Contract C3079
Wellington Transport Models
WTSM update and WPTM development

Wellington Transport Models

ARUP

Model Investigation Report

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Contents

1 Introduction

1.1 Background

Greater Wellington Regional Council (GWRC) has contracted the services of Opus and Arup to rebase and validate the Wellington Transport Strategic Model (WTSM) and to complete the development of the Wellington Public Transport Model (WPTM). The project team is working in partnership with GWRC to complete this project, with significant input to the project being provided by GWRC staff and resources.

The postponement of the 2011 Census to March 2013 means that the full recalibration of WTSM will not be undertaken until a time after this date. Consequently, this update will focus on ensuring that WTSM is capable of providing robust transport forecasting in the interim.

The project is not being undertaken in isolation. It is part of a wider "Model Improvement Programme" designed to match and prioritise current and anticipated needs against available data, skills and resources over a 10 year period. While it may be subjected to adaptation this programme nevertheless represents a useful "map" to help plan a route forward.

TN26: GWRC Summary Model Improvement Programme

1.2 Objective

The overall objective of the project is to update the modelling tools maintained by GWRC to a 2011 base and develop enhanced predictive capabilities for public transport usage. The models are to be completed in a timely manner to provide the assessment platform for the Public Transport Spine Study (Railway Station to Regional Hospital) ("the Spine Study") and assist with other significant transportation projects in the Wellington Region such as the Wellington Bus Review and the Road's of National Significance (RoNS) project. This project will provide a modelling tool that is current and can better meet the needs of transport planning, public transport development and land-use integration in the region.

1.3 This Report

This report describes the investigation processes undertaken to date and proposed further work. It outlines the intended overall model design and the associated approach the project team will take to achieve the goals above, but it does not necessarily lay out the detailed processes that will be used. The detailed processes will evolve as data becomes available and a better understanding of the base situation is achieved. It is intended that as the study progresses that work will be documented through a series of Technical Notes which will provide the basis to communicate findings and discuss with the client and Peer Reviewer decisions in relation to model design. Section **Error! Reference source not found.** of this report sets out the details of Technical Notes prepared to date and to be prepared. This report has been prepared at the commencement of the project to:

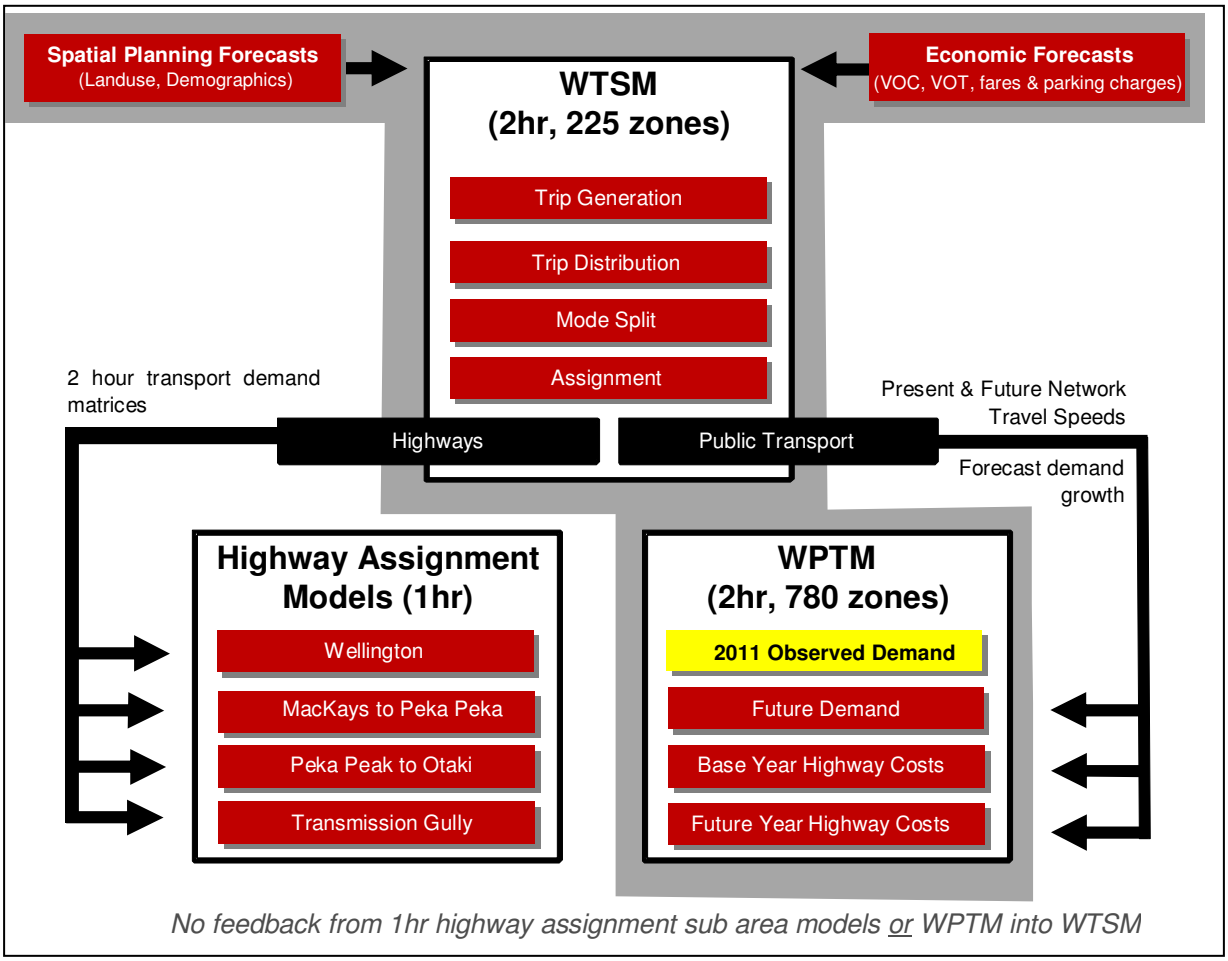
- Document key findings from the consultant's review of the existing WTSM model;
- Set out the proposed structure of and functionality of the WTSM and WPTM models where there is certainty and to identify topics for further investigation where there is not certainty; and

- Form an agreed basis against which the delivery of the consultant services will be measured.

2 Model Scope

2.1 Model Structure

A high level structure of the models focussing on the interrelationship between WTSM, WPTM and sub-regional highway assignment models is illustrated in the diagram below (the greyed out area shows the focus for this project). The functionality and purpose of the models is described in the following section.



2.2 Model Context and Usage

2.2.1 WTSM

WTSM is GWRC's strategic four stage transport model implemented in EMME/3 that is used to inform transport strategy and policy in the Wellington region. Whilst WTSM is used to inform specific project and packages, its detail is often not sufficient for the needs of some projects. As a result the demand matrices are used for a number of more specific traffic models such as the Wellington, Transmission Gully, and Kapiti SATURN models and also more specific project models like the Wellington Inner City Bypass Paramics model.

WTSM was originally built to coincide with the 2001 census and was delivered in 2003. In 2006 SKM was appointed to update the model to a 2006 base using 2006 Census and other data - this 2006 version of the model is referred to as the delivered model. Travel behavioural models in WTSM are derived from the home interview and other surveys collected for the original 2001 development.

This project will retain the current functionality of WTSM, apart from improvements to the airport module, whilst rebasing it from 2006 to 2011.

Specifically, our approach includes an update of all WTSM input parameters to 2011, including values of time (VOT) and vehicle operating costs (VOC). The part of the model update dealing with demographics has been commissioned separately by GWRC and we have integrated this into our programme and process. Whilst we will update the trip generation, mode choice and distribution models in respect of input land use and parameters to reflect 2011 conditions, we have assumed no recalibration of these models. However the improved network and lines files developed for this project, which will be common with WPTM, and improved EMME capability provide potential enhancements.

Details of the proposed network changes and WTSM upgrades are provided in sections 7 and **Error! Reference source not found.** below.

2.2.2 WPTM

One of the key outcomes of this project will be developing a PT assignment model that is robust and fit for purpose – the WPTM model.

WPTM will be an EMME/3 public transport model primarily based on assignment processes, but also incorporating a choice modelling process for access mode aspects. It will rely on WTSM to forecast growth or changes in public transport demand and provide costs affecting travel choice. WPTM will provide three key enhancements to public transport forecasting capability:

- A more detailed assignment based on a more disaggregate zone system than WTSM (WTSM has 225 internal zones and 3 external zones, WPTM will have in the order of 780 zones);
- A more accurate representation of observed demand by factoring the WTSM synthesised demand against observed demand derived from surveys and ticket data; and
- Some improved functionality such as access mode forecasts.

Details of the proposed WPTM structure and functionality are provided in section 9 below.

2.2.3 SATURN Highway Models

The traffic models mentioned in section 2.2.1 above are not specifically in the scope of this upgrade, but consideration with respect to any changes made to WTSM so that the interface and application is maintained and/or enhanced is thought worthwhile.

2.3 Model Periods

The periods modelled are to remain consistent with the existing two hour periods incorporated in the WTSM model and are as described in Table 1 below. Consistent with the scope set out in the project brief, WPTM will not model the PM period although the design will allow this functionality to be added at a later stage if required.

Table 1 – Model Time Periods

Period	Period included	WTSM	WPTM
AM	7:00 – 9:00	Highway & Transit	Transit
IP	9:00 – 16:00#	Highway & Transit	Transit
PM	16:00 – 18:00	Highway & Transit	Not modelled

Note - IP is modelled as a 2 hour period representing average conditions over this 7 hour period.

2.4 Interface

This project will create a seamless interface between the WTSM and WPTM models. It is important for both the development and operation of the model that common datasets are used as much as possible for both models and that the interfaces are automated. The key issues are:

- That both models use a common network and transit lines; and
- Development of an automated process to convert demand from the WTSM's 225 zones to the WPTM's 780 zones.

3 Key Issues

The following subheadings highlight key issues and task for the project. These are covered further in remaining sections of the report.

3.1 Public Transport Forecasting

One of the challenges faced in WTSM, and most strategic four stage models for that matter, is its ability to represent public transport in sufficient detail or accuracy for the needs of project assessment. A key aspect of the WPTM will be the demand factoring model which works by applying changes in demand due to either growth, or projects, from WTSM and applying these changes to the observed demand in WPTM. A key issue will be that the process of developing WPTM and the availability of more detailed public transport demand data for the base year will likely highlight some of the existing deficiencies (known and unknown) of the existing WTSM. However a fundamental role of WPTM will be to provide the basis of "corrected" or factored forecasts, and this means the modelling process will not be designed for feeding back any changes to WTSM in ongoing application of the model. Therefore any changes to be made to WTSM in this project to improve performance in relation to public transport modelling will focus on the base year model calibration and validation. This issue will be reviewed during the model calibration process and will be addressed in Technical Note 19.

3.2 WPTM Observed Demand

Key challenges will be:

- Obtaining good data as a basis to develop the observed 2011 public transport demand; and
- Applying a structured approach with knowledge of Wellington to use that data to establish the base demand.

3.3 Airport Travel

The project will add functionality to the airport special generator model of WTSM to forecast public transport trips as well as private vehicle trips for flight related trips.

3.4 Implementation

The upgrade of EMME software to version 3.4.1 provides potential to improve the public transport assignment in WPTM alone or both WTSM and WPTM. The areas that may provide improvement include:

1) Explicit specification of generalised cost components

The Strategy Transit Assignment with Variants allows explicit specification of generalised cost components for boarding, in-vehicle and auxiliary transit, making it easier to extract true travel times and travel costs. In addition, the perception factors for each time and cost component can be element-specific.

2) Optional prohibition of connector-to-connector paths

Flow between two adjacent zones may be assigned to a sequence of connectors. Such connector-to-connector paths can now be prohibited or allowed where desired. This new handling of connector-to-connector paths makes it easier to compensate for network coding issues such as large zones or a dense network.

3) Options to distribute flow between connectors at centroids

The flow from a zone is no longer limited to leaving from one connector (the connector yielding the best transit time) to the destination zone, as in the optimal strategy. Now, it is possible to distribute flow among all connectors leaving a zone using proportions calculated with a logit model, or user-defined proportions for all or a subset of connectors. The possibility to distribute flow between connectors at centroids makes it easier to model the competition between parallel services, or an uneven population distribution in large zones.

4) Distribution of flow between attractive lines at stops

The distribution of flow is no longer limited to the frequency of the transit lines that pass at that node. Now, it is possible to distribute the flow between attractive lines based on a combination of frequency and travel time to destination. Distributing the flow between attractive lines provides a new way to represent the attractiveness of faster services and the unattractiveness of slower services.

These improvements need to be tested in both WTSM and WPTM. Whilst they potentially provide more flexibility for WTSM particularly with respect to access to stations, the impact on the assignment will need to be monitored to maintain compatibility with other aspects of WTSM such as mode choice.

5) The use of EMME Modeller™

INRO (the developers of the EMME/3 software) is in the process of testing EMME Modeller™ which is a new application framework for travel demand forecasting, transportation planning and related applications. It provides planners and transport modellers with an improved modelling interface through a new component-based development system.

We recognise that this project provides a significant opportunity to start migration of the existing model algorithms over to the enhanced format. However as of November 2011 EMME Modeller remains as a beta release and our communication with other users of the beta software has identified that some bug issues have been encountered. Therefore at this stage we have decided not to proceed with use of EMME Modeller, however this does not rule out implementation of this capability in later versions of the Wellington models.

3.5 Base WTSM

WTSM has been modified since the formal 2006 update, but not all of these modifications have been fully documented. Discussions during the inception process have indicated it is preferable to start with the 2006 model that has been documented and peer reviewed. The exception will be the networks, which are being significantly enhanced.

In their investigations of the model uplifted from GWRC The team noted there were two separate macro folders – one called "delivered" and one called "additional" where additional folder contained macros added by GWRC modellers between delivery of the model in 2008 and uplifting of the model by Opus in July 2011. While it was thought that most of the additional macros related to either restructuring macros so the model could run across GWRC servers or reporting functions, it was confirmed that GWRC has been unable to locate official technical notes documenting the affect changes had on the base model (in any) i.e. there was documentation with instructions on how to run WTSM on GWRC machines but none confirming that these changes did not affect initial validation.

A "model synchronisation" task undertaken by David Young Consulting and Opus International Consultants at the behest of GWRC early in 2011 achieved a satisfactory level of consistency between forecasts. This was important because Opus had uplifted the modified version of the model while David Young was still operating a version that was delivered to GWRC in 2008. However, this task focused on forecasting models rather than re-running the base so a task has therefore been included in the programme to *rerun the base model with the additional macros and re-check validation.* If this re-run task "un"validates the model The Team will return to the 2008 delivered model macros.

3.6 Validation of WTSM

As the task involves little change to the model structure or functionality the validation of WTSM will be dependent on the quality of data supplied to the model. It will be important to test any changes to the model incrementally to assess changes to the 2006 validation.

