential long-term / irreversible environmental implications of these issues as an important strategic consideration. All other issues were given an individual weighting of 8%. Whilst all these other environmental issues are important, the lesser weighting given to them is because these impacts are more amenable to management and mitigation measures. All weightings were determined and agreed at a specialist workshop held with the Environment and Heritage Team.

- **Table 4-2 Weighted assessment ratings**

Option Description	Hydrogeology	Hydrology, WQ & Aquatic Ecology	Land Contamination	Flora and Fauna (terrestrial)	Cultural Heritage	Air Quality	Noise	Sustainability	Rating
Weighting (% of 100)	8%	8%	8%	8%	8%	15%	15%	30%	
Option A	-1.47	-1.08	-1.20	-1.20	-1.74	-0.45	-0.99	-1.98	**-1.26**
Option B	- 1.37	-1.08	-1.20	-1.20	-1.74	0.00	-1.05	-0.99	**-1.08**
Option C	-1.08	-0.80	-0.80	-0.80	-1.60	-0.30	-0.92	+1.98	**-0.54**
Option D	-0.95	-0.66	-1.44	0.00	-0.80	+0.45	-0.24	+2.97	**-0.08**

- **Figure 4-1 Weighted Assessment Ratings**



The results indicate that all options are rated as having minor effects overall when considered over the broad study area, and that there is no individual category of issue that presents a significant risk (with appropriate management) or fatal flaw. As expected in a study which has focussed on potential interactions associated with new transport infrastructure, Option D performs the best from an environmental perspective, due to the absence of road infrastructure initiatives and minimal change from 2031 Base Case conditions. Similarly, the relatively modest road infrastructure initiatives and continuation of Base Case travel patterns associated with Option C are the main contributing factor to its second ranking overall. Both Options A and B comprise significant road infrastructure initiatives that will result in substantial changes to Base Case travel patterns. Construction impacts associated with the transport road infrastructure, combined with operational impacts arising from changed travel patterns, leads to their higher negative (but still minor) rating.

Looking at the results from the perspective of issues, environmental sustainability emerges as the most influential factor, consistent with the preliminary and strategic purpose of this study. The environmental sustainability ratings accorded to Options C and D represent the highest positive, individual scores. The cultural heritage ratings for Options A, B and C represent the highest negative individual scores, followed by the negative hydrogeological ratings for Options A and B. Contributing factors to these results are as follows:

- The positive environmental sustainability scores for Options C and D are due to the significant public transport initiatives they comprise and the comparative advantage afforded to those initiatives over private vehicle travel through the absence of major new road infrastructure and a continuation of

congested Base Case traffic conditions. A disadvantage is that the absence of new road infrastructure limits the opportunity to introduce improved on-road public transport, cycling and pedestrian facilities, compared to Options A and B in particular. It is also noted that this appraisal does not consider economic and social disadvantages associated with a continuation of Base Case levels of traffic congestion for Option D (in particular) and Option C. These implications are being separately considered in the Economic and Social Appraisals.

- The moderately negative ratings for cultural heritage for Options A, B and C reflect the sensitive Indigenous and non-Indigenous environments occurring in the vicinity of the proposed infrastructure initiatives. Due to the preliminary nature of this study, a precautionary approach has been taken in identifying potential interactions associated with each of the preliminary alignments provided during the course of the study. During detailed planning, potential interactions would be discussed with the design team and appropriate modifications adopted to avoid or manage potential interactions.
- The minor to moderate ratings for potential hydrogeological interactions associated with Options A and B arise from the risk of groundwater intrusion into tunnels during construction in areas of Yarra Delta sediments. Consistent with the precautionary approach adopted for the cultural heritage assessment, this potential risk has been raised as an issue requiring further consideration during subsequent detailed planning phases. It is noted that advanced tunnelling construction techniques are available to minimise the risk of groundwater intrusion during tunnel construction.

5. Conclusions

The purpose of this Phase 3 Options Appraisal is to provide information about potential environmental interactions likely to be associated with each of the four nominated options.

Assessments have comprised a rapid appraisal based on preliminary concept plans and previously published information. The assessments are based on a detailed knowledge of the study area (eg flora and fauna, heritage, hydrogeology etc) and the experience and expertise of specialist study team members. The assessments provide an indication of the likely issues and interactions associated with each option for the purpose of identifying issues that will require further investigation during detailed planning and environmental assessment of any selected option.

Based on the Rapid Appraisal Assessments undertaken by the specialists, the following conclusions can be made about potential environmental and heritage interactions associated with each option:

- All options are rated as having minor effects overall when considered from a network-wide perspective, and there is no individual category of issue that presents a significant environmental risk (with appropriate management) or fatal flaw;
- Using the weighted assessment ratings, the most influential factors to be addressed during the detailed planning and environmental assessment phase are environmental sustainability, cultural heritage and hydrogeology, particularly for Options A and B;
- Option D is the best performing option based on environmental and heritage factors, including when longer term, strategic considerations of environmental sustainability, noise and air quality are given emphasis. While this option does not directly address anticipated 2031 Base Case traffic congestion and amenity problems (addressed separately in the Economics and Social Appraisals), it maximises the comparative advantage afforded to the public transport initiatives, does not involve construction impacts associated with major new road infrastructure and minimises noise and air quality effects compared with the Base Case;
- Option C also performs well in terms of longer term environmental sustainability factors due its emphasis on public transport initiatives without major new road infrastructure. Unlike Option D, Option C does attempt to alleviate current traffic congestion and freight accessibility problems, albeit with substantial environmental and social (not covered in this assessment) implications;
- Options A and B provide a comprehensive suite of road network development and public transport initiatives that would alleviate current traffic congestion and freight accessibility problems, including much improved access to the Port of Melbourne. However, environmental and heritage issues associated with construction and operation of these major transport infrastructure initiatives, and the changed traffic patterns that would result, combine to record a minor negative rating for these options.

Appendix A Summary Appraisal Tables

A.1 Hydrogeology

APPRAISAL SUMMARY TABLE - Hydrogeology	
OPTION:	Option A
Description	Eastern Freeway to West Gate Freeway road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Key potential interactions in relation to groundwater are likely to occur in the construction phase. A tank tunnel has been assumed, hence no groundwater inflows have been assumed during operation.
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE	RISKS	WEIGHTING (%)	RATING
Potential for groundwater infiltration during construction of option	Construction issues – Length of tunnel in Yarra Delta Sediments	Yarra Delta sediments are made up of a number of different geology types (Tertiary sediments have been included in this group) which could result in increased tunnelling difficulties due to continually varying rock and sediment types and potential for increased groundwater inflows into the tunnel. Yarra Delta sediments are unfavourable relative to bedrock.	Yarra Delta sediments are located along and the vicinity of the Maribynong River (for approx 3 km of road tunnel). Rail tunnel exits would be in Yarra Delta sediments (approx 3.7km of rail tunnel in total). Basalt and sandstone aquifers are located within the remainder of the road tunnel length (~ 10 km basalt, ~ 6 km sandstone). Rail tunnel all sandstone.	-2	Low for all – field investigations would need to be undertaken to confirm groundwater levels, geology and to determine degree of interaction of groundwater with each of the identified impacts	High risk at this stage prior to detailed field investigation.	36	-0.72
Potential for development of acid sulphate groundwater and the subsequent remobilisation of soil contaminants	Construction issues – Length of tunnel in Yarra Delta Sediments Operation Issues – management of acid sulphate groundwater and contaminant movement.	There is a higher potential for acid sulphate groundwater consequential of tunnelling through the Yarra Delta sediments, relative to the bedrock. Acid sulphate groundwater has the potential to occur in areas of shallow cut and cover tunnels and may generate soil contaminant movement, due to the lowering of groundwater levels.	Yarra Delta sediments are located along and the vicinity of the Maribynong River (for approx 3 km of road tunnel). Rail tunnel exits would be in Yarra Delta sediments (approx 3.7km of rail tunnel in total).	-2			10	-0.20
Potential for groundwater infiltration during construction of option	Construction issues – Tunnel size	The greater the tunnel size the greater the potential issues. This is because as the size of the tunnel increases the tunnel diameter increases significantly and hence the surface area of the tunnel increases. This results in the potential for increased groundwater inflow into the tunnel.	A road tunnel is approximately twice the size/circumference of a rail/light rail tunnel	-2			21	-0.42
Potential for groundwater infiltration during construction of option	Construction issues – Tunnel depth	The greater the tunnel depth the greater the potential issues. This is because as the depth of the tunnel increases the hydraulic head increases and hence the groundwater inflow rate increases linearly.	Road tunnel approximately 15 – 20 metres depth. Rail tunnel approximately 20 to 45 metres depth	-2			16	-0.32

Potential need to extract and treat groundwater	Tunnel Inflows	Where tunnel is located below groundwater level, the potential exists for continual pumping into or out of aquifer(s) during construction of the tunnel, depending on the tunnelling construction technique adopted.	Lowering of groundwater levels and potential pumping requirements – along general length of tunnel.	-1.5			11	-0.17
Effects on existing infrastructure, such as underground drainage	Land Subsidence	Where significant lowering of the watertable occurs (predominantly in the Yarra Delta sediments) land subsidence may result impacting on surface infrastructure such as buildings and roads.	Yarra Delta sediments are located along and the vicinity of the Maribynong River (length ~ 3 km).	-2			6	-0.12
							TOTAL SCORE	**-1.95**

APPRAISAL SUMMARY TABLE - Hydrogeology

OPTION:	Option B
Description	Eastern Freeway to Sunshine Road road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Key potential interactions associated with groundwater are in the construction phase. A tank tunnel has been assumed, hence no groundwater inflows have been assumed during operation.
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Potential for groundwater infiltration during construction of option	Construction issues – Length of tunnel in Yarra Delta Sediments	Yarra Delta sediments are made up of a number of different geology types (Tertiary sediments have been included in this group) which could result in increased tunnelling difficulties due to continually varying rock and sediment types and increased groundwater inflows into the tunnel. Yarra Delta sediments are unfavourable relative to bedrock.	Yarra Delta sediments are located along and the vicinity of the Maribynong River (length road tunnel ~ 3 km). Rail tunnel exits would be in Yarra Delta sediments. Basalt and Basement aquifers are located within the remainder of the road tunnel length (km length basalt ~ 12 km, sandstone ~ 6 km). Rail tunnel all sandstone.	-1.5	Low for all – field investigations would need to be undertaken to confirm groundwater levels, geology and to determine degree of interaction of groundwater with each of the identified impacts	High risk at this stage prior to detailed field investigation.	36	-0.54
Potential for development of acid sulphate groundwater and the subsequent remobilisation of soil contaminants	Construction issues – Length of tunnel in Yarra Delta Sediments, Operation Issues – management of acid sulphate groundwater and contaminant movement.	There is a higher potential for acid sulphate groundwater consequential of tunnelling through the Yarra Delta sediments, relative to the bedrock. Acid sulphate groundwater is most likely to occur in areas of shallow cut and cover tunnels and may generate soil contaminant movement, due to the lowering of groundwater pH.	Yarra Delta sediments are located along and the vicinity of the Maribynong River (length road tunnel ~ 3 km). Rail tunnel exits would be in Yarra Delta sediments.	-1			10	-0.10
Potential for groundwater infiltration during construction of option	Construction issues – Tunnel size	The greater the tunnel size the greater the potential issues. This is because as the size of the tunnel increases the tunnel diameter increases significantly and hence the surface area of the tunnel increases. This results in the potential for increased groundwater inflow into the tunnel.	A road tunnel is approximately twice the size/circumference of a rail/light rail tunnel	-2			21	-0.42

Potential for groundwater infiltration during construction of option	Construction issues – Tunnel depth	The greater the tunnel depth the greater the potential issues. This is because as the depth of the tunnel increases the hydraulic head increases and hence the groundwater inflow rate increases linearly.	Road tunnel approximately 15 – 20 metres depth. Rail tunnel approximately 20 to 40 metres depth	-2			16	-0.32
Potential need to extract and treat groundwater	Tunnel Inflows	Where tunnel is located below groundwater level, the potential exists for continual pumping into or out of aquifer(s) during construction of the tunnel, depending on the tunnelling construction technique adopted.	Lowering of groundwater levels and potential pumping requirements – along general length of tunnel.	-1.5			11	-0.165
Effects on existing infrastructure, such as underground drainage	Land Subsidence	Where significant lowering of the watertable occurs (predominantly in the Yarra Delta sediments) land subsidence may result impacting on surface infrastructure such as buildings and roads.	Yarra Delta sediments are located along and the vicinity of the Maribynong River. (km length ~ 3 km)	-1			6	-0.06
							TOTAL SCORE	**-1.61**

APPRAISAL SUMMARY TABLE - Hydrogeology

OPTION:	Option C.
Description	CBD rail tunnel, road tunnel from Eastern Freeway to Smithfield Road – no other lengths of tunnel.
Base Case	
Problem Addressed	Key potential interactions associated with groundwater are in the construction phase. A tank tunnel has been assumed, hence no groundwater inflows have been assumed during operation.
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Potential for groundwater infiltration during construction of option	Construction issues – Length of tunnel in Yarra Delta Sediments	Yarra Delta sediments are made up of a number of Yarra Delta sediments are made up of a number of different geology types (Tertiary sediments have been included in this group) which could result in increased tunnelling difficulties due to continually varying rock and sediment types and increased groundwater inflows into the tunnel. Yarra Delta sediments are unfavourable relative to bedrock.	Yarra Delta sediments are located along and the vicinity of the Maribynong River. Rail tunnel exits would be in Yarra Delta sediments. The majority of the Rail tunnel is likely to be constructed in the Basalt and Basement aquifers.	-1.0	Low for all – field investigations would need to be undertaken to confirm groundwater levels, geology and to determine degree of interaction of groundwater with each of the identified impacts	High risk at this stage prior to detailed field investigation.	36	-0.36
Potential for development of acid sulphate groundwater and the subsequent remobilisation of soil contaminants	Construction issues – Length of tunnel in Yarra Delta Sediments, Operation Issues – management of acid sulphate groundwater and contaminant movement.	There is a higher potential for acid sulphate groundwater consequential of tunnelling through the Yarra Delta sediments, relative to the bedrock. Acid sulphate groundwater is most likely to occur in areas of shallow cut and cover tunnels and may generate soil contaminant movement, due to the lowering of groundwater pH.	Yarra Delta sediments are located along and the vicinity of the Maribynong River. Rail tunnel exits would be in Yarra Delta sediments.	-1.0			10	-0.10
Potential for groundwater infiltration during construction of option	Construction issues – Tunnel size	The greater the tunnel size the greater the potential issues. This is because as the size of the tunnel increases the tunnel diameter increases significantly and hence the surface area of the tunnel increases. This results in increased groundwater inflow into the tunnel.	A road tunnel is approximately twice the size/circumference of a rail/light rail tunnel	-2.0			21	-0.42

Potential for groundwater infiltration during construction of option	Construction issues – Tunnel depth	The greater the tunnel depth the greater the potential issues. This is because as the depth of the tunnel increases the hydraulic head increases and hence the groundwater inflow rate increases linearly.	Rail tunnel approximately 20 to 40 metres depth	-2.0			16	-0.32
Potential need to extract and treat groundwater	Tunnel Inflows	Where tunnel is located below groundwater level, continual pumping into or out of aquifer(s) may be required to construct, operate and maintain the tunnel.	Lowering of groundwater levels and potential pumping requirements – along general length of tunnel.	-1.5			11	-0.17
Effects on existing infrastructure, such as underground drainage	Land Subsidence	Where significant lowering of the watertable occurs (predominantly in the Yarra Delta sediments) land subsidence may result impacting on surface infrastructure such as buildings and roads.	Yarra Delta sediments are located along and the vicinity of the Maribynong River.	-0.5			6	-0.03
							TOTAL SCORE	**-1.40**

