North East Link
Environment Effects Statement

EXPERT WITNESS REPORT

William McDougall
Independent Transport Planner
15 July 2019
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Executive summary

1 I, William McDougall, am an independent transport planner and engineer with over 40 years’ experience in transport modelling and appraisal processes for major projects and strategy planning. Under instructions from Maddocks Lawyers acting for Banyule, Boroondara and Whitehorse Councils, this report presents my expert opinions on two particular aspects of the North East Link (NEL) Environment Effects Statement (EES):

- Does the EES adequately document and assess the Project against the Transport System Objectives and Decision Making Principles in the Transport Integration Act (TIA)?
- Does the strategic demand modelling (Zenith) in the EES adequately document and assess the nature and extent of the traffic and transport impacts of the project?

Transport Integration Act

2 I observe that the EES assessment of NEL against the TIA is very high-level and focuses on linking NEL’s own ‘objectives and guiding principles’ to the TIA’s Transport System Objectives and Decision Making Principles. The assessment includes a number of ‘Project responses’ which are general statements rather than detailed quantification of the Project’s effects.

3 The transport-related ‘Project responses’ simply state that NEL will provide things like (for example) ‘improved travel times for commuting to work and education facilities’ or ‘facilitate integrated and seamless travel within and between different modes of transport’, without cross-referencing whereabouts in the EES these outcomes are quantified, if at all. Some key effects of NEL that are in conflict with the TIA are omitted, especially the indication that, despite including the Doncaster Busway, it will result in a net shift of demand to car, increasing typical 2036 weekday car travel by 13,000 trips and 1.7 million vehicle-kilometres whilst also reducing public transport patronage by 3,000 trips a day. These substantial figures are clearly stated in the NEL Business Case but have not been picked up in the EES. In this respect, NEL goes against one of the TIA’s key objectives, namely ‘Reducing the need for private motor vehicle transport and the extent of travel’.

Strategic demand modelling

4 NEL’s impact on travel and transport is assessed using the Zenith strategic transport model of Victoria developed by Veitch Lister Consulting (VLC). Such transport models are extremely complex and require careful setting-up so that they:

- replicate present day travel and transport tasks in their entirety, with particular attention to the area that the subject project or initiative will influence;
- respond plausibly to changed assumptions (for example, changes to travel costs or land use patterns); and
- thus can be used with maximum confidence when predicting transport activity in future years and the effects of the subject initiative on those predictions.

5 In my considered opinion, despite the extensive documentation given, the Zenith model significantly under-performs in several key respects.
Firstly, it overestimates present day travel activity. In this respect, the model has been improved since I reviewed it previously (for the West Gate Tunnel), but questions still remain about its accuracy. Both the number and average length of trips seems high.

Secondly, partly because of this overestimation, but also, I suspect, because of the way it represents the area of influence of NEL, it generally overestimates traffic volumes and travel times on key routes in NEL's vicinity. It is usual practice to make concerted efforts to improve this aspect of these models, but no evidence is given of any attempts to do so in this case.

Thirdly and most importantly, an illogical and unnecessary workaround is used specifically to force the model to produce more growth in trips and trip-km in future years, by omitting to loop through a crucial step in the model's four-step estimation process. No other models (the State Government's own Victorian Integrated Transport Model included) do this, to my knowledge. Added to the present-day overestimation, Zenith thus produces larger future growth in demand than should be expected, going against observed trends of the last 15-20 years in the process. Furthermore, this workaround also underestimates the extent to which NEL will induce more travel, which will in turn produce optimistic projections of its traffic relieving effects and travel time savings.

A peer review of the Zenith model was carried out by Dr Luis Willumsen, after the modelling has been completed. Despite commenting on the workaround method mentioned above, Dr Willumsen did not apparently pick up on the points that I have raised, stating that he was ‘…not in a position to comment on whether the … expected growth is consistent with current thinking in Victoria.’

Dr Willumsen also stated that the modelling needed to take more account of future transport technology shifts. A sensitivity test was then done which showed that possible advent of ‘mobility as a service’ (MaaS) and ‘connected and autonomous vehicles’ (CAVs) would reduce 2036 car travel demand by 18% (and car trip-hours by 7%). Traffic volumes on NEL would also go down, by 5%.

The questionable assumptions behind the transport modelling, especially the illogical future demand projection method and the lack of consideration of emerging trends in transport technology, have led to significant over-estimates of future travel demand and exaggerate the need for, and performance of, NEL.

**Consequences for the EES**

The incomplete and generalised assessment of NEL against the TIA shows that the EES has significant ‘optimism bias’ toward NEL by overstating and generalising its benefits whilst also understating or omitting to mention some of its negative effects.

The issues with the Zenith modelling are far-reaching. As well as throwing into doubt the overall need for NEL in its current form, it influences all of the subsequent assessments of NEL’s traffic related effects, upon which much of the EES is based. I consider that the Zenith modelling should be reworked, the scope of the Project revisited, and all traffic-related effects should be recalculated before the EES can be regarded as providing a credible, objective estimate of its effects.
Finally, the new population forecasts just released (12 July 2019) by the Department of Environment, Land, Water and Planning show more population growth (but also significant changes to its distribution) for Melbourne, compared to the 4-year-old projections on which NEL transport modelling and planning is based. The consequences of this must also be carefully considered, because they provide the basis for the travel and transport forecasts.
Introduction

This is an expert report prepared by me, William McDougall, on the subject of North East Link (NEL, or the Project), for the Environment Effects Statement (EES) hearings process.

Expert details

My name is William McDougall, of 55 Bimbiang Crescent, Rye, Victoria 3941.

I have a bachelor’s degree in Civil Engineering (City University, 1977). I am a Chartered Member of the Institution of Engineers Australia and a member of the Chartered Institute of Logistics and Transport in Australia. I am a transport planner and engineer with 42 years of post-graduate experience in the UK, Middle East, Asia and Australasia. I have been resident in Australia since 1985 and an Australian citizen since 1996. For most of my career I worked for consulting firms, primarily Travers Morgan (1977-1994), and Sinclair Knight Merz (1998-2014). Since 2014 I have practiced in an independent, self-employed capacity, with private and government clients.

My primary areas of expertise are transport strategy; planning and feasibility studies; traffic, economic and environmental evaluation; transport modelling and appraisal. I attach a summary curriculum vitae of my career experience (Appendix A).

Instructions for preparing this report

I was instructed to prepare this report by Maddocks Lawyers, who are acting on behalf of Banyule, Boroondara and Whitehorse Councils in relation to the Project EES process. My instructions from Maddocks were to provide my opinion on the following matters, subject to my area of expertise:

a) Does the EES adequately document and assess the Project against the Transport System Objectives and Decision Making Principles in the Transport Integration Act (TIA)?

b) Does the strategic demand modelling (Zenith) in the EES adequately document and assess the nature and extent of the traffic and transport impacts of the project?

In my assessment of (b) above, my focus is on the high-level modelling results and the overall modelling approach, rather than the detailed traffic volume predictions on roads in the vicinity of the Project, although I do comment on the accuracy of the model in replicating present day conditions.

I have prepared this report independently, with no inputs from others. I have relied solely on publicly-available documents and data, with my own analysis thereof where noted.

Structure of this report

My report is structured under three headings as follows:

- The Project in a policy context
- Strategic travel demand forecasting
- Summary and observations
23 Appendices A-C contain more information to supplement the main report.

Witness statement

24 I have made all the inquiries that I believe are desirable and appropriate and no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.
The Project in a policy context

In this Chapter I review the Project in the context of relevant government policy, particularly the Victorian Transport Integration Act (TIA)’s *Transport System Objectives* and *Decision Making Principles*.

**Background**

North East Link was itemised in Infrastructure Victoria (IV)’s 2016 30-Year Strategy as a priority for implementation in the 10-15 year timeframe (i.e. 2026-2031).

The Government responded by putting NEL (and most of IV’s other recommendations) into its Victorian Infrastructure Plan (2017), with $100m towards the Project’s development. In the 2018/19 budget, $110 million was added to this sum to fast-track development activities to get the Project ‘ready to go to market’ in 2019, thus bringing it forward in investment priorities.

The NEL Business Case, released in late May 2018, gave a benefit-cost ratio of 1.3 with a Project cost of $15.8 billion. The budget for the Project currently sits at $16.5 billion.

**What the EES says**

The NEL EES covers policy issues for the Project in several places:
- Chapter 1 (Introduction) gives objectives and guiding principles for the Project
- Chapter 2 (Project rationale) sets out the policy context for the Project (in section 2.4)
- Chapter 3 of Technical Report A (Traffic and Transport) describes ‘legislation, policy and guidelines that forms the framework that guides the development of North East Link’.

**Summary of TIA intent**

The overall intent of the TIA is enshrined in the *Transport System Objectives* and *Decision Making Principles*, to which all transport initiatives are supposed to be subject. In their entirety, the objectives and principles seek to ensure that initiatives are aimed at improving utilisation of existing assets, balancing demands across modes and achieving positive outcomes for the economy, society and the environment.

**Project responses to TIA transport system objectives**

The EES explains the Project’s response to the TIA by aligning its own objectives and guiding principles under the TIA’s Transport System Objectives (EES Table 2-1). The alignment is done as shown in Table 1.
Table 1: Alignment of NEL objectives and principles with TIA

<table>
<thead>
<tr>
<th>Transport Integration Act</th>
<th>Social and economic inclusion</th>
<th>Economic prosperity</th>
<th>Environmental sustainability</th>
<th>Integration of transport and land use</th>
<th>Efficiency, coordination and reliability</th>
<th>Safety and health and wellbeing</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEL objectives</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Improve business access and growth in Melbourne’s north, east and south-east</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Improve household access to employment and education in Melbourne’s north, east and south-east</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Improve freight and supply chain efficiency and industrial growth across the north, east and south-east</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Improve access, amenity and safety for communities in the north-east</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEL guiding principles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Minimise impacts on communities</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Minimise impacts on environmental and cultural assets</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Minimise impacts during the construction phase</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Optimise the efficient use of resources</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: analysis of EES Table 2-1.

32 EES Table 2-1 gives a series of ‘Project responses’ against each of the TIA transport system objectives. Table 2 lists these Project responses with my commentary alongside. I have only listed the transport-related responses close to my area of expertise; the EES also has Project responses relating to environmental and social effects and their management.