3.7 Interface and Zone System

An issue considered in the initial stages of the study was the question as to whether the modelling should proceed with a different level of zone detail for WTSM and WPTM, or to move towards having a common more detailed zone system. There are two separate investigations that have covered directly and indirectly the issue over zone detail:

Variable Trip Matrix Investigation for Wellington Regional projects by SKM for the NZTA. This investigation focused on the treatment of forecast demands in SATURN models in the Wellington Region. Each of the SATURN Models in the Wellington Region are assignment-simulation models which use demand matrices for AM, Inter and PM Peak hours for light and heavy vehicles as model inputs. One of the concerns raised when using outputs from WTSM was lack of model detail in Kapiti Coast in particular. The investigation examined various methods for addressing these concerns with several of the options including: 1) further refinement of the WTSM Zone system in the Kapiti Coast and 2) extraction of run algorithms from WTSM for direct usage in the Highway Assignment models. Given the timeframes involved it was not possible to include any (or allow for any) of these suggestions in the WTSM update scope. However, The Team understands that some of the findings may be adapted for inclusion in WTSM06 to assist with particularly pressing concerns on RoNs projects so may be in further updates discussed in Section 1.1 (The 10 Year Model Improvement Programme); and

Zone Refinement Investigation undertaken during this study in consultation with NZTA and GWRC. Part way into the study GWRC asked The Team to look into the possibility of refining the Demand Model in WTSM to 780 zones to match WPTM. It was thought this approach may be able to address some of the concerns raised in the point above over the Kapiti Coast Zones and potentially provide for a more seamless transfer of data between

the two models. However, it was decided that a disaggregation of the zone system would require a recalibration of the mode split and trip distribution models and given programme constraints it was decided that this would be best dealt with at a later date. (**TN26: GWRC Summary Model Improvement Programme**)

Given that different zone systems will be employed development of a strong interface between WTSM and WPTM is important to limit network coding effort and automate the conversion of public transport demand from the 225 zone WTSM to a 780 zone WPTM. More detail on this topic is provided in section 10 of this report.

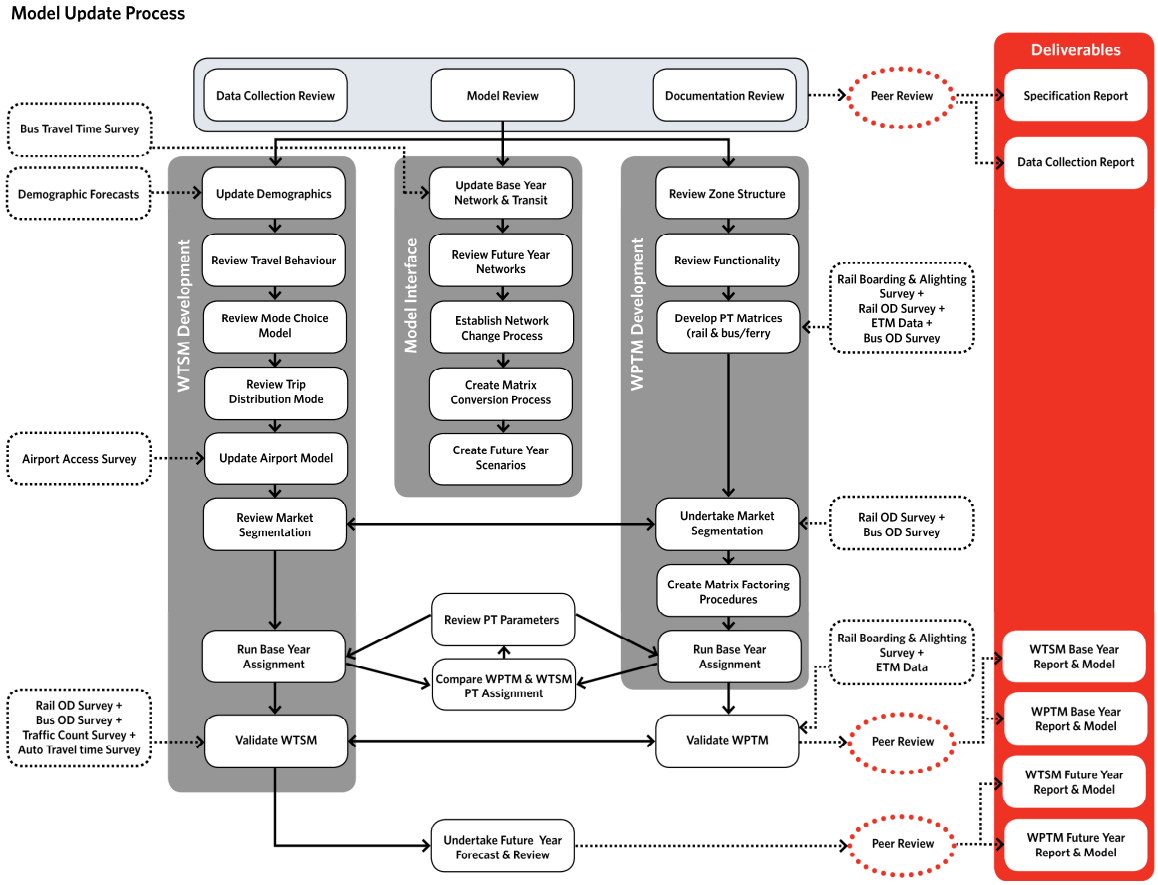
3.8 Documentation and Training

One of the recognised weaknesses of the current WTSM is the documentation of projects, developments and enhancements of the model and lack of a reasonable method to control inputs and outputs of the model runs. Creating another modelling interface between WTSM and WPTM adds emphasis to the need to address these issues. The team will refresh the existing process of documenting model runs, including an easier method to detail schemes included and excluded from models as well as background demographic assumptions, including fuel pricing and travel demand management assumptions.

The inclusion of the GWRC staff working with the consultant team on this project is providing the necessary training and knowledge of the model development. We will run a model user training course for team members to gain a good knowledge of the final model. If required we will also run a two day SATURN training course for users who may be utilising the new WTSM / WPTM models in the assessment of the PT spine study.

4 Methodology

The following figure summarises the key study tasks, the general sequence in which they will be undertaken to develop each of the models and their interface, and the key steps where the development of the models is interlinked.



4.1 Summary of Tasks

The figure above has been broken down and described in sections throughout the report. As stated earlier, the purpose of the following sections is not to lay out a detailed methodology but to describe the activities that will be undertaken to *confirm* a methodology*. Detailed methodological descriptions are planned for later publication as the team completes their investigation of issues identified under the topics listed below:

- **Project Inception** is described in more detail in Chapter 5. It reinforces the fact the project is underway and that each of the key team members understands their roles and responsibilities.
- **Data Collection** is described in more detail Chapter 6. It picks up on key issues involved in the collection of Bus/Rail OD surveys, vehicles count screenlines, rail boarding counts, bus travel times and highway travel times.

* This is because the final methodology may be influenced by the type and quality data being collected. This is particularly true for the WPTM model development as building trip matrices from stop to stop ETM data is a relatively new approach in Australasia.

- **Network Development** is described in more detail within Chapter 7. While the proposal called for the retention of the coding *approach* described the WTSM User Manual, we plan to completely replace the links and nodes to make the network more compatible with the public transit services. This chapter lists the steps involved in making the network changes and the measures being put in place to assess the impacts of the changes. Again, it will be supported by a more detailed technical note once investigations are complete.
- **WTSM Update** is described in more detail within Chapter 8. The key aspects of the WTSM upgrade are: rebasing land use and demographics from 2006 to 2011; improve airport forecasting module by adding car vs. public transport mode split; provide a consistent interface with WPTM; and improve reporting procedures.
- **WPTM Development** is described in more detail within Chapter 9. It outlines main points of difference between WTSM and WPTM (e.g. the 225 zones for WTSM versus 780 zone system for WPTM), and the steps involved in developing the 2011 base demand matrices from Electronic Ticketing Machine (ETM) data with improved sub-routines for the access leg mode choice. It also contains a description of the general approach for forecasting changes in public transport demand. Further documentation will be provided in a detailed technical note.
- **Interface** is described in more detail within Chapter 10. It covers how the team will approach the process of transferring information between WTSM and WPTM. For example highway travel times from WTSM will be used in WPTM to help model bus travel times.
- **Validation** is described in more detail within Chapter 11. While no significant changes are proposed for the validation of WTSM (compared with the update of the model in 2008) there is a need to address how WPTM will be both calibrated and validated. This chapter therefore lays out potential framework for defining new validation criteria.
- **Reporting** described in more detail within Chapters 13 and 14. These chapters cover reporting both in the sense of production of standardised model outputs routines (or "reports") and the report documents specified in the RFT/MIR e.g. the Model Validation Report.
- **Training** described in the previous section 3.8.

5 Project Inception

Scope

An inception meeting was held on Thursday the 7th of July attended by Opus, GWRC, Arup and John Bolland. This meeting set-out the initial approach for the project and discussed some of the early details. Resulting from the inception meeting and subsequent minutes each of the team members understood their role and the steps required to start the project.

Meetings were also held to start the data collection / collation process. The Project Quality Plan was provided to GWRC and set out:

- communication processes;
- inputs and outputs required for the project;
- project scope and sub-objectives;
- personal responsibilities of the key team members;
- key deliverables;
- quality control processes;
- budgets;
- health and safety plans; and
- the programme.

The PQP was accepted by GWRC on 26th of July 2011.

The collection of data is key to the start of the project and meetings have also been held with TDG to ascertain the data they have and the processes they are going through to collect the relevant information for the model build.

The project area has been established on the 5th floor of Opus' Majestic Centre offices on Willis Street. This area was available from early August and has already been utilised as much as possible with Opus and GWRC and will be used additionally by Arup staff over the coming months.

Data Requirements

None

Issues

Issues are discussed below under risk.

Risk

Mis-communication between the consultancy team and the client may be an issue throughout the project. To mitigate against this we propose to include the client and his team as much as is practicably possible.

Relevant Technical Notes

None

6 Data Requirements

6.1 Bus Intercept Surveys

Scope

Intercept surveys are required to gather OD and trip purpose information from bus users to supplement the ETM data provided by bus operators. A review of the bus routes in the Wellington Region has identified and prioritised routes that should be surveyed to achieve appropriate coverage of bus users based on the following criteria:

- Route patronage;
- Service frequency and stopping pattern (i.e. express vs. all-stops);
- Geographic coverage;
- Routes servicing special generators such as hospitals, educational institutions and the airport; and
- Bus routes servicing modal interchanges.

Timing of the intercept surveys has been significantly constrained by the advent of the Rugby World Cup (RWC) (commencing 9th September), the need to complete WPTM in time for use in the PT Spine Study, and the time required to plan and prepare surveys. This has resulted in a short window for surveys to be largely completed between the 5th and 9th September 2011. This window unfortunately coincides directly with the mid-semester break at Massey University but avoids other events likely to disrupt travel behaviour.

Some surveys may occur outside of the 5-9th September window due to time constraints however only routes where the impact of the RWC is limited will be surveyed outside this period.

A full list of services selected for survey is included in Appendix A.

Additional information regarding the determination of these routes and the number of surveyors deployed is available through GWRC but is covered by confidentiality agreement with the bus operators.

Data requirements

ETM data from Wellington Bus companies. Discussed separately in section 6.2.

Issues

Survey period may be impacted by University breaks and any travel behaviour changes in the lead up to the RWC. We will investigate measures that can correct for these impacts.

Risk

While the original scoping programme allowed for significant time to adapt for inconsistency between the intercept survey and the ETM data, there may still be additional time required to quantify any potential errors.

Technical Notes

TN2 Survey Sampling Methodology

TN3 ETM Data Cleaning and Analysis

TN4 Bus and Rail Intercept Survey Methodology

6.2 Bus ETM Data

Scope

The team collected bus ETM data. The ETM data contains boarding and alighting movements for individual passengers by:

- Bus service/route/company;
- Time;
- Boarding and alighting locations;
- Fare; and
- Ticket type (e.g. child/adult).

The information will be used to:

- Build PT demand matrices which is discussed in the section 9;
- Develop fare functions; and
- Estimate in-vehicle travel times.

Data Requirements

Bus ETM Data from individual operators

Issues

Discussed under the risks section

Risks

- Missing data e.g. some companies may have data for trips at boarding but not at the alighting point. Methods for dealing with this issue will be covered in the technical note: TN3 ETM Data Cleaning and Analysis
- Commercial sensitivity over data collection will be dealt with through negotiation of privacy contracts.

Technical Notes

TN3 ETM Data Cleaning and Analysis

6.3 Bus Travel Times

Scope

Bus travel time data will be calculated from the ETM data provided by the bus companies as mentioned above in Section 7.2.

Data requirements

ETM data from Wellington Bus companies

Issues

ETM data requires detailed analysis before bus travel times can be extracted.

Risk

ETM data does not supply relevant information to extract the bus travel times

Technical Note

TN3 ETM Data Cleaning and Analysis

6.4 Rail Intercept Surveys

Scope

Intercept surveys are required to gather OD and trip purpose information from rail users to supplement the boarding and alighting survey.

TDG were engaged to develop a survey methodology and undertake the surveys; including a preliminary pilot survey of the Johnsonville Line. The team have supplemented the initial methodology by providing an analysis of the pilot survey to determine if the methodology would provide a large enough sample size. The results of this analysis are included in Appendix B.

OD surveys took place between 16th and 19th August, 2011. During this period an extreme weather event occurred which may impact on travel behaviour for most lines; particularly for services on the Wairarapa line due to the closure of Rimutaka Hill Road (the only road connection between the Wairarapa and the rest of the region).

Travel behaviour changes resulting from the extreme weather event impacted on the validity of some of the surveys. Two lines where re-surveyed on the 26th and 27th of October 2011 – the Kapiti line and the Lower Hutt line.

Data Requirements

Survey data from TDG

Issues

Issue discussed under risk heading

Risk

Low sample rate

Interpeak surveys on Wednesday the 26th of October 2011 were affected by the All Blacks Rugby World Cup victory parade in Wellington.

Technical Notes

TN4 Bus and Rail Intercept Survey Methodology

6.5 Rail Boarding Surveys

Scope

Boarding and alighting surveys were undertaken by TDG at each rail station between 7th June and 10th June. The WPTM Model Structure Report and the Validation Guidelines Technical Reports will provide more detail on how the data is intended to be used.

Tasks include:

Compare the counts against the counts conducted from the 2006 update.

Data collection

Rail boarding surveys from TDG

Issues

Issues covered under risks

Risks

The difference in the interpeak time frames between modelled and observed. Counts were undertaken between 11am and 1pm whereas the model interpeak represents an average two hours between 9am and 4pm.

Technical Notes

TN4 Bus and Rail Intercept Survey Methodology

6.6 Rail Travel Times

Scope

Rail travel time data will be calculated directly from timetables.

Data requirements

Rail timetables sourced from GWRC (either in hardcopies or from the Metlink website)

Issues

Issues discussed under risk.

Risk

Using rail timetables does not replicate exactly the times that trains run to. Any delays on the service will not be included in the observed data.

Technical Note

TN20 WTSM Calibration & Validation

6.7 Vehicle Count Surveys

Scope

Vehicle surveys are required to gather link classified counts for validation purposes.

TDG were engaged to develop a survey methodology and undertake the surveys. The team have supplemented the initial methodology by identifying additional count sites freed up when Hutt City Council advised that some of the count locations were already covered by their traffic monitoring programme.

The counts were programmed to begin on the 1st of August and finish on the 27th of September 2011.

