PART C - PROJECT DESCRIPTION

1. PROPOSAL TITLE:
Optimising the Design and Implementation of Public Transport Priority Initiatives (LP100100159)

2. AIMS AND BACKGROUND

2.1 Background
Almost two thirds of Australians live in capital cities [1] which have accounted for 78% of national economic growth between 2001 and 2006 [2]. However, traffic congestion is emerging as a major constraint in achieving national economic potential in cities. Federal research has shown that total travel in Australian cities has grown ten-fold in the last 60 years with the cost of traffic congestion on the economy totalling $9.4B in 2005 [3]. These costs are amongst the highest in the world when compared to our Gross Domestic Product (GDP). They represent 2.1% of GDP in 2001 and compared with 1.5% for the USA and 2.0% for the OECD average [4]. As urban populations continue to grow traffic congestion is expected to more than double by 2020 with the costs of congestion expected to reach $20.4B by this time [3]. These economic problems are exacerbated by concerns about the environmental impacts of congestion and the effects it has on the quality of life of urban residents.

A substantive literature now supports the development of public transport (PT) systems as a means of transporting large numbers of people around cities in an efficient and effective manner [5]. State transport policies now support urban public transport with subsidies of many $Billions annually. The majority of visitors to all the major Australian central cities now travel using public transport with increases in access being recorded in recent times [6].

Although most Australian cities have urban railway systems, for most urban residents local PT is a bus. Indeed, about half of all urban PT ridership in Australia is bus (or tram) based with many cities having entirely bus based service e.g. Adelaide, particularly smaller urban centres. Even Sydney and Melbourne CBD’s have substantive on-road public transport (ORPT) access with 22% (bus, [7]) and 14% (bus, tram [8]) respectively.

ORPT faces significant efficiency and effectiveness issues where traffic congestion is high and growing. For this reason all city jurisdictions are promoting the development of traffic priority systems for ORPT. Public Transport priority is the ‘adoption of traffic engineering measures to positively discriminate in favour of transit vehicles, usually on the basis of the greater passenger carrying abilities of these modes’[9]. Traffic priority includes a wide range of measures ranging from the full reallocation of roadspace to create ORPT lanes to adjustments to road layouts to remove traffic bottlenecks. More recent technological developments have included adjustment to traffic signal systems to provide extra green time including the ‘active’ sensing of ORPT vehicles to enable efficient use of signals [10, 11].

2.2 Problem Context
Although public transport priority is a growing in Australia (e.g. a 43% increase in bus lane length in Sydney since 2004/5 [12]) there are significant challenges associated with the design and implementation of these schemes:
A. Competing Uses - In general priority measures involve trading off competing interests for the use of road space and time. Planners must make difficult and politically sensitive decisions about providing priority to one group of road users over others.

B. Limited Strategic Methodologies - Despite many decades of development of priority systems throughout the world the rationales and methodologies applied have been remarkably simplistic. A review by the authors showed that most of the research literature in the field had based decisions on road space allocation on only limited criteria such as travel time impacts alone omitting the wider environmental, operational or infrastructure impacts [13].

C. Marginal Outcomes from a Strategic Perspective – Although public transport priority has clear efficiency benefits, outcomes from priority schemes have tended to be small and marginal. This is because competing objectives and localised planning have obscured wider strategic outcomes. Research has shown methodologies to be limited with regards to mode shift, trip retiming and trip suppression [14]. There is a need to develop new methodologies which focus on strategic objectives such as maximising throughput of people. These approaches can act to support ‘strong’ bus priority measures rather than marginal changes to existing infrastructure [14].

D. Overly Generic Design Guidance – a number of guidelines are available to assist in developing priority systems both nationally [15] and locally [16, 17]. However these are usually generic in nature. They describe the types of treatment possible but don’t show where they do and don’t work and hence provide little practical assistance for implementing schemes in the field.