33 My comments show that the Project’s stated effects are generalised and questionable, to varying degrees. Key points are that:

- The Project’s impacts on travel times between key origins and destinations are not well documented in the EES. Travel time savings due to the Project are generally indicated between defined points at the beginning and end of the Project. This ignores the effect of changes in traffic beyond those points, caused by traffic accessing the Project, which will affect overall journey times for complete journeys. It ought to be possible for details to be given, from the transport modelling, of the key ultimate origins and destinations that NEL users will have and state the Project’s effects on those end-to-end journey times.
- Despite including initiatives for public transport, cycling and walking, the Project’s main function is clearly to improve conditions for vehicular traffic. According to Business Case figures, it induces and attracts an additional 13,000 car trips and 1.7 million car trip-km whilst also reducing public transport patronage by 3,000 trips on a typical weekday in 2036 (this effect is also likely to be an underestimate; I discuss this further in the next Chapter). The EES omits virtually all reference to this.
- The Project’s effect on the number of commercial vehicle trips has not been quantified, whilst that on cycling and walking trips has either not been quantified or not reported in the documents (Zenith modelling includes active transport in its mode split model, whilst its commercial vehicle model is stand-alone and trips are only re-routed).
### Table 2: Comments on NEL EES ‘Project responses’ to TIA

<table>
<thead>
<tr>
<th>NEL - Transport related responses</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Jobs growth in key locations</td>
<td>No specifics are given. The macroeconomic assessment carried out for the Business Case could be used to quantify the expected amount, timing and location of job growth due to the Project.</td>
</tr>
<tr>
<td>2 Additional jobs accessible to households</td>
<td>Project impacts on job accessibility could be quantified from work done for the Business Case.</td>
</tr>
<tr>
<td>3 Improved travel times for commuting to work and education facilities</td>
<td>Improved travel times are given relating to points either end of the Project, which is misleading. Travel times between key land uses and locations should be separately identified or quantified to itemise the effects of the Project on door-to-door journeys.</td>
</tr>
<tr>
<td>4 Improved travel times between residential areas and key local destinations in the north-east</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>5 Improvements to public transport (through the Doncaster Busway)</td>
<td>Despite inclusion of the Doncaster Busway, the Business Case shows that total public transport patronage will go down with the Project (presumably due to mode shift from public transport to car), by about 3,100 trips (equivalent to about 3 full trainloads) per weekday in 2036.</td>
</tr>
<tr>
<td>6 Improved conditions and connections for cyclists and pedestrians on local and arterial roads</td>
<td>Some cycling and pedestrian facilities are included in the Project, and traffic changes on existing roads will change cyclist and pedestrian amenity. No details are given to quantify the extent of improved conditions for cyclists and pedestrians (such as changes to cyclist and pedestrian safety).</td>
</tr>
<tr>
<td>7 Additional workers accessible to businesses</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>8 Travel time savings and improved travel reliability for businesses</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>9 Improved business access to suppliers</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>10 Improved travel times for freight trips</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>11 Support for a range of transport modes</td>
<td>Although the Project ostensibly includes initiatives to improve public transport, cycling and walking, it will primarily benefit car and commercial vehicle users. The Business Case shows that, in 2036, the Project will induce 13,400 more weekday car trips and 1.7 million car trip-km, while public transport trips will go down by 3,100. Induced commercial vehicle trips are not estimated by the transport modelling approach, and changes to cycling and/or walking trips are not reported on.</td>
</tr>
<tr>
<td>12 Improved connectivity between key business and employment areas</td>
<td>Business to business agglomeration impacts - can be used to quantify these effects.</td>
</tr>
<tr>
<td>13 Improved travel times between residential areas and key local destinations</td>
<td>See comment under response 3</td>
</tr>
<tr>
<td>15 Improved utilisation of existing transport infrastructure</td>
<td>Depends how one defines ‘improved utilisation’. Relieved roads will be less used, whilst those with traffic increases will be used more. Existing public transport assets will be used less due to the mode shift to car. Mode shift to/from cycling and/or walking has not been reported on.</td>
</tr>
<tr>
<td>16 Balance efficiency across the network to optimise network capacity and reduce travel times</td>
<td>Depends how one defines ‘efficiency’ and ‘optimisation’. See comment under response 15.</td>
</tr>
<tr>
<td>17 Facilitate integrated and seamless travel within and between different modes of transport</td>
<td>Project inclusions for different modes are secondary to the main function of the Project (namely to improve conditions for road traffic). See comment under response 5.</td>
</tr>
</tbody>
</table>

As well as making unquantified (and sometimes misleading) Project responses, the EES omits to comment at all on some aspects of the TIA transport system objectives. Some of these omissions seem due to the fact that the Project does not address them; that is not a problem, because the Project is not aiming to satisfy all of the TIA objectives. However, there
are some quite important issues on which the EES is silent, where the Project has a negative consequence.

35 The Project responses to the TIA transport system objectives omits mention of its negative consequences for:
   - *promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment and reduce the overall contribution of transport-related greenhouse gas emissions*: the Project will increase car and truck use (although the latter is not quantified by the transport modelling), leading to increases in fuel use and carbon emissions.
   - *reducing the need for private motor vehicle transport and the extent of travel*: The Project leads to increased car use and reliance, creates longer car trips and reduces public transport patronage (despite the inclusion of the Doncaster Busway).

Other policy contexts of the Project

36 Chapter 2 of the EES also makes comment on the Project’s alignment with the Planning Policy Framework and local government Planning Schemes. In many cases the statements about the Project’s effects are similar to those relating to the TIA, with similar omissions and lack of detail to support the statements made.


37 Chapter 3 of the Traffic and Transport Impact Assessment discusses legislation, policy and guidelines relevant to the Project’s transport and traffic aspects. The assessment makes general comments about the ‘relevance to the North East Link’ of various Federal and State legislative instruments.

38 The general tone is to highlight where the Project ‘fits’ with legislation and policy, supported by short generalised statements linking the Project’s own stated objectives and guiding principles to those of various pieces of legislation.

39 An example is the discussion under the Planning and Environment Act 1987 in Table 3-2 therein. It lists the Act’s seven key objectives for planning in Victoria and states that they are supported by the Project’s objectives and guiding principles. It mentions that the Project will affect land in subject municipalities (requiring an Amendment to their planning schemes) but goes no further than this.

40 The discussion on relevant State and local government policy is more comprehensive. It links the Project and its effects to the State Planning Policy Framework, Road Safety Plan, Plan Melbourne, Victorian Infrastructure Plan, Freight Plan, Cycling Strategy and the Rail Network Development Plan. It also cites many local government plans and transport strategies, picking out where they mention the Project (not all of them do) and otherwise identifying how the Project will benefit the areas and support the plans.

41 There is virtually no indication of any conflict or contradiction between the Project and these various documents. Where Project impacts are mentioned, the comment is generally that they will be managed in various ways with very little specific detail, nor referencing where else in the EES to look for them.
Strategic travel demand forecasting

Background

42 Strategic travel demand modelling provides estimates of travel demand and traffic activity, which are usually fed into more detailed traffic modelling processes (such as microsimulation modelling and intersection capacity assessment) when assessing the effects of a particular transport initiative.

43 The Zenith model used for the NEL EES is a ‘four-step model’ (as is the State Government’s Victorian Integrated Travel Model (VITM) and all other strategic travel demand models of this type). These models use demographic information (population, employment and education place distribution) and transport network details (roads, railways and public transit services) as the main inputs. They estimate the amount and distribution of travel demand that will be generated, then use that demand to estimate the amount of traffic on the road network and patronage on public transport.

44 The four steps employed in the travel modelling process are:
   • **Trip generation** – estimates frequency of trip origins and destinations, from the demographic input data.
   • **Trip distribution** – matches origins with destinations, often using a gravity model.
   • **Mode choice** – apportions trips between available transport modes.
   • **Trip assignment** – allocates trips using each mode to available routes.

45 Each step uses algorithms developed over many years worldwide, to reflect travel behaviour. The processes are segmented to produce estimates for different:
   • trip purposes (e.g. travel to and from work, school, shopping, recreation);
   • time periods (e.g. peak and off peak times of a typical day); and
   • transport modes (e.g. car, bus, train, bicycle, walk).

46 The usual approach is to run several iterations of the last three steps, using the travel times and costs from the loaded network to re-calculate the trip distribution, mode choice and assignment steps until the model converges to a stable result.

47 A base year model is calibrated and validated using a recent year, then future years or scenarios are developed by changing demographic data, pricing and networks accordingly. Travel demand for each future year or scenario is then run using the same four steps as the validated base year model. The calibration and validation process is vitally important to ensure that the model is as accurate as it can be, thus improving the confidence with which its prediction of future year travel and transport demands can be interpreted. It is also important to calibrate each of the four steps in turn as accurately as possible, to avoid cumulative errors building up through the step-wise modelling process.

48 It is vital to establish and demonstrate that the chosen modelling procedure:
   • Replicates existing conditions within suitable tolerances.
   • Behaves predictably when changes are made to model input assumptions.
• Produces plausible estimates of future year activity when suitable assumptions are incorporated.

49 Extensive specialist time and resources are required to build and populate transport models, which can become very large and complex. Good practice is assured to a degree by modelling guidance issued by State and Federal authorities and advisory bodies. Independent peer review of the work, while it is happening, is also a vital requirement to ensure the best outcomes.

50 My observations regarding the Zenith NEL modelling undertaken by Veitch Lister Consulting (VLC) to represent existing conditions and future years are described below.

Replicating existing conditions

Overall amount of travel – trips, trip-km and trip-hours

51 Information on the Zenith NEL model’s base year outputs is limited. However, by comparing figures in the EES (Technical Report A) and the Business Case (Appendices C, K and R) it is possible to establish some indicators of the overall level of travel demand represented in the model.

52 In the following tables, data from the reports is shown on a white background and my calculations from them are on a light grey background.

53 Table 3 gives daily travel statistics for Greater Melbourne in the Zenith NEL model, with figures from the NEL Business Case as well. I have calculated per capita and annual vehicle-km figures using data from the Business Case.

Table 3: Modelled 2016 travel demand in Zenith NEL model (EES)

<table>
<thead>
<tr>
<th>Modelled weekday - Gt Melbourne</th>
<th>2016 base EES (1)</th>
<th>2016 base Business Case (2)</th>
<th>2016 BITRE (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle trips</td>
<td>12,579,000</td>
<td>9,453,000</td>
<td></td>
</tr>
<tr>
<td>Vehicle-km of travel</td>
<td>123,577,000</td>
<td>120,149,000</td>
<td></td>
</tr>
<tr>
<td>Vehicle-hrs of travel</td>
<td>2,771,000</td>
<td>2,729,000</td>
<td></td>
</tr>
<tr>
<td>Average speed (km/h)</td>
<td>44.6</td>
<td>44.0</td>
<td></td>
</tr>
<tr>
<td>Population (4)</td>
<td>4,555,954</td>
<td>4,555,954</td>
<td></td>
</tr>
<tr>
<td>Average vehicle trip length (km)</td>
<td>9.8</td>
<td>12.7</td>
<td></td>
</tr>
<tr>
<td>Annual veh-km travel/capita (5)</td>
<td>9,195</td>
<td>8,940</td>
<td>8,853</td>
</tr>
</tbody>
</table>

Sources: 1) NEL EES Technical Report A Table 5.1  
2) Calculated from figures in NEL Business Case Appendix C Table 17  
3) BITRE Yearbook 2018 - Australian Infrastructure Statistics  
4) Population: NEL Business Case Appendix R (App B Table B1), plus Yarra Ranges Shire  
5) Calculated using weekday-to-year factor of 339 (NEL Business Case Appendix Q1 section 2.3.1)

54 The Zenith NEL model was recalibrated between the Business Case and the EES, but it is not clear why the EES figures have about 25% more vehicle trips than those in the Business Case (but only about 3% more trip-km). I have calculated the annual vehicle-km/capita figure for comparison with data from the Bureau of Infrastructure, Transport and Regional Economics (BITRE) which is used by VLC in their reporting to analyse trends in vehicle use. The Zenith NEL (EES) model gives about 4% more vehicle-km of travel per capita per annum than BITRE in 2016.
The Business Case also gives some figures from which total trips can be estimated, I assume for Zenith’s entire modelled area, although the Business Case does not specify this (Table 4). These figures are significantly different to those from the EES in Table 3. The differences are too large to be explained solely by the possibility that they cover different areas.