Tasks include:

- Liaise with TDG to collect the counts;
- Compare the counts against the counts conducted from the 2006 update; and
- Set up vehicle count validation spreadsheets.

Data requirements

Results from tube counts and detailed site descriptions with site photos if possible.

Issues

Extreme weather patterns impacted on the survey programme.

Sites near the Westpac Stadium were surveyed before the RWC games took place but there may be a general increase in traffic across the region due to an increase in overall visitors. This will be checked against historic NZTA telemetry data.

Risk

Severe weather

Not exactly the same count locations as before. The 2006 validation report cited instances of unknown locations for count sites – therefore validation was not as precise as it might have been.

Technical Notes

TN20 WTSM Calibration & Validation

6.8 Vehicle Travel Times

Scope

Vehicle travel times will be calculated using the Beca / NZTA bi-annual travel time survey data.

Data requirements

Beca / NZTA March and November travel time spreadsheets.

Issues

Issues discussed under risk.

Risk

Low sample rate on longer routes. A meeting has been held to discuss ways of increasing sample rates but this was too late to be implemented in the November 2011 surveys.

Technical Note

TN20 WTSM Calibration & Validation

7 Network Preparation

7.1 Base Year Network Development

Scope

The team are adopting an approach which partially automates the development of the network and PT services files. Links, nodes, and PT services will be developed using the GWRC Public Transport Database (PTD) and Road Centreline GIS files as a starting points. We propose to develop both the WTSM and WPTM network and PT services using the following procedure:

1. Bus stop coordinates will be "snapped" to a road centreline file in GIS and converted to EMME nodes and links using an appropriate node numbering system.

2. The network will be cleaned and corrected with additional nodes as required.

3. Curvature will be added to the links using the EMME link vertices function where appropriate, both to help calculate link distances and generally improve the presentation of the model. Elevation will be added to the node coordinates using GIS so gradients can be incorporated into link length (gradient impact on VoC in point 7 below).

4. The WTSM 06 link and intersection coding regime will be reviewed and augmented as necessary before being applied to the network. Initial link types will be allocated based on hierarchies provided in the road centrelines files supplied by GWRC. *Initial* free-flow speeds and other attributes such as capacity will be allocated according to the tables listed in the Model User Documentation (which assign certain attributes based on what link type has been specified). Capacities for intersection types with fixed rather than calculated capacities will be allocated from local area highway assignment models such as the WTM. The task of adjusting these link attributes will be carried out using a mixture of:
    a. Journey time surveys;
    b. Aerial photography (from online sources and GWRC if possible); and
    c. Extensive local knowledge and site visits as required.

5. We recognise the importance of being able to model the access/egress leg of PT journeys and the role this level of analysis will play in the PT Spine Study and Bus Review. Additional coding (links and nodes) will therefore be included along high density land use and PT corridors. This will allow more accurate modelling of the PT services and access/egress routes around these areas i.e. areas of intensification will include more walk links. All road links that that are selected for inclusion in the final model which are walkable will be coded as such.

6. EMME Transit lines files will be produced from the GWRC PTD. A documented script will be created to undertake this task which will enable a seamless interface between the PTD and the WTSM & WTPM and allow for quick updates in the future.

7. An additional line of inquiry identified in the original proposal involved investigating impacts of gradients on Vehicle Operating Costs and speeds. While the team still plans to carry out this task it will be limited to an 'assignment-only' process which will be run

after the full four stage model has run without it. This is because the Trip Distribution Model was calibrated without gradient incorporated explicitly. To summarise:

- The task is investigative only – the gradient impact on vehicle operating costs, vehicle kms, vehicle minutes and assignment routing will be analysed, reported and will only be included in the final version of the model if it aids in assignment validation; and
- It will be applied at the assignment only stage of the model once the full four stage model has completed.

Model run algorithms will be updated to incorporate any new features added as part of the general review.

Data requirements

Obtaining the required input files – GIS road centreline file, elevation coordinates, aerial photography, and GWRC PT database.

Issues

Issues discussed in 'risks' section

Risk

The network refinements may change the degree to which the model validates. The risks will be managed by adopting an "incremental" change and reporting process which check many of the key modifications in isolation.

Technical Note

TN1 Network Preparation

7.2 Network Change Process

Scope

The existing WTSM "Netcreator" procedures will be retained and improved as required. The Teams review of the current procedures for modifying networks and PT services found existing netcreator routines very helpful. The main cause for concern from the version uplifted from GWRC by Opus was there were a number of undocumented or poorly described network/service modifications. When used fully and correctly netcreator procedures work quite well.

While the purpose of this project is centred on rebasing the model rather than option testing, known schemes will be more fully described in the netcreator file (with potential "hyperlinks" to scheme folders on the GWRC server). The development of future year networks is discussed in 7.3.

Issues

Issues discussed under risk.

Risk

The process developed is not maintained (however this is not an issue for this update but more for ongoing use)

Technical Note

TN1 Network Preparation

7.3 Future Year Networks / Projects

Scope

Future year networks will be specified by GWRC and created for 2021, 2031 and 2041 and will include projects as agreed upon by GWRC and stakeholders. At the time of writing this report GWRC had meetings arranged with NZTA to confirm schemes going forward.

Data Requirements

Detailed project descriptions; and

While it is recognised that is difficult to predict detailed Public Transport service information for future years the team will work with GWRC to develop initial schemes and service improvements. This will include GWRC representatives on the PT Spine Study and the Regional Bus Review.

Issues

Gaining agreement from GWRC and stakeholder as to the projects which will be included in the future year forecasts; and

Determining suitable public transport services to be included in the future year forecasts; particularly around service frequencies to be implemented.

Some of the decisions as to the future network cases may be linked to the issues of the future regional land use scenarios which are discussed in section 8.8.

Risk

Coding errors; and

Coding inconsistencies between projects.

Technical Notes

TN1 Network Preparation

TN23 Future Year Demographic Data and Networks

8 WTSM

8.1 Introduction

The key aspects of the WTSM upgrade are:

- rebasing from 2006 to 2011 – which includes updating demographic inputs and model parameters such as economic inputs, parking costs, fares etc;
- improve airport forecasting module by adding car vs. public transport mode split;
- provide a consistent interface with WPTM; and
- improve reporting procedures.

We will update the various components on an "incremental" basis so they can be included or excluded as part of the model building i.e. we will analyse and report using standard model outputs the impacts of the changes listed below:

1) Develop networks & PT services from GIS & GWRC PTD. This is described in Section 7.
2) Update economic parameters (VOC, VOT, PT fares, parking etc). This is described in Section 8.2.
3) Update land use/demographic 2011 rebasing work, update car ownership data and update trip generation model. This is described in Section 8.3 and Section 8.4.
4) Develop airport mode split submodel. This is described in Section 8.6.
5) Compare WTSM PT synthetic matrices against WPTM observed matrices. This is described in Section 8.5.
6) Review & test EMME version 3.4.1 functionality. This is described in Section 3.4.
7) Revalidate WTSM 2011. This is described in Section 8.7.
8) Run forecast scenarios. This is described in Section 8.8.

The composition of the incremental tests will be subject to a separate technical note: **TN 22 Base Model Run and Sensitivity Testing.**

8.2 Review WTSM Model Parameters and Procedures

Scope

The following parameters will be reviewed, along with how they've been incorporated into the model structure:

- Values of time;
- Vehicle operating costs (fuel price and fuel efficiency);
- PT Fares (including review of boarding distance based fares, and transfer penalties); and
- Parking costs (commuter and non-commuter).

The parameters will be adjusted with latest values from NZTA's EEM where possible and will be augmented after review of the Auckland, Sydney and Melbourne Strategic Transport Models for best practice.

Where possible, spreadsheets and procedures form the update of the delivered model will be used.

Data requirements

- Values of time;
- Vehicle operating costs (fuel price and fuel efficiency);
- PT Fares (including review of boarding distance based fares, and transfer penalties); and
- Parking costs (commuter and non-commuter).

Issues

Confirm with Nick Sargent and David Young how the above parameters are performing in the existing model.

Risk

Model algorithms may need to be updated if the independent review of the parameters identifies significant deficiencies.

Technical Note

TN15 Model Parameter Updates

8.3 Update Trip Generation Model Inputs

Scope

Prism Consulting will provide demographic data to rebase the model from 2006 to 2011. The key tasks for the team are:

- Liaison with Prism to establish protocols for the sharing of information;
- Before taking responsibility for the 2011 demographic data the modelling team will analyse and report on the data received; and
- The trip generation model will then updated with demographic data provided by Prism Consulting.

We will also work with data collection consultants to ensure the external trips (i.e. vehicles into and out of the region at SH1 and SH2) are collected for the base year. For clarity, we will apply the same trip distribution algorithms for externals applied in the 2006 model update i.e. it will be an update model inputs not model form.

With regards to the update of HCV demand, we recognise the difficulties the region has had in generating reliable HCV demands in the past and the HCV model was last calibrated prior to 2006. The team understands GWRC has commissioned David Young separately to

undertake this task. The team will collect and review the HCV demand from GWRC. The review will consist of such tasks as:

- Correlating HCV trip productions and attractions at the 24 hour level with total employment in each zone; and
- Double checking the growth assumptions made between 2006 and 2011.

Data requirements

2011 state highway flows at the SH1 and SH2 external connectors;

2011 land use update spreadsheets and technical documentation from Prism; and

2011 HCV update spreadsheets and technical documentation form David Young.

Issues

Given the lack of any other data the team has to rely upon the Prism demographic forecasts.

Risk

Inherent assumptions in Prism work are incorrect.

Technical Notes

TN11 HCV matrix development

TN10 2011 demographic report

8.4 Update of Car Ownership Inputs

Scope

The car ownership model is included in the trip generation spreadsheets, so makes use of the input demographic data. The update will be undertaken by comparing actual car ownership in the Wellington region with the 2011 model forecast of the proportions of households by car ownership level (0 cars, 1 car, 2+ cars). The forecast will be from the original model base year, 2001. An additive adjustment factor will be applied which shifts the forecast up or down in order to fit the actual data.

Data requirements

2011 Car Ownership update spreadsheets and technical documentation form David Young.

Issues

As the 2011 Census was not undertaken the 2011 “actual” data has been estimated from analysis of historic Census data.

Risks

Incorrect levels of car ownership affect trip generation rates to the degree it makes validation difficult.

Technical Notes

TN11 Car ownership model - Base Year

8.5 Mode Split and Distribution Model changes from Input Updates

Scope

Whilst no recalibration exercise is proposed at this stage we will analyse and report impacts of the updates of key inputs (such as the new 2011 land use/demographic data) with respect to distribution and mode split models.

We will:

- Analyse and report on changes in highway trips by comparing the highway matrices against proportional trip length distributions from the WTSM 06 i.e. in light of the fact no new highway trip length data is being collected the patterns established in WTSM 06 will be maintained.
- Analyse and report on changes in PT trips by comparing the 2011 PT matrices against both the delivered model matrices and observed trip matrices from WPTM - the development of a 2011 fully observed public transport matrix presents an excellent opportunity to compare WTSM trip length distributions against observed data. WTSM and WPTM public transport trips matrices will be analysed, compared and reported.
- Analyse and report the impact for new EMME PT multi-routing assignment procedures. We see potential benefits with access choice to stations.

Data requirements

Observed demand matrices as discussed in section 9

Issues

Establish criteria with peer reviewer to assess the performance of the mode split and trip distribution models

Risk

Run of the model with new network and land use fails to meet criteria set by the model peer reviewer

Technical Note

TN18 WTSM Calibration / Validation

8.6 Develop and Implement Airport Modal Sub-Choice Model

Scope

The current model deals with flight related business and leisure trips for residents and non-residents and applies productions based on CBD employment and population. The problem is that it does so in a way which outputs demand at a vehicle based level for only for car and taxi trips i.e. it exclude the direct modification of the model to allow for the possibility of allocating some demand to public transport modes.

We will review the basic assumptions for trip generation and distribution, and update procedures to generate person trips as opposed to vehicle trips. The major improvement will be the incorporation of a mode split function. Given the lack of available data in Wellington this will be developed using parameters from elsewhere, for example the Melbourne Victorian Integrated Transport Model (VITM). A key element will be to understand the current level of PT demand at the airport. Our approach will be:

- Collate existing transport demand data by undertaking vehicle count and occupancy surveys at all access and egress points to the airport for both private vehicles, public transport, taxis and hire cars;
- Update trip generation functions based on total trips rather than just vehicle trips;
- Review current distribution functions - no major change is anticipated;
- Develop a mode split between private vehicle trips, taxi trips, and public transport trips based on highway and public transport cost skims by purpose (resident/non-resident/business/leisure);
- Identify typical mode split parameters; and
- Conduct sensitivity testing on the mode split parameters for each purpose.

Data requirements

- Existing public transport demand collected as part of a vehicle occupancy survey;
- Future airport passenger projections from the airport operators (and review these assumptions with GWRC i.e. GWRC to provide sign off on the projections); and
- Benchmark parameters from other models.

Issues

- Applying parameters that are appropriate for Wellington;
- Developing an approach that deals with current demand and future growth;
- The availability of relevant data and information from the airport. One issue may be that the airport bus data may not produce enough trips to register; and
- Applicability of parameters from other models.

Risk

- Lack of data may limit accuracy of forecasts.

Technical Note

TN8 Airport Survey Methodology

TN9 Airport Model WTSM

8.7 WTSM Validation

Scope

It is important that the two models are validated together. Any issues that need to be addressed in WTSM will reflect in WPTM and possibly vice versa. Validation guidelines for WTSM and WPTM will be developed appropriately for strategic models comparative to previous WTSM, EEM and international best practice and reported in technical note 17 Validation Guidelines and Criteria. The approach and guidelines will be agreed in the early project stages to minimise risk of programme slippage. We will provide an additional focus on aspects that are important for the Public Transport Spine Study.

The overall validation process and relevant criteria are discussed further below in Section 11. In relation to WTSM the specific validation tasks will include:

- Review coding and inputs;
- Collate validation data;
- PT screenlines if available;
- PT boardings by sector from ETM for WTSM;
- Highway travel times using surveyed data;
- Commercial Vehicles by screenline using available data;
- Highway screenlines and key strategic routes; and
- Bus travel times.

Data requirements

- PT screenlines if available;
- PT boardings by sector from ETM for WTSM;
- Highway travel times using surveyed data;
- Commercial Vehicles by screenline using available data;
- Highway screenlines and key strategic routes; and
- Bus travel times.

Issues

Some key issues to consider include:

- The development of the observed public transport demand matrices for the WPTM will provide a validation check for WTSM;
- The team will utilise data from any other sources that are available. Opus has a comprehensive understanding of other potential data sources;
- Establish validation criteria with peer reviewer; and
- Collect data as it becomes available rather than in one mass data collection exercise.

Risk

Initial assignment of the model causes a significant deterioration in model validation when compared to the 2006 update.

Technical Note

TN17 Validation Guidelines and Criteria

TN18 WTSM Calibration / Validation

8.8 WTSM Forecasting

Scope

Future year models will be created for 2021, 2031 and 2041 the details of which will be documented further in TN23 Future Year Demographic Data and Networks. In order to produce these future forecasts a fundamental input is the agreed demographic data. The following paragraphs describe the process that will be used to generate that data.