APPRAISAL SUMMARY TABLE - Hydrogeology

OPTION:	Option D
Description	CBD rail tunnel, no road upgrades proposed
Base Case	
Problem Addressed	Key potential interactions associated with groundwater are in the construction phase. A tank tunnel has been assumed, hence no groundwater inflows have been assumed during operation.
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Potential for groundwater infiltration during construction of option	Construction issues – Length of tunnel in Yarra Delta Sediments	Yarra Delta sediments are made up of a number of Yarra Delta sediments are made up of a number of different geology types (Tertiary sediments have been included in this group) which could result in increased tunnelling difficulties due to continually varying rock and sediment types and increased groundwater inflows into the tunnel. Yarra Delta sediments are unfavourable relative to bedrock.	Yarra Delta sediments are located along and the vicinity of the Maribynong River. Rail tunnel exits would be in Yarra Delta sediments. The majority of the Rail tunnel is likely to be constructed in the Basalt and Basement aquifers.	-1.0	Low for all – field investigations would need to be undertaken to confirm groundwater levels, geology and to determine degree of interaction of groundwater with each of the identified impacts	High risk at this stage prior to detailed field investigation.	36	-0.36
Potential for development of acid sulphate groundwater and the subsequent remobilisation of soil contaminants	Construction issues – Length of tunnel in Yarra Delta Sediments, Operation Issues – management of acid sulphate groundwater and contaminant movement.	There is a higher potential for acid sulphate groundwater consequential of tunnelling through the Yarra Delta sediments, relative to the bedrock. Acid sulphate groundwater is most likely to occur in areas of shallow cut and cover tunnels and may generate soil contaminant movement, due to the lowering of groundwater pH.	Yarra Delta sediments are located along and the vicinity of the Maribynong River. Rail tunnel exits would be in Yarra Delta sediments.	-1.0			10	-0.10
Potential for groundwater infiltration during construction of option	Construction issues – Tunnel size	The greater the tunnel size the greater the potential issues. This is because as the size of the tunnel increases the tunnel diameter increases significantly and hence the surface area of the tunnel increases. This results in increased groundwater inflow into the tunnel.	A road tunnel is approximately twice the size/circumference of a rail/light rail tunnel	-1.0			21	-0.21

Potential for groundwater infiltration during construction of option	Construction issues – Tunnel depth	The greater the tunnel depth the greater the potential issues. This is because as the depth of the tunnel increases the hydraulic head increases and hence the groundwater inflow rate increases linearly.	Rail tunnel approximately 20 to 40 metres depth	-2			16	-0.32
Potential need to extract and treat groundwater	Tunnel Inflows	Where tunnel is located below groundwater level, continual pumping into or out of aquifer(s) may be required to construct, operate and maintain the tunnel.	Lowering of groundwater levels and potential pumping requirements – along general length of tunnel.	-2			11	-0.22
Effects on existing infrastructure, such as underground drainage	Land Subsidence	Where significant lowering of the watertable occurs (predominantly in the Yarra Delta sediments) land subsidence may result impacting on surface infrastructure such as buildings and roads.	Yarra Delta sediments are located along and the vicinity of the Maribynong River.	-0.5			6	-0.03
							TOTAL SCORE	**-1.24**

A.2 Hydrology, water quality and aquatic ecology

APPRAISAL SUMMARY TABLE – Hydrology, water quality and aquatic ecology	
OPTION:	**Options A & B**
Description	East West road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal. A distinguishing feature of the options for this appraisal is that Option A involves a bridge over the Maribyrnong River, while Option B comprises a cut and cover tunnel under the Maribyrnong River.
Base Case	
Problem Addressed	Potential interactions with Werribee River, Dry Creek, Skeleton Creek, Stony Creek, Kororoit Creek, Maribyrnong River, Moonee Ponds Creek and Yarra River.
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Continued ability of waterways to carry floodwaters	Hydraulic capacity of Maribyrnong River (2 locations) and Moonee Ponds Creek (2 locations) along with potential impact on Werribee River	Preliminary concept plans indicate that an additional lane will be required to be cantilevered over Moonee Ponds Creek for both Options A and B. For Option A, there is the potential for hydraulic effects of piers in the Maribyrnong River in the vicinity of Footscray Road. Creation of a coffer dam to construct the cut and cover tunnel under the Maribyrnong River has the potential to reduce to reduce waterway capacity and would need to be investigated further during detail design. Werribee River currently has flood capacity issues and potential impacts associated with the Tarneit Rail proposal would require further investigation.	Potential afflux impact on flood levels would need to be engineered out to mitigate any potential effects	-2	High	Low risk associated with potential impact on hydraulic capacity floodplain functions since management measures are available	15	-0.30
Maintain base flows and surface water flows of streams	Base flows and surface water flows of Maribyrnong River, Kororoit Creek, Moonee Ponds Creek and Stony Creek	Overall impact is likely to be insignificant assuming tunnels are fully tanked. Groundwater infiltration into the tunnel has the potential to reduce the following stream flows: Maribyrnong River estuary – very small impact; Moonee Ponds Creek – insignificant as it is a concrete channel;Stony Creek/Kororoit Creek – very minor impact only. Overall impact is likely to be very small because tunnels pass beneath streams at 90° and do not run parallel to channel, with the exception of Maribyrnong River which is	Estimate stream flow and assess loss. The loss will be based on the groundwater infiltration to tunnel, depending on tunnel design and construction technique.	-1	Medium	Risks can be managed by application of advanced tunnelling techniques to minimise or avoid groundwater infiltration.	20	-0.20

		proposed to cross at 45 ^{O} (Option A). Any groundwater infiltration from tunnel will require treatment prior to release into any waterway.						
Environmental sensitivity of the catchment	Low sensitivity in west and east. High Sensitivity in the Port area and areas adjoining the Werribee Plains grasslands.	Low to medium sensitivity. Catchments fully urbanised but waterways retain some significant environmental values (especially Maribyrnong River and Kororoit Creek and Werribee Plains grasslands). However, impacts are likely to be minor if tunnelled below streams and streamflow loss is minimal. Potential impacts on terrestrial and aquatic flora and fauna values (including fish passage) associated with cut and cover tunnel under Maribyrnong River (Option B)	Potential indirect impacts on areas adjoining grassland EVC	-2	High		20	-0.40
Ability to effectively treat stormwater runoff, prior to discharge to steams	Potential impact on the water quality of Yarra River – adjacent to Eastern Portal of road tunnel	A potential constraint is the lack of open space to effectively treat stormwater runoff. Construction of a coffer dam on the Maribyrnong River (Option B) has the potential to impact on water quality, as does the possibility of increased flows in the event that the waterway cross section is reduced during construction. Any new works will require Best Practice Treatment. Road runoff from Eastern Portal area will need treatment prior to release into waterways.	Detailed investigations required to develop best practice stormwater runoff measures	-2	Medium		15	-0.30
Potential impacts on Groundwater Dependant Ecosystems	Potential reduction in stream flows.	Overall impact is likely to be very small because tunnels cross streams at 90° and do not run parallel to channel with the exception of Maribyrnong River which is proposed to cross at 45 ^{O} (Option B)	Number of stream crossings Geology near stream crossings	-0.5	Medium	If stream flow loss is significantly greater than expected this will impact groundwater dependant ecosystems	15	-0.075
Effects on existing infrastructure, such as underground drainage	Potential conflicts with drainage and sewerage infrastructure	Depending on depth of tunnels, there will be a possible conflict with Melbourne Water drainage / sewerage infrastructure. Need to ensure adequate separation between tunnel and Alexandra Parade Main Drain.	How many potential conflicts there are with major services Depth of tunnel (separation distance)	-0.5	Medium		15	-0.075
							TOTAL SCORE	-1.35

APPRAISAL SUMMARY TABLE - Hydrology, water quality and aquatic ecology	
OPTION:	**Option C**
Description	Upgrade of the existing road system from Eastern Freeway to Smithfield Road, upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Potential impacts on waterways
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Continued ability of waterways to carry floodwaters	Impacts on the hydraulic capacity of waterways	Potential impact on Werribee River due to proposed Tarneit rail.	Need to engineer out potentialafflux impact on flood levelst to mitigate any potential effects	-2	high		15	-0.30
Maintain base flows and surface water flows of streams	Potential impact from tunnel	No significant impact Any groundwater infiltration from tunnel will require treatment prior to release into any waterway	Estimate stream flow and assess loss. The loss will be based on the groundwater infiltration to tunnel.	0	Medium	No significant stream flow losses expected	20	0.00

Environmental sensitivity of the catchment	Low sensitivity in west and east. High Sensitivity in the Port area and Werribee plains	Low to medium sensitivity. Catchments fully urbanised but waterways retain some significant environmental values (especially Maribyrnong River and Kororoit Creek). However, impacts are likely to be minor if tunnelled below streams and streamflow loss is minimal. Potential for Werribee Plains grasslands to be impacted.	Loss of grassland EVC	-2	High		20	-0.40
Ability to effectively treat stormwater runoff, prior to discharge to steams	Potential impact on the water quality of rivers and creeks	Low impacts in Western areas.	Investigations to be carried out during detailed planning to identify best practice measures	-1	High		15	-0.15
Potential impacts on Groundwater Dependant Ecosystems	Potential reduction in stream flows.			0	Medium	If stream flow loss is significantly greater than expected this will impact groundwater dependant ecosystems	15	0.00
Effects on existing infrastructure, such as underground drainage	Potential conflicts with drainage and sewerage infrastructure	Areas adjacent to portals are likely to provide conflict	How many potential conflicts there are with major services	-1	Low		15	-0.15
							TOTAL SCORE	-1.00

APPRAISAL SUMMARY TABLE - Hydrology, water quality and aquatic ecology	
OPTION:	**Option D**
Description	CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Potential impacts on waterways
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: Maintenance of surface/groundwater flows & protection of water quality	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Continued ability of waterways to carry floodwaters	Impacts on the hydraulic capacity of waterways	Potential impact associated with Tarneit Rail proposal as Werribee River currently has issues with capacity for flood flows	Need to engineer out potential afflux impact on flood levels to mitigate any potential effects	-2	High		15	-0.30
Maintain base flows and surface water flows of streams	Potential for base flows to be impacted by tunnel under Moonee Ponds Creek and Maribyrnong River	Overall impact is likely to be insignificant assuming tunnels are fully tanked, as for options A, B and C. Any groundwater infiltration from tunnel will require treatment prior to release into any waterway.	Estimate stream flow and assess loss. The loss will be based on the groundwater infiltration to tunnel.	-0.5	Medium	Stream flow loss is significantly greater than expected.	20	-0.10

Environmental sensitivity of the catchment	Impacts on the environmental values of the catchment	Low sensitivity of catchment in built up areas. Potential interactions during construction on grasslands for Tarneit Railway.	Potential indirect impact on grassland EVC	-1	Medium		20	-0.20
Ability to effectively treat stormwater runoff, prior to discharge to steams	Potential impact on the water quality of rivers and creeks	Minimal impact as there are suitable areas for stormwater treatment measures	Assessment to see if stormwater runoff can be treated to best practice	-0.5	High		15	-0.075
Potential impacts on Groundwater Dependant Ecosystems	Potential reduction in stream flows.	Insignificant impact		0	Medium	If stream flow loss is significantly greater than expected this will impact groundwater dependant ecosystems	15	0.00
Effects on existing infrastructure, such as underground drainage	Potential conflicts with drainage and sewerage infrastructure	There is the potential for conflicts in the built up area associated with the proposed CBD rail tunnel	How many potential conflicts there are with major services	-1	Low		15	-0.15
							TOTAL SCORE	-0.83

A.3 Land Contamination

APPRAISAL SUMMARY TABLE – Land Contamination	
OPTION:	Option A
Description	Eastern Freeway to West Gate Freeway road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Acid rock and soils and contaminated soil
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: **Protecting human health and environment**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**Weighting (%)**	**Total**
Disposal of Acid Sulphate Soil (and Acid Rock)	Environmental impact associated with production of waste, management and disposal of acid sulphate soil and acid rock	Length of tunnel (volume of spoil) within Yarra Delta Sediments has high likelihood of being acid sulphate soil and Silurian Bedrock has possibility of exhibiting acid rock characteristics Note, only tunnels have been included, limited acid sulphate producing material is likely to be encountered as part of surface roadworks	6.7 km of tunnel through Yarra Delta Sediments (road and rail tunnels) Approximately 720,000 m3 (in-situ) of spoil (assume 70% requires management/disposal for acid sulphate) 2.7 km of tunnel through the Silurian Bedrock (road and rail tunnels). Approximately 350,000 m3 (in-situ) of spoil (assume 60% requires management/ disposal). Total ≈ 1 milllion m3	- 2	M	Limited knowledge of extent of acid rock (in Silurian)	20	-0.4

Disposal of Contaminated Soil	Residual envrionmental impact associated with production of waste, management and disposal of contaminated spoil	Length of tunnel which is through areas of potentially contaminated soil and within likely depth of soil contamination	Approx 3.6 km of tunnel through areas of potential contamination (estimated 90,000m3 of contaminated soil) Approx 5.2 km of new roads through areas of potential contamination (estimated 50,000m3 of contaminated soil) Approx 5.2 km of elevated structures through areas of potential contamination (estimated 40,000m3 of contaminated soil) Approx 10.7 km of elevated structures through areas of potential contamination (estimated 50,000m3 of contaminated soil) Approx 1.4 km of Rail tunnel through areas of potential contamination (estimated 12,000m3 of contaminated soil) Total Approximately 242,000 m3 (in situ) of spoil requires management/disposal	-2	L	unknown extent of potential contamination	20	-0.4
Manage any potentially contaminated land to safeguard human health during and following construction.	Adverse health impacts from inappropriate management of spoil	Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately	Appropriate assessment and management will ensure that adverse impacts are managed	-1	H	Risk that spoil is not appropriately characterised. Risk that Environmental management plans are not developed or implemented appropriately	20	-0.2

Opportunities to contain and allow clean up of contamination in areas adjoining new transport infrastructure.	Reduction in extent of contaminated material in-situ and reduction in disposed and imported soil during construction.	Remediation and management of lengths of tunnel and portals where potential contamination	Approximately 242,000 m3 (in situ) of spoil removed from sites and remediated	1	L	Unknown extent of potential contamination Risk of inappropriate re-use of material.	10	0.10
Minimise waste water production and energy for treatment of contaminated goundwater during construction and operation	Production of wastewater and energy use associated with ongoing treatment of infiltrating water	Length of tunnel through contaminated groundwater areas – NB There is potential for significantly increased inflow in areas of the Yarra Delta sediments as opposed to New Volcanics and Silurian	5.0 km of tunnel in areas of contamination (approx 3.1 Km through Yarra Delta sediments – high inflow)	- 2	L	Potentially extensive volume of contaminated groundwater inflow – ongoing treatment issues	30	-0.6
							TOTAL SCORE	**-1.5**
Other interactions, e.g. environmental, social								
Significant project costs associated with assessment, management and disposal of contaminated soil and acid rock/ sulphate soils								

APPRAISAL SUMMARY TABLE – Land Contamination								
OPTION:	Option B (Road and PT)							
Description	Eastern Freeway to Sunshine Road including CBD rail tunnel							
Base Case								
Problem Addressed	Acid rock, soil and contaminated soil and groundwater							
Other Options								
Govt. policies / strategies supported								
OBJECTIVES: **Protecting human health – and the environment**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**Weighting (%)**	**Total**

Disposal of Acid Sulphate Soil (and Acid Rock)	Environmental impact associated with production of waste, management and disposal of acid sulphate soil and acid rock	Length of tunnel (volume of spoil) within Yarra Delta Sediments has high likelihood of being acid sulphate soil and Silurian Bedrock has some possibility of exhibiting Acid rock characteristics	7.3 Km of tunnel through Yarra Delta Sediments Approximately 820,000m3 (in-situ) of spoil (assume 70% requires management/disposal for acid sulphate) 2.7Km of tunnel through the Silurian Bedrock. Approximately 350,000 m3 (in-situ) of spoil (assume 60% requires management/ disposal). Total ≈ 1.2 million m3	- 2	M	Limited knowledge of extent of acid rock (in Silurian)	20	-0.4
Disposal of Contaminated Soil	Environmental impact associated with production of waste, management and disposal of contaminated spoil	Length of tunnel which is through areas of potentially contaminated soil and within likely depth of soil contamination NB: 40% of soil encountered in surface roadworks contaminated. 10% of tunnels assumed to be at depths likely to encounter contamination (Tunnels at greater depth or within bedrock are less likely to propose an issue)	Approx 4.7 km of tunnel through areas of potential contamination (estimated 120,000m3 of contaminated soil) Approx 4.8 km of new roads through areas of potential contamination (estimated 46,000m3 of contaminated soil) Approx 8.8 km of elevated structures through areas of potential contamination (estimated 68,000m3 of contaminated soil) Approx 10.1 km of road widening through areas of potential contamination (estimated 48,000m3 of contaminated soil) Approx 1.4 km of Rail tunnel through areas of potential contamination (estimated 12,000m3 of contaminated soil) Total Approximately 290,000 m3 (in situ) of spoil requires management/disposal	-2	L	unknown extent of potential contamination	20	-0.4