The Business Case figures have a lot more car trips. Maybe they are car person-trips, not vehicle trips. I have extracted comparable figures from the Victorian Integrated Survey of Travel and Activity (VISTA) where possible, for Greater Melbourne and Victoria. The Zenith NEL model produces significantly more car and public transport trips than VISTA. It also produces significantly higher car kilometres and less hours travelled, making the average speed of car travel in Greater Melbourne (45km/h in the EES) substantially more than VISTA’s 29km/h. Part of this might be because VISTA’s travel times are based on estimates by survey participants and cover the entire journey (thus including access/egress time at each end), but a difference of this magnitude is difficult to ignore.

**Table 4: Total Zenith area modelled 2016 trips (NEL Business Case)**

<table>
<thead>
<tr>
<th>Daily travel (1)</th>
<th>Zenith NEL model 2016</th>
<th>VISTA Person-travel Greater Melb 2014-16 (2)</th>
<th>Victoria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Car</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>14,243,944</td>
<td>9,640,500</td>
<td>10,206,538</td>
</tr>
<tr>
<td>Vehicle km travelled</td>
<td>140,217,397</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle hours travelled</td>
<td>2,974,472</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean speed (km/h)</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average car trip length (km)</strong></td>
<td>9.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Freight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>698,774</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(LCV+) Vehicle km travelled</td>
<td>13,475,107</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCV) Vehicle hours travelled</td>
<td>245,867</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean speed (km/h)</td>
<td>56</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Av freight veh trip length (km)</strong></td>
<td>19.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean speed (Car+LCV+HCV)</strong></td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Av Car+LCV+HCV trip length (km)</strong></td>
<td>10.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Public transport</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>1,532,474</td>
<td>1,138,871</td>
<td>1,160,115</td>
</tr>
<tr>
<td>PT mode share (%)</td>
<td>8.4%</td>
<td>8.6%</td>
<td>8.3%</td>
</tr>
<tr>
<td><strong>Total daily trips (from PT share)</strong></td>
<td>18,243,738</td>
<td>13,240,550</td>
<td>13,966,732</td>
</tr>
<tr>
<td><strong>Population (3)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>5,263,194</td>
<td>6,022,322</td>
<td></td>
</tr>
<tr>
<td><strong>Trips per day per capita</strong></td>
<td>3.47</td>
<td>2.89</td>
<td>2.32</td>
</tr>
</tbody>
</table>

Sources: 1) NEL Business Case Appendix Q1 Table 15 - assumed to refer to the entire Zenith modelled area
2) Greater Melbourne figures include trips to and from areas outside Melbourne
3) Includes allowance for population of additional modelled area (outside Greater Melbourne)

The Zenith NEL model produces travel demand of 3.47 trips per day per capita in 2016. This is 22% more than VISTA, which produced trips per head of 2.89 in 2014-16 for trips wholly within Greater Melbourne. It also produced lower trips per head for areas outside Greater Melbourne (but VISTA survey coverage was not across Victoria in its entirety).

The Zenith NEL (Business Case) model produces significantly more car travel than VISTA (Table 4), while the Zenith NEL (EES) model produces more car travel than the Business Case model (Table 3).

VISTA is a resident-based travel survey; it excludes commercial vehicles and trips by visitors to the survey area. Daily commercial vehicle trips in Zenith are 0.13 per capita, and I estimate visitor trips at about 0.12 per capita (from about 200,000 visitors a day in Melbourne,
avertaging from National Visitor Survey data), leaving about 3.22 trips per head in Zenith that might be attributed to residents. If so, the Zenith NEL model appears to overestimate trip activity by residents by about 11% compared to VISTA, in 2016.

Part of the explanation for this might be that Zenith’s trip generation model is calibrated to 2009 VISTA data; more recent VISTA surveys have shown a downward trend in trips per capita. Also, there are other trip types estimated by Zenith (‘special generators’) but no information on how much they contribute to the total.

Another feature of Zenith (which was evident in the West Gate Tunnel modelling) seems to be an overestimation of the average length of trips, although it is not possible to compare person-trip lengths directly between VISTA and Zenith because there are no Zenith outputs of this available.

**Model performance in NEL study area**

Appendix B of the VLC Transport Modelling Summary Report (EES Technical Report A, pdf–pages 682-781) compares the base year (2016) model’s outputs (traffic counts, travel times and public transport patronage figures) against surveyed data in the area around NEL. This is an important step in model development, to ensure that a wide-area model like Zenith is sufficiently accurate in the immediate area of influence of NEL.

Usually, this ‘local area validation’ results in some fine tuning of the model’s settings to ensure that it provides the best possible results (i.e. the smallest differences between modelled and observed data). There is no evidence of any fine-tuning measures in VLC’s report; the local area validation results are described, in general highlighting where it performs well and often omitting to comment on (or under-stating) where it performs badly.

There are a number of issues that, in my opinion, could have been drawn out in more detail and steps taken to improve the model’s performance by adjusting some of its settings (for example, error-checking the way the local transport network is represented in the model, and fine tuning speed-flow curves), which is usual practice. Getting the best possible representation of present-day conditions gives the greatest confidence in the model’s behaviour when used to represent future years, both with and without NEL in place.

**Travel times**

The report says that 34 peak and 18 interpeak travel time surveys were available for validation purposes; the surveyed routes are illustrated in Appendix Figure B.4 of the report. Table B.12 shows that across these 34 routes as a whole, the modelled travel speeds are somewhat lower than the surveyed values (especially in the AM peak). In Appendix B3, a series of 36 graphs (Figures B.29 to B.60) are presented, giving AM peak, interpeak and PM peak modelled and surveyed travel times in each direction on six of the routes for which survey data is available:

- **Bulleen Road/Banksia Street/Rosanna Road/Greensborough Highway corridor** – this corridor validates better than any of the others reported on, with modelled travel times very similar to surveyed except for northbound in the interpeak (modelled 13% more than surveyed).
• **Greensborough Bypass to Kangaroo Ground-Wattle Glen Road** – shows large discrepancies in the morning peak westbound, and evening peak eastbound, both over 40% more than surveyed – although these are not in the peak traffic flow direction

• **Fitzsimons Lane/Williamsons Road** – significant differences between modelled and surveyed; the modelled travel times are 34% more than surveyed in the AM peak southbound, and 20-30% less in the PM peak (in both directions).

• **Eastern Freeway (Springvale Road to Alexandra Parade)** – modelled travel time is only 6% less than surveyed in the AM peak westbound, but in all other time periods and directions it is more, by between 8% and 20%.

• **Kangaroo Ground-Warrandyte Road** – the northbound AM peak graph (Figure B41) is incorrect (it seems to be a duplicate of Figure B43, which is for the Ringwood-Warrandyte Road). In the other time periods and directions, the model is 14-26% more than surveyed.

• **Ringwood-Warrandyte Road** – the modelled times are significantly more than surveyed, especially southbound in the AM peak (79% more) and northbound in the PM peak (29% more).

66 The last two routes (north and south of Warrandyte) have comparatively small traffic volumes and are fairly remote from NEL, so their accuracy may be less important than some of the others.

67 Apart from highlighting the comparatively good travel times on the Rosanna Road corridor (which is the corridor where the biggest traffic changes are expected with NEL), the local area validation report makes no mention or qualitative assessment of the model’s performance on the other five routes described above. It also does not provide corresponding graphs for the other routes shown in Figure B.4, however most of these are in the north-west part of the NEL study area, and not on roads that are likely to be greatly affected by NEL.

68 I consider that travel time comparisons on only six routes is insufficient to gauge the overall performance of the Zenith model in the NEL study area, especially as the model’s tendency in most cases is to overestimate surveyed travel times on these routes. To me, this ought to have prompted further investigation and possibly adjustment of the model parameters (for example the built-in speed/flow relationships). Furthermore, travel time surveys were apparently not available or carried out on a number of key routes in the area, including Bell/Banksia Street, Plenty Road, Heidelberg and Lower Heidelberg Roads, whose traffic performance is likely to be affected by NEL.

**Traffic volumes**

69 The base year modelled traffic volumes are compared with surveyed traffic counts at 485 locations, shown on a map in Appendix Figure B.1 and listed in Appendix B1 (Appendix Table B.35). I have copied the tabled numbers into a spreadsheet for ease of analysis.

70 As stated in the body of the base year local area validation report, the modelled and surveyed traffic volumes are within accepted tolerances in an overall sense. However, there are a few significant issues on some of the more important routes, as follows (starting with the routes where travel times are compared, as discussed above):
• **Rosanna Road/Greensborough Highway** – modelled traffic volumes are close to surveyed in all time periods. However, daily commercial vehicle flows are overestimated by up to 20% on Rosanna Road, and overestimated by about 40% on Greensborough Highway.

• **Greensborough Bypass to Kangaroo Ground-Wattle Glen Road** – Greensborough Bypass volumes are overestimated by around 25%, yet for some reason the model shows no commercial vehicles. Diamond Creek Road volumes are overestimated by over 20% between Civic Drive and Yan Yeang Road and underestimated by a similar amount between Yan Yeang Road and Ryans Road. Through Diamond Creek and on to Hurstbridge Main Road, modelled volumes are closer to surveyed.

• **Fitzsimons Lane/Williamsons Road** – Williamsons Road daily traffic volumes are overestimated at the southern end and underestimated at the northern end, by about 10% (but the differences are greater at peak times).

• **Eastern Freeway** – modelled traffic volumes are generally about 13% lower than surveyed in the AM peak in both directions, and 9% lower in the PM peak. Daily commercial vehicle traffic is overestimated by 38%.

• **Kangaroo Ground-Warrandyte Road** – traffic volumes are comparatively small on this route, but the model overestimates them by up to 30% (and commercial vehicles are roughly double the surveyed values).

• **Ringwood-Warrandyte Road** – modelled traffic volumes are about 16% higher than surveyed at the Ringwood end, and lower at the Warrandyte end. There are no commercial vehicles modelled at the Warrandyte end.

• **Bell/Banskia Street** – traffic volumes are significantly overestimated on Bell Street (by up to 25% overall, with greater overestimates in the AM and PM peaks. Commercial vehicle volumes are overestimated by up to 150%.

• **Plenty Road** – AM peak volumes are overestimated by 40-80% (and daily commercial vehicle volumes by up to 200%) south of Bell Street, and by about half that further north.

• **Heidelberg Road** – modelled daily traffic volumes at Darebin Creek are 10-15% overestimated, with bigger differences during the peaks. At the Hoddle Street end, the modelled volumes are much more accurate.