While not part of the original scope of this project Opus has been separately commissioned to undertake a study that will provide demographic inputs into WTSM scenarios for the RoNS, PT Spine study, PT improvements study and general GWRC analysis. This will give context to the Levin to Wellington Airport corridor and the State Highway Two corridor under three strategic land use scenarios plus sensitivity analysis and other region wide analysis.

The Opus work will act as a guide for GWRC and the NZTA to understand growth patterns under three particular land use scenarios within the Wellington Region that would facilitate transport modelling for current and future planned transport projects.

The current strategic highway network planning and programming in Wellington needs further analysis of land use and project land use scenarios to facilitate further assessment and economic evaluation of transport projects in the Wellington Region.

Current predictions for low, medium, and high growth scenarios to date need to be further developed, specifically in relation to the forecasted land use impacts, trends and distribution that may occur as a result of Wellington's growth. It is these prediction which in general, support regional transportation analysis, for example RLTS Strategy Development, RoNS, PT Spine Study and other significant region wide investigations. The use of the medium growth scenario in WTSM only partially picks up on the different land use demands that are currently occurring, planned or projected.

There are existing development scenarios for the Wellington region and this is reasonably well understood for other areas, however, the potential for wider economic analysis of the land use and growth potential needs to be considered for:

- Levin/Palmerston North (effect at the regional boundary north of Otaki);
- Kapiti Coast;
- Porirua;
- Lower/Upper Hutt;
- Wellington City; and
- Wairarapa combined.

It is understood that the land use scenarios are best considered as a package rather than in isolation.

The methodology is summarised below as to how Opus propose to carry out the analysis of three land use scenarios. It is based on our understanding of the matters provided by Tony Brennand, NZTA and Nick Sargent, GWRC, and matters discussed at the a meeting dated 13 September 2011.

The three concepts for land use and growth scenarios to be investigated are:

- **Intensification of the CBD** – high growth scenario in the Wellington CBD and resulting redistribution of overall growth from other districts of the Wellington Region - Kapiti Coast, Porirua, Wairarapa, Upper Hutt and Lower Hutt.
- **Western Drift** – high growth scenario along the RoNS corridor toward the north and the resulting redistribution of overall growth from other districts of the Wellington Region – Wellington City, Wairarapa, Upper Hutt and Lower Hutt. This scenario also has to consider the external zone to the north of the WTSM area which will capture changes in growth for Levin / Foxton / Palmerston North etc.
- **De-centralisation of the CBD** – high growth scenario for Porirua, Kapiti Coast, Lower Hutt, Upper Hutt, Wairarapa and resulting redistribution of overall growth in Wellington City.

The general process involves information gathering and review, investigation of three scenarios, analysis of investigation findings, redistribution of growth under each of the three scenarios and production of a draft report and associated land maps and changes in land-use / employment and external zone numbers.

The NZTA and GWRC project managers will also have the opportunity to review reports and discuss the findings with the Opus team before the final versions are produced for discussion with other stakeholders.

Additionally, values of time, vehicle operating costs assumptions (fuel cost# versus change in vehicle efficiency), parking charges, TDM functions#, future HCV demand#, and Public Transport fare information) will all be updated for each of the horizon years.

Being produced by David Young

These future year forecasts will be utilised to undertake future year base model tests for this Wellington Transport Models project.

Testing will be completed on the forecast models to ensure reasonable and logical patterns are produced by the model in the future years as would be expected with the growth from the demographic projections. Inherent in these checks are sensitivity checks on the networks to ensure no spurious routing or delay occurs causing unusable or illogical travel patterns. As well as testing the individual models responses to the growth demographics this stage of the project will also test that there is a logical result when testing the interface between the WTSM demand model and the WPTM public transport assignment.

All of the above tests and checks will give the team, GWRC and all stakeholders confidence in the stability and robustness of the model and the techniques used to produce the model.

Data Requirements

- 2011 Land Use Inputs – Russell Jones;
- Price Waterhouse Coopers (PWC) report;
- In addition to these documents there other Regional and District Policy Strategies and Development Plans;
- forecast fuel cost[#] versus change in vehicle efficiency;
- forecast parking charges;
- forecast TDM functions[#];
- forecast HCV demand[#]; and
- forecast Public Transport fare information.

Issues

- Defining and getting agreement on a “base” future network from stakeholder group.
- Agreeing with the peer reviewer the sensitivity tests to be undertaken to ensure the model responds sensibly to policy interventions e.g. checking to see if a nominal uplift in PT fares produces a sensible decrease in PT Patronage.

Risk

- Differing views on what should be included in the base forecast network.
- TLA stakeholder comments on land-use scenarios

Technical Note

TN11 HCV Matrix Development

TN12 Travel Demand Management Modelling

TN14 Forecasting Parameters

TN23 Future year demographic data & networks

[#] Being produced by David Young

TN24 Future year base model tests

9 WPTM

9.1 Introduction

The WPTM model will provide the following enhancements compared to WTSM:

- Provide a more detailed public transport assignment;
- Improve the modelling of transfers and access legs as a result of a detailed walk network;
- Provide additional functionality including improved modelling of access modes; and
- Allow for a more robust validation of the WTSM PT component.

These enhancements will provide a model that is soundly based on observed data and more detailed, discerning and consistent in the predicted response to testing of public transport system changes. Together WTSM and WPTM will provide a modelling framework that is better suited than WTSM alone to testing of issues like route changes, restructuring of services, fare system changes, and potential introduction of new routes or modes.

Previously a version of WPTM was partially developed by GWRC using some observed data from 2009, but development was not completed and was discontinued. In some sections below this work is referred to as the existing WPTM. This work was reported in a Draft Technical Report – "Wellington Public Transport Model Development", GWRC August 2010. The brief and discussions with the client and the peer reviewer have identified that a less complicated version of WPTM is to be developed. In this regard it has been determined that crowding and reliability aspects will not be included in this development of WPTM. Park and ride will be considered as part of the overall access mode modelling as discussed further below.

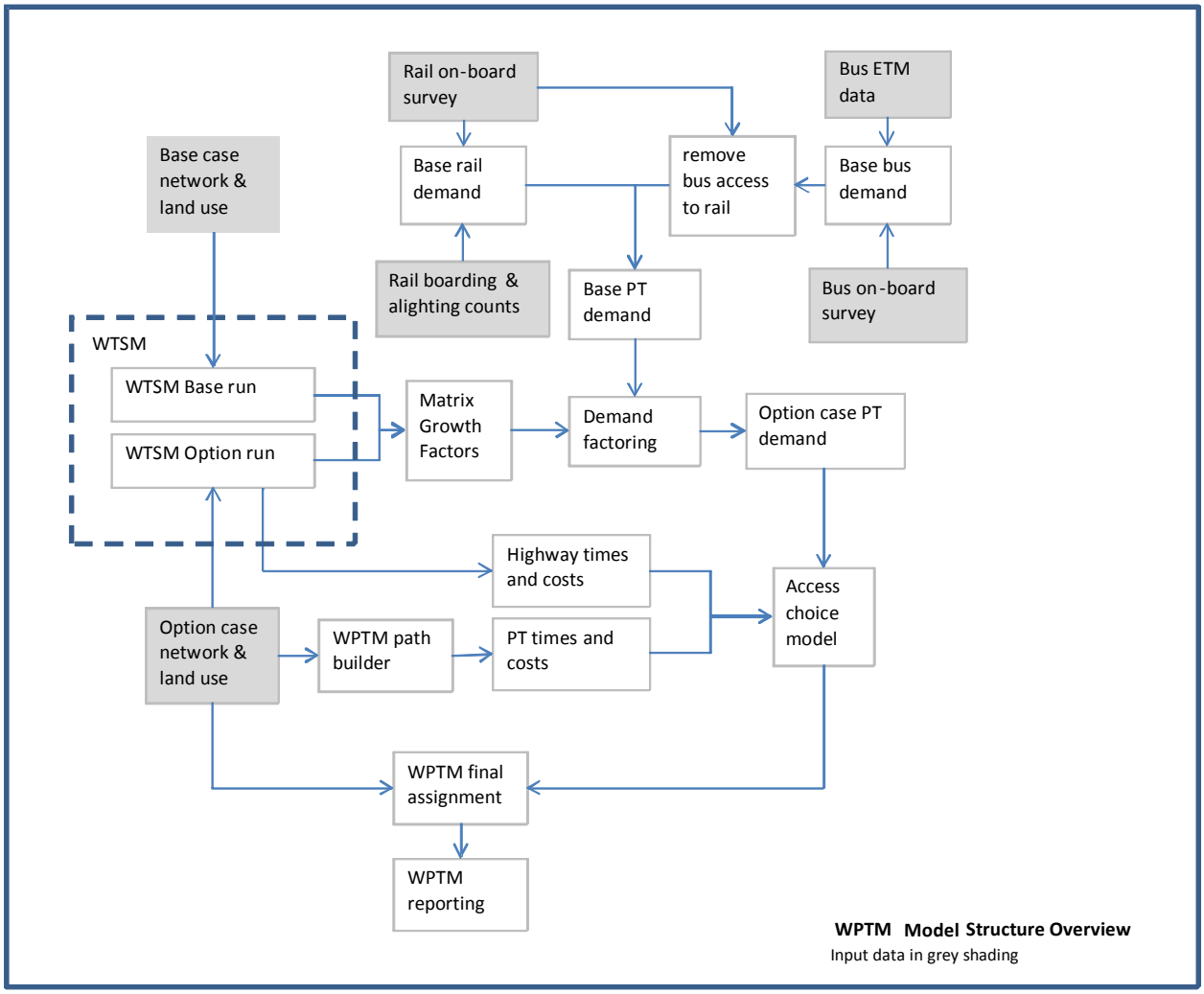
The remainder of this section outlines key features and issues for the proposed WPTM. A more detailed consideration of these issues and explanation of features of WPTM will be presented in Technical Note 6.

9.2 Model Structure

The intended overall model structure is shown in the figure below, indicating the linkage with WTSM and the usage of the key data sets to derive the base public transport demand. At this level the structure figure does not indicate the demand segmentation to be included in the model, which is discussed in the following section.

The model form is based on these key aspects:

- Access mode choice (and which station for car access) by logit choice model; and
- All other PT routing (and so sub-mode, e.g. bus versus rail) choices by assignment.



9.3 Demand Segmentation

Scope

Base year demand segmentation will be undertaken based on trip purposes expressed in the rail and bus OD surveys. The number of segmentations will be dependent on the quantity and quality of the OD survey data available. A comparison of these segmentations with WTSM will be undertaken and may result in modifications to the trip segmentation that is provided to WPTM from WTSM to ensure consistency between the two models.

Trip purposes will be aligned with WTSM as closely as possible although some purposes may be aggregated in WPTM where there is insufficient data to create separate trip purposes. For instance WTSM home-base other and home-based shopping trips may be aggregated.

Final demand segmentation will be determined in discussion with the peer reviewer once observed matrices have been developed from OD survey data. Trip purposes that are likely to be included as a minimum are work, education, and other. The initial assessment of data and ticketing processes indicates that child travel is likely to be treated either as a separate

class or as a subcategory of the education and other trip purposes. Consideration will also be given to treatment of special zones such as the airport.

Data requirements

Bus and Rail OD intercept surveys – to provide trip purpose segmentation consistent with WTSM.

Bus ETM Data and Rail boarding and alighting counts.

Issues

Demand segmentation provides more flexibility for assignment.

Alignment of trip purposes with WTSM is required to provide a basis for factoring of WTSM forecasts.

Quality of survey data.

Risk

Trip purpose aggregations may vary significantly between WTSM and WPTM due to the differences in modelling process.

Technical Notes

TN5 Bus and Rail Intercept Survey Methodology

TN6 WPTM Structure

TN7 PT Matrix Development.

9.4 Zone Structure

Scope

The 780 zone structure that has been implemented during the development of WPTM will be reviewed to ensure that it is fit for purpose.

Specific tasks:

1. Review existing documentation;
2. Overlay 780 zone structure with new highway and PT network and with the 225 zone system;
3. Check that zone connectors are representative of actual walk distances;
4. Check that zone connectors near fare boundaries are applied to the correct location;
5. Check that zones are representative of homogeneous land use where possible;
6. Provide GWRC with draft zone structure for review; and
7. Alter zone structure and connectors as required.

Data requirements

Network details, Fare zones, Land use

Issues

Matching zone detail with model functionality and scheme needs (e.g. extra detail along the PT Spine Corridor between the Wellington Railway Station and Wellington Hospital)

Risk

Extensive alterations to zone structure could impact on delivery time frames.

Relevant Technical Notes

TN1 Network Preparation

TN10 2011 Demographic Report

TN23 Future Year Demographic Data and Networks

9.5 Access Model

Scope

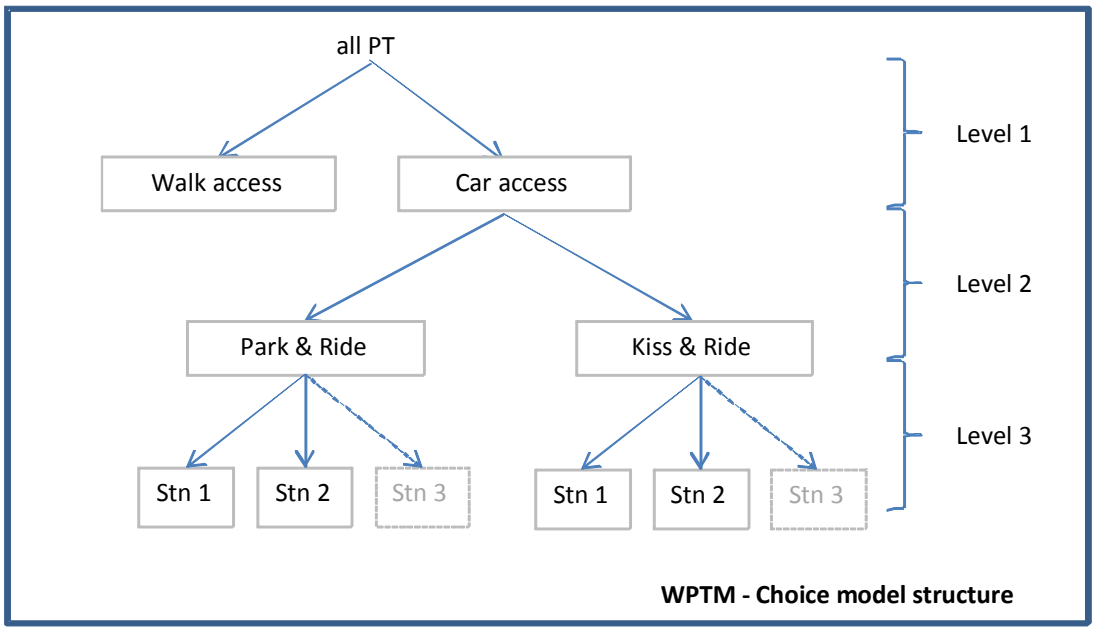
Provide a modelling approach to represent the choice of access mode, car versus walk (or walk and bus) to rail stations. On the basis of existing behaviour in Wellington (and to be confirmed through survey analysis) it is considered not necessary to model access mode for bus travel.