Manage any potentially contaminated land to safeguard human health during and following construction.	Adverse health impacts from inappropriate management of spoil	Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately	Appropriate assessment and management will ensure that adverse impacts are managed	-1	H	Risk that spoil is not appropriately characterised. Risk that Environmental management plans are not developed or implemented appropriately	20	-0.2
Opportunities to contain and allow clean up of contamination in areas adjoining new transport infrastructure.	Reduction in extent of contaminated material in-situ and reduction in disposed and imported soil during construction.	Remediation and management of lengths of tunnel and portals where potential contamination	Approximately 290,000 m3 (in situ) of spoil from sites and remediated	1	L	Unknown extent of potential contamination Risk of inappropriate re-use of material.	10	0.10
Minimise waste water production and energy for treatment of contaminated goundwater during construction and operation	Production of wastewater and energy use associated with ongoing treatment of infiltrating water	Length of tunnel through contaminated groundwater areas – NB significantly increased inflow in areas of the Yarra Delta sediments as opposed to New Volcanics and Silurian	6.1 km of tunnel in areas of contamination (approx 3.7 Km through Yarra Delta sediments – high inflow)	- 2	L	Potentially extensive volume of contaminated groundwater inflow – ongoing treatment issues	30	-0.6
							TOTAL SCORE	**-1.5**
Other interactions, e.g. environmental, social								
Significant project costs associated with assessment, management and disposal of contaminated soil and acid rock/ sulphate soils								

APPRAISAL SUMMARY TABLE – Land Contamination	
OPTION:	Option C
Description	Road Upgrades and CBD rail tunnel
Base Case	
Problem Addressed	Acid rock, soil and contaminated soil and groundwater
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: **Protecting human health and the environment**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**Weighting (%)**	**Total**
Disposal of Acid Sulphate Soil (and Acid Rock)	Environmental impact associated with production of waste, management and disposal of acid sulphate soil and acid rock	Length of tunnel (volume of spoil) within Yarra Delta Sediments has high likelihood of being acid sulphate soil and Silurian Bedrock has possibility of exhibiting Acid rock characteristics Note, only tunnels have been included, limited acid sulphate producing material is likely to be encountered as part of surface roadworks	5.2 Km of tunnel through Yarra Delta Sediments Approximately 460,000m3 (in-situ) of spoil (assume 70% requires management/disposal for acid sulphate) 0.5Km of tunnel through the Silurian Bedrock. Approximately 25,000 m3 (in-situ) of spoil (assume 60% requires management/ disposal). Total ≈ 485,000 m3	- 1	M	Limited knowledge of extent of acid rock (in Silurian)	30	-0.3
Disposal of Contaminated Soil	Environmental impact associated with production of waste, management and disposal of contaminated spoil	Length of tunnel which is through areas of potentially contaminated soil and within likely depth of soil contamination NB: 40% of soil encountered in surface roadworks contaminated. 10% of tunnels assumed to be at depths likely to encounter contamination (Tunnels at greater depth or within bedrock are less likely to	Approx 0.2 km of tunnel through areas of potential contamination (estimated 5,000m3 of contaminated soil) Approx 6.6 km of new roads through areas of potential contamination (estimated 64,000m3 of contaminated soil) Approx 0.6 km of elevated structures through areas of potential contamination (estimated 5,000m3 of	-1	L	unknown extent of potential contamination	20	-0.2

		propose an issue)	contaminated soil) Approx 1.4 km of Rail tunnel through areas of potential contamination (estimated 12,000m3 of contaminated soil) Total ≈ 96,000 m3					
Manage any potentially contaminated land to safeguard human health during and following construction.	Adverse health impacts from inappropriate management of spoil	Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately	Appropriate assessment and management will ensure that adverse impacts are managed	-1	H	Risk that spoil is not appropriately characterised. Risk that Environmental management plans are not developed or implemented appropriately	20	-0.2
Opportunities to contain and allow clean up of contamination in areas adjoining new transport infrastructure.	Reduction in extent of contaminated material in-situ and reduction in disposed and imported soil during construction.	Remediation and management of lengths of tunnel and portals where potential contamination	Approximately 96,000 m3 (in situ) of spoil from sites remediated	0	L	Unknown extent of potential contamination Risk of inappropriate re-use of material.	10	0.00
Minimise waste water production and energy for treatment of contaminated goundwater during construction and operation	Production of wastewater and energy use associated with ongoing treatment of infiltrating water	Length of tunnel through contaminated groundwater areas – NB significantly increased inflow in areas of the Yarra Delta sediments as opposed to New Volcanics and Silurian	1.6 km of tunnel in areas of contamination (approx 1.1 Km through Yarra Delta sediments – high inflow)	-1	L	Potentially extensive volume of contaminated groundwater inflow – ongoing treatment issues	30	-0.3
							TOTAL SCORE	**-1**
Other interactions, e.g. environmental, social								
Significant project costs associated with assessment, management and disposal of contaminated soil and acid rock/ sulphate soils								

APPRAISAL SUMMARY TABLE – Land Contamination	
OPTION:	Option D (Rail Only)
Description	CBD Rail Tunnell
Base Case	
Problem Addressed	Acid rock, soil and contaminated soil and groundwater
Other Options	
Govt. policies / strategies supported	

OBJECTIVES: **Protecting human health and the environment**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**Weighting (%)**	**Total**
Disposal of Acid Sulphate Soil (and Acid Rock)	Environmental impact associated with production of waste, management and disposal of acid sulphate soil and acid rock	Length of tunnel (volume of spoil) within Yarra Delta Sediments has high likelihood of being acid sulphate soil and Silurian Bedrock has some possibility of exhibiting Acid rock characteristics	3.9 Km of tunnel through Yarra Delta Sediments Approximately 230,000m3 (in-situ) of spoil (assume 70% requires management/disposal for acid sulphate) 0.5 Km of tunnel through the Silurian Bedrock. Approximately 2,100 m3 (in-situ) of spoil (assume 60% requires management/ disposal). Total ≈ 232,000 m3	- 1	M	Limited knowledge of extent of acid rock (in Silurian)	30	-0.3
Disposal of Contaminated Soil	Environmental impact associated with production of waste, management and disposal of contaminated spoil	Length of tunnel which is through areas of potentially contaminated soil and within likely depth of soil contamination NB: 10% of tunnels assumed to be at depths likely to encounter contamination (Tunnels at greater depth or within bedrock are less likely to propose an	Approx 1.4 km of Rail tunnel through areas of potential contamination (estimated 12,000m3 of contaminated soil) Total ≈ 12,000 m3	0	L	unknown extent of potential contamination	30	0.0

Manage any potentially contaminated land to safeguard human health during and following construction.	Adverse health impacts from inappropriate management of spoil	Areas of acid producing spoil and contamination are required to be characterised, handled and disposed of appropriately	Appropriate assessment and management will ensure that adverse impacts are managed	-1	H	Risk that spoil is not appropriately characterised. Risk that Environmental management plans are not developed or implemented appropriately	20	-0.2
Opportunities to contain and allow clean up of contamination in areas adjoining new transport infrastructure.	Reduction in extent of contaminated material in-situ and reduction in disposed and imported soil during construction.	Remediation and management of lengths of tunnel and portals where potential contamination	Approximately 12,000 m3 (in situ) of spoil from sites remediated	0	L	Unknown extent of potential contamination Risk of inappropriate re-use of material.	10	0.00
Minimise waste water production and energy for treatment of contaminated goundwater during construction and operation	Production of wastewater and energy use associated with ongoing treatment of infiltrating water	Length of tunnel through contaminated groundwater areas – NB significantly increased inflow in areas of the Yarra Delta sediments as opposed to New Volcanics and Silurian	1.4 km of tunnel in areas of contamination (approx 0.9 Km through Yarra Delta sediments – high inflow)	-1	L	Potentially extensive volume of contaminated groundwater inflow – ongoing treatment issues	30	-0.3
							TOTAL SCORE	**-0.8**
Other interactions, e.g. environmental, social								
Significant project costs associated with assessment, management and disposal of contaminated soil and acid rock/ sulphate soils								

A.4 Flora and fauna (terrestrial)

APPRAISAL SUMMARY TABLE – Flora and fauna (terrestrial)	
OPTION:	**Option A**
Description	Eastern Freeway to West Gate Freeway road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Protection and enhancement of biodiversity values
Other Options	
Govt. policies / strategies supported	*Flora and Fauna Guarantee Act 1998, Planning and Environment Act 1987, Victoria's Native Vegetation Framework, Port Phillip and Westernport Native Vegetation Plan,*

OBJECTIVES: **Protecting and enhancing biodiversity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RANKING**
Potential interactions with mapped EVCs	Potential modification or removal of native vegetation.	9 Coastal Saltmarsh, 55 Plains Grassy Woodland, 56 Floodplain Riparian Woodland, 61 Box Ironbark Forest, 132 Plains Grassland, 641 Riparian Woodland, 653 Aquatic Herbland, 895 Escarpment Shrubland, 935 Estuarine Wetland/Estuarine Swamp Scrub Mosaic Key areas of potential sensitivity : ▪ Eastern Freeway and Yarra River ▪ Stony Creek Backwash, near West Gate Bridge ▪ Areas adjoining Derrimut Grasslands	Potential interactions within 250m buffer, to allow for preliminary nature of design concepts and considering both potential direct and indirect interactions EVC Hectares 9 1.7 55 8.1 56 5.9 61 1.4 132 6.3 641 2.1 653 1.8 895 2.9 935 0.2	-2	Medium	Medium	25	-0.50
Potential interactions with mapped biosites	Potential modification to biosites.	Dights Falls, Mobil Service Station (Grass VPME07), Newells Paddock, Footscray, Princes Freeway Swamp, Yarra Bend Park (Grass PPKW001).	250m buffer Name Hectares	-2	Medium	Medium	25	-0.50

		Key area of potential sensitivity: ▪ Eastern Freeway and Yarra River ▪ Newells Paddock, Footscray ▪ Areas adjoining Derrimut Grasslands	Dights Falls 4.3 Mobil Service Station (Grass VPME07) 10.6 Newells Paddock, Footscray 11.6 Princes Freeway Swamp 0.8 Yarra Bend Park (Grass PPKW001) 96.4					
Potential interactions with threatened flora and fauna	Potential removal of threatened flora and fauna, their habitat or introduction of movement barriers	The majority of the area is highly urbanised and is not likely to pose major issues with threatened flora or fauna. Key areas of potential sensitivity: ▪ Eastern Freeway and Yarra River ▪ Stony Creek Backwash, near West Gate Bridge. ▪ Areas adjoining Derrimut Grasslands ▪ Newells Paddock, Footscray	250m buffer Fauna: 67 species Flora: 26 species	-1	Medium	Medium	25	-0.25
Potential Interactions with other vegetation (may include in street trees or parklands)	Potential modification or removal of native vegetation.	Areas of native grassland in proximity to the Derrimut Grasslands, The Memorial Park Crematorium and Floral Lawn Cemetery, Urban Forest Reserve G.J. Hosken Reserve, Hansen Park, McIvor Reserve, Donald McLean Reserve, Stony Creek Park Backwash, Newells Paddock Wetlands Park, J.J. Holland Park, Royal Park, Princes Park, Yarra Bend Park, Quarries Park, Henry Turner Memorial Reserve, Queens Pde and Alexandra Pde All these areas have the potential to contain streets trees or parklands that are protected under local planning schemes.	Not available	-1	Medium	Low	25	-0.25
							TOTAL SCORE	**-1.50**

APPRAISAL SUMMARY TABLE - Flora and fauna (terrestrial)

OPTION:	**Option B**
Description	Eastern Freeway to Western Ring Road road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Protection and enhancement of biodiversity values
Other Options	

Govt. policies / strategies supported	*Flora and Fauna Guarantee Act 1998, Planning and Environment Act 1987, Victoria's Native Vegetation Framework, Port Phillip and Westernport Native Vegetation Plan,*							
OBJECTIVES: **Protecting and enhancing biodiversity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RANKING**
Potential impact on mapped EVCs	Potential modification or removal of native vegetation.	9 Coastal Saltmarsh, 55 Plains Grassy Woodland, 56 Floodplain Riparian Woodland, 61 Box Ironbark Forest, 132 Plains Grassland, 641 Riparian Woodland, 653 Aquatic Herbland, 895 Escarpment Shrubland, 935 Estuarine Wetland/Estuarine Swamp Scrub Mosaic Key areas of potential sensitivity: ▪ Eastern Freeway and Yarra River ▪ Braybrook Rail Reserve, west of Tottenham station ▪ Areas adjoining Derrimut Grasslands	250m buffer: EVC Hectares 9 1.7 55 8.4 56 6.1 61 1.7 132 24.9 641 2.2 653 2.1 895 3.0 935 0.2	-2	Medium	Medium	25	-0.50
Potential impact on mapped biosites	Potential modification to biosites.	Braybrook Rail Reserve (Grass PPSU002), Dights Falls, Mobil Service Station (Grass VPME07), Newells Paddock, Footscray, Princes Freeway Swamp, Yarra Bend Park (Grass PPKW001). Key areas of potential sensitivity: ▪ Eastern Freeway and Yarra River ▪ Braybrook Rail Reserve, west of Tottenham station ▪ Areas adjoining Derrimut Grasslands ▪ Newells Paddock, Footscray	250m buffer: Name Hectares Braybrook Rail Reserve (Grass PPSU002) 2.2 Dights Falls 4.4 Mobil Service Station (Grass VPME07) 12.4 Newells Paddock, Footscray 11.6 Princes Freeway Swamp 0.8 Yarra Bend Park (Grass PPKW001) 98.5	-2	Medium	Medium	25	-0.50
Potential interactions with threatened flora and fauna	Potential removal of threatened flora and fauna, their habitat or introduction of	The majority of the area is highly urbanised and is not likely to pose major issues with threatened flora or fauna.	250m buffer: Fauna: 76 species	-1	Medium	Medium	25	-0.25

	movement barriers	Key areas of sensitivity: ▪ Eastern Freeway and Yarra River ▪ Areas adjoining Derrimut Grasslands ▪ Newells Paddock, Footscray	Flora: 42 species					
Potential Impact of other vegetation (may include in street trees or parklands)	Potential modification or removal of native vegetation.	Areas of native grassland in proximity to Derrimut Grasslands, The Memorial Park Crematorium and Floral Lawn Cemetery, Buckingham Reserve, Urban Forest Reserve, G.J. Hosken Reserve, Spurling Reserve Hansen Park, McIvor Reserve, Donald McLean Reserve, Stony Creek Park Backwash, Newells Paddock Wetlands Park, J.J. Holland Park, Royal Park, Princes Park, Yarra Bend Park, Quarries Park. All these areas have the potential to contain streets trees or parklands that are protected under local planning schemes.	Not available	-1	Medium	Low	25	-0.25
							TOTAL SCORE	**-1.50**

APPRAISAL SUMMARY TABLE - Flora and fauna (terrestrial)

OPTION:	**Option C**
Description	Upgrade of the existing road system from Eastern Freeway to Smithfield Road, upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Protection and enhancement of biodiversity values
Other Options	
Govt. policies / strategies supported	*Flora and Fauna Guarantee Act 1998, Planning and Environment Act 1987, Victoria's Native Vegetation Framework, Port Phillip and Westernport Native Vegetation Plan,*

OBJECTIVES: **Protecting and enhancing biodiversity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RANKING**
Potential impact on mapped EVCs	Potential modification or removal of native vegetation.	935 Estuarine Wetland/Estuarine Swamp Scrub Mosaic, 9 Coastal Saltmarsh, 653 Aquatic Herbland. Key areas of sensitivity: ▪ Stony Creek Backwash, near West Gate Bridge	250m buffer: EVC Hectares 9 1.7 132 0.3 935 0.2	-1	Medium	Medium	25	-0.25