**Public transport patronage**

71 The report gives details of modelled and surveyed passenger flows on rail and bus services in the study area. Appendix Table B.22 shows that modelled passenger loads on the Hurstbridge and South Morang lines entering the city in the AM peak are close to surveyed. No details are given of daily or PM peak figures (perhaps because no surveyed data is available). Rail station entries by line segment are given in Appendix Table B.23 for the AM peak (and show significant variations, with station entries significantly overestimated especially between Diamond Creek and Hurstbridge (137% more than surveyed) and Montmorency-Eltham (59% more)). Appendix Table B.24 shows that daily station entries are overestimated by 25-57% on the line segments listed, and 24% overall.

72 The fact that AM peak passenger volumes entering the city are modelled accurately but the station entries are significantly overestimated warrants further investigation (VLC acknowledges that this is an issue), especially if trains are modelled with higher passenger loads further out along the lines, making them less attractive to passengers closer to the city.
Modelled boardings on bus routes appear to be closer to surveyed values, but only total boardings are given rather than investigating the distribution of patronage along each route (possibly because of a lack of survey data).

It might be argued that, because the model is being used to assess a road project, its accuracy on the public transport side might be less important (because public transport carries a small proportion of total trips being modelled). However, NEL does include a public transport component, whose patronage performance could influence peak period road-based travel demands significantly. Also the future year modelling of NEL shows that, despite the Doncaster Busway, 3,000 trips a day are lost to public transport overall due to travellers diverting from public transport (I daresay mainly from train) to car. This is a significant and under-reported finding of the transport modelling which may itself be quite sensitive to the quality of representation of public transport services in the model. For example, if (as it seems) train patronage is over-estimated in the base year, there would be less spare capacity for future year growth. Adjusting this to improve the model’s validation might produce a different response in public transport patronage when NEL is modelled in future years.

Future year activity

VLC uses an unusual and, in my view, illogical ‘workaround’ to produce future year demand projections with the Zenith Project model. The evidence provided to justify this approach shows clearly that it produces more and longer trips in future years than the conventional method.

VLC calls their method a ‘single loop’ model. It involves omitting the ‘distribution’ step when iterating the four-step model, instead looping through only the mode split and assignment steps, with a fixed trip distribution. Figure 1 illustrates the two methods diagrammatically.

Figure 1: ‘Loop-through’ and ‘single loop’ distribution approaches

The Zenith NEL model only uses the ‘single loop’ approach in modelling future years, and it also feeds base year (2016) network travel times and costs into those future year modelled scenarios to feed the single iteration of the distribution step at the outset of the calculation process. This is clearly an artificial representation of future years. VLC documentation is silent.
on whether this approach is used in all their modelling work, or only in the Zenith NEL model. It was used in the Zenith modelling for the West Gate Tunnel (with concern expressed by the independent peer reviewer and I at the time), and I believe the East West Link as well (although I have found nothing in the documentation either way). The Government’s own VITM model (and all other four-step models that I know of) does not use such an approach, and it thus produces lower amounts of travel demand in future years than Zenith does, with all other inputs being virtually identical.

78 No information is given on whether the ‘single loop’ approach has always been used in Zenith modelling in Victoria, nor whether it is used in other cities’ Zenith models (none of the general Zenith documentation on VLC’s website mentions it). Also, there is no explanation given for choosing to run the distribution step with base year network times and costs, and how much difference it would make to run it with future year times and costs instead.

79 Table 5 and Table 6 give the high-level modelling results from the EES and the Business Case. For a 38% population increase, the Zenith NEL model produces 33% more vehicle trips and 44% more vehicle-km of travel in 2036 compared to 2016. Average vehicle trip length increases by 8%. It also produces 57% more vehicle-hours, so average travel speeds go down by 8%.

**Table 5: Modelled travel demand in Zenith NEL model (EES)**

<table>
<thead>
<tr>
<th>Modelled weekday</th>
<th>2016 Base</th>
<th>2036 Base case</th>
<th>% change 2016-2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle trips</td>
<td>12,579,000</td>
<td>16,775,000</td>
<td>33%</td>
</tr>
<tr>
<td>Vehicle-km of travel</td>
<td>123,577,000</td>
<td>178,393,000</td>
<td>44%</td>
</tr>
<tr>
<td>Vehicle-hrs of travel</td>
<td>2,771,000</td>
<td>4,356,000</td>
<td>57%</td>
</tr>
<tr>
<td>Average speed (km/h)</td>
<td>44.6</td>
<td>41.0</td>
<td>-8%</td>
</tr>
<tr>
<td>Population (2)</td>
<td>4,555,954</td>
<td>6,290,192</td>
<td>38%</td>
</tr>
<tr>
<td>Average vehicle trip length (km)</td>
<td>9.8</td>
<td>10.6</td>
<td>8%</td>
</tr>
<tr>
<td>Annual veh-km travel/capita (3)</td>
<td>9,195</td>
<td>9,614</td>
<td>5%</td>
</tr>
</tbody>
</table>

Sources: 1) NEL EES Technical Report A Table 5.1  
2) Population: NEL Business Case Appendix R (App B Table B1), plus Yarra Ranges Shire  
3) Calculated using weekday-to-year factor of 339 (NEL Business Case Appendix Q1 section 2.3.1)

80 The Zenith NEL Business Case model figures in Table 6 show similar percentage changes between the two years, but as already shown, the EES model has about 25% more vehicle trips than the Business Case model.
Table 6: Modelled travel demand in Zenith NEL model (Business Case)

<table>
<thead>
<tr>
<th>Modeled weekday</th>
<th>2016 Base (1)</th>
<th>2036 Base case (2)</th>
<th>% change 2016-2036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle trips</td>
<td>9,453,000</td>
<td>12,478,000</td>
<td>32%</td>
</tr>
<tr>
<td>Vehicle-km of travel</td>
<td>120,149,000</td>
<td>173,015,000</td>
<td>44%</td>
</tr>
<tr>
<td>Vehicle-hrs of travel</td>
<td>2,729,000</td>
<td>4,284,000</td>
<td>57%</td>
</tr>
<tr>
<td>Average speed (km/h)</td>
<td>44.0</td>
<td>40.4</td>
<td>-8%</td>
</tr>
<tr>
<td>Population (4)</td>
<td>4,555,954</td>
<td>6,290,192</td>
<td>38%</td>
</tr>
<tr>
<td>Average vehicle trip length (km)</td>
<td>12.7</td>
<td>13.9</td>
<td>9%</td>
</tr>
<tr>
<td>Annual veh-km travel/capita (5)</td>
<td>8,940</td>
<td>9,324</td>
<td>4%</td>
</tr>
</tbody>
</table>

Sources: 1) Calculated using 2016-2036 growth figures given in source (2)  
2) NEL Business Case Appendix C Table 17 (Road vehicle trips, 2036 ‘no project’ scenario)  
3) NEL Business Case Appendix K Table 1 (2036 ‘project case’ vs 2036 ‘no project’ scenario)  
4) NEL Business Case Appendix R (App B Table B1), plus Yarra Ranges Shire  
5) Calculated using weekday-to-year factor of 339 (NEL Business Case Appendix Q1 section 2.3.1)

The Business Case also provides longer range demand projections (Table 7), which would have been required for the economic evaluation. I assume they are for the entire modelled area (the documentation is not clear on this).

Table 7: Zenith Business Case model results

<table>
<thead>
<tr>
<th>Daily travel (1)</th>
<th>Base (no Project) case</th>
<th>Change from 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2036</td>
</tr>
<tr>
<td>Car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>14,243,944</td>
<td>19,077,614</td>
</tr>
<tr>
<td>Vehicle kilometres travelled</td>
<td>140,217,397</td>
<td>201,633,086</td>
</tr>
<tr>
<td>Vehicle hours travelled</td>
<td>2,974,472</td>
<td>4,617,177</td>
</tr>
<tr>
<td>Mean speed (km/h)</td>
<td>47</td>
<td>44</td>
</tr>
<tr>
<td>Average car trip length (km)</td>
<td>9.8</td>
<td>10.6</td>
</tr>
<tr>
<td>Freight (LCV+HCV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle kilometres travelled</td>
<td>698,774</td>
<td>986,485</td>
</tr>
<tr>
<td>Vehicle hours travelled</td>
<td>13,475,107</td>
<td>20,045,022</td>
</tr>
<tr>
<td>Mean speed (km/h)</td>
<td>56</td>
<td>50</td>
</tr>
<tr>
<td>Average freight veh trip length (km)</td>
<td>19.3</td>
<td>20.3</td>
</tr>
<tr>
<td>Mean speed (Car+LCV+HCV)</td>
<td>48</td>
<td>44</td>
</tr>
<tr>
<td>Average Car+LCV+HCV trip length (km)</td>
<td>10.3</td>
<td>11.0</td>
</tr>
<tr>
<td>Public transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of trips</td>
<td>1,532,474</td>
<td>3,216,253</td>
</tr>
<tr>
<td>Total daily trips (from PT mode share)</td>
<td>18,243,738</td>
<td>25,730,024</td>
</tr>
<tr>
<td>Population (2)</td>
<td>5,263,194</td>
<td>7,263,065</td>
</tr>
<tr>
<td>Trips per day per capita</td>
<td>3.47</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Sources: 1) NEL Business Case Appendix Q1 Table 15 - assumed to refer to the entire Zenith modelled area  
2) Includes allowance for population of additional modelled area (outside Greater Melbourne)

This data shows similar changes between 2016 and 2036 to the EES figures, for vehicle travel. It also shows significant increases in public transport patronage (nearly doubling by 2051). Average car and commercial vehicle trip lengths increase, as does the total number of trips per capita, contributing to significant increases in total vehicle-km per capita.

It is noteworthy that another key document – Plan Melbourne – includes figures that are substantially less than Zenith’s, more so than can be explained by the extra modelled area. It gives, for Greater Melbourne:
• 12.5 million trips a day (2017) for a population of 4.5 million (2.8 trips/head/day)
• 22.9 million trips a day (2050) for a population of 7.9 million (2.9 trips/head/day)

This demonstrates again that the Zenith NEL model seems to have more trips, now and in future, than should be expected, even allowing for the trips that VISTA surveys do not cover.

In their reporting, VLC goes to some length to justify why, in their opinion, their ‘single loop’ method produces better future trends. Most of this relies on their view that Melbourne is getting physically larger as it grows, and that this is making trips – particularly motor vehicle trips – longer. They compare the results of their future year forecasts with projections made in 2015 by BITRE (Information Sheet 74, *Traffic and congestion cost trends for Australian cities*, 2015) which suggested that, despite vehicle-km per capita falling in most capital cities since 2000 or so, this trend would be reversed (or at least bottom out) to produce growth again, from 2015 onwards.

In contradiction of this, BITRE’s latest publication of trends (Yearbook 2018, *Australian Infrastructure Statistics*) shows that passenger-km of travel and vehicle-km per capita in Melbourne (and other cities, to varying degrees) is continuing to fall (vehicle-km per capita fell another 2% from 2015-2018, despite Melbourne’s population growing by 8% over the same period). BITRE researchers have recently advised me that they are currently updating their data for 2019, after which they will turn their attention to revising the 2015 projections, later this year.