The access choice decision for rail – whether to walk or to take the car (P+R or K+R) – will be determined using a logit choice model. We propose to operate this choice model in 'absolute' formulation. This means that the observed shares are used only to calibrate the model: for application, the model predicts the choice shares. This formulation allows for us to forecast in completely new markets as well as forecasting changes in existing markets.

For those who choose P+R or K+R, there will be a second layer of choice to divide demand between the best two (or possibly three) access stations. The trips are then assigned via the nominated station. For the calibration of the base model, P+R and K+R will be allowed only via rail (first boarding). For future years, bus P+R projects can be modelled.

For those who choose walk-access, the stop or station chosen, and the mode and route boarded will be determined through assignment.

The following figure represents the structure of a three level nested logit model that is proposed to be developed.



Development of the model will require definition of utilities for each choice and estimation and calibration of model scaling parameters and coefficients. It is proposed to draw on a range of sources for these parameters, including WTSM and other local and international guidelines.

Implementation of the model will also require the allocation zones to stations for the purpose of matrix manipulations in EMME.

Data requirements

Rail intercept survey

Any other available data on rail parking characteristics – demand and supply

Issues

Correct specification of model to achieve appropriate level of relative sensitivity at each level of the choice tree.

Calibration and validation of model.

Risk

Non – modelled characteristics affecting parking location choice leading to poor calibration. Minimise risks by constraining choices to ensure realism in behaviour and/or allow for station based constants to assist in calibrating model.

Relevant Technical Notes

TN5a Bus Intercept Survey Analysis

TN5b Rail Intercept Survey Analysis

TN6 WPTM Structure

TN7 PT Matrix Development

TN19 WPTM Calibration / Validation

9.6 Observed Demand Matrices

The final demand for assignment in WPTM will be a single trip matrix for each demand segmentation purpose; however, observed trip matrices by each main mode (Bus or Rail) will be generated initially and used to aid in the validation of the model. The following sections describe a general approach as to how data will be manipulated to generate the observed demand matrices. The detail will be reviewed and confirmed in subsequent technical notes.

9.6.1 Bus

Scope

As well as bus this demand matrix will also incorporate cable car travel.

Develop observed bus origin to destination matrices by purpose through a process building up from stop-to-stop demand matrices by ticket type:

1. Generate stop to stop matrices from ETM records with complete boarding and alighting information.
2. Generate stop-to-stop matrices for ETM records without alighting information based on patterns observed from complete records
3. Use intercept survey stop-to-stop matrix to assign any remaining trips from the ETM data where data could not be synthesised based on complete ETM records;
4. Identify and separate bus trips with transfers to bus to allow separate processing of multi leg bus trips
5. Identify and separate bus trips that involve bus access to rail for these trips to be included in the rail matrix only
6. Use bus intercept survey to partition overall demand into trip purposes
7. Use bus intercept survey to identify access and egress patterns and use a gravity model approach to distribute stop demands to travel zones
8. Validate matrix

Data Requirements

ETM data

Bus intercept survey data

Issues

Quality of O-D survey data – ability to split by purpose.

Risk

Development of O-D matrices lies on the critical path for this project; delays in receiving data may impact on project deadlines.

Relevant technical notes

TN5a Bus Intercept Survey Analysis

TN5b Rail Intercept Survey Analysis

TN6 WPTM Structure

TN7 PT Matrix Development

TN19 WPTM Calibration / Validation

9.6.2 Rail

Scope

As well as rail this demand matrix will also incorporate ferry travel.

Develop observed rail demand matrices by purpose:

1. Generate station-to-station OD matrices from intercept survey data;
2. Scale station-to-station survey to match observed boardings and alightings;
3. Build zone to zone matrix;
4. Segment matrix by mode of access; and
5. Validate matrix.

Data Requirements

Rail OD data

Rail Boarding and alighting survey

Ferry boarding and alighting data

Risk

Any significant delays or cancellations on survey days may result in additional work to appropriately factor survey results. The severe snow storms affected the initial surveys and consequently two lines (the Kapiti and Lower Hutt lines) have been resurveyed on Wednesday the 26th and Thursday the 27th of October 2011.

Relevant technical notes

Development of the model will require definition of utilities for each choice and estimation and calibration of model scaling parameters and coefficients. It is proposed to draw on a

range of sources for these parameters, including WTSM and other local and international guidelines.

Data requirements

Rail intercept survey

Any other available data on rail parking characteristics – demand and supply

Issues

Correct specification of model to achieve appropriate level of relative sensitivity at each level of the choice tree.

Calibration and validation of model.

Risk

Non – modelled characteristics affecting parking location choice leading to poor calibration. Minimise risks by constraining choices to ensure realism in behaviour and/or allow for station based constants to assist in calibrating model.

Relevant Technical Notes

TN5a Bus Intercept Survey Analysis

TN5b Rail Intercept Survey Analysis

TN6 WPTM Structure

TN7 PT Matrix Development

TN19 WPTM Calibration / Validation

9.7 Generalised Cost

Generalised costs components of public transport trips will be used as elements of the access model (see 9.5 above) and the assignment process (see 9.9 below).

Each of the elements contributing to the generalised cost of PT travel will be reviewed as described in the following subsections. The general approach will be to adopt consistent parameters in both WTSM and WPTM, with the initial adoption of existing values (allowing updating for any specific cost changes such as fare increases etc) used in WTSM. Any review/changes of parameters will need to consider impacts to the validation performance of both models, as described in Section 11. In some cases, because of differences in the level of detail between the two models (particularly zone size and issues of representing travel time on centroid connectors), it may be appropriate to adopt a different approach between the two models.

Relevant Technical Notes

TN15 Model Parameter Updates

TN16 PT Assignment Procedure – WTSM and WPTM

TN19 WPTM Calibration / Validation

9.7.1 Transfers

WPTM will incorporate the same transfer penalty as used in WTSM. The new networks will contain sufficient walk links between stops and stations to accurately emulate transfers between modes. We will review the current transfer penalty structure and values and update as required especially where work is being done as part of the PT Spine study.

9.7.2 Fare Structure

Currently fares in WPTM are represented in the assignment process through a flagfall and an additional in-vehicle time as a passenger crosses a fare zone boundary. We will examine the value of fares to ensure that these are up to date and examine the possibility of implementing a distance based fare system.

9.7.3 Access and Egress

In addition to updating the zone connectors and walk links to be more representative of actual travel distances we will review weightings applied to access time for PT trips. Review will involve comparing weightings with previous versions of WTSM, APT and other transport models.

Issues

Applying a low walk weighting may result in significant numbers of walk only trips.

9.7.4 Wait Time

Factors applied in the WTSM model (which affect both mode split and assignment aspects of the model) will be reviewed and if considered appropriate altered in both WTSM and WPTM. Consideration will be given to the approach applied for low frequency services, where wait times may be more closely related to users knowledge of timetables rather than to the general approach of adopting half the service headway. We will review the line specific rail wait time factors that were adjusted in the WTSM 2006 delivered model to help improve model validation.

9.7.5 In Vehicle Time

Scope

Consider options for assignment of buses either based on timetable or based on highway assignment with allowance for dwell time. Review application of bus priority in WTSM for application to WPTM. The preference is to use highway costs and dwell times for forecasting and validate assigned times to timetable.

Issues

Allowance for dwell time, perhaps allow a higher dwell time in CBD compared to elsewhere.

Data Requirements

The WPTM report quotes some Golden Mile Passenger surveys for dwell time – which we will review if data is available.

May need to investigate if the proportion of Snapper card users alters dwell times and how these might be affected in forecast years. Whilst this may be a small component generalised cost for individuals overall effects on bus travel times may be significant.

9.8 WPTM Forecasting

9.8.1 Demand factoring

Scope

Demand forecasts at the overall matrix level for the WPTM model will be based on the observed matrix which will be factored at a zone to zone level to reflect demand changes that have occurred in WTSM between a base and option case.

Application of both additive and factored increments will be used to establish the most robust method to reflect demand changes in future years. Determining which OD pairs are grown additively or factored (or a combination of the two) will be based on criteria derived from demand, forecast land use and demographics. The process is likely to be iterative and the peer reviewer will be asked to comment between iterations to ensure that the final result provides a robust solution.

Special attention will be paid to development zones to ensure an appropriate adjustment is made. In such cases using the absolute WTSM public transport forecasts for a zone may be appropriate.

Issues

Creating a process that can accommodate changes should unforeseen land use development eventuate or for specific projects with significant land use changes.

Determining whether the WTSM growth will be applied additively or multiplicatively or a combination of both.

Determining how the WTSM growth will be disaggregated into the WPTM Zone system. This is covered in more detail in Section 10.1

Risk

Identifying all significant areas to be developed for each forecast.

Technical Notes

TN6 WPTM Structure

TN20 WPTM Forecasting

9.8.2 Light Rail (other new modes)

The introduction of new modes within an assignment model will be considered. We will adopt mode and vehicle parameters that are consistent with international best practice and appropriate to the Wellington situation. If efforts can be conveniently coordinated we will work with the PT Spine team to incorporate information from their literature review and other similar projects.

Technical Notes

TN6 WPTM Structure

TN20 WPTM Forecasting

9.9 Develop and Test Assignment Procedure

Scope

A review and test of the new EMME assignment procedures will be undertaken.

Implement optimal PT assignment approach in model. This may involve using one or all of the new functions available in EMME as below:

1. Explicit specification of generalised cost components
2. Optional prohibition of connector-to-connector paths
3. Options to distribute flow between connectors at centroids
4. Distribution of flow between attractive lines at stops

A series of tests will be completed which will look at the impact of utilising each of these functions individually and modelling results will be examined to determine the appropriateness of each. The review is likely to look at the following impacts on WPTM:

- Services were significant change in patronage occurs as a result of different assignment parameters or approaches;
- Variations in average travel time between zones;
- Changes in boardings at stops and stations; and
- Changes to the number of transfers.

Initial analysis will be submitted for peer review prior to a final implementation of the PT assignment and validation.

Issues

Thorough review needs to be undertaken to understand the implications of new EMME functions on modelling process, reporting and results.

Risk

Any parameters utilised in the new function may be hard to justify. Tracing errors/issues in results when using new functions will be more difficult due to absence of experience with functions. It may be possible to draw on the expertise of INRO to alleviate such issues.

Relevant Technical Notes

TN6 WPTM Structure

TN19 WPTM Calibration / Validation

TN20 WPTM Forecasting

TN22 Base Model Run and Sensitivity Testing

10 Model Interface

10.1 WTSM to WPTM Matrix Conversion Process

Scope

The transfer of demand between the two models will be a complicated process as a result of the differences in zone structure. There are two different areas that need to be addressed in order to achieve this:

- The disaggregation of zones from 225 to 780 zones. Disaggregating zones between WTSM and WPTM is a crucial part in achieving an accurate PT model as it will ultimately determine the length of access legs for the PT assignment and consequently which transit services are chosen by users. We propose to examine a range of approaches for ensuring that the disaggregation of demand to a finer zonal level is relevant, utilising land use and demographic data, and access costs. For example a process similar to disaggregating WTSM matrices for SATURN models.
- The demand segmentation between the two models and the level of demand segmentation applied at the interface of the two models is important. We will consider alternative options from an aggregated approach where trip purposes are combined to a more segmented approach as discussed under segmentation (see section 9.3).

The disaggregation process will be drafted once the zone structure has been finalised and submitted to the peer reviewer prior to a final implementation.

Data requirements

2011 demographic data at the finest practical level (ideally meshblock) that can be provided by demographers.

Bus and rail OD data to provide information about relationship between zone and stop.

Issues

The application of zonal disaggregation in future years needs consideration. In particular identification of any major developments that may require special consideration.

Relevant Technical Notes

TN1 Network Preparation

TN6 WPTM Structure

TN10 2011 Demographic Report

10.2 WTSM to WPTM Network Conversion Process

Scope

With WTSM and WPTM sharing the same network, only zones and zone connectors need to be added/removed to convert a WTSM network to WPTM. This will be implemented

though a macro process embedded within the modelling system. Access modelling in WPTM will however require the allocation of special purpose zones to rail stations.

For some projects, alterations to the zone structure of WTSM, and consequently WPTM, may be required. We will minimise the amount of manual input required in these instances and document a process which allows for these modifications to be made in a robust manner.

Issues

Accommodating different centroid connector system, whilst maintaining a common network.

Risk

Whilst adding detail to the WTSM network adds some risks (refer Section 7) it is considered that adopting a common network minimises the ongoing effort and risks associated with potential coordination of different network details in WTSM and WPTM.

Relevant Technical Notes

TN1 Network Preparation

TN21 WTSM – WPTM Interface

10.3 Create User Interface Mechanism

Scope

A flexible user interface will be developed using EMME's macro language. A master macro will be developed to enable the following:

- WPTM to run seamlessly with WTSM including demand matrix disaggregation process;
- WPTM and WTSM to be run independently;
- A control file input that will provide efficient input of parameters, reduce potential error and help document scenario assumptions;
- Select line and select link analysis process; and
- Traversal process for Wellington City, Transmission Gully and Kapiti SATURN models.

The user interface process will be drafted and provided to the peer reviewer and GWRC for review prior to implementation. This initial draft will provide a discussion point for GWRC, in particular, to identify areas in the process that can be improved bearing in mind the operational and version control requirements that GWRC has for WPTM. Following this the process will be finalised, agreed (with GWRC and the peer reviewer) and implemented.

Issues

As discussed in Section 3.4 consideration has been given to use of EMME Modeller in developing WPTM however it has been decided not to introduce this capability to the model at this stage.

Risk

The introduction of WPTM components and the interlinking of WTSM and WPTM add complexity to the overall modelling process and so increase the potential for user errors in applying the model. The development of a well controlled interface seeks to minimise this risk.

Relevant Technical Notes

TN21 WTSM – WPTM Interface

11 Validation Process and Criteria

It is important that the two models are validated together. Any issues that need to be addressed in WTSM will reflect in WPTM and possibly vice versa. Validation guidelines for WTSM and WPTM will be developed appropriately for strategic models comparative to previous WTSM, EEM and international best practice including the UK WebTAG and this will be reported in technical note 17 – Validation Guidelines and Criteria – WTSM and WPTM. This will discuss the criteria in greater detail both in terms of their sources and the measure used to ensure the models accurately replicate the base travel patterns.

The approach and guidelines will be agreed prior to starting the validation process to minimise risk of programme slippage. This will involve discussions with the peer reviewer. As identified in the inception process it will also be useful to consult with the NZTA performance and investment group in identifying relevant performance criteria. We will provide an additional focus on aspects that are important for the Public Transport Spine Study.

It is recognised that the project is a rebasing exercise rather than a full recalibration of the model and in the absence of new behavioural data and model recalibration it is expected that the validation performance of WTSM is unlikely to significantly change from its existing status. In this context:

- Benchmarking of the 2011 validation against the 2006 validation will provide insight into model performance;
- It will be useful where possible through the model development process to compare the implications of model component changes in an incremental fashion, to identify the impacts associated with the individual changes; and
- Whilst WPTM is expected to improve PT modelling through a more detailed approach and more direct reliance on observed travel, it will still draw on key elements of WTSM (e.g. WPTM will require the WTSM travel times to develop the bus travel time functions) and therefore will be subject to similar issues in relation to observed versus modelled performance.