E. Limited Diagnostic Tools – designing priority schemes requires a multidisciplinary approach combining the skills of traffic engineering with the operational concerns of ORPT scheduling and management. Schemes have tended to be designed with a road planning bias with little consideration of operational, time or in particular ORPT resource and reliability impacts. There is a need to develop diagnostic tools which can more readily identify appropriate locations and types of measures.

F. Problem of ‘Spot’ vs ‘Combination’ Treatments – Two main approaches have been used to develop priority treatments; ‘spot’ (localised single treatment) and ‘combination’ or corridor based approaches combining many measures in a package of treatments. While little is understood about the impacts of individual measures even less is understood about how measures in packages act to improve the operation of ORPT or affect the impacts these schemes have on other road users. For example increasing returns to scale might well be expected when treatments are combined. Unfortunately little is understood about these effects.

G. Limited Understanding of New Technologies – There is evidence that advances in implementing active traffic signal priority schemes is being constrained by limited technical knowledge and understanding of how they can be developments in the field [10]. There have been some good examples of innovation. For example the Dynamic Fairway and Intermittent Bus Lane project in Melbourne involve the use of dynamic signals to provide bus lane when only buses are present. While this was a world first development a review has shown their implementation was inappropriate to traffic conditions based on international evidence [18].

H. Limited Performance Monitoring – A common recommendation of guidelines for the introduction of priority schemes (e.g. [19, 20]) is that post implementation monitoring programs should be undertaken to build an understanding of performance impacts. Unfortunately performance monitoring has been limited to date despite the large number of schemes implemented.
I. Local/Corridor not Network Focus – Almost all research studies in this field have examined priority design in relation to a single road or road link. However the authors work has clarified that network based assessment is important when considering traffic diversion impacts which can be significant on priority projects[21].

The proposed research addresses most of the above problems. The authors have already completed published work improving some aspects of methodologies [11, 13, 22] including recent preliminary work on the network wide methodologies [21]. The focus of the proposed study is on improving methodologies at both the tactical level, in terms of treatment design and at the strategic level in terms of objective oriented approaches.

2.3 Research Objective and Aims
The overall objective of the project is to ‘improve methodologies and guidance to enable the optimisation of design and implementation of public transport priority initiatives’. The project has the following research aims:
A. Development of new objective oriented methodologies focussing on maximising throughput of people not vehicles within the context of the wider social, economic and environmental impacts of transport.
B. Develop diagnostic tools to identify appropriate problems to be addressed by priority treatments on ORPT routes
C. Evaluate the performance of priority treatments in a series of road configuration and traffic condition contexts
D. Identify optimal conditions for the implementation of traffic priority treatments of different kinds
E. Investigate the performance of priority treatment as single isolated or ‘spot’ treatments and the impact of combinations of treatments on performance in group or corridor treatment conditions
F. Provision of practical guidelines for implementation of treatments based on the above objectives

The project will focus on the following priority treatments in relation to bus and tram services in Melbourne:
- Road space reallocation measures (including new lanes, queue jump lanes, set back and mid-block designs, clearway and traffic turn ban concepts including full time, part time and the new dynamic lane concept)
- Traffic signal design measures (including passive and active signal design measures, B/T lights, clear phase combinations and conditional and un-conditional priority measures); and
- Road and traffic management measures (including bottleneck removal, stop removal and relocation and the removal of indented bus bays).

3. SIGNIFICANCE AND INNOVATION

3.1 Addressing an important problem
Some 64% of Australians live in capital cities [1] which have accounted for 78% of national economic growth between 2001 and 2006 [2]. Traffic congestion is emerging as a major constraint in achieving national economic and social potential in cities. It costs the economy $9.4B in 2005 in wasted time and resources which expected to more than double to $20.4B by 2020 [3]. Congestion is a factor reducing the international economic competitiveness of Australia; as a share of GDP congestion costs represent 2.1% of GDP in 2001 compared with
1.5% for the USA and 2.0% for the OECD average [4]. These economic problems are exacerbated by concerns about the environmental impacts of congestion and the effects it has on the quality of life of urban residents.