Potential impact on mapped biosites	Potential modification to biosites.	Key areas of sensitivity: ▪ Newells Paddock, Footscray	250m buffer: Name — Hectares Newells Paddock, Footscray — 11.6	-1	Medium	Medium	25	-0.25
Potential interactions with threatened flora and fauna	Potential removal of threatened flora and fauna, their habitat or introduction of movement barriers	The majority of the area is highly urbanised and is not likely to pose major issues with threatened flora or fauna. Key areas of sensitivity: ▪ Newells Paddock, Footscray ▪ Stony Creek Backwash, near West Gate Bridge	250m buffer Fauna: 31 species Flora: 7 species	-1	Medium	Medium	25	-0.25
Potential Impact of other vegetation (may include in street trees or parklands)	Potential modification or removal of native vegetation.	Stony Ck Pk Backwash, McIvor Reserve, Angliss Reserve, Dobson Reserve, Donald McLean Reserve, Henry Turner Memorial Reserve, Footscray Park, Newells Paddock Wetlands Park, Maribyrnong River, Royal Park South, Zoological Gardens, Princes Park. All these areas have the potential to contain streets trees or parklands that are protected under local planning schemes.	Not available	-1	Medium	Low	25	-0.25
							TOTAL SCORE	**-1.00**

A.5 Cultural Heritage

APPRAISAL SUMMARY TABLE – Cultural Heritage	
OPTION:	**Option A**
Description	Eastern Freeway to West Gate Freeway road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Preserving indigenous and non-indigenous heritage values
Other Options	
Govt. policies / strategies supported	*Aboriginal Heritage Act* 2006, *Heritage Act* 1995, *Planning and Environmental (Planning Scheme) Act* 1996, *Aboriginal Heritage Regulation* 2007

Road Initiatives **OBJECTIVES:** **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places, areas of cultural heritage sensitivity and areas of Aboriginal significance	Potential moderate-high impacts on Indigenous heritage places and areas.	The area around Dights Falls is said to have been an important inter-tribal or inter-clan meeting/ceremony ground including being a Corroboree site. The natural rock falls at Dights Falls were also a river-crossing point and fish trapping location. A burial ground at the confluence of Merri and the Yarra is also said to have existed. Potential for visual, structural and spiritual interactions during construction. Widening of the Eastern Freeway and associated earthworks near the eastern portal of the new tunnel has the potential for direct and indirect interactions in this area. Royal Park was an important Aboriginal camping ground and has high Aboriginal significance. Area may be impacted visually and structurally by construction of the tunnel and ramp to City Link. Artefact scatters and other cultural/archaeological material may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of alignment where West Gate joins Western Ring Rd and near proposed road widening of Western Ring Road. Construction in this area would be likely to require a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006. Potential for impacts to social significance of archaeological and Aboriginal Places of significance.	-2	Moderate-high	Moderate to high (western exits)	16.67	-0.33

		Potential impacts to be determined through undertaking consultation with the Aboriginal community.					
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potentially high impact on non-Indigenous sites and places	Area around Queens Pde is covered by a Heritage Overlay and tunnel connections at this location may have an impact on heritage significance. There are a number of heritage overlays here that may be of interest: HO327 & 334– the North and South Fitzroy precinct HO93 – the street trees in Queens Parade The majority of the area between Eastern Fwy and City Link is covered by Heritage Overlays and some VHR sites, including the Melbourne Cemetery and some Melbourne Uni buildings. Tunnelling through this area may result in vibration and subsidence impacts on heritage buildings and VHR sites. Impacts to social, religious and visual significance of key European cultural heritage sites. Construction and tunnelling around Royal Park, Melbourne Uni and Melbourne Cemetery, will require extensive community and government consultation regarding visual and structural impacts	-3	Low-moderate	Moderate-high	16.67	-0.50
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Potential moderate-high impact on area of Indigenous cultural sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed alignment. The Maribyrnong River is an area of cultural heritage sensivity as defined in the *Aboriginal Heritage Regulations* 2007. . Construction around Dynon Rd and Smithfield Rd would be likely to require a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006. Construction around the Stony Creek and Yarra River confluence, Stony Creek crossing and Moonee Ponds Creek exits (including City Link) may also trigger e requirement for CHMP due to their being defined as areas of cultural heritage sensivity under the *Aboriginal Heritage Regulations* 2007. Construction around where West Gate joins Western Ring Rd may impact on Western Plains landscape, an area of cultural heritage sensivity if so, would also trigger a CHMP.	-2	Moderate-high	Moderate -high (partic. Kororoit Creek)	16.67	-0.33
<u>Public Transport Initiatives</u> **OBJECTIVES:**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING** **(% OF 100)**	**RANKING**

Preserving Indigenous / non-Indigenous heritage							
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on Indigenous heritage places and areas.	For the CBD Rail and Doncaster Rapid Bus Transport options there are no obvious interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance, however, would need to undertake consultation with Aboriginal community to confirm. For the Tarneit Rail, artefact scatters may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of the indicative rail corridor at the Derrimut Rd proposed station and surrounding area. There are also artefact scatters in the area around Deer Park. Construction in these areas would be likely to require a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006.	-2	Moderate-high	Moderate to high	16.67	-0.33
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potential low-moderate impacts on with known locations of non-Indigenous sites/places and heritage overlays	Heritage Overlays and Victorian Heritage Register sites may be impacted visually and structurally by construction and may result in vibration and subsidence impacts on heritage buildings and VHR sites. A possible rail station near VHR listed buildings at Melbourne University will potentially impact on the social, historical and visual significance of these buildings. A possible rail station is shown at the Footscray Railway Station Complex. This is a VHR listed site and is of aesthetic, architectural, social and historical importance to the State of Victoria. Construction at this site will potentially impact on the social, historical and visual significance of this site. May need community and government consultation regarding visual, historical and structural impacts. Proposed bus interchange at Victoria Park will need to ensure construction does not impact on the VHR listed Victoria Park or nearby buildings, which are protected by Heritage Overlay controls. Road widening proposed along Ballarat Rd may impact on Kinnears Ropeworks, which is located on Ballarat Rd, Footscray. Kinnears Ropeworks (VHR listed) is a large industrial complex of buildings built between 1909-1969. It is of historical, social, scientific (technological) and architectural significance to the State of Victoria. There are also several other properties covered by a Heritage Overlay that will be potentially impacted by the road widening works.	-2	Low-moderate	Moderate	16.67	-0.33

		Ashley St / Paramount Rd upgrading will impact on one property covered by a Heritage Overlay					
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Low potential for impacts on areas of Indigenous cultural heritage sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed Tarneit Rail and may trigger a requirement for a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006.	-2	Moderate-high	Moderate	16.67	-0.33
						TOTAL SCORE	**-2.17**

APPRAISAL SUMMARY TABLE – Cultural Heritage	
OPTION:	**Option B**
Description	Eastern Freeway to Western Ring Road road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Protection of indigenous and non-indigenous heritage values
Other Options	
Govt. policies / strategies supported	*Aboriginal Heritage Act 2006*, *Heritage Act 1995*, *Planning and Environmental (Planning Scheme) Act* 1996, *Aboriginal Heritage Regulation* 2007

Road Upgrades **OBJECTIVES:** **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on Indigenous heritage places and areas.	The area around Dights Falls is said to have been an important inter-tribal or inter-clan meeting/ceremony ground including being a Corroboree site. The natural rock falls at Dights Falls were also a river-crossing point and fish trapping location. A burial ground at the confluence of Merri and the Yarra is also said to have existed. Area may be impacted visually and structurally by construction. Widening of the Eastern Freeway and associated earthworks near the eastern portal of the new tunnel has the potential for direct and indirect interactions in this area. Royal Park was an important Aboriginal camping ground and has high Aboriginal significance. Area may be impacted visually and structurally by construction of the tunnel and ramp to City Link. Artefact scatters may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of the proposed alignment along Western Ring Road from Forest Rd to Boundary and in addition in vicinity of alignment where West Gate joins Western Ring Rd. Construction includes both new road and road widening. Construction in this area would be likely to require a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006. Potential for impacts to social significance of archaeological and Aboriginal Places of significance.	-2	Moderate	Moderate - High	16.67	-0.33

		Potential impacts to be determined through undertaking consultation with the Aboriginal community.					
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potentially high impact on non-Indigenous sites and places	Area around Queens Parade is covered by a Heritage Overlay and tunnel connections at this location may have an impact on heritage significance. The majority of the area between Eastern Fwy and City Link is covered by Heritage Overlays and some VHR sites, including the Melbourne Cemetery and some Melbourne Uni buildings. Tunnelling through this area may result in vibration and subsidence impacts on heritage buildings and VHR sites. Impacts to social, religious and visual significance of key European cultural heritage sites. Construction and tunnelling around Royal Park, Melbourne Uni and Melbourne Cemetery, will require extensive community and government consultation regarding visual and structural impacts There is a cluster of VHR sites and Victorian Heritage Inventory (VHI) sites in the vicinity of the alignment near Maribyrnong River in Footscray, the most significant being Henderson House (VHR), which is of historical and architectural significance to the State of Victoria, and Saltwater River Crossing and Footscray Wharves (VHR), which are of historical, archaeological and social importance to the State of Victoria. Cut and cover construction is proposed for this area which could have a significant impact. A tunnel is proposed underneath Footscray Railway Station Complex (VHR), which is of aesthetic, architectural, social and historical importance to the State of Victoria. Potential for vibration and subsidence impacts.	-3	Low-Moderate	Moderate-High	16.67	-0.50
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Potential moderate-high impact on area of Indigenous cultural sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed alignment. The Maribyrnong River has high potential for Aboriginal sensitivities. Construction around Dynon Rd and Smithfield Rd would be likely to require a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006. Construction at the Stony Creek and Kororoit Creek crossing may also trigger e requirement for CHMP. Construction along Western Ring Road from Forest Rd to Boundary and around where West Gate joins Western Ring Rd may impact on Western Plains landscape if so, would also trigger a CHMP.	-2	Moderate-high	Moderate -high	16.67	-0.33

Public Transport Upgrades **OBJECTIVES:** **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on indigenous heritage places and areas.	For the CBD Rail and Doncaster Rapid Bus Transport options there are no obvious interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance, however, would need to undertake consultation with Aboriginal community to confirm. For the Tarneit Rail, artefact scatters may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of the indicative rail corridor at the Derrimut Rd proposed station and surrounding area. There are also artefact scatters in the area around Deer Park. Construction in these areas would be likely to require a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006. Not near Derrimut grasslands	-2	Moderate-high	Moderate to high	16.67	-0.33
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potential low-moderate impacts on with known locations of non-Indigenous sites/places and heritage overlays	Heritage Overlays and Victorian Heritage Register sites may be impacted visually and structurally by construction and may result in vibration and subsidence impacts on heritage buildings and VHR sites. A possible rail station near VHR listed buildings at Melbourne University will potentially impact on the social, historical and visual significance of these buildings. A possible rail station is shown at the Footscray Railway Station Complex. This is a VHR listed site and is of aesthetic, architectural, social and historical importance to the State of Victoria. Construction at this site will potentially impact on the social, historical and visual significance of this site. May need community and government consultation regarding visual, historical and structural impacts. Proposed bus interchange at Victoria Park will need to ensure construction does not impact on the VHR listed Victoria Park or nearby buildings, which are protected by Heritage Overlay controls.	-2	Low-moderate	Moderate	16.67	-0.33

Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Low potential for impacts on areas of Indigenous cultural heritage sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed Tarneit Rail and may trigger a requirement for a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006.	-2	Moderate-high	Moderate	16.67	-0.33
						TOTAL SCORE	**-2.17**

APPRAISAL SUMMARY TABLE – Cultural Heritage	
OPTION:	**Option C**
Description	Upgrade of the existing road system from Eastern Freeway to Smithfield Road, upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Protection of indigenous and non-indigenous heritage values
Other Options	
Govt. policies / strategies supported	*Aboriginal Heritage Act 2006*, *Heritage Act 1995*, *Planning and Environmental (Planning Scheme) Act* 1996, *Aboriginal Heritage Regulation* 2007

Road Upgrades **OBJECTIVES:** **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on indigenous heritage places and areas.	Royal Park was an important Aboriginal camping ground and has high Aboriginal significance. Area may be impacted visually and structurally by construction. Potential for Impacts to social significance of archaeological and Aboriginal Places of significance. Potential impacts to be determined through undertaking consultation with the Aboriginal community.	-1	Moderate	Moderate to high	16.67	-0.17
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potentially high impact on non-Indigenous sites and places	The majority of the area between Eastern Fwy and City Link is covered by Heritage Overlays and some VHR sites, including the Melbourne Cemetery and some Melbourne Uni buildings. Potential impacts on heritage buildings and VHR sites. Particularly along Princes Street and Rathdowne Impacts to social, religious and visual significance of European cultural heritage sites. Construction around	-3	Moderate	Moderate - High	16.67	-0.50

		Royal Park, Melbourne Uni and Melbourne Cemetery, will require extensive community and government consultation regarding visual and structural impacts Road widening proposed along Ballarat Rd may impact on Kinnears Ropeworks, which is located on Ballarat Rd, Footscray. Kinnears Ropeworks (VHR listed) is a large industrial complex of buildings built between 1909-1969. It is of historical, social, scientific (technological) and architectural significance to the State of Victoria. There are also several other properties covered by a Heritage Overlay that will be potentially impacted by the road widening works. Ashley St / Paramount Rd upgrading will impact on one property covered by a Heritage Overlay					
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Potential moderate-high impact on area of Indigenous cultural sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed alignment. The section of tunnel from Royal Park to Smithfield Rd has potential impacts on an area of cultural heritage sensitivity due to the location of entry and exit points within 200m of the Moonee Ponds Creek and Maribyrnong River. In particular, the Maribyrnong River has high potential for Aboriginal places. Construction around these areas would be likely to require a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006. Construction of the Dynon Rd and Smithfield Rd link would similarly trigger a CHMP. The construction of the freight connectivity box will interact with Stony Creek at a number of points and is also likely to trigger a CHMP.	-2	Moderate	Moderate - High	16.67	-0.33
<u>Public Transport initiatives</u> **OBJECTIVES:** **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING** **(% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on Indigenous heritage places and areas.	For the CBD Rail and Doncaster Rapid Bus Transport options there are no obvious interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance, however, would need to undertake consultation with Aboriginal community to confirm. For the Tarneit Rail, artefact scatters may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of the indicative rail corridor at the Derrimut Rd proposed station and	-2	Moderate-high	Moderate to high	16.67	-0.33

		surrounding area. There are also artefact scatters in the area around Deer Park. Construction in these areas would be likely to require a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006.					
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potential low-moderate impacts on with known locations of non-Indigenous sites/places and heritage overlays	Heritage Overlays and Victorian Heritage Register sites may be impacted visually and structurally by construction and may result in vibration and subsidence impacts on heritage buildings and VHR sites. A possible rail station near VHR listed buildings at Melbourne University will potentially impact on the social, historical and visual significance of these buildings. A possible rail station is shown at the Footscray Railway Station Complex. This is a VHR listed site and is of aesthetic, architectural, social and historical importance to the State of Victoria. Construction at this site will potentially impact on the social, historical and visual significance of this site. May need community and government consultation regarding visual, historical and structural impacts. Proposed bus interchange at Victoria Park will need to ensure construction does not impact on the VHR listed Victoria Park or nearby buildings, which are protected by Heritage Overlay controls.	-2	Low-moderate	Moderate	16.67	-0.33
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Low potential for impacts on areas of Indigenous cultural heritage sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed Tarneit Rail and may trigger a requirement for a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006.	-2	Moderate-high	Moderate	16.67	-0.33
						TOTAL SCORE	**-2.00**

APPRAISAL SUMMARY TABLE – Cultural Heritage	
OPTION:	**Option D**
Description	CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Preservation of indigenous and non-indigenous heritage values
Other Options	
Govt. policies / strategies supported	*Aboriginal Heritage Act 2006*, *Heritage Act 1995*, *Planning and Environmental (Planning Scheme) Act* 1996, *Aboriginal Heritage Regulation* 2007

OBJECTIVES: **Preserving Indigenous / non-Indigenous heritage**	**IMPACTS**	**DESCRIPTION**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING** **(% OF 100)**	**RANKING**
Potential interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance	Potential moderate-high impacts on indigenous heritage places and areas.	For the CBD Rail and Doncaster Rapid Bus Transport options there are no obvious interactions with known locations of Indigenous cultural heritage places and areas of Aboriginal significance, however, would need to undertake consultation with Aboriginal community to confirm. For the Tarneit Rail, artefact scatters may be disturbed or destroyed by construction. There are registered Aboriginal artefact scatters in vicinity of the indicative rail corridor at the Derrimut Rd proposed station and surrounding area. There are also artefact scatters in the area around Deer Park. Construction in these areas would be likely to require a Cultural Heritage Management Plan (CHMP) under the Aboriginal Heritage Act 2006.	-2	Moderate-high	Moderate to high	33.33	-0.67
Potential interactions with known locations of non-Indigenous sites/places and heritage overlays	Potential low-moderate impacts on with known locations of non-Indigenous sites/places and heritage overlays	Heritage Overlays and Victorian Heritage Register sites may be impacted visually and structurally by construction and may result in vibration and subsidence impacts on heritage buildings and VHR sites. A possible rail station near VHR listed buildings at Melbourne University will potentially impact on the social, historical and visual significance of these buildings. A possible rail station is shown at the Footscray Railway Station Complex. This is a VHR listed site and is of aesthetic, architectural, social and historical importance to the State of Victoria. Construction at this site will potentially impact on the social, historical	-2	Low-moderate	Moderate	33.33	-0.67

		and visual significance of this site. May need community and government consultation regarding visual, historical and structural impacts. Proposed bus interchange at Victoria Park will need to ensure construction does not impact on the VHR listed Victoria Park or nearby buildings, which are protected by Heritage Overlay controls.					
Predictive modelling of impacts to areas of Indigenous cultural heritage sensitivity	Low potential for impacts on areas of Indigenous cultural heritage sensitivity	Areas of moderate to high cultural heritage sensitivity will potentially be impacted by the proposed Tarneit Rail and may trigger a requirement for a Cultural Heritage Management Plan (CHMP) under the *Aboriginal Heritage Act* 2006.	-2	Moderate-high	Moderate	33.33	-0.67
						TOTAL SCORE	**-1.00**

A.6 Air Quality and Greenhouse

This Appendix is in two parts: (i) The first provides descriptions of the methodology used to rank the *Options A-D* and lists some numerical results; (ii) The second part provides the results in the standard Appraisal Table format.