Figure 2 shows annual vehicle-km of travel per capita in Australia’s capital cities, calculated from the BITRE 2018 Yearbook data. It clearly shows that this metric has been falling steadily since peaking in 2003 or thereabouts in Sydney and Melbourne (with Melbourne showing the greatest downward trend).

Figure 3 shows annual passenger-km of travel per capita in Melbourne, broken down by mode of transport. It follows the same downward trend since 2003. It also shows that reduction in travel per capita by car is the greatest contributor to this trend.

Clearly, travel and vehicle use in Melbourne is growing slower than population growth, and has been for the last 15 years.

Why is vehicle-km per capita in Melbourne – and indeed, many other cities – falling? There are many factors contributing to this. However, I consider that land use changes are a significant influence.

Analysis by transport researcher Chris Loader (in his blog [www.chartingtransport.com](http://www.chartingtransport.com)) shows that, whilst Melbourne has indeed been spreading geographically for many years, the density of people in populated areas has actually been increasing since the mid-1990s. This is some years ahead of the downturn in BITRE’s vehicle-km per capita indicator. Mr Loader analyses all capital cities in Australia and shows that the density increases have been happening virtually everywhere, with Sydney and Melbourne leading the trend and others following. Denser areas produce lower amounts of trip-km per capita, because people do not have to travel so far to get to opportunities. Thus the observed trends of densification and reduced trip-km per capita in all Australian cities.
Figure 2: Annual vehicle-km per capita in Australian cities, 1973-2018

Source: Analysis of data from BITRE Yearbook 2018, Australian Infrastructure Statistics

Figure 3: Annual passenger-km of travel per capita in Melbourne, 1977-2017

Source: Analysis of data from BITRE Yearbook 2018, Australian Infrastructure Statistics
One of Mr Loader’s many charts on the subject is reproduced in Figure 4. It clearly demonstrates that densification started in the 1990s in Sydney and Melbourne with Brisbane, Adelaide and Perth following later, and to a much lesser degree.

**Figure 4: Population-weighted density in Australian cities**


Another significant influence on travel demand is the degree of ‘self-containment’ in a given area (essentially, how many jobs, education opportunities and other activities can be fulfilled locally). However, for jobs in particular, even if there is a large number of jobs in a given part of the city, the amount of take-up by local workers there is quite small. This has a strong influence on the amount of travel to work, and the resulting trip-km of travel.

I have analysed this using VISTA travel data at LGA level for Melbourne. I have also developed future projections of travel, using the same population and employment projections that VLC have used in the Zenith NEL model (given in the Business Case), to predict how trip lengths might change. More information is provided in Appendix B.

I have analysed the projected population and employment growth used in the Zenith NEL modelling to show it by distance from Melbourne CBD (Figure 5). Although this is a coarse-level assessment (using the LGA-level data in the Project Business Case) it indicates that future growth will be increasingly concentrated closer to the centre than away. This will continue the densification trend of recent years already shown by Mr Loader’s analysis.
At this coarse (LGA) level of analysis, I estimate that the weighted average distance of Greater Melbourne’s population from the CBD is 24.3km in 2016, increasing slightly to 24.7km in 2036 and then reducing to 24.5km in 2051, as the outer growth areas fill, and growth shifts closer to the centre.

I believe further research into these demographic shifts is warranted. Transport models (especially Zenith, with its fine-grained zone system) have population, employment and school enrolment data into the future at a very fine level of detail, which would be a great improvement over the simplified analysis I have done.

If Melbourne’s growth continues in this way (which is actually a cornerstone of Plan Melbourne), it should promote limited growth in trips and trip-km per capita, if at all. In my considered view, there is no supportable basis for projecting a forced increase in travel-km per capita to the extent that VLC does, by choosing the illogical ‘single loop’ method for future year forecasts.

In Figure 6 I have compared Zenith forecasts and backcasts (given in the Project EES documentation) with BITRE trends in vehicle-km of travel per capita in Melbourne. I have also added a trendline reflecting Melbourne’s population density (shown as area/person, indexed to the vehicle travel in 1981) from Mr Loader’s analysis. The rate at which Melbourne’s population density is increasing could be a strong influence on the continuing downward trend in vehicle-km per capita.
Figure 6: Melbourne vehicle-km per capita trends

100 Figure 6 shows how the Zenith NEL (EES) projections for growth are above current trends, in the high range of the 2015 BITRE forecasts, which are themselves subject to updating soon. It also shows the ‘backcasting’ which VLC uses to suggest that the ‘single loop’ method produces better backcasts as well as forecasts. However, I do not find the evidence for this very convincing. Looking at Figure 6, I would say it provides stronger support for the ‘loop through’ method, especially if the base year (2016) starting point of Zenith NEL (EES) modelling was lower (i.e. closer to the level indicated by BITRE data and VISTA).

101 To me, there is no logic in calibrating and validating a modelling process for the base year, then using a different (and illogical) method to forecast future years. If the ‘single loop’ process is supposed to be more accurate, why is the base year model not run that way as well, perhaps feeding network times and costs from about ten years ago into the distribution model? It is clearly against established modelling practice to use a four-step model in this way for the stated purpose of producing more and longer trips, just because the proper method does not give enough growth as VLC seems to want.

Future project inclusions

102 When modelling travel demand in future years for projects, it is customary to include in the modelled transport networks any projects that are committed or planned in those future years. The Department for Transport and its predecessors have, for several years, ensured that consistency is applied to this approach by nominating which projects should be included or excluded in a given future year.

103 Some major projects also have projects that are dependent on them (i.e. initiatives that cannot proceed before the project being evaluated). The Department is careful to examine such eventualities and modify the future year project lists accordingly. For economic
evaluations, it is important not to include ‘downstream’ projects (i.e. those contingent on the subject project proceeding) without also including the cost of them in the economics.

104 These principles are sound in concept but can lead to complications in practice, especially when evaluating large projects. I wonder if, in the EES stage, project inclusions should be revisited to make sure that any downstream consequences of the project are included as well as the primary impacts.

105 This is important because the post-opening impacts of the Project discussed in the EES are mainly assessed only for one year (2036). Many of the impacts will continue, to varying degrees, for years beyond that, especially those associated with changes in traffic and with any subsequent projects that may be contingent on the Project.

106 As far as major projects are concerned, 2036 modelling for the EES excludes:
- East West Link
- Outer Metro Ring Road
- Airport Rail Link
- Melbourne Metro 2
- Suburban Rail Loop
- Doncaster Rail

107 This is mainly a timing issue, because these projects are not expected to be in place in 2036. However only the Outer Metro Ring Road and Airport Rail were included in the 2051 base network for the Business Case, so the East West Link, Melbourne Metro 2, Suburban Rail Loop and Doncaster Rail are ignored. Whilst their future is unclear under present Government policy, many other projects for which the same could be said are included, especially road improvements. I am of the opinion that this will understate the impact of future projects, especially major public transport projects like Melbourne Metro 2, the Suburban Rail Loop and Doncaster Rail, whose effect is likely to be a reduction in car use in the project area in future years.

108 Another key issue in this respect is that many toll road contracts, including City Link and West Gate Tunnel, include compensation clauses in relation to initiatives that might give operators lower revenues in future years. This could affect future Governments’ project planning significantly, yet no information is given on this issue in the EES.

Peer review report

109 A peer review of the Zenith NEL model was recently released as part of the EES documentation (Transport Model Peer Review Report, February 2019). The review is for the North East Link Authority by Luis Willumsen, an acknowledged expert in transport modelling of many years’ standing. His review was done after the EES traffic modelling was complete, and it did not result in any changes thereto.

110 As suggested by Dr Willumsen, additional work was done by VLC on scenarios involving new transport technologies (principally, Mobility as a Service (MaaS) and Connected and Automated Vehicles (CAVs)). In this additional work, it was reported that MaaS and CAV
trends could reduce the total number of 2036 modelled car trips by 18%, with a resulting 5% reduction in the forecast traffic flows on NEL.

In his review, Dr Willumsen says of the forecasting method:

‘...the Gravity Model generally used in Trip Distribution, exaggerates the response of changing jobs or residences when travel costs change thus making equilibration a more difficult task. The VLC model follows normal practice of feeding back directly the costs from assignment to higher sub-models. However, the model uses the costs of the first iteration to run Distribution and Mode Choice and feed back costs of subsequent iterations only to mode choice. VLC calls this “damped” or “single distribution” approach in contrast with “loop through distribution” method. In my view, both approaches risk failing to achieve convergence; the “loop through distribution” method runs a higher risk and to an extent VLC is right to call their approach a “dampening technique”.

VLC undertook a “backcasting” exercise to show that its approach is more consistent with the observed evolution of total vehicle kilometres. The results are consistent with my expectation and provide further support to the approach adopted by VLC.

Most of the models I had been tasked to review treat this issue in a pragmatic but theoretically poor way. This does not seem to have detracted much from their ability to produce reliable forecasts. The approach adopted by VLC is, in a way, better than most in that it controls or dampens wild oscillations present when direct feed back on distribution and mode choice are implemented to aim for convergence.

…I am not in a position to comment on whether the list of projects and expected growth is consistent with current thinking in Victoria.’ (p22).

I agree that, in general, trip distribution gravity models are more difficult to ‘equilibrate’ mathematically. However, I do not see what that has to do with people’s speed of response to changing travel costs, other than when testing the effect of a specific initiative in a given modelled year, close to the planned opening date of that initiative. I also do not see how removing the distribution step from the iteration process is a logical thing to do. Even if it does improve the convergence of the model by omitting the most mathematically-difficult step, in doing that it compromises the four-step process that is the fundamental basis of this modelling approach, worldwide. Moreover, when Zenith is run in ‘loop-through’ mode, as it is for the base year (2016), the validation report says that it converges well within the tolerances accepted in modelling guidelines.

VLC uses the ‘single loop’ method in future ‘non-project’ years, feeding the base year network costs into the distribution step, because it produces more year-on-year growth in travel demand. This is a premise that I fundamentally disagree with, as already explained, because there is no evidence that travel-km per capita in Melbourne is growing. Dr Willumsen mentions that he cannot comment on the expected growth in the modelling. He also does not comment on the fact that VLC uses base year (2016) network costs in the first iteration for future year model runs (I wonder if Dr Willumsen was aware of this). I do not believe that the demand forecasts and backcasts are better for it, and I consider that it produces excessive demand growth compared with recent trends and future continuing densification of Melbourne.

I consider that a ‘single loop’ approach might be used in years close to the opening year of a specific project (thus removing or reducing the re-distribution effect of that project, if indeed that is the effect of the single loop method), but only in the ‘with-project’ scenario, with network costs from the ‘no project’ scenario in the modelled year (not the base year) fed into
the distribution step, and with a close eye on its influence on the model’s estimation of induced travel effects of the project, which I expect would also be sensitive to the method used (more on this later).