For most urban residents public transport operates on-road and is unreliable and slow due to high and increasing levels of traffic congestion. This project strengthens national approach to the design and implementation of ORPT traffic priority schemes to make cities work better in economic, environmental and social terms.

3.2 Advancing Knowledge and Innovation

The following are the major knowledge advances expected from the project:

**Comprehensive Objective Oriented Priority Design** – Previous research has tended to emphasise localised pressures and ignore the strategic outcomes in making decisions about priority schemes. This gap will be addressed through the development of a framework for including and emphasising strategic outcomes in the decision making process. The aim is to develop a rational decision making process to achieve more comprehensive and significant outcomes for the transport system.

**Diagnosis methodologies** – a major aim of the project is to develop a diagnostic tool for route level assessment of traffic flow performance of routes. While performance monitoring methods are developed for public transport management [23] approaches for ORPT are simplistic and tend to be focused on either road or bus planning and rarely both. Furthermore approaches are often led by data availability and quality than the factors driving performance of ORPT or traffic engineering design. The study will take an objectives based approach to development of methodologies.

**Quantifying time and space trade-off impacts** – traffic flow theory forms a well developed basis for road planning studies. More recently micro-simulation modelling tools, such as those envisaged in this research, have been adopted to experiment with road configuration and traffic flow condition parameters. Research of this kind has been rare, focussed on a small sub-set of issues associated with priority and often specific to particular locations (e.g. [13, 24, 25]). This project aims to provide a systemic assessment of types of conditions for a full range of measures.

**New approaches for field measurement of impacts** – the research aims to fill the post implementation performance measurement gap with existing priority schemes. One aspect of this will involve integration of data from historical records of bus and tram automatic vehicle monitoring (AVM) systems with sources such as the SCATS traffic flow record database. These systems are relatively rare internationally providing opportunities for original work in the field. The research aims to add value through development of approaches to retrospectively monitor performance of implemented schemes by integrating these data sources in a reliable and statistically defendable manner.

**Quantifying marginal rate of return on multiple priority projects** – project aim E is important for implementation of priority but is also an under-researched area internationally. While there are specific examples where measures have been studied in groups [13, 24] none of these approaches has been systematic or comprehensive as is proposed in this research.

**Network Trade-offs in Priority Design** – The authors previous research has identified a lack of methodologies examining the provision of priority on a network, rather than a corridor, basis. This is an important perspective since route diversion is an important behaviour relative to priority schemes which is often missed in corridor and local level design. The authors have developed new theoretical approaches to this issue associated with a PhD project adopting bi-level mathematical programming problem to simple networks[21]. The proposed research will apply and test this theoretical research at a more practical level.
4. APPROACH AND TRAINING

4.1 Approach
The project is a collaborative study of Monash University and the industry partners in Victoria, the Department of Transport and VicRoads and international expert Hounsell at the University of Southampton. Collaboration will be facilitated through a ‘Project Reference Group’ where research team and partner officers will meet to develop and agree study progress.

There are two major aspects of the research method which act as an input to improving priority design and implementation (Task Area A and B):
A. **Collation of Field Performance Measurement.** This includes the assembly of existing before/after field survey data, the historical review of AVM records and the application of new field surveys for priority initiatives implemented during the research project.

B. **Development of Case Study Traffic Micro-Simulation Test Beds** – we propose to adopt the Aimsun traffic micro-simulation software as the basis for experimental testing of road configurations and traffic conditions. As part of the research we will bring together numerous traffic micro simulation model applications already developed for Melbourne authorities into the same consistent test software.