Scope

The validation tasks may include:

- Review coding and inputs;
- PT screenlines if available;
- PT boardings by sector from ETM for WTSM [bus only];
- Rail boardings by station from manual observations.
- Highway travel times using surveyed data;
- Tree building and logic checks;
- Commercial Vehicles by screenline using available data;
- Highway screenlines and key strategic routes;

- Bus travel times for both WTSM (from timetable information) and WPTM (from ETM data if this is possible); and
- Policy sensitivity testing

Data Requirements

Validation data – public transport and highway surveys

Issues

The previous 2006 validation provides a benchmark, but the 2011 validation is dependent on the quality of available 2011 data.

The development of the observed public transport demand matrices will provide a validation check for WTSM.

The assignment of WPTM will be checked by assigning the developed matrices and checking against the ETM and rail count data. Whilst not an independent check, we believe it is important to use the best available data to develop the observed demand matrices rather than holding data back and producing an inferior demand matrix.

Risk

Achieving model performance to meet specified criteria is typically a challenging aspect of any model development process and leads to a time and resource risk. Whilst our program and resourcing has been conscious of this there remains a risk that unanticipated issues will arise during this part of the model development process, particularly in relation to WPTM which is a new model.

Relevant Technical Notes

TN17 – Validation Guidelines and Criteria – WTSM and WPTM

TN18 – WTSM Calibration / Validation

TN19 – WPTM Calibration / Validation

12 Process Control

12.1 File Control

Scope

We will check and enhance, if required, the existing "Model Excellence" System at GW. It is understood that the existing excellence system has some useful elements and some elements which are not working. As part of the review we will recommend which elements should be retained and which should be removed in favour of a new control system. This can also be extended to the control of output files & results and will make the process of maintaining, retracing and transporting model runs more effective.

We will also consider a system of backing up files and documenting those to ensure the systems at GWRC are not overloaded with unnecessary data that is outdated or no longer needed for the immediate projects being assessed.

Data Requirements

None

Issues

The existing model excellence system will provide a starting point but this will most likely be changed extensively retaining the elements that work whilst replacing or removing the elements that did not work or where not being used.

Risk

It may be decided not to keep any of the model excellence system and start the process control from scratch. If this is required a new system will need integrating with the modelling approach used by GW.

Relevant Technical Note

None

13 Model Outputs and Reporting Routines

Scope

Because WPTM will utilise the same network as WTSM the same network reporting structure will be implemented in WPTM as WTSM. In addition we will create mode, corridor, and trip purpose specific outputs for WPTM network attributes which will also be used as part of the validation process.

For matrix specific reporting we will create specific routines that will export key data stored in matrices in two sets: one which is largely consistent with those already used in WTSM (utilising zone equivalence tables) and one set which is specifically for use in WPTM analysis. The first set will allow users to check consistency between models whilst the second will allow more detailed analysis of the PT model using the new functionality of EMME 3.4.1 if it provides value.

Data Requirements

None

Issues

The standard model outputs will be used to carry out performance and sense checks for do-min and option models. This may need amending once the models are completed and the in particular the WPTM is finalised.

Risk

None

Relevant Technical Notes

14 Project Reports

Scope

As identified in the project brief we will deliver the following key technical reports for the project:

1) This model design report

2) Documentation of surveys undertaken

3) Model update, development and validation report

In addition to these three key reports the modelling consultants will also produce 26 technical notes throughout the model development. These notes are detailed in Table 14.1 below which also show delivery dates for the drafts of these technical notes. The review process, in addition to internal reviews, will be initially through the client at GWRC but in a number of key cases the peer reviewer will also be required to review and make comment before the notes are finalised.

The review of these documents will allow the client and the peer reviewer to understand the processes being used and developed for the model update / build and also provide input for the decision making processes as the project progresses.

The reporting and documentation needs detailed design and improvement to ensure the work is retraceable and easily understood. This will be done in conjunction with client and the peer reviewer, as well as utilising internal reviewers in the consultancy team to make sure the documents are easily understood by a non EMME expert.

Table 14.1 – Technical Notes

Tech note number	Note title	Prime author	Draft issue date
1	Network Preparation	Opus	30/11/2011
2	Survey sampling methodology	Arup	delivered
3	ETM data cleaning and analysis	Arup	21/10/2011
4	Bus and rail intercept survey methodology	Survey firms	delivered
5a	Bus intercept survey analysis	Arup	21/10/2011
5b	Rail intercept survey analysis	Arup	25/11/2011
6	WPTM Structure	Arup	11/11/2001
7	PT matrix development	Arup	23/12/2011
8	Airport survey methodology (may combine tech notes 8 and 9)	Opus	16/11/2011
9	Airport Model WTSM (may combine tech notes 8 and 9)	Opus	25/11/2011
10	2011 demographic report	Prism	draft delivered
11	HCV matrix development (adjustment for 2011)	David Young Consulting	18/11/2011
12	Travel Demand Management modelling	David Young Consulting	26/10/2011

Tech note number	Note title	Prime author	Draft issue date
13	Car ownership model - Base Year	David Young Consulting	delivered
14	Forecasting parameters (fuel pricing, VoT, VoC, PT fares etc)	David Young Consulting	draft delivered
15	Model parameter updates (VoT, VoC, PT fares, parking costs etc)	Arup / Opus	18/11/2011
16	PT Assignment procedures - WTSM & WPTM	Arup / Opus	18/11/2011
17	Validation guidelines & criteria - WTSM & WPTM	Arup / Opus	11/11/2011
18	WTSM calibration / validation	Opus	11/12/2011
19	WPTM calibration / validation	Arup	21/01/2012
20	WPTM forecasting	Arup	21/04/2012
21	WTSM - WPTM interface	Arup	23/12/2011
22	Base model run and sensitivity testing	Arup / Opus	11/12/2011
23	Future year demographic data & networks	Opus	21/04/2012
24	Future year base model tests	Arup / Opus	21/04/2012
25	Impacts of model enhancements / updates (could be part of calibration /validation)	Arup / Opus	21/01/2012
26	GWRC Summary Model Improvement Programme	GWRC	11/11/2011

Data Requirements

None

Issues

GWRC has an existing model excellence procedure which aims to control model usage, inputs and outputs. Whilst this system is not perfect and needs overhauling some of the elements of it work well. The team will review the excellence system and retain the elements that work whilst updating or replacing the elements that have not proved to be so successful.

This is a key area of concentrated effort for the consultancy team to ensure that once this project is completed GWRC will be left with full and clear documentation to enable complete understanding of the process and structures used to rebase WTSM and develop WPTM.

The document control systems used will also be designed in such a way to make the tracking of project work clear and easily useable for people who have no knowledge of the model using it in the future.

There are some issues related to confidentiality of PT data that need consideration as at what level of data can be provided in reporting and/or in relation to restricting access to the study reports.

Risk

The outputs will be designed in conjunction with the client, peer reviewer and the PT Spine team to ensure all groups receive what is needed for their needs, however, this cannot be defined at this stage and will be an ongoing element of the project.

Relevant Technical Note

None

Memorandum

To	Nick Sargent (GW)	Date	9 August 2011
Copies	David Dunlop (Opus) Fraser Fleming (Opus) Julie Ballantyne (TDG)	Reference number	222090-00/JM
From	Bruce Johnson (Arup) Joseph Metcalfe (Arup)	File reference	002-C
Subject	Wellington Transport Models - Data Collection Sampling Methodology & Selected Routes		

Introduction

This memo has been prepared to direct the collection of bus intercept surveys at the direction of Greater Wellington Regional Council for the Wellington Transport Models project.

This note is intended to give guidance as to where resources should be directed to provide sufficient coverage of the bus routes to inform the WTSM/WPTM model update process. It is not intended to provide specific advice on planning or conducting the surveys and it is anticipated that TDG will evaluate staffing requirements to produce the best outcome given the resources available.

Methodology

The aim of the methodology adopted was to identify the routes to be surveyed which will allow reasonable conclusions regarding the travel characteristics and origins and destinations of rail and bus users to be made whilst minimising the resource/cost implications of the data collection exercise.

The methodology was primarily based on a qualitative assessment of the attributes of individual bus services. The attributes of individual services that were considered important to capture as part of the overall routes to be surveyed are as follows:

- Geographic coverage
- Routes servicing special generators such as hospitals, educational institutions and the airport
- Stopping pattern of services (e.g. express versus all-stoppers)
- Service frequencies
- Bus routes servicing modal interchanges.

Building on this approach it was also identified that it was reasonable to preferentially omit some services where usage characteristics could be reasonably inferred from nearby services with similar characteristics. For example the catchment and user characteristics for local station feeder bus

services in outlying areas can reasonably be estimated based on the limited geographic spread of catchment zones and applying user patterns relating to nearby services of similar nature.

Survey period

The PT intercept surveys are envisaged to commence in early August and are intended to capture weekday bus users travelling during the AM and inter-peak travel periods. These are defined as 7-9am for the AM peak and 11am-1pm for the inter-peak. Within this document references to AM and IP periods refer to these times.

The duration of the overall survey period and the scheduling of surveys to be undertaken on the suggested services will be at the discretion of the data collection services provider.

Survey teams

The number of survey teams specified for each route is based on data being collected over a single 2-hour AM or inter-peak period. Design of the survey may allow for a reduction in the number of teams deployed if the surveys are conducted across multiple days, or in the case of the inter-peak, the time period is extended. The survey provider should undertake to "spread" teams in this manner should there be a reasonable cost advantage in doing so.

Bus/Trolley services to be surveyed

Table 1 below lists the bus/trolley routes that are considered to be necessary in determining the travel patterns and travel purposes of a representative sample of the bus users in Greater Wellington. The notes column indicates the latest changes to survey route choice and any changes to survey team numbers.

Memorandum

Table 1 – Bus routes to be surveyed and required sample sizes

Priority 1=high, 3=low	Route No.	Route Name	Number of Survey Teams per Route AM	IP	Change from previous note:
1	1	Wellington - Island Bay	2	2	
1	2	Miramar	1	1	Reduced
1	3	Karori - Lyall Bay (Green Route)	2	2	
1	7	Kingston	2	2	
1	11	Seatoun	2	2	
1	14	Wilton - Kilbirnie (silver Route)	2	2	
1	18	Campus Connection (Mirimar - Karori)	1	1	Reduced
1	53	Johnsonville West	1	1	AM reduced
1	54	Churton Park	1	1	AM reduced
1	57	Woodridge*	2	0	
1	83	Eastbourne via Lower hutt	2	2	
1	91	Airport Flyer	3	3	Reduced
1	110	Upper Hutt	2	2	
1	120	Stokes Valley	2	2	
1	121	Valley Heights	2	2	Increased
1	130	Naenae	2	2	
1	150	Western Hills	2	2	IP Increased
1	160	Wainuiomata North	2	2	IP Increased
1	220	Ascot Park	2	2	
1	262	Paraparaumu North	1	1	
1	280	Waikanae Beach	1	1	
2	10	Newtown Park			Remove
2	17	Victoria University	2	2	Keep
2	23	Mairangi - Southgate/Houghton Bay	2	2	Keep
2	24	Miramar Heights via Evans Bay			Removed
2	31	Miramar North Express*			Removed
2	44	Khandallah - Strathmore (Blue route)	2	2	Keep
2	211	Wellington - Porirua	1	1	Keep
3	4	Happy Valley*			Removed
3	21	Wrights hill - Vogeltown			Removed
3	30	Seatoun Express*			Removed
3	46	Broadmeadows (Blue route)*			Removed
3	52	Johnsonville via Newlands**			Removed
		Total Survey Teams	43	41	
		Total Survey Routes	25	24	

* To be surveyed during the AM peak period only
** To be surveyed during the IP period only

Figures 1 and 2 below represent the overall boarding profiles for all bus services (Excluding Kapiti and Porirua) during the AM and IP respectively. This data may be useful in informing overall strategies for staff deployment across the survey periods. It is noted that on individual routes profiles vary, and in the AM routes starting remote from the CBD having a higher proportion of passengers boarding earlier in the period than shown by the overall profile.

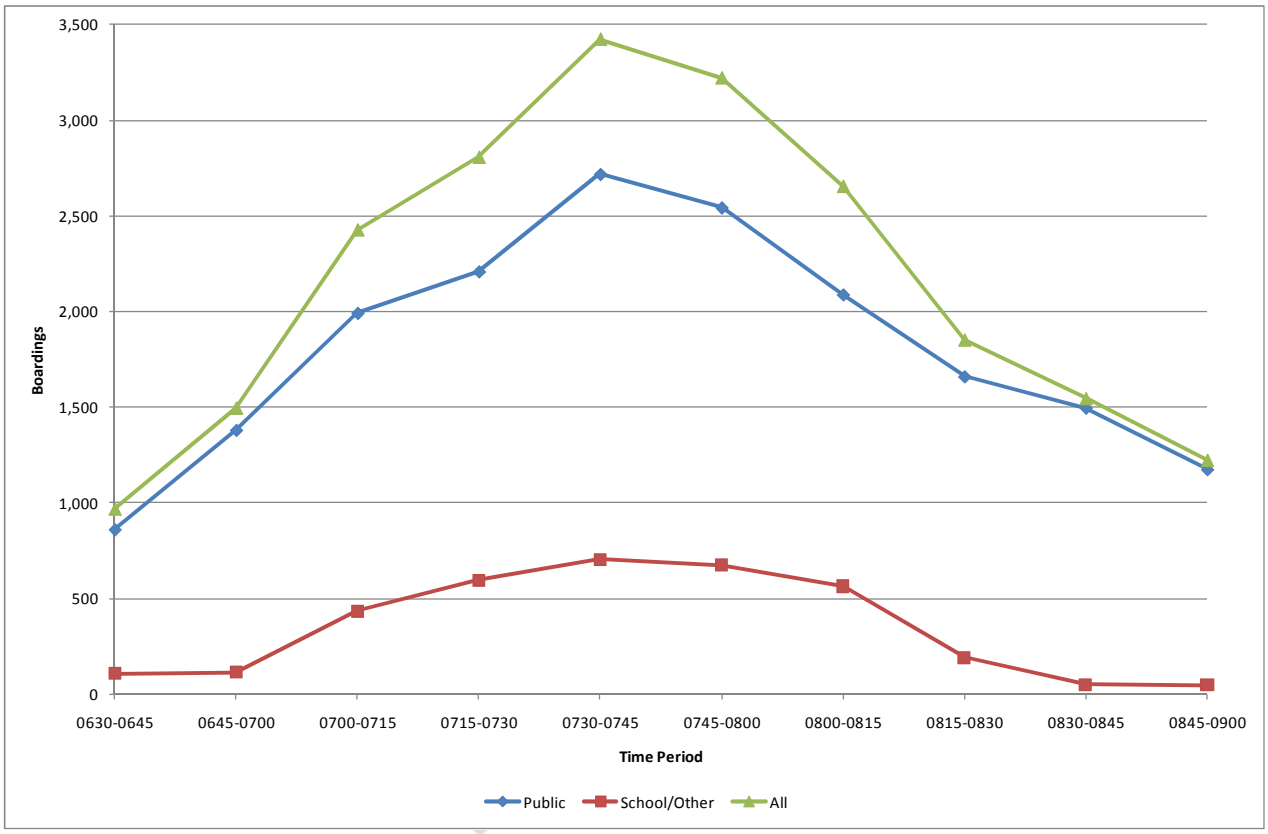


Figure 1 – AM peak period boarding profile (extended to include 6.30am – 7.00am)