115 I also observe that, in any given year of consideration, people are constantly changing house and work locations to a surprisingly high degree. Whilst data on work changes are difficult to find, recent figures released by ABS show that changes to population in a single year (2016-2017) in Greater Melbourne comprise:

- natural increase 36,000
- net internal migration 10,000
- net overseas migration 83,000

116 Looking at the data at SA2-area level (of which Greater Melbourne has 309) shows that no fewer than 431,000 people – 9% of the entire city’s population – internally migrated (i.e. changed their residential location) between SA2s within the city in that year. This is probably an underestimate, because it excludes people who might have relocated within an SA2 (typically the size of a suburb) and it shows that people are actually quite mobile in their housing decisions. They are likely to be even more mobile in their job choices. The argument that project-induced land use changes can take many years (which, incidentally, is used to postpone the effects of induced traffic, thus increasing the time savings in the early years of projects in economic evaluations) has never been conclusively proven as far as I’m aware, and is difficult to believe, with this insight.

Effects of the Project in Zenith modelling

117 Consideration of induced travel and traffic brings me to consider the stated effects of the Project on the total amount of travel by different modes.

118 VLC states that the use of ‘single loop’ modelling, with base year network costs, ‘means that the redistributional impacts of new transport infrastructure, and thus induced demand, are accounted for’. They also state that ‘The undampened loop through distribution approach assumes that changes in accessibility instantaneously affect travel patterns. However, travel patterns are often the result of long-term decisions (that is, where to live, work and study) which are only made periodically, and play out over many years.’

119 This seems to imply that the ‘single loop’ distribution will produce less induced travel than the ‘loop through’ method, when used to test the effects of a project, but no supporting information is provided to confirm this. Moreover, the ‘single loop’ approach is used to produce forecasts relating to the Project in 2036 and 2051, many years after the planned opening year of 2027, by which time any relocation effects would surely have already happened.

120 The EES (Chapter 6) states that ‘Data from the strategic transport model was used to compare changes in transport mode for the 2036 ‘no project’ and ‘with project’ scenarios within the study area and across metropolitan Melbourne. The data indicated that North East Link would not result in a material increase in road vehicle trips relative to trips made using public transport and active transport (walking and cycling) as the project would provide upgrades across all transport modes.’
Table 5.1 in Technical Report A belies this. It shows that, in 2036, the Project will create 13,000 more vehicle trips a day in the study area (19,000 in Greater Melbourne as a whole). It also creates 1.7 million more vehicle-kilometres of travel a day in the study area. No figures are given for the change in public transport trips, but the Business Case (Appendix Q1 Table 16) shows a reduction in public transport patronage of 3,000 trips a day. The same table shows no change in commercial vehicle trip numbers (and a reduction in commercial vehicle-km), but that is because Zenith’s commercial vehicle modelling component is not able to model induced commercial traffic at all (the number of commercial vehicle trips stays constant in a given year).

These changes are produced with a modelling approach that probably underestimates the induced traffic effect, according to VLC’s statements. If so then it would also overstate the travel time savings that the Project will offer.

The effects of the Project on transport and traffic, and all of the consequent traffic-related impacts (air quality, emissions, noise, safety) have been assessed for 2036, 10 years after opening. Using the Zenith ‘single loop’ method produces more underlying traffic growth, but also probably overstates the vehicle travel time savings of the Project because it underestimates induced travel.

Previous uses of Zenith in Victoria

In 2015 while working in the Department of Economic Development, Jobs, Transport and Resources, I reviewed the transport modelling for the West Gate Tunnel project business case, in conjunction with the independent peer reviewer, John Allard. We both had significant concerns about the Zenith model used on that project.

In my 2017 submission to the Senate Economics References Committee’s Inquiry into the operations of existing and proposed toll roads in Australia, I showed that the Zenith model for that project produced more – and longer – base year vehicle trips than both the VISTA surveys and the Victorian Integrated Transport Model (VITM, the Government’s own transport demand model). These differences are too large to be explained by the larger modelled area of Zenith compared to VITM, and by the extra trips in Zenith that VISTA does not survey.

Due to the single-loop modelling method, it also projected greater growth of travel into the future than VITM, to the extent that, in 2031, Zenith was producing 13% more car trips and 79% more car-km of travel than VITM (which was in use at that time on other project travel forecasts, including the Melbourne Metro Rail Tunnel).

Zenith has been used to forecast travel and traffic activity in Government planning of major toll road projects over recent years (East West Link, West Gate Tunnel, North East Link). VITM has only been used on one (un-tolled) major road project, the Mordialloc Freeway, but it has been used on virtually all of the recent public transport project business cases (Melbourne Metro Rail Tunnel, Level Crossing Removals, Mernda Rail extension) and many smaller projects of all types.

Only one project – the Melbourne Metro Rail Tunnel – has been assessed using both models and the results compared in a public document (Melbourne Metro Rail Tunnel Business Case
Appendix 5, 2015). VITM was used for the main calculations, while Zenith was used as a secondary ‘sense-check’ model. Unfortunately, this comparison stopped short of publishing differences between the two models’ overall travel activity forecasts. It listed some of the methodological differences between VITM and Zenith, but it did not mention Zenith’s ‘single loop’ forecasting method in that list (nor, indeed whether Zenith was used that way for the Melbourne Metro project work). However, it did indicate that Zenith produced higher public transport patronage growth than VITM, stating that VITM therefore represented a ‘conservative view of the public transport improvements as a result of Melbourne Metro’. It also stated that ‘VITM was selected as the primary forecast model due to its model performance and validation’. The economic evaluation (Melbourne Metro Rail Tunnel Business Case Appendix 6, 2015) showed that using Zenith results instead of VITM produced a benefit-cost ratio of 1.4 instead of 1.1, with all other inputs the same.

Zenith modelling evidently produces more bullish forecasts than VITM, whilst also underestimating induced traffic effects due to projects. It has primarily been used in planning for toll roads (partly because VITM does not have a sophisticated toll diversion capability, although tolls can be represented in the model), whilst VITM has been used mainly for public transport planning. This de-facto policy could result in over-estimating the benefits of toll roads whilst underestimating those of public transport projects, at the Business Plan stage. At the EES stage, the overestimation of traffic growth, combined with underestimation of the induced traffic effect of a road project, will probably have a number of consequences:

- The traffic-relieving effects of the road project will be overestimated, as will the travel time savings;
- The traffic-related impacts (noise, visual, emissions and air quality) will be underestimated through not accounting sufficiently for induced traffic.

Late addition – new population forecasts for Victoria

On 12 July 2019, the Department of Environment, Land, Water and Planning (DELWP) released its latest projections of population in Victoria (Victoria in Future, 2019).

The projections contain significant increases in population growth from the figures used in the transport modelling for NEL (which were based on the 2015 issue of VIF). I have briefly reviewed the changes, which are summarised in Table 8.

There is substantially more population growth in the latest forecasts. NEL work was based on 2016-2036 growth of 1.73 million, while the latest figures give 2.09 million, an increase of 360,000. Whilst this will obviously result in more travel demand, it will also change the distribution significantly around Melbourne. Most of the difference between the old and new projections is in the west, south east and inner parts of Melbourne.

The implications of this for NEL are difficult to predict. Quite a lot of work is required to get these projections broken down into the detailed level needed for the Zenith modelling, and to develop accompanying projections of employment and education places.

I consider that the distortions inherent in the ‘single loop’ method of forecasting used in Zenith must be removed before any further transport modelling is undertaken. Given the
magnitude of the changes in the latest population projections, it is highly advisable to put a high priority on processing new demographic data for the transport modelling as well.

**Table 8: Victoria in Future 2019 compared with NEL population growth**

<table>
<thead>
<tr>
<th>Melbourne region</th>
<th>Population growth 2016-2036</th>
<th>% of total change in growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NEL</td>
<td>VIF2019</td>
</tr>
<tr>
<td>Inner</td>
<td>316,000</td>
<td>391,000</td>
</tr>
<tr>
<td>Inner East</td>
<td>80,000</td>
<td>113,000</td>
</tr>
<tr>
<td>Inner South</td>
<td>72,000</td>
<td>102,000</td>
</tr>
<tr>
<td>North East</td>
<td>221,000</td>
<td>242,000</td>
</tr>
<tr>
<td>North West</td>
<td>122,000</td>
<td>137,000</td>
</tr>
<tr>
<td>Outer East</td>
<td>86,000</td>
<td>89,000</td>
</tr>
<tr>
<td>South East</td>
<td>321,000</td>
<td>404,000</td>
</tr>
<tr>
<td>West</td>
<td>450,000</td>
<td>551,000</td>
</tr>
<tr>
<td>Morn Peninsula</td>
<td>66,000</td>
<td>65,000</td>
</tr>
<tr>
<td><strong>Greater Melbourne</strong></td>
<td><strong>1,734,000</strong></td>
<td><strong>2,094,000</strong></td>
</tr>
</tbody>
</table>

*Source: summarised from *Victoria in Future 2019*, DELWP*
Summary and observations

Policy context

135 Statements in the EES about the Project’s effects and context under legislation and policy are generally limited to identifying where it supports them, with virtually no reference to any conflicts.

136 Description of the Project’s alignment with the TIA in particular is generalised and omits or glosses over some of the Project’s key negative impacts. No mention is made of the Project’s effect in encouraging more, not less, private motor vehicle use, even with the public and active transport components.

Strategic transport modelling

137 The Zenith NEL travel demand model:
• overestimates present day travel activity significantly;
• uses an illogical and inconsistent method to predict future year activity, thus intentionally producing excessive travel growth that is counter to current trends and future planned growth distribution in Melbourne;
• underestimates the induced travel effects of the Project, probably leading to optimistic estimates of travel time savings in future years; and
• does not have the capability to estimate induced traffic effects for commercial vehicles at all.

138 Vehicular travel demand is substantially overestimated, in both the number and average length of trips, now and in the future, and induced traffic effects of the Project in future modelled years is underestimated. This is likely to have significant implications for the traffic conditions that the model predicts on the road network in general. Furthermore, the Zenith model results are fed into the more detailed traffic simulation models used to assess the traffic effects of the Project, on which many of the environmental effects of the Project in the EES are based, throwing them into significant doubt.

139 The validation process indicates that, despite the travel overestimation, the base year (2016) model replicates observed vehicle traffic counts and travel times within required tolerances. It is difficult to say whether reviewing the base year level of demand will change this significantly.

140 Future growth, on the other hand, is much more sensitive to VLC’s methodology. If a ‘loop through’ model approach was used to model future years, I would expect it to reduce forecast traffic growth significantly. It would also probably produce a larger induced traffic effect due to the Project, thus reducing its stated benefits.

141 It is difficult to predict what consequences this might have for the Project until such modelling is completed. There is little or no recoding needed to do proper, ‘loop-through’ modelling (indeed VLC has already done a run to illustrate the difference in growth it produces) so it should be possible to test the Project in this context, although this would not
address the issues with the 2016 base year model. Results from a ‘loop through’ run of the Project should be made available so that the differences can be assessed, in terms of overall travel growth, induced traffic effects and the projected traffic volumes and travel times with and without the Project.