In addition task area C focuses on the input to the priority treatment identification process (Diagnosis issues). Task area D concerns network priority research. Task area E considers the development of a framework for the inclusion and emphasis of strategic rather than local issues in the decision making process regarding priority scheme design. The following specific study tasks relating to each task area, are proposed in the order identified in Figure 1.
- **A1 - Existing Field Survey Data Collation** – collation of existing field studies in Melbourne
- **A2 - Develop Approach and Collate AVM Records** – develop methods and go through historical AVM/traffic flow records to understand before/after impacts of treatments
- **A3 - Field Measurement of New Priority Initiatives** – (limited) before and after studies of priority measures implemented during the study time frame
- **B1 - Collation of Test Bed Case Study Models** – assembly of pre-existing models and conversion into ‘Aimsun’ system
- **B2 - Develop Test Bed Modelling Methodologies** – develop method for experiments including systematic approaches to road configuration, traffic condition modelling
- **B3– Review Guidelines, Develop & Test Scenarios – Road Space Reallocation Measures**
- **B4– Review Guidelines, Develop & Test Scenarios – Traffic Signal Priority Measures**
- **B5– Review Guidelines, Develop & Test Scenarios – Road & Traffic Management**

Tasks B3 to B5 follow a similar approach to different groups of priority measures. In each, the finding of previous research evidence and guidelines is assembled with regard to performance rules for priority measures. These are used to inform the design of experiments of these measures using the modelling test beds. Results aim to develop and generalise optimum conditions for each type of measure.
- **B6 – Assessment of Measures in Groups** – a series of tests examining how measures act together to impact ORPT and road users.
- **C1 – Review Previous Priority Treatments Identification Methods** – includes assessing research evidence as well as review approaches for defining ‘problem’ routes in Australia
- **C2 – Develop Diagnostic Tool** – this examines the aims and potential data sources which would inform defining problem areas to be addressed by priority measures.
- D1 – Network Priority Testing – this is where some of the concepts of priority treatments are tested at a network level using methodologies developed by the authors.
- E1 – Identifying and Valuing Strategic Priorities – this involves workshopping strategic outcomes of priority planning with key decision makers. We envisage using the Analytical Hierarchy Process (AHP, [26]) as a means of elaborating quantitative criteria from discussions. The authors have some experience in using AHP successfully in this role in transport contexts [27]. Valuation will also be based on economic approaches taking the procedures developed in the authors previous work [13] to a strategic level.
- E2 – Modelling of Priority Outcomes – Transport modelling will generate priority design outcomes for strategic objectives using both transport demand models, micro-simulation and theoretical modelling. The modelling will aim to be inclusive of travel behaviour factors not commonly modelled including ‘induced traffic’ and ‘time shifting’ of trips. It will be informed by the teams previous work in this area [13, 14].
- E3 – Developing Decision Making Models – A multi-criteria framework will be developed which reflects the range of emphasis on objectives and related this to transport outcomes. This will form the basis of a decision tool for strategic application of priority schemes.

**Figure 1 – Proposed Research Plan**

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<th>Tasks</th>
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<tr>
<td><strong>A1</strong> - Existing Field Survey Data Collation</td>
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<td><strong>A2</strong> - Develop Approach and Collate AVM Records</td>
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<td><strong>A3</strong> - Field Measurement of New Priority Initiatives</td>
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<td><strong>B1</strong> - Collation of Test Bed Case Study Models</td>
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<td><strong>B2</strong> - Develop Test Bed Modelling Methodologies</td>
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<td><strong>B3</strong> - Review Guidelines, Develop &amp; Test Scenarios – Roadspace Reallocation Measures</td>
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<td><strong>B4</strong> - Review Guidelines, Develop &amp; Test Scenarios – Traffic Signal Priority Measures</td>
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<tr>
<td><strong>B5</strong> - Review Guidelines, Develop &amp; Test Scenarios – Road &amp; Traffic Management Measures</td>
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<tr>
<td><strong>B6</strong> - Assessment of Measures in Groups</td>
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<tr>
<td><strong>C1</strong> - Review Previous Priority Treatments Identification Methods</td>
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<td><strong>C2</strong> - Develop Diagnostic Tool</td>
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<td><strong>D1</strong> – Network Priority Testing</td>
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<td><strong>E1</strong> – Identifying and Valuing Strategic Priorities</td>
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<tr>
<td><strong>E2</strong> – Modelling of Priority Outcomes</td>
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<tr>
<td><strong>E3</strong> – Developing Decision Making Models</td>
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Tasks are sequenced together in the research plan (Figure 1) to ensure a logical flow of inputs and outputs to tasks. Field performance measurement tasks (Group A) occur first but have a continuous element (A3). Test Bed Modelling Tasks (Group B) require methodology and data preparation before experiments commence (in year 2). Diagnostic tool development tasks (C) occur early in the project while Network based modelling (Task E) occurs at the end of the study. Strategic Framework development (Task group E) is planned mid-project and relies on the development of test beds in year 1.
4.2 Research Training
The project includes theoretical, design and fieldwork components with a wide scope for research training activities. We have proposed two APAI PhD students support the project due to the wide scope for theoretical exploration in the research in several new knowledge areas (section 2.2). Our plan at this stage is to focus one APAI on diagnosis tool development while the other will work on modelling theory and application.