A.6.1 Air Quality Scoring Methodology

This section sets out the calculations used to determine final scores for the (semi-qualitative) air quality assessment. The criteria used for the assessment are, for each Option versus the Base Case: (1) Potential for air quality impacts on the Melbourne Airshed; (2) Potential effects on air quality at the local level; and (3) Potential air quality impacts from road tunnel stack emissions.

Using these three criteria, estimates for numerical ratings relative to the Base Case have been determined and these are provided in **Table A.5-1**. The reasoning for the score estimates for parameters (1) and (3) are provided in the main body of the report and will not be repeated here. The next sub-section provides descriptions and results for the analysis of parameter (2).

- **Table A5-1 Raw assessment scores – relative to Base Case**

Route Option	(1) Impacts on Airshed	(2) Local air quality effects	(4) Road tunnel stacks
A	0	- 0.18	-1.5
B	0	+ 0.10	-2.0
C	0	- 0.13	-1.0
D	0	+ 0.36	0.0

A.6.2 Notes on potential air quality effects at the local level criteria

This section details the method used for determining the numerical scores provided for potential air quality effects at the local level. The method is based on the assumption that changes in traffic flow associated with flows that are already high, (e.g. morning peaks greater than 5,000 vehicles), and changes to those high flows having the greatest potential to affect air quality at locations adjacent to the alignment. The effects could be potential air quality impacts associated with increased emissions, or potentially improved air quality associated with reduced traffic congestion.

First, the VLC modelling results for morning peak traffic volumes predicted for each of the options were selected as the key input data for the analysis. Local (near-road) air quality impacts have been assumed to be better reflected in these more intense traffic flows, which would affect air quality on nearby sensitive receivers (as opposed to 24-hour average traffic flows that may be more reflective of impacts on the Melbourne Airshed).

The selected morning peak traffic flow data, based on morning peaks greater than 5,000 vehicles, are illustrated in **Figure A5-1** below (figure extract from a spreadsheet). Note that few reductions, (in comparison to the Base Case), are predicted for the morning peaks for any of the options. Specifically higher morning peaks are predicted for: Western Ring Road, Princes Highway, Westgate Freeway, and Eastern Freeway.

Some of the higher traffic flows have been deleted from the analysis because they are considered separately elsewhere (tunnels), or the air pollutants are expected to be well dispersed due to the emissions being remote from sensitive receptors, such as emissions from higher elevations; i.e., Westgate Bridge and CityLink.

- **Figure A5-1 Predicted morning-peak traffic flows >5,000 vehicles**

SCREENLINE 2031	ROAD	Base Case	Option A	Option B	Option C	Option D
Screenline 2: Outer West	Western Ring Road	12,170	14,117	13,940	12,059	12,155
	Princes Highway	14,130	14,337	14,150	14,119	13,981
Screenline 3: West	Ballarat Road	5,201	5,361	5,125	5,583	5,104
	Geelong Road	4,744	4,795	6,094	5,118	4,576
	Westgate Freeway	16,621	16,091	14,038	14,993	14,010
Screenline 4: Inner West	Ballarat Road	3,222	4,686	2,825	5,621	3,147
	Dynon Road	5,165	4,418	4,555	4,834	4,925
	Westgate Bridge	x	x	x	x	x
Screenline 5: Inner South	Beaconsfield Parade	5,318	5,244	5,253	5,310	5,333
	Queens Road	6,825	6,641	6,655	6,675	6,730
	St Kilda Road	5,508	5,388	5,375	5,400	5,434
Screenline 6: Central	Princes Street	3,934	3,788	3,962	5,343	3,804
	Burnley/Domain Tunnels	x	x	x	x	x
Screenline 7: Inner East	Heidelberg Rd	6,388	6,150	6,207	6,228	6,208
	Eastern Fwy	11,420	11,272	11,340	11,449	11,395
	City Link	x	x	x	x	x
	Dandenong Road	5,367	5,185	5,219	5,247	5,280
CBD - East-West	CityLink	x	x	x	x	x
	Hoodle St	5,352	5,457	5,455	5,489	5,542
East-West - north	Tullamarine Fwy	10,336	10,549	10,449	10,349	10,320

The raw scores for these high morning peak flows were based on differences between the traffic flows for each option and the Base Case, for each screenline analysed. These differences were converted to scores between approximately -3 and +3 for vehicle flows of approximately 10,000 vehicles, and between approximately -2 and +2 for vehicle flows of approximately 5,000 vehicles.

For example, scores for alignments with morning peaks consisting of approximately 10,000 vehicles were based on a score of approximately -3 for the Western Ring Road alignments (Options A and B). Similarly, vehicle flows of approximately 5,000 vehicles were based on a score of approximately -2 for the substantially increased flow for Ballarat Road. These examples are shown highlighted in **Figure A5-2**, which shows the set of (raw) scores for all alignments.

- **Figure A5-2 Calculated raw scores for morning-peak traffic flows >5,000 vehicles**

SCREENLINE 2031	ROAD	not used	Option A	Option B	Option C	Option D
Screenline 2: Outer West	Western Ring Road		**-3.2**	**-2.9**	0.2	0.0
	Princes Highway		-0.3	0.0	0.0	0.2
Screenline 3: West	Ballarat Road		-0.2	0.1	-0.5	0.1
	Geelong Road		-0.1	-1.7	-0.5	0.2
	Westgate Freeway		0.9	4.2	2.6	4.2
Screenline 4: Inner West	Ballarat Road		-1.8	0.5	**-3.0**	0.1
	Dynon Road		0.9	0.8	0.4	0.3
	Westgate Bridge		x	x	x	x
Screenline 5: Inner South	Beaconsfield Parade		0.1	0.1	0.0	0.0
	Queens Road		0.2	0.2	0.2	0.1
	St Kilda Road		0.2	0.2	0.1	0.1
Screenline 6: Central	Princes Street		0.2	0.0	-1.8	0.2
	Burnley/Domain Tunnels		x	x	x	x
Screenline 7: Inner East	Heidelberg Rd		0.3	0.2	0.2	0.2
	Eastern Fwy		0.2	0.1	0.0	0.0
	City Link		x	x	x	x
	Dandenong Road		0.2	0.2	0.2	0.1
CBD - East-West	CityLink		x	x	x	x
	Hoodle St		-0.1	-0.1	-0.2	-0.2
East-West - north	Tullamarine Fwy		-0.3	-0.2	0.0	0.0

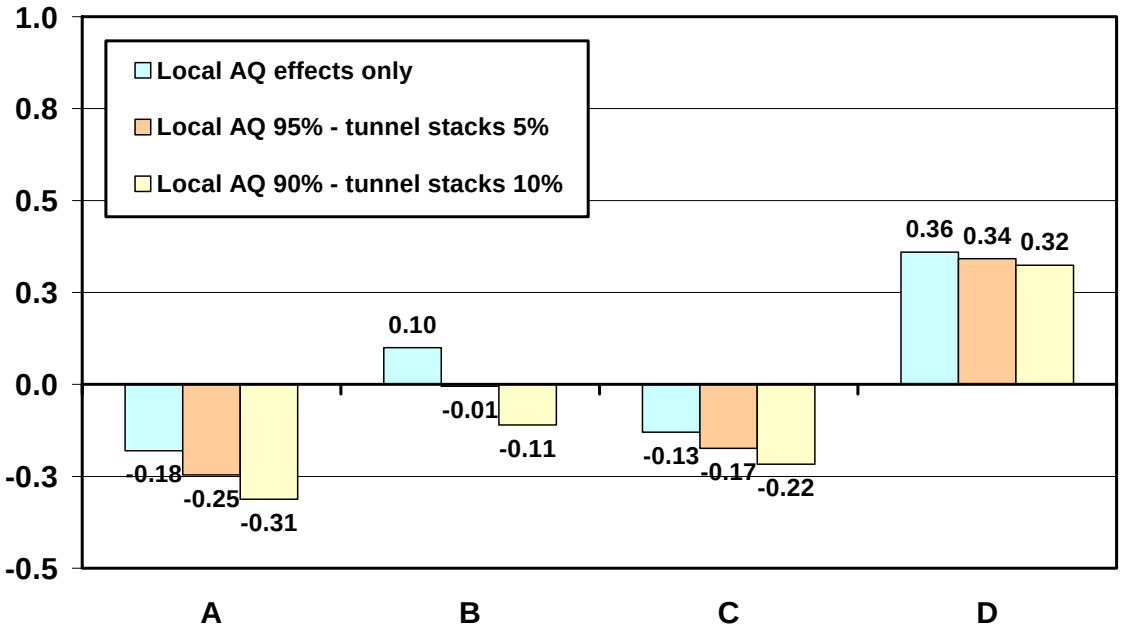
The final raw scores, for Criteria 2, local air quality effects, were then determined by an average of these raw scores (2 significant figures are shown here only to assist with tracking of the calculations):

- Option A = **- 0.18**; Option B = **+ 0.10**; Option C = **- 0.13**; Option D = + **0.36**.

A.6.3 Final calculated scores

The Criteria (1), airshed impacts, is effectively deleted from the final analysis because the Option results are all very similar to the Base Case. Weightings were assigned to the raw parameter scores provided in **Table A5-1** and three trial results are provided in **Figure A5-3**. The first trial considers the effects on local air quality only (Criteria 2, shown in blue); the second shows the results with some weighting given to the scores for Criteria 3, impacts from stacks. A small weighting (5%) is assigned to stacks here with the assumption that tunnel and stack design would lead to good air emissions control. The results for a slightly larger weighting (10%) are provided for the third trial.

- **Figure A5-3 Calculated raw scores for each alignment based on peak AM traffic flows**



Selecting the middle trial as the 'final answer', and given that results for Options A and C are very similar, the final results are provided in **Table A5-2**. Note that numerical precision has been carried through all the calculations, so results re-calculated using only the data provided here may not produce the same results exactly.

- **Table A5-2 Final scores for air quality effects**

Route Option	Final scores	Rank
A	- 0.2	Approx. equal 3rd
B	~ 0	2nd
C	- 0.2	Approx. Equal 3rd
D	+ 0.3	1st

Refer also to the project's standard Appraisal Table format provided overleaf.

A.6.4 Air Quality Assessment

OPTION:	A. Rail tunnel etc. + new roads and upgrades
Description	
Base Case	
Problem Addressed	**(a) Ambient air quality impacts on human health and amenity; & (b) Air pollutant impacts on human occupational health and safety**
Other Options	**-----**
Govt. policies / strategies supported	**SEPP (Air Quality Management)**

OBJECTIVES:	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	RATING	CONFIDENCE	RISKS
Protecting / enhancing existing air / amenity						
To minimise ambient air quality impacts on human health and amenity in specific localities.	Human health & amenity (a) increased air pollutant concentrations; (b) reduced visibility; (c) worsening odours; (d) visible plumes from stacks; (e) deposited soot.	Road vehicle air emissions impacting on ambient air quality near roadways; (b) impacting on ambient air quality in the Melbourne Airshed; and (c) impacting on amenity more particularly near the road alignment.	VLC-modelled air emissions: NOx used as the key indicator.	**-0.2**	**Medium**	**Medium**
To minimise impacts on Occupational Health & Safety (vehicle occupants, motorcycle and bicycle riders, pedestrians).	Human health	Air pollutants adjacent to road alignments and for example within vehicle cabins while in tunnels.	VLC-modelled air emissions: NOx used as the key indicator.			
OPTION:	**B. Rail tunnel etc. + new roads and upgrades**					
Other cells as above.				**0.0**		
OPTION:	**C. Rail tunnel etc. + new roads and upgrades**					
Other cells as above.				**-0.2**		
OPTION:	**D. Rail tunnel etc. but no new roads / upgrades**					
Other cells as above.				**+0.3**		

A.6.5 Greenhouse Gas Emissions

OPTION:	All (A, B, C & D)
Description	
Base Case	
Problem Addressed	**Greenhouse gas emissions**
Other Options	**-----**
Govt. policies / strategies supported	**SEPP (Air Quality Management)**

OBJECTIVES:	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE	RISKS
Contribute to target of containing climate change impacts						
Efficient use of resources and reduce energy use and greenhouse gas emissions	Global climate	Warmer global temperatures and rising sea level for example, causing, e.g., potential losses and shifts in human populations.	Total CO2 emissions for the Base Case and 4x Options assessed for the transport corridor and associated networks.	**0** Performance of the options were very similar for each of the options and the Base Case based on the transport modelling results. Refer Sustainability section for broader, interpretive analysis	**High**	**Low**

A.7 Noise

APPRAISAL SUMMARY TABLE - Noise	
OPTION	**Option A**
Description	Public Transport: Three Public Transport initiatives are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes,Tarneit Rail. Road: New East-West Road Option – from Eastern terminal at Eastern Freeway and Hoddle St to Western terminal at Laverton. Major interchanges at Western Link at Parkville, Dynon Rd at Footscray and West Gate Freeway at Williamstown Rd.
Base Case	2031
Problem Addressed	Road and rail operational noise and construction noise
Other Options	
Govt. policies / strategies supported	There are no policies regarding rail noise. VicRoads Traffic Noise Reduction Policy referenced and EPA Technical Guideline 302/92 for construction noise.
Notes	- dB(A) refers to the full criteria descriptor. - a 3 dB(A) change results from a halving or doubling in traffic volume. - Community reaction to extra (new) traffic noise is generally greater than a reaction to an equivalent noise reduction. Also, whilst significant traffic volume changes will only cause a small increase in traffic noise levels, the community reaction to an increase in traffic volumes (forecast or actual) is significant compared to the small change in noise levels. The weightings in the assessment are based on this premise.