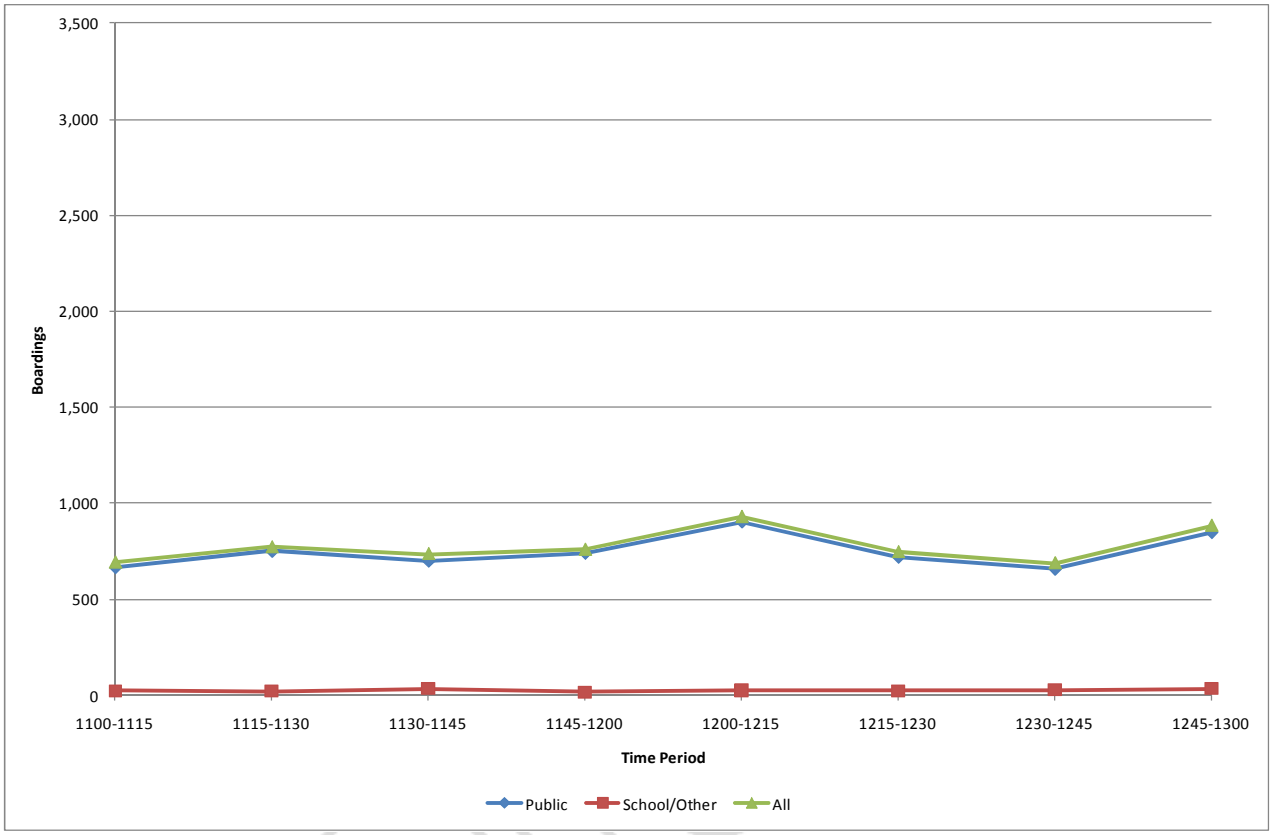


Figure 2 – IP period boarding profile

Memorandum

ARUP

To	Bruce Johnson, Joe Metcalfe	Date	28 July 2011
Copies	Peter Dunn	Reference number	222090-00/MOR
From	Marius Roman x 45402 (MEL17.NW.17)	File reference	001-B
Subject	Wellington Transport Models - Data Collection Sampling Methodology & Selected Routes		

NB: Confidential bus information removed to allow inclusion in Scoping Report

Confidential Information – Security Requirements

This document includes Confidential Information covered by a Confidentiality Agreement between NZ Bus Limited and Greater Wellington Regional Council. Information in this document should be protected in accordance with requirements of the Agreement

Memorandum

Introduction

This memo has been prepared as part of the Arup / Opus commission for Greater Wellington Regional Council for the Wellington Transport Models project.

The document describes the methodology used in the selection of the rail and bus routes to be surveyed as part of the data collection exercise for the project. The resultant services that we consider important to capture based on this methodology have also been listed and a simple statistical analysis has also been undertaken to check how many services will need to be surveyed to obtain a reasonable sample size. Finally, estimated costs are provided as a means of checking that the data collection task is not beyond the allocated budget.

This note is intended to give guidance as to where resources should be directed and the number of responses required to provide meaningful results. It is not intended to provide specific advice on planning or conduct of the surveys and it is anticipated that the service provider conducting the surveys will evaluate staffing requirements to produce the best outcome for the given resources available.

Methodology

The aim of the methodology adopted was to identify the routes to be surveyed which will allow reasonable conclusions regarding the travel characteristics and origins and destinations of rail and bus users to be made whilst minimising the resource/cost implications of the data collection exercise.

The methodology is primarily based on a qualitative assessment of the attributes of individual rail and bus services. The attributes of individual services that were considered important to capture as part of the overall routes to be surveyed are as follows:

- Geographic coverage
- Routes servicing special generators such as hospitals, educational institutions and the airport
- Stopping pattern of services (e.g. express versus all-stoppers)
- Service frequencies
- Bus routes servicing modal interchanges.

Building on this approach it was also identified that it was reasonable to preferentially omit some services where usage characteristics could be reasonably inferred from nearby services with similar characteristics. For example the catchment and user characteristics for local station feeder bus services in outlying areas can reasonably be estimated based on the limited geographic spread of catchment zones and applying user patterns relating to nearby services of similar nature.

A supporting quantitative assessment of required sample sizes has also been undertaken to understand the number of services hours required to be surveyed. The quantitative analysis uses rail boardings from surveys undertaken in June 2011 and ETM bus patronage data along with specified confidence intervals and margins of error to estimate the required size of the population to be sampled. This is then compared to the number of completed forms that are anticipated to be returned based on the results of the bus and rail pilot surveys.

Memorandum

Statistical considerations

A statistical approach to guide selection of appropriate sampling size has been applied and is described below. It is emphasised though that this methodology is for high level planning purposes only and does not represent the statistical level of confidence that will be achievable in estimating some of the more disaggregate elements of the model.

At the lowest level of detail the modelling process will representing trips by purpose between individual origin destination pairs across the whole network. The sparseness of this data, especially in relation to public transport trips where many cells will be of low or zero value, means within practical budget constraints it is impractical to define a statistically significant data collection approach at this level of detail. This is issue is common to strategic models in general and already applies to specific elements of WTSM.

Given the above we have adopted the general approach that we wish to be reasonably confident of key parameters of the population using individual stops or routes on the network. In the case of trains this is directly related to survey methodology which collects data at each stop with a known population size in each peak period – using this approach we can estimate for example the sample size required to be confident about the distribution of access modes for users of individual stations. For bus routes, where population estimates relate to the overall route usage, the approach is less directly related to individual stops, but provides some measure of confidence in determining how characteristics such as trip purpose may vary across individual routes. Such information will be useful in determining appropriate strategies for ultimate weighting of the sample data against ETM data of stop to stop travel.

The formula[1] used for the calculation of the required sample size is:

$$\frac{\qquad\qquad\qquad\qquad}{\qquad\qquad\qquad\qquad}$$

Where,

= sample size

= Chi-square for the specified confidence level at 1 degree of freedom. For the analysis presented below a 95% confidence level has been specified.

= population size

= population proportion for the parameter of interest. The worst case for sample size is for a 50% proportion and this value has been used in the analysis presented below.

= desired margin of error. A value of 10% has been adopted in the analysis.

Survey period

The PT intercept surveys are envisaged to commence in early August and are intended to capture weekday rail and bus users travelling during the AM and inter-peak travel periods. These are defined as 7-9am for the AM peak and 11am-1pm for the inter-peak. Within this document

[1] Krejcie & Morgan, *Determining Sample Size for Research Activities*, Educational and Psychological Measurement, #30, pp. 607-610

references to AM and IP periods refer to these times. The analysis of ETM data is based on reporting trips with a boarding time falling within these specified times.

The duration of the overall survey period and the scheduling of surveys to be undertaken on the suggested services will be at the discretion of the data collection services provider.

Selected routes

Rail services to be surveyed

Given the proposed survey method (i.e. surveyors positioned on platforms as opposed to in-vehicles) all stations within the Metlink service area will need to be included in the rail intercept surveys. This excludes the stations on the Johnsonville Line surveyed during the AM peak period as part of the rail pilot survey undertaken on Wednesday 29th June 2011. This implies a total of 45 stations during the AM peak and 53 stations during the IP period.

The results of the pilot survey on the Johnsonville line during the AM peak period are given in Table 1. This information was used as part of the quantitative analysis undertaken for the scoping of the rail surveys reported in Table 2.

Table 1 – Results of pilot survey on Johnsonville rail line, AM peak period

		Number of Forms			
Boarding Station*	**Total in Pilot**	**Distributed**	**Refused**	**Completed[1]**	**Total in Pilot**
Johnsonville	245	153	92	91	37%
Raroa	71	55	16	43	61%
Khandallah	161	143	18	73	45%
Box Hill	54	32	22	19	35%
Simla Crescent	199	186	13	57	29%
Awarua Street	178	174	4	117	66%
Ngaio[2]	166	139	27	80	48%
Crofton Downs	175	172	3	92	53%
TOTAL	**1,249**	**1,054**	**195**	**572**	**46%**

* Excludes Wellington station

1 'Completed' defined as responses with valid trip purpose and valid origin and destination responses at better than suburb level

2 Buses replaced trains on the 7:31am and 8:25am services to Wellington

Table 2 – Rail stations to be surveyed and required sample sizes

	Total Boardings*		**Required Sample Size[1] (Percentage of Total Boardings)**		**Anticipated Completed Returns[2]**		**Anticipated less Required**	
Station/Line	**AM**	**IP**	**AM**	**IP**	**AM**	**IP**	**AM**	**IP**
Johnsonville								
Johnsonville	n/a	66	n/a	41 (62)	n/a	30	n/a	-10
Raroa	n/a	8	n/a	9 (114)	n/a	4	n/a	-5
Khandallah	n/a	5	n/a	9 (183)	n/a	2	n/a	-7
Box Hill	n/a	9	n/a	9 (102)	n/a	4	n/a	-5

Station/Line	Total Boardings* AM	Total Boardings* IP	Required Sample Size[1] (Percentage of Total Boardings) AM	Required Sample Size[1] (Percentage of Total Boardings) IP	Anticipated Completed Returns[2] AM	Anticipated Completed Returns[2] IP	Anticipated less Required AM	Anticipated less Required IP
Simla Crescent	n/a	25	n/a	23 (92)	n/a	12	n/a	-12
Awarua Street	n/a	74	n/a	41 (55)	n/a	34	n/a	-7
Ngaio	n/a	22	n/a	17 (76)	n/a	10	n/a	-7
Crofton Downs	n/a	15	n/a	17 (111)	n/a	7	n/a	-10
Wellington	n/a	76	n/a	44 (58)	n/a	35	n/a	-9
Subtotal	n/a	300	n/a	209 (70)	n/a	138	n/a	-71
Wairarapa								
Note: Stations north of Upper Hutt not surveyed								
Already on train	835	-	86 (10)	-	461	-	375	-
Upper Hutt	63	-	37 (59)	-	35	-	-2	-
Waterloo	237	-	69 (29)	-	131	-	62	-
Petone	23	-	17 (73)	-	13	-	-4	-
Wellington	11	-	9 (83)	-	6	-	-3	-
Subtotal	1,169	-	218 (19)	-	645	-	427	-
Hutt Valley								
Upper Hutt	175	39	63 (36)	28 (73)	97	22	34	-7
Wallaceville	154	13	59 (38)	9 (70)	85	7	26	-2
Trentham	181	28	63 (35)	23 (82)	100	15	37	-8
Heretaunga	78	4	44 (56)	0 (0)	43	2	-1	2
Silverstream	305	17	74 (24)	17 (98)	168	9	95	-7
Manor Park	41	6	28 (69)	9 (152)	23	3	-6	-6
Pomare	73	10	41 (56)	9 (91)	40	6	0	-4
Taita	271	16	71 (26)	17 (104)	150	9	79	-8
Wingate	51	6	33 (65)	9 (152)	28	3	-5	-6
Naenae	196	36	65 (33)	28 (79)	108	20	43	-9
Epuni	94	12	47 (50)	9 (76)	52	7	5	-3
Waterloo	1,245	103	89 (7)	49 (48)	687	57	598	8
Woburn	277	36	72 (26)	28 (79)	153	20	81	-9
Ava	249	12	70 (28)	9 (76)	137	7	68	-3
Petone	241	46	69 (29)	33 (72)	133	25	64	-8
Ngauranga	2	1	0 (0)	0 (0)	1	1	1	1
Kaiwharawhara	1	2	0 (0)	0 (0)	1	1	1	1
Wellington	122	117	54 (44)	54 (46)	67	65	14	11
Subtotal	3,756	504	940 (25)	333 (66)	2,073	278	1,133	-54
Kapiti								
Waikanae	243	62	69 (28)	37 (60)	134	34	65	-3
Paraparaumu	473	95	80 (17)	49 (52)	261	52	181	3

Station/Line	Total Boardings* AM	Total Boardings* IP	Required Sample Size[1] (Percentage of Total Boardings) AM	Required Sample Size[1] (Percentage of Total Boardings) IP	Anticipated Completed Returns[2] AM	Anticipated Completed Returns[2] IP	Anticipated less Required AM	Anticipated less Required IP
Paekakariki	147	15	59 (40)	17 (111)	81	8	22	-8
Muri	-	-	-	-	-	-	-	-
Pukerua Bay	126	16	55 (44)	17 (104)	70	9	14	-8
Plimmerton	235	19	69 (29)	17 (88)	130	10	61	-6
Mana	151	12	59 (39)	9 (76)	83	7	25	-3
Paremata	345	12	76 (22)	9 (76)	190	7	115	-3
Porirua	910	124	87 (10)	54 (43)	502	68	415	15
Kenepuru	31	10	23 (74)	9 (91)	17	6	-6	-4
Linden	221	28	67 (30)	23 (82)	122	15	55	-8
Tawa	207	35	66 (32)	28 (81)	114	19	48	-9
Redwood	254	20	70 (27)	17 (83)	140	11	71	-6
Takapu Road	167	10	62 (37)	9 (91)	92	6	31	-4
Kaiwharawhara	1	4	0 (0)	0 (0)	1	2	1	2
Wellington	70	139	41 (58)	57 (41)	39	77	-2	20
Subtotal	3,581	601	881 (25)	352 (59)	1,977	332	1,096	-20
Melling								
Melling	245	17	70 (28)	17 (98)	135	9	66	-7
Western Hutt	72	2	41 (57)	0 (0)	40	1	-1	1
Petone	160	3	60 (38)	0 (0)	88	2	28	2
Ngauranga	0	1	0 (0)	0 (0)	0	1	0	1
Kaiwharawhara	1	1	0 (0)	0 (0)	1	1	1	1
Wellington	39	12	28 (73)	9 (76)	22	7	-7	-3
Subtotal	517	36	199 (38)	26 (72)	285	20	86	-6
TOTAL	9,023	1,441	2238 (25)	920 (64)	4,981	768	2,743	-152

* Based on data from Rail Passenger Boarding and Alighting Surveys, June 2011

\- No data available for these routes

[1] Using 95% confidence and 10% margin of error

[2] Based on information from pilot survey. Uses 46% completed returns for stations on the Johnsonville line and assumes a 55% completed returns rate for stations along all other lines. This 20% increase is based on the assumption that issues identified during the Johnsonville pilot survey will be reduced, if not eliminated altogether, improving the response rate

The information in Table 2 shows that sampling the rail stations over a 2hr period is not anticipated to yield the required sample sizes for the given confidence and margin of error specified for all stations. The majority of stations in the AM peak will be satisfied by a 2hr sample period (due to the larger population size during this period), however a 2hr survey period during the interpeak would appear to be insufficient at most locations. The information also highlights that, from a statistical perspective, attention needs to be paid to maximising response rates at low demand stations in order to achieve confidence in estimating particular characteristics of the station users.