5. NATIONAL BENEFIT

5.1 Industry partner benefits
The expected benefit of the results are:
  i. Improved methodologies for design and implementation of priority measures including consideration of network design issues and a framework for emphasis of strategic objectives in priority scheme design
  ii. Development of diagnostic tools for identifying the need for priority measures on ORPT services
  iii. Assessment of optimal conditions for the adoption of priority treatments based on road configurations and traffic conditions
  iv. An improved understanding of the strategic approach to developing packages of priority treatments with better synergy and cost effectiveness of groups of measures
  v. Assembly of micro-simulation models in a single suite for future development and testing of design options.

5.2 Industry sector benefits
Benefits i. to iv. should apply to transport planning in all Australian cities. The Melbourne based work includes tram as well as bus based modelling. While Melbourne has more tram services than other Australian cities, plans for the development of light rail are in place for many Australian cities (e.g. Gold Coast, Perth, Sydney, Adelaide, Canberra). The research can inform these development programs.

5.3 Broader benefits for Australia
The strategic focus of the project is improving the economic efficiency of transport by addressing transport congestion problems in cities. Congestion has negative social and environmental impacts on urban residents which will also be addressed by improved approaches to the provision of priority systems in cities. These issues affect not only the major cities where 64% of Australians live, but have relevance to larger towns where bus services operate in regional Australia.

6. PARTNER ORGANISATION COMMITMENT AND COLLABORATION

6.1 Specific Partner Contributions
VicRoads is providing a cash commitment of $84,000 p.a. for three years. It is also committing staff time for the following senior staff to attend the Project Reference Group meeting; Mr Russell Bittner (Director Tram & Bus Projects), Mr Simon Basic (Manager Bus Projects), Mr Brendan Pauwells (Manager Tram Projects) and Mr Roger Lau (Manager Tram and Bus Programs). In addition in-kind inputs will include access to data such as traffic flow information. The Department of Transport has no cash inputs. Rather in-kind inputs include the access of staff time to the PRG including PI Ray Kinnear (Deputy Director of Public Transport, Mr Robert Abboud (Manager Project Coordination) and Mr Chris Bright
In addition DoT will provide access to data inputs including previous reports, AVM and patronage data.

6.2 Partner Rationale for Involvement
The project was developed as a result of several separate requests from members of the proposed Project Reference Group in both organisations. Bringing these together in a single project has thus fitted well with the aims of both partners. As the policy development and funding authority for transport in Victoria, DoT has developed and is funding programs to improve public transport priority systems in Victoria. It is therefore directly concerned in the effectiveness of its programs including bus and tram priority projects throughout the state. VicRoads is the project delivery and road management authority for Victoria. It designs and delivers priority projects as part of its road management responsibilities. Clearly the project is directly relevant to the effectiveness of VicRoads responsibilities in this area.