Public Transport initiatives

OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	The rail noise objective will be applied, whilst the contribution of the bus option to the road infrastructure will be considered.	There are three public transport proposals for this option. CBD Rail Tunnel, Doncaster Rapid Transport and Tarneit Rail.	The impacts of the three options are: <u>CBD Rail Tunnel:</u> There will be an increase in train traffic that will generate a small increase in rail noise. The increase will be restricted to the areas next to the Werribee and Dandenong lines. <u>Doncaster Rapid Transport:</u> There will be an increase in bus trips and a small increase in road traffic noise along the new bus routes. <u>Tarneit Rail:</u> There will be an increase in train traffic on the Werribee and Deer Park lines that will generate a small increase in existing rail noise in the areas next to the lines. There will be new rail noise in the proposed V/Line corridor between Werribee and Deer Park.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve.	15	-0.08
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	There will be new noise impacts from the proposed new rail links, whilst there will be small increases in existing noise levels where the option upgrades the existing infrastructure.	The following potential changes to noise exposure are identified. <u>CBD Rail Tunnel</u>: Potentially the surface corridor component of this initiative will need to be widened to accommodate the extra rail-lines, and the noise source will get closer to some residences. The	An estimate of the noise changes is made. <u>CBD Rail Tunnel</u>: The Werribee corridor is not as restricted as the Dandenong corridor, so there should be only a small increase at properties abutting the line. There will be a significant number of properties impacted by increases in rail noise in the Dandenong corridor as the corridor may need widening, with the removal of some					

		railway noise objective is already exceeded in some locations and more locations will exceed the criteria with this proposal. Near the heavily utilised Dandenong corridor the noise impacts will be a key issue to be addressed during detailed planning. Doncaster Rapid Transport: There will be small increases in traffic noise levels on the Eastern Freeway; the existing noise barriers may be able to accommodate this increase. Increases in traffic noise due to new or improved routes, will probably not require amelioration. Tarneit Rail: As it is a new railway line there will be new impacts. Most of the line will be in rural like areas which have a low existing noise level. The urban sections will have slightly higher existing noise levels. The impacts in areas abutting the new line will be significant.	properties. Doncaster Rapid Transport: The increase in traffic noise on the Eastern Freeway will be less than 1 dB(A). With changes in traffic flow on some roads eg Johnston St, as the traffic lanes are reduced, there will be a significant reduction in traffic noise, up to 5 dB(A), regardless of the increase in bus traffic. Where there are new and improved bus routes, there will be up to 1 dB(A) increase in traffic noise levels. Tarneit Rail: The new railway noise levels will be up to 20-30 dB(A) Lmax louder than the existing background noise levels. The criteria Leq hourly levels, could be >10 dB(A) than existing levels, during the hours of railway operation.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve. Changes in road lanes and road access that is needed to fore fill the proposal may lead to community reaction.	20	-0.1
Potential enhancement of acoustic environment due to reduction in traffic	Where traffic is removed from an area due to increased patronage of enhanced public transport services, there will be a reduction in associated traffic noise.	There would be significant reductions in existing traffic noise at locations where the traffic configuration is altered significantly. Generally, there will be small reductions in traffic noise levels at a small number of locations where motor vehicle users are attracted to the enhanced public transport services.	If the Johnston St traffic measures are bought in then there could be up to 5 dB(A) noise reduction in this area. In other areas the reduction could be as little as 1 dB(A).	+1	M	Lane closures will lead to traffic disruption.	5	+0.05
Reduction in traffic volumes on local streets	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be small reductions in traffic noise levels at some locations as motor vehicle passenger's transfer to the more attractive public transport options.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Needs to be backed by strong and lasting traffic management measures.	5	+0.05
Road network development initiatives								
OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	Substantial traffic noise attenuation measures will be required to achieve the assessment criteria.	Additional traffic on the Eastern Freeway (east of Hoddle Street), City Link (north of Flemington Road) and Westgate Freeway (west of Hyde Street) could require additional noise protection to achieve criteria. City Link has a traffic noise criteria	Noise attenuation measures will include noise barriers and other road based techniques and building insulation where this is a reasonable option. Other than the forecast growth on City Link (north of Flemington Road), there is little flexibility for unforecast growth, such as what could result from the proposed new freeway connection. If the volumes increase on City Link substantially, the Link criteria may be exceeded	-1.5	M	Imprecise traffic volumes and % heavy vehicle content could result in small noise level errors.	15	-0.23

		of 63dB(A) L10 (18hr), fixed for the duration of the concession.	and new noise barriers will need to be installed.					
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	Approximately 750 residences will be directly impacted by a range of noise level increases along the route alignment.	Increases in noise levels in sensitive areas: Substantial – Ballarat Rd, Maidstone, Paramount Rd, Ashley St, West Footscray, Moderate – Queens Pde, Fitzroy, Hyde St, Yarraville, Small – Clifton Hill, Tranancore, Kew, and other suburbs adjacent to the Eastern Freeway. Other potential small increases are in: Altona North, West Sunshine, and Brunswick West. Noise increases on Western Link will need to be investigated as part of the assessment process as there may be significant financial penalties associated with noise treatments on the Link.	Noise barriers on the proposed road would need to be erected in these areas (length): - Yarraville (Hyde St) protecting about 35 residences, 300m Retrofitted barriers will be required in the following areas: - Eastern Freeway, Clifton Hill, 700 m protecting about 40 residences - City Link, West Brunswick to Parkville, 4000m protecting about 150 residences - West Gate Freeway, Williamstown Rd to Grieve Pde, 4000m protecting about 250 residences Building insulation would be required in these areas: - Tunnel portal to Queens Pde, protecting about 15 residences, - Ballarat Rd, protecting about 200 residences, - Paramount Rd & Ashley St protecting about 60 residences.	-1.5	M	New noise source in Yarraville and removes buildings and vegetation in Fitzroy which will meet community opposition.	15	-0.23
Potential enhancement of acoustic environment due to reduction in traffic	There will be small decreases in noise levels in many areas where traffic volumes are predicted to decrease.	There will be potentially small changes in noise levels even though there will be significant reductions in the traffic volumes. There may be opportunities to enhance the reduction by applying traffic management techniques (road closures, traffic restrictions, etc) as traffic is diverted to the proposed road.	Variable noise and traffic congestion reductions in the Collingwood, Fitzroy, Carlton and Parkville areas.	+1	M	Perceived low noise reduction seen as only minor benefit by residents.	5	+0.05
Reduction in traffic volumes on local streets	There will potentially be significant traffic volume reductions in most inner city areas.	Modelling indicates that in the inner suburbs there are areas where a significant number of roads may have a traffic volume reduction of more than 40%. Whilst this is a large number of vehicles, this only translates to a small reduction in noise levels.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Management measures to capture benefits of reduced traffic volumes will require consultation with potentially effected stakeholders.	5	+0.05
Other interactions, e.g. environmental, social	Construction Noise	Construction noise will probably extend over a few years in some locations, and will result in on-going annoyance with in the local community.	Construction noise will need to be ameliorated if it extends outside the normal hours of operation according to EPA noise guidelines.	-1	M		7.5	-0.08
	Traffic modelling volumes	Whilst traffic noise is relatively insensitive to small changes in traffic volume, there will be a perception that traffic model variations will result in inaccuracies in the traffic noise impact modelling	Determine and communicate the noise level changes associated with the traffic modelling changes if and when they occur. Potential for misleading information.	-0.5	S		2.5	-0.01
OPTION TOTAL RATING								**-0.66**

APPRAISAL SUMMARY TABLE - Noise	
OPTION:	**Option B**
Description	Public Transport: Three Public Transport routes are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail. Road: Full New East-West Option - Eastern terminal at Eastern Freeway and Hoddle St, Western terminal at Western Ring Road at Sunshine West. Major interchanges at Western Link at Parkville, Dynon Rd at Footscray and West Gate Freeway at Williamstown Rd.
Base Case	
Problem Addressed	Roads Traffic Noise and Construction Noise
Other Options	
Govt. policies / strategies supported	There are no policies regarding rail noise. VicRoads Traffic Noise Reduction Policy referenced and EPA Technical Guideline 302/92 for construction noise.
Notes	- dB(A) refers to the full criteria descriptor. - a 3 dB(A) change results from a halving or doubling in traffic volume. - Community reaction to extra (new) traffic noise is generally greater than a reaction to an equivalent noise reduction. Also, whilst significant traffic volume changes will only cause a small increase in traffic noise levels, the community reaction to an increase in traffic volumes (forecast or actual) is significant compared to the small change in noise levels. The weightings in the assessment are based on this premise.

Public Transport initiatives

OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	The rail noise objective will be applied, whilst the contribution of the bus option to the road infrastructure will be considered.	There are three public transport proposals for this option. CBD Rail Tunnel, Doncaster Rapid Transport and Tarneit Rail.	The impacts of the three options are: <u>CBD Rail Tunnel:</u> There will be an increase in train traffic that will generate a small increase in rail noise. The increase will be restricted to the areas next to the Werribee and Dandenong lines. <u>Doncaster Rapid Transport:</u> There will be an increase in bus trips and a small increase in road traffic noise along the new bus routes. <u>Tarneit Rail:</u> There will be an increase in train traffic on the Werribee and Dear Park lines that will generate a small increase in existing rail noise in the areas next to the lines. There will be new rail noise in the proposed V/Line corridor between Werribee and Dear Park.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve.	15	-0.08
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	There will be new noise impacts from the proposed new rail links, whilst there will be small increases in existing noise levels where the option upgrades the existing infrastructure.	The following potential changes to noise exposure are identified. <u>CBD Rail Tunnel</u>: Potentially the corridor will be widened to accommodate the extra rail-lines, and the noise source will get closer to some residence. The railway noise objective is already exceeded in some locations and more locations will exceed the criteria	An estimate of the noise changes is made. <u>CBD Rail Tunnel</u>: The Werribee corridor is not as restricted as the Dandenong corridor, so there should be only a small increase at properties abutting the line. There will be a significant number of properties impacted by increases in rail noise in the Dandenong corridor as the corridor may need widening, with the removal of some properties. <u>Doncaster Rapid Transport:</u>					

		with this proposal. Near the heavily utilised Dandenong corridor the noise impacts will be a major issue and will need addressing. Doncaster Rapid Transport: There will be small increases in traffic noise levels on the Eastern Freeway; the existing noise barriers may be able to accommodate this increase. Increases in traffic noise due to new or improved routes, will probably not require amelioration. Tarneit Rail: As it is a new railway line there will be new impacts. Most of the line will be in rural like areas which have a low existing noise level. The urban sections will have slightly higher existing noise levels. The impacts in areas abutting the new line will be significant.	The increase in traffic noise on the Eastern Freeway will be less than 1 dB(A). With changes in traffic flow on some roads eg Johnston St, as the traffic lanes are reduced, there will be a significant reduction in traffic noise, up to 5 dB(A), regardless of the increase in bus traffic. Where there are new and improved bus routes, there will be up to 1 dB(A) increase in traffic noise levels. Tarneit Rail: The new railway noise levels will be up to 20-30 dB(A) Lmax louder than the existing background noise levels. The criteria Leq hourly levels, could be >10 dB(A) than existing levels, during the hours of railway operation.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve. Changes in road lanes and road access that is needed to for fill the proposal may lead to community reaction.	20	-0.10
Potential enhancement of acoustic environment due to reduction in traffic	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be significant reductions in existing traffic noise at locations where the traffic configuration is altered significantly. Generally, there will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	If the Johnston St traffic measures are bought in then there could be up to 5 dB(A) noise reduction in this area. In other areas the reduction could be as little as 1 dB(A).	+1	M	Lane closures will lead to traffic disruption.	5	+0.05
Reduction in traffic volumes on local streets	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Needs to be backed by strong and lasting traffic management measures.	5	+0.05
Road network development initiatives								
OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	Traffic noise attenuation measures will be required to achieve the assessment criteria.	Additional traffic on the Eastern Freeway (east of Hoddle Street), City Link (north of Flemington Road) and Western Ring Road (near Fitzgerald Road) could require additional noise protection to achieve criteria. An area in Sunshine West, between the Western Ring Road and Ashley Street) will be	Noise attenuation measures will include noise barriers and other road based techniques and building insulation where this is a reasonable option. Other than the forecast growth on the City Link, there is little flexibility for unforecast growth, such as what could be generated by the new freeway linkages If the volumes increase on the Link substantially, the criteria may be exceeded.	-1.5	M	Imprecise traffic volumes and % heavy vehicle content could result in small noise level errors.	15	-0.23

		subjected to a new source of noise. City Link has a traffic noise criteria of 63dB(A) L10 (18hr), fixed for the duration of the concession.						
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	About 685 residences will be directly impacted by a range of noise level increases along the route option.	Increases in noise levels in sensitive areas: Substantial – Paramount Rd, Ashley St, West Sunshine, Moderate – Queens Pde, Fitzroy, West Footscray, Small – Clifton Hill, Tranancore, Kew, and other suburbs adjacent to the Eastern Freeway. Other potential small increases are in: Altona North, Brunswick West. Noise increases on City Link will need to be investigated as part of the assessment process as there may be significant financial penalties associated with noise treatments on the Link.	Noise barriers on the proposed road would need to be erected in these areas (length): - West Sunshine, new road, protecting about 200 residences, 2500m - West Footscray, Rupert St, protecting about 100 residences, 1500m Retrofitted barriers will be required in the following areas: - Eastern Freeway, Clifton Hill, 700 m protecting about 40 residences - City Link, West Brunswick to Parkville, 4000m protecting about 150 residences - West Gate Freeway, Williamstown Rd west to Railway, 1500m protecting about 120 residences Building insulation would be required in these areas: - Queens Pde, protecting about 15 residences, - Paramount Rd & Ashley St protecting about 60 residences.	-1.5	M	New noise source in Yarraville and removes buildings and vegetation in Fitzroy which will meet community opposition.	10	-0.15
Potential enhancement of acoustic environment due to reduction in traffic	There will only be small decreases in noise levels in many areas where traffic volumes are predicted to decrease.	There will be potentially small changes in noise levels even though there will be significant reductions in the traffic volumes. There maybe opportunities to enhance the reduction by applying traffic management techniques (road closures, traffic restrictions, etc) as traffic is diverted to the proposed road.	Variable noise and traffic congestion reductions in the Collingwood, Fitzroy, Carlton and Parkville areas.	+1	M	Perceived low noise reduction seen as only minor benefit by residents.	5	+0.05
Reduction in traffic volumes on local streets	There will potentially be significant traffic volume reductions in most inner city areas.	Modelling indicates that in the inner suburbs there are areas where a significant number of roads may have a traffic volume reduction of more than 40%. Whilst this is a large number of vehicles, this only translates to a small reduction in noise levels.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Management measures to capture benefits of reduced traffic volumes will require consultation with potentially effected stakeholders..	5	+0.05
Other interactions, e.g. environmental, social	Construction Noise	Construction noise will probably extend over a few years in some locations, and will result in on-going annoyance with in the local community.	Construction noise will need to be ameliorated if it extends outside the normal hours of operation according to EPA noise guidelines.	-1	M		7.5	-0.08
	Traffic modelling volumes	Whilst traffic noise is relatively insensitive to small changes in traffic volume, there will be a perception that traffic model variations will result in inaccuracies in the traffic noise impact modelling	Determine and communicate the noise level changes associated with the traffic modelling changes if and when they occur. Potential for misleading information.	-0.5	S		2.5	-0.01
OPTION TOTAL RATING								**-0.70**

APPRAISAL SUMMARY TABLE - Noise	
OPTION:	**Option C**
Description	Public Transport: Three Public Transport routes are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes, Tarneit Rail. Road: Upgraded existing roads - Eastern Freeway at eastern terminal Clifton Hill to Flemington Rd, West Gate Freeway Yarraville. West Parkville, Ballarat Road, Maidstone, Cemetery Rd, Paramount Rd and Ashley St, West Footscray. Elevated link and tunnel in Kensington.
Base Case	
Problem Addressed	Road and rail Operational Noise and Construction Noise
Other Options	
Govt. policies / strategies supported	There are no policies regarding rail noise. VicRoads Traffic Noise Reduction Policy referenced and EPA Technical Guideline 302/92 for construction noise.
Notes	- dB(A) refers to the full criteria descriptor. - a 3 dB(A) change results from a halving or doubling in traffic volume. - Community reaction to extra (new) traffic noise is generally greater than a reaction to an equivalent noise reduction. Also, whilst significant traffic volume changes will only cause a small increase in traffic noise levels, the community reaction to an increase in traffic volumes (forecast or actual) is significant compared to the small change in noise levels. The weightings in the assessment are based on this premise.