142 There are several possible outcomes of lower traffic growth predictions and shorter predicted car journeys for the Project:
- It could be postponed, in which case the effects of new transport technologies and other initiatives (such as the proposed Suburban Rail Loop) would come into stronger consideration and should be included in the forecasting assessments.
- It could proceed with a lesser scope, thus reducing its cost and adverse impacts.
- It might not attract traffic flows sufficient to meet revenue expectations, weakening its financial performance and attractiveness to bidders during tendering.

143 I also consider that any changes to the EES traffic forecasting should be taken back into the Business Case process, to re-examine the economic and financial justification before proceeding further. VITM should be used as a sensitivity test on all transport modelling results (after its toll diversion modelling capability is improved, or perhaps using Zenith for that step only, in assignment mode), with its results carried through the Business Case and EES processes if the differences are material.

144 Basing the Project justification, prioritisation and evaluation of its impacts in the EES on the results of one demand modelling tool, with questionable underlying assumptions, ought to be unacceptable for a public investment the size of NEL, Victoria’s largest road project.

145 The issues outlined herein have wider implications for transport planning and project prioritisation in Victoria. In recent years, Zenith has been used to forecast the effects of toll road projects, whilst the Government’s model, VITM, has been used for public transport ones. These two models produce markedly different present and future year trip quantities and distributions. Zenith’s ‘single loop’ method is illogical and overestimates future demand, whilst also underestimating the induced travel effects of road projects. This overstates the travel time savings that road projects will produce, inflates the benefit-cost ratios and distorts the traffic-related effects on which many of the project impacts presented in EES’s are based.

146 All the above conclusions are reinforced considerably by the large increases (and changes in the distribution of) future population growth in Melbourne, which were released by DELWP on 12 July 2019. The impacts of these changes on all aspects of NEL must be carefully considered before going further.
Appendix A  Summary Curriculum Vitae

William McDougall

Personal details
Full name: William Roderick Tritton McDougall
Address: 55 Bimbiang Crescent, Rye, Victoria 3194, Australia
Telephone: +61 (0)457 559 260
Email: william.mcdougall@outlook.com.au
Date and place of birth: 29 September 1954, Malden, Surrey, UK
Citizenship status: Permanent Australian residency since 1985, Australian citizen (carry Australian and UK passports) since 1994

Qualifications and affiliations
BSc (Hons) Civil Engineering, City University (London), 1977
Member of the Institution of Engineers Australia
Member of the Chartered Institute of Logistics and Transport
Past Chair, Engineers Australia Victoria Transport Branch Committee

Overview
I am a freelance transport planner, engineer and economist with over 40 years’ experience in the UK, Australasia, Asia and the Middle East. I have directed a range of studies across all modes of transport and levels of detail, with an emphasis on technical complexity and strategic importance. I have extensive experience in strategy and policy development/analysis, multi-modal studies, economics and financial analysis, multi-criteria appraisal, stakeholder and community consultation, traffic and pedestrian simulation, survey design and transport demand modelling. I have contributed to transport initiatives in most Australian cities as well as in the UK, Asia and the Middle East.

Fields of Special Competence
Public Transport and Highway Strategy; Sustainability in Transport; Planning and Feasibility Studies; Management Consulting and Facilitation; Traffic, Economic and Environmental Evaluation; Financial Modelling; Market Research and Surveys; Transport Modelling and Appraisal; Report and Article Writing; Community Consultation; Presentations, Media Articles and Interviews.

Selected Recent Activities
Expert Advisor and Witness (2014-present) – advised various clients on transport issues relating to statutory processes (primarily EES hearings) for major Victorian projects including Mordialloc Bypass, Fishermans Bend development, West Gate Tunnel, Melbourne Metro Rail Tunnel and East West Link.
Ballarat Rail (2018) – advised a private client on demand for and physical requirements of a new rail station in Ballarat North.
High Speed Rail (2018) – developed demand forecasts and operating plans for high speed rail in the Hume corridor in Victoria, for a private client.
Grattan Institute (2016) – temporarily joined the Grattan Institute as a Transport Fellow to work on research reports into transport policy and help to shape the research agenda.
Melbourne Metro Tram Plan (2013-14) – managed a study to prepare operating plans for the tram system during and after construction of the Melbourne Metro Rail Tunnel. Construction required temporary closure of Swanston Street, so we developed plans to divert the trams to Elizabeth Street. We also developed a post-Metro tram network as a basis for longer-term planning.
**Curriculum vitae**

**William McDougall**

**Melbourne Airport Land Access Strategy** (2012-13) – directed a landside access strategy for Melbourne Airport. We explored different future aviation growth trajectories and the associated landside transport task, and developed a strategy to serve the demand including road and rail elements, to provide a context for decision-making on the Airport Rail Link.

**Northern Rowville and Doncaster Rail Studies** (2011-13) – led the Victorian Government’s Rowville Rail Study and peer-reviewed the concurrent Doncaster Rail Study. Alongside technical and planning work, I did regular ministerial briefings and public presentations to explain the study findings and recommendations.

**Vauxhall Nine Elms Battersea Transport Study** (2008-9) – directed a study into transport needs for a major redevelopment of a large inner London area, including the iconic Battersea Power Station, to accommodate an extra 40,000 people and 20,000 jobs. We demonstrated that the best solution would centre on extending the Underground from Kennington to Battersea Power Station to serve the development area.

**Oman Surface Transport Strategy Study** (2008-9) – provided specialist input to a review of the transport sector in Oman, including development of a travel demand model and reporting on future strategic transport needs and policies. My focus was on ways to develop public transport in Muscat, the capital.

**Melbourne Metro Rail Tunnel early studies** (2006) – led the development of early concepts for the alignment and design of a new rail tunnel to relieve Melbourne’s inner city loop, and an operating strategy for the rail system to reorganise the services into grouped lines. This work shaped the Rail Network Development Plan released by PTV in 2013.

**Melbourne Metropolitan Tram Plan** (2003) – prepared a comprehensive forward plan for the tram network, including route extensions, accessibility measures (platform stops and low-floor trams), tram fleet renewal, depot and power supply upgrades.

**Northern Central City Corridor Study, Melbourne** (2001-2) – managed this study which involved extensive community consultation, frequent ministerial briefings and comprehensive technical studies. We explored a range of scenarios and initiatives and proposed a strategy to develop public transport in Melbourne’s inner north, promote walking and cycling and encourage alternatives to car use.

**Summary career history**

<table>
<thead>
<tr>
<th>Year</th>
<th>Position/Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014 - present</td>
<td>Sole practitioner exploring new opportunities to contribute to better planning for transport</td>
</tr>
<tr>
<td>2016</td>
<td>Transport Fellow, The Grattan Institute (temporary placement)</td>
</tr>
<tr>
<td>2010 - 2014</td>
<td>Principal, Sinclair Knight Merz (now Jacobs Engineering), Australia</td>
</tr>
<tr>
<td>2008 - 2010</td>
<td>Principal and Project Director, Sinclair Knight Merz UK, London</td>
</tr>
<tr>
<td>1997 - 2008</td>
<td>Associate and Team Leader, Sinclair Knight Merz, Australia (Sydney and Melbourne)</td>
</tr>
<tr>
<td>1994 - 1997</td>
<td>Director, ODB Consulting, Sydney</td>
</tr>
<tr>
<td>1985 - 1994</td>
<td>Director and Project Leader, Travers Morgan Australia (Perth, Melbourne and Sydney)</td>
</tr>
<tr>
<td>1977 - 1985</td>
<td>Project Manager and Transport Planner, Travers Morgan and Partners UK (London)</td>
</tr>
<tr>
<td>1972 - 1977</td>
<td>Bachelors degree student sponsored by Travers Morgan and Partners</td>
</tr>
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**Recent Papers and Presentations**

- **Politics and planning in transport.** Smart Urban Futures Conference, Melbourne, 2019.
- **Decentralisation – how will it work?** Research paper for the Balance Victoria initiative, 2019.
- **Fixing Melbourne’s Transport – why we need a new approach.** Transport for Melbourne forum, 2018.
- **Politics, funding and transport – the need for systematic reform.** Australian Institute of Traffic Planning and Management National Conference, Adelaide, 2014.
- **Plan Melbourne: will it deliver integrated transport and land use?** Institute of Transportation Engineers (Australia & New Zealand Section) Seminar, Melbourne, 2014.
- **Societal shifts – cities on the move.** SKM Transport in Cities program article, 2013.
- **Autonomous vehicles – the next revolution.** SKM Transport in Cities program article, 2013.
- **2013 in Review.** Engineers Australia Victorian Transport Branch Seminar, Melbourne, 2013.
Appendix B  Analysis of Melbourne travel demand

Existing (2014-16) situation

B1  VISTA survey data is publicly available for 2007, 2009, 2012-14 and 2014-16. I have used the latest year data to analyse travel patterns and their relationship with land use.

B2  VISTA gives a total of 13.1 million trips in Greater Melbourne on an average weekday in 2014-16, distributed between transport modes as shown in Table 9. Private transport has the majority share (73%), followed by walking (17%), public transport (9%) and cycling (2%).

Table 9: VISTA trips by mode

<table>
<thead>
<tr>
<th>VISTA trips, Greater Melbourne Average weekday, 2014-16</th>
<th>Person trips (million)</th>
<th>Mode shares (%)</th>
<th>Person trip-km (million)</th>
<th>Person trip-hrs (million)</th>
<th>Av trip distance (km)</th>
<th>Av trip speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private transport (motor vehicle, taxi)</td>
<td>9.52</td>
<td>72.8%</td>
<td>85.24</td>
<td>3.22</td>
<td>8.9</td>
<td>26.5</td>
</tr>
<tr>
<td>Public transport (train, tram, bus)</td>
<td>1.13</td>
<td>8.6%</td>
<td>17.97</td>
<td>1.04</td>
<td>16.0</td>
<td>17.3</td>
</tr>
<tr>
<td>All motorised trips</td>
<td>10.65</td>
<td>81%</td>
<td>103.20</td>
<td>4.25</td>
<td>9.7</td>
<td>24.3</td>
</tr>
<tr>
<td>Bicycle</td>
<td>0.23</td>
<td>1.8%</td>
<td>0.97</td>
<td>0.09</td>
<td>4.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Walking</td>
<td>2.19</td>
<td>16.8%</td>
<td>2.31</td>
<td>0.52</td>
<td>1.1</td>
<td>4.4</td>
</tr>
<tr>
<td>All trips</td>
<td>13.08</td>
<td>100.0%</td>
<td>106.49</td>
<td>4.86</td>
<td>8.1</td>
<td>21.9</td>
</tr>
</tbody>
</table>

Source: Analysis of VISTA 2014-16 data

B3  VISTA 2014-16 gives a total of 103.2 million person-km of average weekday travel by motorised modes in Greater Melbourne, with an average trip length of 9.7km.