6.3 Furthering Research Alliances
The project is partly a continuation from a previous research and development project undertaken by Monash University for VicRoads (with DoT as a partner organisation) in 2003. Hence it is already a continuation of a long term research alliance. There are opportunities for further development of this alliance by expanding research depth in the field of network approaches to priority. In addition public transport priority methods for roadspace management can be expanded to consider other modes including factors such as high occupancy vehicle lanes, freight lanes and premium managed lanes.

7. COMMUNICATION OF RESULTS
The primary means of communicating results will be through the production of journal papers in leading international journals. We will also target papers to domestic conferences to ensure dissemination of results within the Australian industry sector. In addition we propose to write a book based on the overall findings of the project. The book will summarise previous approaches and summarise our methodologies, findings and conclusions from the work.

8. ROLE OF PERSONNEL
The following table summarises the roles of each member of the proposed team:

<table>
<thead>
<tr>
<th>Person/ Bid Role</th>
<th>Project Role</th>
<th>Responsibility/ Contribution</th>
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<tbody>
<tr>
<td>Prof G. Currie</td>
<td>Principal chief investigator</td>
<td>Managing and coordinating all parts of the project. Acting as chief liaison and principal supervisor for one of the APAI students and associate supervisor fot he other. Manager of the Research Assistant. Chair of the Project Reference Group.</td>
</tr>
<tr>
<td>Chief Investigator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr Majid Sarvi</td>
<td>Manager of Modelling Tasks</td>
<td>Responsible for the Group B Modelling Tasks, principal supervisor of one of the APAI students and associate supervisor of the other. Member of the Project Reference Group.</td>
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<tr>
<td>Chief Investigator</td>
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<td></td>
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<tr>
<td>Dr Nick Hounsell</td>
<td>International Expert</td>
<td>Review and expert input on major project outputs. Project includes 2 visits to Australia to work with the study team. International member of the Project Reference Group</td>
</tr>
<tr>
<td>Partner Investigator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ray Kinnear</td>
<td>Technical Advisor</td>
<td>Providing expert advice to the team on policy and technical matters and member of the Project Reference Group</td>
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<tr>
<td>Partner Investigator</td>
<td></td>
<td></td>
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<tr>
<td>Russell Bittner</td>
<td>Technical Advisor and VicRoads</td>
<td>Providing expert advice to the team on policy and technical matters. Day to day liaison interface with</td>
</tr>
</tbody>
</table>
Liaison

VicRoads and member of the Project Reference Group

<table>
<thead>
<tr>
<th>Project Research Fellow</th>
<th>Research Management</th>
<th>Undertakes bulk of project tasks under supervision of the Principal Chief Investigator and Chief Investigator. Secretary of the Project Reference Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roger Lau</td>
<td>Technical Advisor</td>
<td>Technical Advisor and Member of the Project Reference Group</td>
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<tr>
<td>VicRoads</td>
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<tr>
<td>Robbert Abboud</td>
<td>Technical Advisor</td>
<td>Technical Advisor and DoT Liaison</td>
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<tr>
<td>Mr Chris Bright, DoT</td>
<td>Technical Advisor</td>
<td>Technical Advisor and Member of the Project Reference Group</td>
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<tr>
<td>Mr Simon Basic, VicRoads</td>
<td>Technical Advisor</td>
<td>Technical Advisor and Member of the Project Reference Group</td>
</tr>
<tr>
<td>Mr Brendan Pauwells, VicRoads</td>
<td>Technical Advisor</td>
<td>Technical Advisor and Member of the Project Reference Group</td>
</tr>
<tr>
<td>APAI Students</td>
<td>Research Support</td>
<td>Main focus is on individual PhD studies however as part of training students will undertake support tasks for the Research fellow and CI’s. One APAI is focussed on Diagnostic tools and the other modelling. These are the areas they will work in.</td>
</tr>
</tbody>
</table>

9. REFERENCES