Public Transport initiatives

OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	The rail noise objective will be applied, whilst the contribution of the bus option to the road infrastructure will be considered.	There are three public transport proposals for this option. CBD Rail Tunnel, Doncaster Rapid Transport and Tarneit Rail.	The impacts of the three options are: <u>CBD Rail Tunnel:</u> There will be an increase in train traffic that will generate a small increase in rail noise. The increase will be restricted to the areas next to the Werribee and Dandenong lines. <u>Doncaster Rapid Transport:</u> There will be an increase in bus trips and a small increase in road traffic noise along the new bus routes. <u>Tarneit Rail:</u> There will be an increase in train traffic on the Werribee and Dear Park lines that will generate a small increase in existing rail noise in the areas next to the lines. There will be new rail noise in the proposed V/Line corridor between Werribee and Dear Park.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve.	15	-0.08

Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	There will be new noise impacts from the proposed new rail links, whilst there will be small increases in existing noise levels where the option upgrades the existing infrastructure.	The following potential changes to noise exposure are identified. CBD Rail Tunnel: Potentially the corridor will be widened to accommodate the extra rail-lines, and the noise source will get closer to some residence. The railway noise objective is already exceeded in some locations and more locations will exceed the criteria with this proposal. Near the heavily utilised Dandenong corridor the noise impacts will be a major issue and will need addressing. Doncaster Rapid Transport: There will be small increases in traffic noise levels on the Eastern Freeway; the existing noise barriers may be able to accommodate this increase. Increases in traffic noise due to new or improved routes, will probably not require amelioration. Tarneit Rail: As it is a new railway line there will be new impacts. Most of the line will be in rural like areas which have a low existing noise level. The urban sections will have slightly higher existing noise levels. The impacts in areas abutting the new line will be significant.	An estimate of the noise changes is made. CBD Rail Tunnel: The Werribee corridor is not as restricted as the Dandenong corridor, so there should be only a small increase at properties abutting the line. There will be a significant number of properties impacted by increases in rail noise in the Dandenong corridor as the corridor may need widening, with the removal of some properties. Doncaster Rapid Transport: The increase in traffic noise on the Eastern Freeway will be less than 1 dB(A). With changes in traffic flow on some roads eg Johnston St, as the traffic lanes are reduced, there will be a significant reduction in traffic noise, up to 5 dB(A), regardless of the increase in bus traffic. Where there are new and improved bus routes, there will be up to 1 dB(A) increase in traffic noise levels. Tarneit Rail: The new railway noise levels will be up to 20-30 dB(A) Lmax louder than the existing background noise levels. The criteria Leq hourly levels, could be >10 dB(A) than existing levels, during the hours of railway operation.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve. Changes in road lanes and road access that is needed for the proposal may lead to community reaction.	20	-0.10
Potential enhancement of acoustic environment due to reduction in traffic	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be significant reductions in existing traffic noise at locations where the traffic configuration is altered significantly. Generally, there will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	If the Johnston St traffic measures are bought in then there could be up to 5 dB(A) noise reduction in this area. In other areas the reduction could be as little as 1 dB(A).	+1	M	Lane closures will lead to traffic disruption.	5	+0.05
Reduction in traffic volumes on local streets	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Needs to be backed by strong and lasting traffic management measures.	5	+0.05
Road network development initiatives								
OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**

Compliance with proposed noise guidelines	Traffic noise attenuation measures will be required to achieve the assessment criteria.	Several residential areas will be subjected to small increases in road traffic noise levels. In most areas there will be a requirement to attenuate to achieve the Criteria.	Noise attenuation measures will include noise barriers and other road based techniques and building insulation where this is a reasonable option.	-1.5	M	Imprecise traffic volumes and % heavy vehicle content could result in small noise level errors.	10	-0.15
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	About 595 residences will be directly impacted by a range of noise level increases along the route option. St Brigids School, University College and multi story flats in Carlton as well as motels in Flemington Rd West Parkville will be impacted by increased noise.	Increases in noise levels in sensitive areas: Substantial – Paramount Rd, Ashley St, West Sunshine, Ballarat Rd, Moderate – Alexandra Pde, Fitzroy, Princes St, & Cemetery Rd, Carlton, College Cres, McArthur Rd, & near Flemington Rd Parkville, Small – Clifton Hill, Kew, and other suburbs adjacent to the Eastern Freeway. Other potential small increases next to the Westgate Freeway in Spotswood and Yarraville . The elevated link and tunnel in Kensington should not directly impact sensitive uses.	New high noise barriers would need to be erected in these areas (length): - McArthur Rd, Parkville protecting about 20 residences, 250m Retrofitted barriers will be required in the following areas: - Eastern Freeway, Clifton Hill, 700 m protecting about 40 residences - West Gate Freeway, Williamstown Rd to west of Cemetery Rd connection, 2500m protecting about 150 residences Building insulation would be required in these areas: - Ballarat Rd, protecting about 200 residences, - Paramount Rd, protecting about 40 residences, - Ashley St, protecting about 20 residences. - Alexandra Pde, Fitzroy protecting about 25 residences - Princes St, Carlton protecting about 100 residences and some high-rise buildings - Cemetery-College Rd, Parkville, Melb Uni buildings	-2.5	M	New noise source in Yarraville and removes buildings and vegetation in Fitzroy which will meet community opposition.	10	-0.25
	The opportunity for enhanced acoustic environment due to diverted traffic is considerably less than for Options A an B, given the absence of major new road infrastructure in Option C.	Modelling indicates there are a small number of locations where the acoustic environment will benefit from reduced traffic volumes.	Variable noise and traffic congestion reductions in the Collingwood, Fitzroy, Carlton and Parkville areas. The potential reduction in truck traffic in Yarraville will significantly reduce noise impacts in this area.	+0.5	M	Perceived low noise reduction seen as only minor benefit by residents.	10	+0.05
Reduction in traffic volumes on local streets	There will potentially be some traffic volume reductions in inner city areas.	Increased capacity of main road network has the potential to result in some relief in inner city areas.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+0.5	M	Traffic volume changes may lead to other unacceptable management techniques.	5	+0.03
Other interactions, e.g. environmental, social	Construction Noise	Construction noise will probably extend over a few years in some locations, and will result in on-going annoyance with in the local community.	Construction noise will need to be ameliorated if it extends outside the normal hours of operation according to EPA noise guidelines.	-1	M		7.5	-0.08
	Traffic modelling volumes	Whilst traffic noise is relatively insensitive to small changes in traffic volume, there will be a perception that traffic model variations will result in inaccuracies in the traffic noise impact modelling	Determine and communicate the noise level changes associated with the traffic modelling changes if and when they occur. Potential for misleading information.	-0.5	S		2.5	-0.01

OPTION TOTAL SCORE (including Construction+ Modelling)	**-0.67**

APPRAISAL SUMMARY TABLE - Noise	
OPTION:	**Option D** Doesn't include any assessment of the impacts of traffic growth on the network in the base case.
Description	Public Transport: Three Public Transport initiatives are proposed – CBD Rail Tunnel, Doncaster Rapid Transport plus other bus routes and the Tarneit Rail proposal. Road There are no road initiatives in this option
Base Case	
Problem Addressed	Road and rail Operational Noise and Construction Noise
Other Options	
Govt. policies / strategies supported	There are no policies regarding rail noise. VicRoads Traffic Noise Reduction Policy referenced and EPA Technical Guideline 302/92 for construction noise.
Notes	- dB(A) refers to the full criteria descriptor. - a 3 dB(A) change results from a halving or doubling in traffic volume. - Community reaction to extra (new) rail/traffic noise is generally greater than a reaction to an equivalent noise reduction. Also, whilst significant traffic volume changes will only cause a small increase in traffic noise levels, the community reaction to an increase in traffic volumes (forecast or actual) is significant compared to the small change in noise levels. The weightings in the assessment are based on this premise.

Public Transport initiatives

OBJECTIVES: **Protecting / enhancing existing air/ noise amenity**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Compliance with proposed noise guidelines	The rail noise objective will be applied, whilst the contribution of the bus option to the road infrastructure will be considered.	There are three public transport proposals for this option. CBD Rail Tunnel, Doncaster Rapid Transport and Tarneit Rail.	The impacts of the three options are: <u>CBD Rail Tunnel:</u> There will be an increase in train traffic that will generate a small increase in rail noise. The increase will be restricted to the areas next to the Werribee and Dandenong lines. <u>Doncaster Rapid Transport:</u> There will be an increase in bus trips and a small increase in road traffic noise along the new bus routes. <u>Tarneit Rail:</u> There will be an increase in train traffic on the Werribee and Dear Park lines that will generate a small increase in existing rail noise in the areas next to the lines. There will be new rail noise in the proposed V/Line corridor between Werribee and Dear Park.	-0.5	M	There may be adverse community reaction to the increase in rail noise and the increase in rail reserve.	15	-0.08
Changes in noise exposure on sensitive receivers such as residences, schools, parklands, hospitals and churches.	There will be new noise impacts from the proposed new rail links, whilst there will be small increases in existing noise levels where the option upgrades the existing infrastructure.	The following potential changes to noise exposure are identified. <u>CBD Rail Tunnel</u>: Potentially the corridor will be widened to accommodate the extra rail-lines, and the noise source will get closer to some residence. The railway noise objective is already exceeded in some locations and more	An estimate of the noise changes is made. <u>CBD Rail Tunnel</u>: The Werribee corridor is not as restricted as the Dandenong corridor, so there should be only a small increase at properties abutting the line. There will be a significant number of properties impacted by increases in rail noise in the Dandenong corridor as the corridor may need widening, with the removal of some properties.	-0.5	M	There may be adverse community reaction to the	20	-0.10

		locations will exceed the criteria with this proposal. Near the heavily utilised Dandenong corridor the noise impacts will be a major issue and will need addressing. Doncaster Rapid Transport: There will be small increases in traffic noise levels on the Eastern Freeway; the existing noise barriers may be able to accommodate this increase. Increases in traffic noise due to new or improved routes, will probably not require amelioration. Tarneit Rail: As it is a new railway line there will be new impacts. Most of the line will be in rural like areas which have a low existing noise level. The urban sections will have slightly higher existing noise levels. The impacts in areas abutting the new line will be significant.	Doncaster Rapid Transport: The increase in traffic noise on the Eastern Freeway will be less than 1 dB(A). With changes in traffic flow on some roads eg Johnston St, as the traffic lanes are reduced, there will be a significant reduction in traffic noise, up to 5 dB(A), regardless of the increase in bus traffic. Where there are new and improved bus routes, there will be up to 1 dB(A) increase in traffic noise levels. Tarneit Rail: The new railway noise levels will be up to 20-30 dB(A) Lmax louder than the existing background noise levels. The criteria Leq hourly levels, could be >10 dB(A) than existing levels, during the hours of railway operation.			increase in rail noise and the increase in rail reserve. Changes in road lanes and road access that is needed to fulfil the proposal may lead to community reaction.		
Potential enhancement of acoustic environment due to reduction in traffic	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be significant reductions in existing traffic noise at locations where the traffic configuration is altered significantly. Generally, there will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	If the Johnston St traffic measures are bought in then there could be up to 5 dB(A) noise reduction in this area. In other areas the reduction could be as little as 1 dB(A).	+1	M	Lane closures will lead to traffic disruption.	5	+0.05
Reduction in traffic volumes on local streets	Where traffic is removed from an area, there will be a reduction in associated traffic noise.	There will be small reductions in traffic noise levels at a small number of locations as motor vehicle passenger's transfer to the more attractive public transport options.	Potential for further reductions in traffic volumes and noise levels with the application of traffic management measures.	+1	M	Needs to be backed by strong and lasting traffic management measures.	5	+0.05
Other interactions, e.g. environmental, social	Construction Noise	Construction noise will probably extend over a few years in some locations, and will result in on-going annoyance with in the local community.	Construction noise will need to be ameliorated if it extends outside the normal hours of operation according to EPA noise guidelines.	-1	M		7.5	-0.08
	Traffic modelling volumes	Whilst traffic noise is relatively insensitive to small changes in traffic volume, there will be a perception that traffic model variations will result in unacceptable inaccuracies in the traffic noise impact modelling	Determine and communicate the noise level changes associated with the traffic modelling changes if and when they occur. Potential for misleading information.	-0.5	S		2.5	-0.01
OPTION TOTAL SCORE (including Construction + Modelling)								**-0.17**

A.8 Environmental Sustainability

APPRAISAL SUMMARY TABLE – Environmental Sustainability	
OPTION:	Option A
Description	Eastern Freeway to West Gate Freeway road connection (including tunnels), upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Assessment of the extent to which each of the options contributes to the target of containing climate change impacts and promoting sustainable transport
Other Options	
Govt. policies / strategies supported	Kyoto Protocol, National Strategy for Ecologically Sustainable Development, Victorian Sustainability Action Statement, Victorian Greenhouse Strategy

OBJECTIVES: Promote Sustainable Transport	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE	RISKS	WEIGHTING (%)	RATING
Enhanced transport system connectivity and reduced congestion	Positive	Linking of existing freeways (Eastern Freeway/CityLink/ Westgate Freeway) would be expected to alleviate anticipated 2031 Base Case congestion in inner city areas, including reduced conflicts between freight traffic and residential amenity. Widening of Western Ring Road and Westgate Freeway, combined with the proposed freeway connection between Westgate Freeway and the Eastern Freeway will divert traffic from congested roads, including Geelong Road and Sunshine Road and reduce freight traffic in Yarraville. From a sustainable transport perspective, the section of new elevated freeway between Westgate Freeway and CityLink could be seen as duplicating the nearby section of CityLink, between Westgate Freeway and Mt Alexander Road. Ballarat Road upgrade will ease anticipated Base Case congestion. Well designed and executed Doncaster Rapid Transport initiative will improve public transport connectivity from the east to the inner north of Melbourne. CBD rail tunnel is critical foundation infrastructure for further network improvements and additions, and will ease current critical rail system capacity constraints. Tarneit Rail proposal will facilitate improved public transport services from the west, including the Werribee line.	.	+3.0		Enhanced connectivity and reduced congestion provide the opportunity to capture road space for enhanced local public transport (eg trams, buses) cycling and pedestrian facilities. Enforcement of bus lane priority will be critical to operation of the Doncaster Rapid Transport initiative. All elements of this initiative need to be implemented e.g. permanent lanes, smart stops etc to achieve full potential. Initiative would also benefit from limited car parking facilities, secure bicycle parking at interchange and landscaping for shade along bike and pedestrian routes. By relieving congestion from the east, the East West road link has the potential to decrease the competitiveness of the Doncaster Rapid Transport initiative relative to private vehicle transport from	33	+0.99

Increased use of public transport, walking and cycling	Net positive	The CBD rail proposal, combined with expected rail network wide benefits, represents a significant impetus to increased public transport patronage across Melbourne. Opportunity exists to capture benefits of reduced traffic congestion with specific initiatives to enhance public transport, pedestrian and cycling facilities. The opportunity created by diversion of through traffic into the proposed East West Link tunnel needs to be captured by creation of cycle lanes in Alexandra Parade and enhanced tram, cycle and pedestrian facilities on north-south routes, including Brunswick Street, Smith Street, Nicholson Street and Lygon Street. The Johnston Street works associated with the Doncaster Rapid Transport initiative provide for priority bus facilities in Johnston Street and an off-street cycle lane in Johnston Street, and possible enhanced facilities in Gertrude Street. Ballarat Road upgrade provides an important bicycle link opportunity, and requires further investigation, as does the posssiblity of cycle lanes on Geelong Road and Sunshine Road. Improvements to the rail system will encourage bike-train combination to cross the city and/or access locations outside the city. Incidental walking will be generated associated with bus and train use; potential to further enhance uptake with landscaping and pedestrian facilities		+1.0		the east. Early implementation of the bus option is recommended to establish use patterns prior to construction of the road link. Sustained improvements are dependent in the medium-longer term on greening fuel sources for electricity to power train network, and liquid fuels to power buses, especially in maintaining non-peak services.	33	+0.33
Consistency with travel demand initiatives	Net negative	Option A provides for a balanced approach to transport system development, with significant enhancements of both the public transport system and road network. The enhanced connectivity has the potential to increase overall travel, particularly discretionary trips. A proactive approach to capturing the 'freed up' road space for enhanced public transport and cycling facilities is required to mitigate potential adverse effects associated with any induced travel effects. Comprehensive Doncaster Rapid Transport initiative will improve public transport connectivity from the east to the inner north of Melbourne. Modal links are critical e.g. Lulie St interchange, North Melbourne station, new Carlton station, as are the introduction of dedicated bike lanes. CBD rail tunnel and Tarneit Rail proposal will enable train system to provide for improved levels of service to respond to existing latent demand for trains. Bus link to North Melbourne station opens up a new, realistic cross city PT option. Combined road improvements and public transport initiatives increase transport choice and potentially lead to		- 2.0			33	-0.66

		increased travel.						
							TOTAL SCORE	**+0.66**
Other interactions, e.g. environmental, social	Evident negative social impacts in the construction of this option from both tunnelling and widening of Ballarat Road. Potentially positive social impact associated with possible Alexandra Parade boulevarde treatment at conclusion of construction. Opportunity provided by Eastern Freeway widening to incorporate enhanced environmental protection at Dights Falls and sections of Yarra Bend Park							
	Major road network upgrade provides supportive infrastructure for the continuation of urban growth in outer/fringe areas without adequate PT services, leaving outer suburban residents vulnerable to petrol price hikes							
	Important PT link to university and hospital, critical for low income, low socio-economic citizens							
	If fully implemented, the Doncaster Rapid Transport initiative would provide enhanced public transport services to a large residential area.							
	These PT improvements provide important options for lower income outer suburban areas that are most exposed to petrol prices, particularly in relation to imminent carbon pricing and the possibility of worldwide peak oil in the next decade.							