B4  Table 10 shows the degree of self-containment of weekday travel by LGA in Greater Melbourne, grouped into different trip purposes. The least self-contained trips are to and from work, of which only 25% takes place within each LGA. These are also the longest trip type in Melbourne (averaging 15.5km). Travel to and from education, on the other hand, is highly localised; 74% takes place within each LGA with an average trip length of 5.2km.

B5  Other home-based travel – mostly shopping, personal business and recreational travel – is more local than trips to and from work (66% within each LGA). Non home-based travel is mostly business-related and shows similar overall characteristics to other home-based travel (although its distribution around the city is different).

Table 10: LGA-containment of weekday trips (LGA-level, VISTA 2014-16)

<table>
<thead>
<tr>
<th>Trip purpose</th>
<th>TOTAL</th>
<th>INTRA-LGA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trips (million)</td>
<td>Trip-km (million)</td>
</tr>
<tr>
<td>Home to work &amp; back</td>
<td>2.78</td>
<td>42.97</td>
</tr>
<tr>
<td>Home to education &amp; back</td>
<td>2.52</td>
<td>13.19</td>
</tr>
<tr>
<td>Other home-based</td>
<td>5.60</td>
<td>35.74</td>
</tr>
<tr>
<td>Non home-based</td>
<td>2.18</td>
<td>14.58</td>
</tr>
<tr>
<td><strong>All trips</strong></td>
<td><strong>13.08</strong></td>
<td><strong>106.49</strong></td>
</tr>
<tr>
<td>Per head of population</td>
<td>2.93</td>
<td>23.85</td>
</tr>
</tbody>
</table>

Source: Analysis of VISTA 2014-16 data

B6  Figure 7 and Figure 8 illustrate travel to work and to education for each LGA. Each graph is sorted from left to right, in increasing self-containment.
B7 Figure 7 shows that, in all LGAs, the local workforce does not fill all of the local jobs. This results in significant inter-LGA travel to (and from) work. It is this travel which, being concentrated in the peaks, influences transport system capacity the most. The greatest attractor of travel to work (by a substantial margin) is the City of Melbourne. It also has by far the largest public transport mode share (56%), most of which is by train. Other job attractors include Dandenong, Monash, Port Phillip and Hume (due to the Airport).

**Figure 7: Job LGA-containment (VISTA 2014-16)**

B8 Figure 8 shows that education trips are much more local, reflecting the fact that many schools are available close to home. The significance of tertiary education in Melbourne, Boroondara and Monash LGAs is evident.

**Figure 8: Education LGA-containment (VISTA 2014-16)**
Future forecasts

B9 I have developed a calibrated trip distribution model to project travel patterns of different purposes (extracted from VISTA data) into the future, assuming that trip times and costs stay unchanged from today. The model works with data at LGA level, thus having 31 zones in Greater Melbourne. For consistency with the Zenith NEL modelling, I have used the LGA-level population and employment projections from the NEL Business Case to generate future trip patterns.

B10 My projections give an indication of future travel demand growth. They are summarised in Table 11 for 2026, 2036 and 2051, for comparison with the VISTA 2014-16 data in Table 9.

B11 My projected total of 18.5 million weekday trips in 2036 is 28% less than the Zenith NEL Business Case model’s result of 25.7 million. My projection is that average trip lengths will stay reasonably constant, driven by demographic growth and distribution that will continue the trend of densification in Melbourne.

B12 It would be helpful to be able to compare my forecasts with both VITM and Zenith modelling, as well as with other forecasts like those by BITRE, on a like-for-like basis concerning modelled areas, base year starting points and future demographic projections.

<table>
<thead>
<tr>
<th>Trip purpose</th>
<th>2026</th>
<th>2036</th>
<th>2051</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TOTAL</td>
<td>INTRA-LGA</td>
<td>TOTAL</td>
</tr>
<tr>
<td></td>
<td>Trips (million)</td>
<td>Trip-km (million)</td>
<td>Av trip km</td>
</tr>
<tr>
<td>Home to work &amp; back</td>
<td>3.41</td>
<td>53.4</td>
<td>15.6</td>
</tr>
<tr>
<td>Home to education &amp; back</td>
<td>3.08</td>
<td>16.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Other home-based</td>
<td>6.75</td>
<td>41.4</td>
<td>6.1</td>
</tr>
<tr>
<td>Non home-based</td>
<td>2.69</td>
<td>17.7</td>
<td>6.6</td>
</tr>
<tr>
<td>All trips</td>
<td>15.93</td>
<td>128.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Per head of population</td>
<td>2.93</td>
<td>23.7</td>
<td></td>
</tr>
<tr>
<td>Home to work &amp; back</td>
<td>3.99</td>
<td>63.3</td>
<td>15.9</td>
</tr>
<tr>
<td>Home to education &amp; back</td>
<td>3.58</td>
<td>18.7</td>
<td>5.2</td>
</tr>
<tr>
<td>Other home-based</td>
<td>7.77</td>
<td>46.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Non home-based</td>
<td>3.15</td>
<td>20.5</td>
<td>6.5</td>
</tr>
<tr>
<td>All trips</td>
<td>18.48</td>
<td>148.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Per head of population</td>
<td>2.94</td>
<td>23.6</td>
<td></td>
</tr>
</tbody>
</table>

Source: McDougall travel modelling

Table 11: Projected travel demand in Melbourne
## Appendix C  Further comments on VLC Transport Modelling Summary Report

### Selected comments and queries

VLC report starts on pdf page 627 of EES Technical Report A.

<table>
<thead>
<tr>
<th>Pdf page</th>
<th>Reference</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>639</td>
<td>Last para: “The Zenith model was most recently recalibrated in 2014, using a Victorian Government survey of travel behaviour in Victoria, the Victorian Integrated Survey of Travel and Activity (VISTA). While the survey was conducted from 2007 to 2010, Victorian Government research indicates that travel behaviour across Melbourne has not changed significantly since that time (DEDJTR, 2013).”</td>
<td>Zenith has not been recalibrated against travel survey data for 5 years, when it was calibrated against data collected 2007-2010. Why has it not been recalibrated against more recent VISTA data (2012-18)? The Victorian Government research mentioned is dated 2013, so is itself 6 years old. Is there any evidence that travel behaviour across Melbourne today (2019) has not changed significantly since 2010 (date of most recent household surveys used to recalibrate Zenith)?</td>
</tr>
<tr>
<td>642</td>
<td>Table 1.1 gives traffic figures comparing Zenith forecasts with actual traffic counts for toll roads in Sydney and Brisbane.</td>
<td>These figures are irrelevant to the performance of the Zenith model for the Project. No detail is given of the years or locations of the forecast and actual traffic volumes. Opening dates of the toll roads are as follows:  • Cross City Tunnel – June 2005  • Lane Cove Tunnel – March 2007  • Clem 7 – March 2010  • Airport Link – July 2012  It is stated that these forecasts were done before the roads opened and independent of toll road bidders. Has VLC also done any forecasts for bidders, and if so, can they provide details of the accuracy of their forecasts in that context?  When were each of the Zenith model forecasts done, and did they use precisely the same methodologies contained in the Zenith Project model (including the single loop distribution method)?  If the Zenith forecasts were done before the roads opened to traffic, what tolls were modelled and how did they relate to the actual tolls charged?  Only total (two-way) traffic flows have been quoted. How do the directional traffic flows compare with observed?  The Airport Link has two main sections (north and south of A3 Gympie Road). Which section does the data in Table 1.1 refer to, and how do modelled and observed figures compare for the other section?</td>
</tr>
<tr>
<td>642</td>
<td>Section 1.3 last para: “While past forecasting accuracy does not guarantee future forecasting accuracy, the track record of Zenith suggests that the fundamentals of the Zenith model are sound. The forecasts for North East Link have been prepared using the same approach.”</td>
<td>The only evidence presented for this assertion are traffic figures on four individual links (all toll roads) in Sydney and Brisbane Zenith models. This is an inadequate basis for this statement.  Do the Sydney and Brisbane Zenith models also use the single loop-through distribution method for future year forecasts? If so, how long has this been the case?</td>
</tr>
<tr>
<td>Pdf page</td>
<td>Reference</td>
<td>Comment</td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| 647      | Significant list of projects not included in 2036 network, including following key projects:  
  - East West Link  
  - Outer Metro Ring Road  
  - Airport Rail Link  
  - Melbourne Metro 2  
  - Suburban Rail Loop  
  - Doncaster Rail | Appears to be mainly a timing issue, because none of these are expected to be in place by 2036. Only two of these projects are included in 2051 modelling, according to the Business Case:  
  - Outer Metro Ring Road  
  - Airport Rail Link  
  East West Link, Suburban Rail Loop and Doncaster Rail are the most significant omissions. |
| 649      | First para: “The model separately forecasts light commercial vehicle (LCV) and heavy commercial vehicle (HCV) trips. The model’s forecasts of LCV and HCV trips are tied to growth in employment by industry and occupation. The number of LCV and HCV trips generated by each job (in a specific industry by occupation) has been assumed to remain fixed in the future.” | This implies that LCV and HCV trips do not allow for the effect of induced traffic. Given the potential effect of NEL on commercial vehicle movements, this is a significant omission. |
| 650      | Second para: “The modelling assumes that VTTS will grow by 1.55% CAGR to 2036 in real terms (that is, over and above CPI) for cars and commercial vehicles.” | Real wages growth has been stagnant for some years. Current Reserve Bank projection is that they will pick up somewhat, but not to the level assumed in the Zenith modelling. |
| 652 on   | Section 4.1 onwards – future trip distribution. Zenith departs significantly from standard practice by using “dampened single loop distribution”, as opposed to “undampened loop through distribution”. The rationale for doing this is stated as follows:  
  “The primary rationale for the dampened single distribution approach ... is that it has historically produced more realistic forecasts of future travel demands. In particular, it was found that the undampened loop through distribution method forecasts that the distance travelled per capita will reduce over time, whereas in reality it has tended to increase overtime due to, among others, the steady expansion of the urban area. The dampened single distribution approach produces forecasts that are more consistent with observed trends.” | As shown in the body of my report, there is no evidence that distance travelled per capita has increased over time due to expansion of the urban area.  
  BITRE shows that distance travelled per capita has been decreasing steadily since the turn of the century in Melbourne and indeed other cities in Australia. Furthermore, the population density of Melbourne has been increasing since the mid-1990s, and Victoria in Future forecasts indicate that this will continue.  
  Therefore, the stated reason for using the single loop distribution method is incorrect. |
| 655 & 656 | Figures 4.2 and 4.3 purport to demonstrate that Zenith Project model is accurate both in terms of future forecasting and backcasting of total vehicle-kilometres travelled per capita (compared to BITRE estimates). | Figures 4.2 and 4.3 are both wrongly labelled as representing national annual average vehicle-km per capita, when in fact they show data for metropolitan Melbourne (confirmed from the data files accompanying BITRE Information Sheet 74).  
  It is possible that the Zenith backcasting results in Figure 4.2 have been indexed to match the BITRE data for the starting point (which appears to be 2011).? Why has 2011 been used as the starting point, when the Zenith Project model base year is 2016? What happens when the backcasting results are taken from 2016? Has indexing also been taken to position the Zenith Project model results on Figure 4.3? |