Should budget allow, it would be desirable to collect surveys during the IP period over a 3-4hr duration to increase response numbers.

It is noted that in the situation where sample sizes are limited by practical budget considerations then alternative strategies may be employed in the model estimation process to counter this. For example, while losing some level of confidence in model accuracy, it may be reasonable to estimate some elements of IP behaviour (such as distribution of access zones) based on AM behaviour.

Other Issues to Address

It is assumed that administration of the survey will be designed to provide an unbiased sample of users and that all users provide similar levels of response rate. In this respect:

- it will be important to consider whether travellers undertaking short trips have sufficient time to complete and return survey forms on their trip.
- there were some comments in relation to the pilot surveys that data returned from school children was less reliable in terms of full completion of origin or destination details.

Consideration needs to be given to practical issues of survey collection and resourcing and analysis implications:

- for train station surveys the methodology is based on collection of forms at the end of a trip. Some in scope surveys with boardings within the defined peak period will end outside the time period so staff resources need to be allocated beyond the survey duration.
- On buses the sampling statistical approach is based on travelling across the whole length of route. It may be possible to consider on board surveys covering just a proportion of the route, however this adds issues of missing collection of distributed forms for uncompleted trips, and complicating assessment of response rates and weighting processes.

Special Services

Wairarapa Trains

Due to travel time issues the stations north of Upper Hutt could involve significant additional resources to gather data in comparison to other locations, with limited additional value for insight into key travel issues. Rather than deploying staff to each station on the Wairarapa Line it may be advantageous to place drop boxes at the Wairarapa Stations and for surveyors to board Wairarpa servies at Upper Hutt to handout surveys. Surveyors could disembark at Waterloo Station before returning to Upper Hutt to repeat the process. Passengers disembarking from Wellington bound trains at Upper Hutt Station would need to be intercepted to complete the survey. Completion rates for this method would be lower but should provide sufficient data to assign passengers to model zones.

Capital Connection

The Capital Connection service running between Wellington City and New Plymouth does not represent a large portion of rail trips but if budget allows it would be advantageous to survey this service. Due to the nature of this service it may be preferable to place surveyors on-board the service at the Waikanai Station and position a surveyor on the Waikanai Platform to intercept any passengers disembarking. No analysis has been undertaken to determine how many surveyors would be appropriate for this service however a minimum of 2 on board and one on platform should be utilised. Currently, this service has not been included in our analysis.

NB: It is noted that Tranz Metro has already been approached regarding conducting surveys on-board trains and further negotiations may be required to allow this to occur for the Wairarapa services. If the movement of surveyors between carriages is the major concern then it may be feasible to use separate staff in each carriage. Tranz Scenic (operator of the Capital Connection) may have similar safety concerns that will need to be addressed.

Cable Car

For completeness the cable car should be surveyed. Given the low capacity of the cable car it is expected that a single surveyor be deployed onboard to undertake these surveys during a 2hr AM and IP period

Memorandum

Bus/Trolley services to be surveyed

Table 3 below lists the bus/trolley routes that are considered to be adequate in determining the travel patterns and travel purposes of a representative sample of the bus users in Greater Wellington. It is therefore recommended that all of the routes listed below are surveyed.

A summary of the proportion of number of routes and total boardings selected to be surveyed compared to the total number of routes and boardings for the Greater Wellington area is given in

Table 4. Boarding data for each route in the Greater Wellington area along with route length and travel times is also given in Table 6 at the end of this document.

It is important to note that as Confidentiality Agreements between Arup, Greater Wellington and Mana Buses (operators of Kapiti and Porirua bus services) have not been signed, ETM data for these services is not available.

Paragraph removed for confidentiality reasons

Table 3 – Bus routes to be surveyed and required sample sizes

Table 3 Removed for confidentiality reasons

Table 4 – Proportion of routes to be surveyed compared to totals for Greater Wellington

Table 4 Removed for confidentiality reasons

It is important to note that routes listed in

Table 3 only include services where the ETM data showed boarding during the peak periods. Regional services with limited operating times or frequencies (e.g. Te Maura – Wellington (92) and Timberlea – Wellington (93)) are consequently not included. ETM data for these services is available outside of the peak periods and will be used to inform the modelling process, however, surveys should not be undertaken on these routes as resources deployed to other services will provide more value.

Figures 2 and 3 below represent the overall boarding profiles for all bus services (Excluding Kapiti and Porirua) during the AM and IP respectively. This data may be useful in informing overall strategies for staff deployment across the survey periods. It is noted that on individual routes profiles vary, and in the AM routes starting remote from the CBD having a higher proportion of passengers boarding earlier in the period than shown by the overall profile.

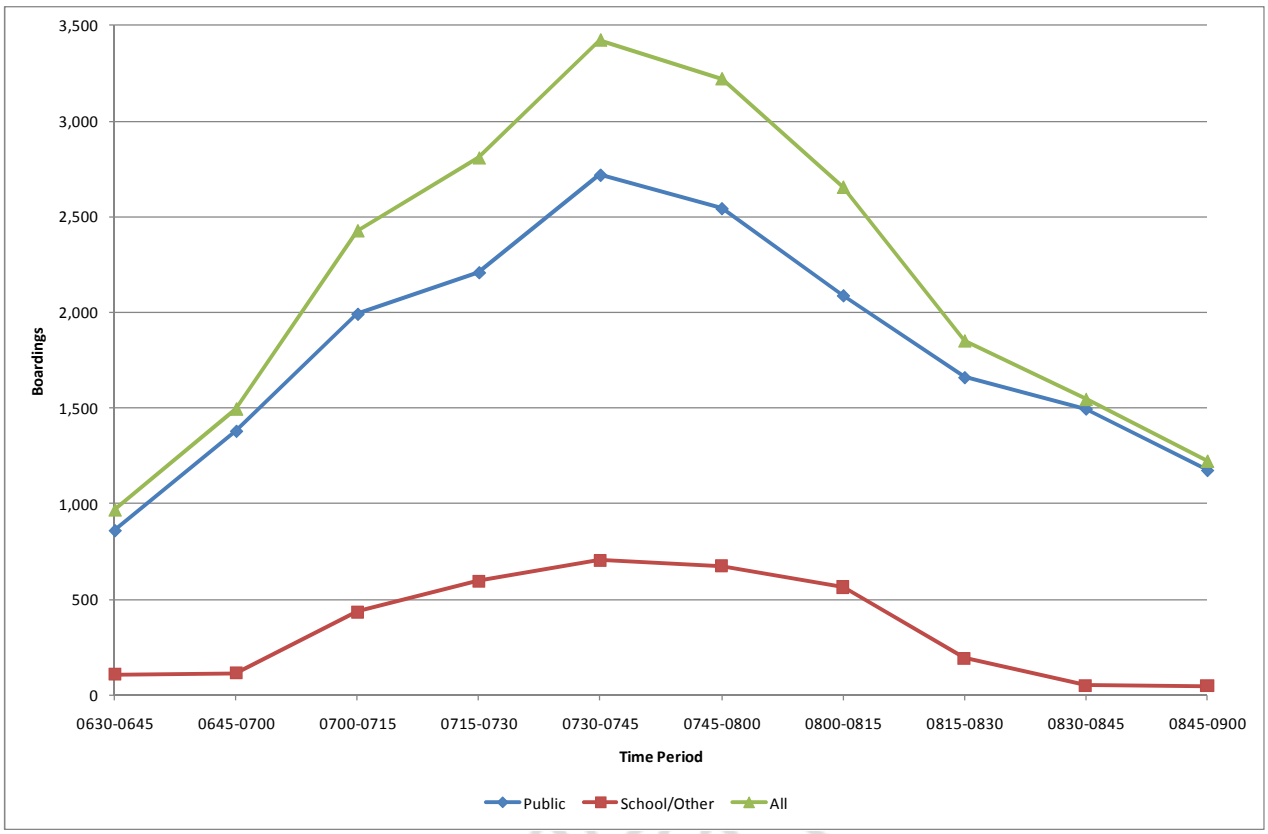


Figure 1 – AM peak period boarding profile (extended to include 6.30am – 7.00am)

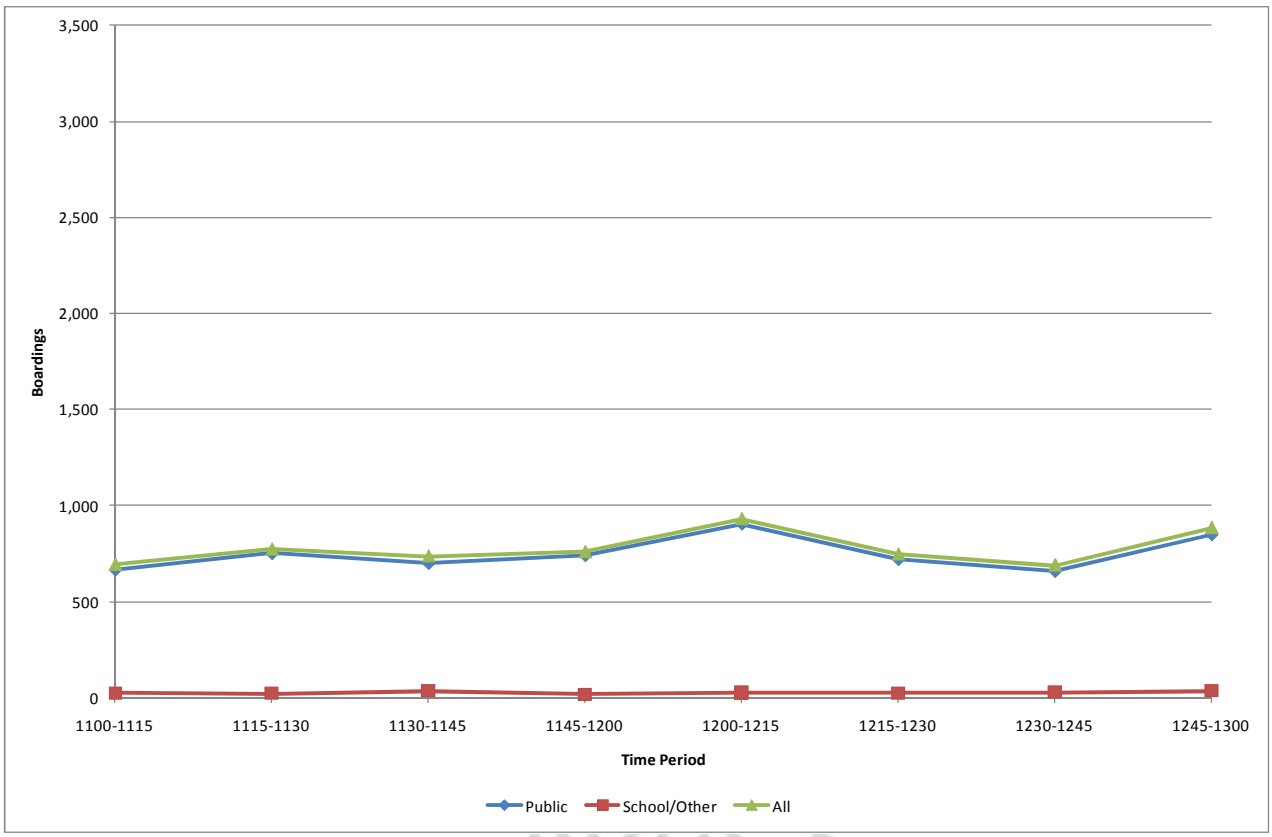


Figure 2 – IP period boarding profile

Special Services

School Buses

School busses have not previously been coded into WTSM; however, education trips that are made by school bus are included in the trip generation process. Modelling school busses specifically within WTSM would require a structural change to the model which would include separating primary/secondary education trips from tertiary trips and assigning the primary/secondary education trips as an additional class.

The changes required to include school bus routes within WTSM fall outside the scope of this study and the value in doing so would be limited. Maintaining consistency between WTSM and WPTM is integral to the modelling process which we have outlined and consequently prohibits the inclusion of school bus service within WPTM at this time.

Surveying of school busses raises privacy issues that would require addressing through communications with schools and parents. Given the relatively low proportion (17% of total boardings during the AM peak) of trips made on school busses it is felt that limited value would be added through this process and resources would be better deployed elsewhere. ETM data and the annual school travel surveys conducted by GW will provide information to help inform the update of WTSM and creation of WPTM in the absence of OD survey data. Information is also being sought from the Ministry of Education which funds these services.

Memorandum

Estimated costs

As an initial step in the survey planning process estimated costs to undertake the surveys have been calculated to gauge whether or not these costs can be accommodated by the budget allocated for the data collection task. The costs have been based on converting anticipated man-hours required to undertake the surveys using an assumed working period for each surveyor and a per hour dollar rate for labour. The travel survey consultant will need to review this memo and advise of actual costs. Some iteration in the planning process to refine the sample to match available budget is likely to be required.

The estimated cost for the data collection task is a ball-park figure only and assumes the following:

- Bus surveys require a team of 3 surveyors per bus (likely to be lower on low volume services, particularly during the IP period)
- Rail surveys require an average team of 3 surveyors per station (likely to be lower during the IP)
- Each surveyor to work for 3 hours per peak period (allows for half an hour travel each way), with the exception of IP surveys on rail platforms where surveyors are assumed to work for 4 hours.
- Each surveyor is paid NZ$40.00 per hour.

Based on the above assumptions and the resource allocation defined in Tables 2 and 3, the overall costs identified in Table 5 have been identified. It is important to note that the costs identified do not include consideration of additional costs associated with logistical constraints, data processing, analysis costs or survey preparation and supervision costs.

Table 5 – Estimated costs of the recommended rail and bus routes to be surveyed

	Estimated Cost (NZ$)		
Mode	**AM Peak**	**Inter-peak**	**AM+IP**
Bus	22,680	15,840	38,520
Rail	16,320	25,600	41,920
Bus & Rail	39,000	41,440	80,440

Memorandum

Table 6 – Data for Greater Wellington bus services*

Table 6 removed for confidentiality reasons