APPRAISAL SUMMARY TABLE – Environmental Sustainability	
OPTION:	Option B
Description	Eastern Freeway to Sunshine Road connection (including tunnels), duplication of Sunshine Road (sections of tunnel and elevated structure, new surface road linking Western Ring Road and Sunshine Road, widening of Western Ring Road, upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Assessment of the extent to which each of the options contributes to the target of containing climate change impacts and promoting sustainable transport
Other Options	
Govt. policies / strategies supported	Kyoto Protocol, National Strategy for Ecologically Sustainable Development, Victorian Sustainability Action Statement, Victorian Greenhouse Strategy

OBJECTIVES: Promote Sustainable Transport	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE	RISKS	WEIGHTING (%)	RATING
Enhanced transport system connectivity and reduced congestion	Positive	Linking of major roads (Eastern Freeway/CityLink/ Sunshine Road) is expected to alleviate Base Case congestion in inner city areas, including reduced conflicts between freight traffic and residential amenity. Network development would provide enhanced east west accessibility between Fitzroy and Brimbank, without diverting additional traffic to the Westgate Freeway corridor. Connectivity of Melbourne's freeway system not enhanced to the same extent as Option A. Well designed and executed Doncaster Rapid Transport initiative will improve public transport connectivity from the east to the inner north of Melbourne. CBD rail tunnel is critical foundation infrastructure for further network improvements and additions, and will ease current critical rail system capacity constraints Tarneit Rail proposal will facilitate improved services from the west, including the Werribee line.		+2.0		Enhanced connectivity and reduced congestion provide the opportunity to capture road space for enhanced local public transport (eg trams, buses) cycling and pedestrian facilities Enforcement of bus lane priority will be critical to operation of the Doncaster Rapid Transport initiative. All elements of this initiative need to be implemented e.g. permanent lanes, smart stops etc to achieve full potential. Initiative would also benefit from limited car parking facilities, secure bicycle parking at	33	+0.66
Increased use of public transport, walking and cycling	Net positive	The CBD rail proposal, combined with expected network wide benefits, represents a significant impetus to increased public transport patronage across Melbourne. Opportunity exists to capture benefits of reduced congestion with specific initiatives to enhance public transport, pedestrian and cycling facilities. The opportunity created by diversion of through traffic into the proposed East West Link tunnel needs to be captured by creation of cycle lanes in Alexandra Parade and enhanced tram, cycle and pedestrian facilities on north-		+1			33	+0.33

		south routes, including Brunswick Street, Smith Street, Nicholson Street and Lygon Street. The Johnston Street works associated with the Doncaster Rapid Transport initiative provide for priority bus facilities in Johnston Street and an off-street cycle lane in Johnston Street, and possible enhanced facilities in Gertrude Street. Proposed duplication of Sunshine Road via sections of elevated structure and tunnel provides the opportunity to enhance cycling and pedestrian facilities on Sunshine Road itself. Improvements to rail system will encourage bike-train combination to cross the city and/or access locations outside the city. Incidental walking will be generated associated with bus and train use; potential to further enhance uptake with landscaping and pedestrian facilities.				interchange and landscaping for shade along bike and pedestrian routes. By relieving congestion from the east, the East West road link has the potential to decrease the competitiveness of the Doncaster initiative relative to private vehicle transport from the east. Rapid implementation of the bus option is recommended to establish use patterns prior to construction of the road link. Sustained improvements dependent in the medium-longer term on greening fuel sources for electricity to power train network, and liquid fuels to power buses, especially in maintaining non-peak services.		
Consistency with travel demand initiatives	Net negative	Option B provides for a balanced approach to transport system development, with significant enhancements of both the public transport system and road network. Option B enhances east west road network connectivity more directly than Option A. The enhanced connectivity has the potential to increase overall travel, particularly discretionary trips. A proactive approach to capturing the 'freed up' road space for enhanced public transport and cycling facilities is required to mitigate potential adverse effects associated with any induced travel effects. Comprehensive Doncaster Rapid Transport initiative will improve public transport connectivity from the east to the inner north of Melbourne. Modal links are critical e.g. Lulie St interchange, North Melbourne station, new Carlton station, as are the introduction of dedicated bike lanes. CBD rail tunnel and Tarneit Rail proposal will enable train system to provide for improved levels of service to respond to existing latent demand for trains. Bus link to North Melbourne station opens up a new, realistic cross city PT option. Combined road improvements and public transport initiatives increase transport choice and potentially lead to increased travel..		-2.0			33	-0.66
						TOTAL SCORE		+0.33

Other interactions, e.g. environmental, social	Evident negative social impacts from tunnelling. Potentially positive social impact for potential Boulevard treatment of Alexandra Parade at conclusion of construction. Opportunity provided by Eastern Freeway widening to incorporate enhanced environmental protection at Dights Falls and sections of Yarra Bend Park.
	Major roads provide supportive infrastructure for the continuation of urban growth in outer/fringe areas without adequate PT services, leaving outer suburban residents vulnerable to petrol price hikes
	Important PT link to university and hospital, critical for low income, low socio-economic citizens
	If fully implemented, the Doncaster Rapid Transit initiative would provide enhanced public transport services to a large residential area.
	These PT improvements provide important options for lower income outer suburban areas that are most exposed to petrol prices, particularly in relation to imminent carbon pricing and the possibility of worldwide peak oil in the next decade.

APPRAISAL SUMMARY TABLE – Environmental Sustainability	
OPTION:	Option C
Description	Upgrade of the existing road system from Eastern Freeway to Smithfield Road (including 1.5km length of tunnel and length of elevated structure from Royal Park to Smithfield Road), widening of Ballarat Road to six lanes, upgraded roads and new surface road connections associated with a package of enhancements to the road freight network, CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal.
Base Case	
Problem Addressed	Assessment of the extent to which each of the options contributes to the target of containing climate change impacts and promoting sustainability
Other Options	
Govt. policies / strategies supported	Kyoto Protocol, National Strategy for Ecologically Sustainable Development, Victorian Sustainability Action Statement, Victorian Greenhouse Strategy

OBJECTIVES: **Promote Sustainable Transport**	**IMPACTS**	**QUALITATIVE DESCRIPTION**	**QUANTITATIVE MEASURE**	**ASSESSMENT**	**CONFIDENCE**	**RISKS**	**WEIGHTING (%)**	**RATING**
Enhanced transport system connectivity and reduced congestion	Net positive	Option C comprises an upgrade of the existing road network that is expected to alleviate some Base Case traffic congestion, without the gains in connectivity of either Options A or B. Well designed and executed Doncaster Rapid Transport will improve public transport connectivity from the east to the inner north of Melbourne. CBD rail tunnel is critical foundation infrastructure for further network improvements and additions, and will ease current critical rail system capacity constraints Tarneit Rail proposal will facilitate improved rail services from the west, including the Werribee line.		+1		Marginal improvements to Base Case levels of traffic congestion will make enhancement of on-road public transport, cycling and pedestrian facilities difficult. Enforcement of bus lane priority will be critical to operation of the Doncaster Rapid Transport initiative. All elements of this initiative need to be implemented e.g.	33	+.0.33
Increased use of public transport, walking and cycling	Net Positive	Some minor incidental improvements expected with reduced congestion, but only if accompanied by specific efforts to improve pedestrian and cycling environment. Cycling could be encouraged if lanes are included on Ballarat Road, Cemetery Road, Alexandra Road		+1			33	+0.33

		upgrades, for example. The Johnston Street works associated with the Doncaster Rapid Transport initiative provide for priority bus facilities in Johnston Street and an off-street cycle lane in Johnston Street, and possible enhanced facilities in Gertrude Street. Improvements to rail system will encourage bike-train combination to cross the city. Doncaster Bus initiative provides clear advantage to cycling through separated lanes. Incidental walking will be generated associated with bus and train use; potential to further enhance uptake with landscaping and pedestrian facilities.				permanent lanes, smart stops etc to achieve full potential. Initiative would also benefit from limited car parking facilities, secure bicycle parking at interchange and landscaping for shade along bike and pedestrian routes.		
Consistency with travel demand initiatives	Net positive	Option C provides for a focus on public transport enhancements, with relatively minor road network connectivity improvements. Therefore travel demand is unlikely to increase with this option. Minor congestion improvements from proposed road upgrades do not provide the opportunity for enhancements to on-road public transport, cycling or pedestrian facilities. Comprehensive Doncaster Rapid Transit initiative will improve public transport connectivity from the east to the inner north of Melbourne. Modal links are critical e.g. Lulie St interchange, North Melbourne station, new Carlton station, as are implementation of dedicated bike lanes. CBD rail tunnel is critical foundation infrastructure for further network improvements and additions, and will attract public transport mode shift by improving the functioning of existing services around the city loop Tarneit Rail proposal will facilitate improved services from the west, including the Werribee line.		0		Sustained improvements dependent in the medium-longer term on greening fuel sources for electricity to power train network, and liquid fuels to power buses, especially in maintaining non-peak services.	33	0
							TOTAL SCORE	**+ 0.66**

Other interactions, e.g. environmental, social	Clear deleterious social and local amenity impacts to Cemetery Rd upgrade, Ballarat Rd upgrade.
	Important PT link to university and hospital, critical for low income, low socio-economic citizens
	If fully implemented, the Doncaster Rapid Transit initiative service would provide enhanced public transport services to a large residential area .
	These PT improvements provide important options for lower income outer suburban areas that are most exposed to petrol prices, particularly in relation to imminent carbon pricing and the possibility of worldwide peak oil in the next decade
	This option only minimally addresses freight movements leaving the Port of Melbourne.

APPRAISAL SUMMARY TABLE – Environmental Sustainability

OPTION:	Option D
Description	CBD rail tunnel, Doncaster Rapid Transport enhancement and Tarneit Rail proposal
Base Case	
Problem Addressed	Assessment of the extent to which each of the options contributes to the target of containing climate change impacts and promoting sustainable transport.
Other Options	
Govt. policies / strategies supported	As for other options, plus Melbourne 2030 Directions 1 (A More Compact City) and 8 (Better Transport Links), Action 15: Sustainable and Efficient Transport Systems of Our Environment, Our Future- Sustainability Action Statement 2006, Meeting our Transport Challenges, 2006,

OBJECTIVES: Promote Sustainable Transport	IMPACTS	QUALITATIVE DESCRIPTION	QUANTITATIVE MEASURE	ASSESSMENT	CONFIDENCE	RISKS	WEIGHTING (%)	RATING
Enhanced transport system connectivity and reduced congestion	Neutral	Option D focuses entirely on improvements to the public transport system, without any development of the road network. Congestion levels are expected to be similar to the Base Case, as would overall road network connectivity. Well designed and executed Doncaster Rapid Transport initiative will improve public transport connectivity from the east to the inner north of Melbourne. CBD rail tunnel is critical foundation infrastructure for further network improvements and additions, and will ease current critical rail system capacity constraints . Tarneit Rail proposal will facilitate improved rail services from the west, including the Werribee line. However, gaps in Melbourne's principal road network will remain, resulting in continuing congestion. Freight movements to Port of Melbourne will continue to be adversely effected and current conflicts in residential areas may increase with the completion of EastLink.		0		Continuation of Base Case levels of traffic congestion will make enhancement of on-road public transport, cycling and pedestrian facilities difficult. Enforcement of bus lane priority will be critical to operation. Enforcement of bus lane priority will be critical to operation of the Doncaster Rapid Transport initiative. All elements of this initiative need to be implemented e.g. permanent lanes, smart stops etc to achieve full potential. Initiative would also benefit from limited car parking facilities, secure bicycle parking at interchange and landscaping for	33	0
Increased use of public transport, walking and cycling	Positive	Option D's focus on public transport holds potential for mode shift to public transport. However, continuation of Base Case levels of traffic congestion will provide very limited opportunities for significant improvements to on-road facilities for public transport (eg trams), cycling and pedestrians. The Johnston Street works associated with the Doncaster Rapid Transport initiative provide for priority bus facilities in Johnston Street and an off-street cycle lane in Johnston Street, and possible enhanced facilities in Gertrude Street		+1.0			33	+0.33

		Improvements to the rail system will encourage bike-train combination to cross the city and/or access locations outside the city. Incidental walking will be generated associated with bus and train use; potential to further enhance uptake with landscaping and pedestrian facilities.				shade along bike and pedestrian routes.		
Consistency with travel demand initiatives	Positive	The public transport enhancements, combined with Base Case levels of road congestion, are likely to reduce private motor vehicle demand. Congested roads, similar to the Base Case, do not provide the opportunity for enhancements to on-road public transport, cycling or pedestrian facilities. Comprehensive Doncaster Bus initiative offers clearly competitive public transport for eastern suburbs compared to private vehicle use. Modal links are critical e.g. Lulie St interchange, North Melbourne station, new Carlton station, dedicated bike lanes. Comprehensive Doncaster Bus initiative will improve public transport connectivity from the east to the inner north of Melbourne. Modal links are critical e.g. Lulie St interchange, North Melbourne station, new Carlton station, dedicated bike lanes. CBD rail tunnel and Tarneit Rail unlocks train system for greater service to respond to existing latent demand for trains. Bus link to North Melbourne station opens up a new, realistic cross city PT option.		+2.0		Sustained improvements dependent in the medium-longer term on greening fuel sources for electricity to power train network, and liquid fuels to power buses, especially in maintaining non-peak services.	33	+0.66
							TOTAL SCORE	**+0.99**

Other interactions, e.g. environmental, social	Important PT link to university and hospital, critical for low income, low socio-economic citizens
	If fully implemented, the Doncaster rapid transit service would attract patronage and make extension of the outer network more viable
	These PT improvements provide important options for lower income outer suburban areas that are most exposed to petrol prices, particularly in relation to imminent carbon pricing and the possibility of worldwide peak oil in the next decade.
	These initiatives do not directly address freight movements leaving from and arriving at the Port of Melbourne. They do however provide the basis for a transport mode shift to public transport over time, with 'freed up' road space potentially of benefit to freight movements.
	Important PT link to university and hospital, critical for low income, low socio-economic citizens.

Appendix B DOI Strategic Merit Test

STRATEGIC MERIT TEST

RATING SYSTEM

Rating	Description
+3	Major positive impacts resulting in substantial and long-term improvements or enhancements of the existing case. Substantial benefits flowing to a large number of people / industries
+2	Moderate positive impact, possibly of: • Short-term duration with significant benefits; or • Medium-term duration with resultant mid-range benefits; or • Long-term duration with mid-range or lower benefits. Positive outcomes may be in terms of new opportunities and outcomes of enhancement or improvement. Benefits flowing to a specific range of people or industries in certain areas
+1	Minimal positive impact, possibly only lasting over the short-term. May be confined to a limited area or to limited people / industries.
0	Neutral – no discernible or predicted positive or negative impact
-1	Minimal negative impact, probably short-term, able to be managed or mitigated, and will not cause substantial detrimental impacts. May be confined to a small area or to a limited number of people / industries
-2	Moderate negative impact. Impacts may be: • Short-term duration with significant impacts; or • Medium-term duration with resultant mid-range impacts; or • Long-term duration with mid-range or lower impacts. Impacts will most likely respond to management actions. Impacts affecting a moderate area, a specific range of people or industries in certain areas
-3	Major negative impacts with long-term and possibly irreversible impacts leading to serious damage, degradation or deterioration of the physical, economic or social environment. Substantial impacts affecting a large number of people / industries. Possible mitigation measures impose significant cost.

If not applicable do not rate with a '0'; strike out indicator and remove from analysis of that particular option.