The New Zealand Transport Model: Current Systems and Sectors

Prepared for:
Tim Herbert
Manager – Financial, Economic and Statistical Analysis
Ministry of Transport

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Catherine Mills
## Quality Assurance Statement

<table>
<thead>
<tr>
<th>Department of Civil and Environmental Engineering</th>
<th>Project Manager: Jan Noering</th>
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<tr>
<td>The University of Auckland</td>
<td></td>
</tr>
<tr>
<td>Private Bag 92019</td>
<td></td>
</tr>
<tr>
<td>Auckland 1142 New Zealand</td>
<td></td>
</tr>
<tr>
<td>Prepared by: Catherine Mills</td>
<td></td>
</tr>
<tr>
<td>Reviewed by: Doug Wilson</td>
<td></td>
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<td>Approved for issue by: Doug Wilson</td>
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## Revision Schedule

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<th>Rev. No</th>
<th>Date</th>
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<tr>
<td>1</td>
<td></td>
<td>Draft</td>
<td>Catherine Mills</td>
<td>Doug Wilson</td>
<td>Doug Wilson</td>
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<td>2</td>
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Executive Summary

To assist in the planning of future infrastructure and services projects, and plan funding and test policy changes within the transportation industry at a national level, there is a need to develop a national transportation model that is able to consider all sectors.

The Ministry of Transport has commissioned the University of Auckland (UoA) to undertake a review of New Zealand (NZ) and international industry practices and capabilities. Industry stakeholder consultation is planned to assist in developing the concept of a National Transportation Model within the NZ context. The aim of this particular report is to provide an overview of the transportation industry in NZ, including the governance, sectors, modelling and data capabilities of the industry.

As part of the initial project scoping workshop, it was decided to focus on four main sectors of the transportation industry; the aviation, rail, maritime and land transport sectors. A review of models in NZ revealed that most models are developed within a geographic context relevant to a specific level of governance in New Zealand. That is, existing models are generally either nationally, regionally or locally relevant to a specific area and cover multiple transportation modes and sectors. Models have been reviewed within the context of their spatial area, and the relevant sectors for each model have been identified.

New Zealand has strong three step and four step modelling capabilities in local and regional contexts, and for econometric modelling at a national level. There are also emerging capabilities in the development of hybrid models, comprising both four-step and econometric modelling, and the development of holistic models, such as the mediated modelling approach. Currently no models comprehensively include both freight movements and public transport movements. This may be attributed to the current best practices of modelling freight outputs in terms of tonne-kilometres and other movements in terms of person-trips.

A number of key modelling issues for further consideration were identified, including:

- Model zones and spatial area aggregation;
- Accounting for changes in the structure of the economy and in people’s travel behaviours; and
- Modelling constraints on the supply of transport corridor space and land supply.

A review of the data currently used in existing transport models identified the key data suppliers to be the Ministry of Transport (MoT), Statistics New Zealand, road controlling authorities such as the New Zealand Transport Agency (NZTA), territorial local authorities, and regional councils. Research relating to New Zealand travel patterns, in relation to household structure, identified that further data is required in this area.
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1. Introduction

The purpose of this project is to assist MoT in developing the concept of a New Zealand National Transport model (NZNTM), and in the process developing a research partnership between MoT and UoA. As part of developing this concept, the UoA are undertaking a best practice international/national review and will deliver a scoping document that recommends a specification and outlines how the MoT/Crown Agencies could develop the necessary capabilities to run and manage the model.

The project will involve significant stakeholder engagement and consultation, especially to understand the various models currently used in New Zealand, particularly at a national level.

The intention of this report is to identify and examine the systems and sectors in New Zealand that could be involved in the development of a inter modal NZ National Transportation Model. This has involved a review of the New Zealand context, including the relevant governance structures to the transportation industry and communication with key stakeholders within the modal sectors of the industry. A key issue raised, while establishing the New Zealand context, is the integration between industry sectors concerned with the movement of freight or goods, with the sectors involved with the movement of people for the purposes of labour supply or recreation.

A review of transportation models currently in use within the context of national, regional and local governance has been undertaken across all industry sectors. This has involved the identification of each transport model, its owners and developers and also describing the purpose and intended use of each model. The model dimensions and resource requirements were also reviewed, including the model structure and feedback loops, inputs and outputs.

A data summary has been created, detailing what data is currently used in New Zealand transport models and whether the data is readily available or needs to be requested. This report does not cover asset management models (this will be covered in a separate report) or any safety related modelling by transport sector or mode.

Conclusions have been presented covering the industry structure in New Zealand and the existing modelling capabilities available within each industry sector.

The body of the report is structured into the following sections:

- The New Zealand Context, considering the various sectors and governance levels in New Zealand, including land transport, rail, maritime and aviation sectors and national, regional and local governance;
- Existing New Zealand transport models, separated into subsections based on the national, regional and local governance structure. The transport sectors included in the model are included in each model description;
- Data used in the existing models identified in the previous section; and
- Modelling software currently used for transport modelling in New Zealand.
2. New Zealand Context

2.1. Government Structures

There are three tiers of government in New Zealand:

- Central Government;
- Regional Government; and
- Territorial Local Authorities, (City Councils or District Councils).

The local and regional governance boundaries are set out in Figure 1 below.

![Figure 1: Local and regional government boundaries in New Zealand (Terralink, 2013).](image)

There are 16 regions, 12 city councils, 53 district councils and two unitary authorities (Auckland Council and Chatham Islands Council) in New Zealand. Some territorial local authorities are also unitary authorities as the territorial local authority boundaries align with the regional boundaries, for example Nelson City, Tasman and Marlborough.

Territorial local authority boundaries do not necessarily coincide with regional boundaries, which means that some district councils are in multiple regions, for example, the Taupo District is in the Waikato, Bay of Plenty, Hawkes Bay and Manawatu-Wanganui Regions.

In terms of infrastructure funding in New Zealand, regional governments are responsible for funding transportation services in each region (for example public transport services), while local governments...
are responsible for the development and maintenance of infrastructure for transportation, including local roads, and in some cases airports or other major public infrastructure. National infrastructure, including State Highways in both city and rural areas, are funded by the New Zealand Transport Agency (NZTA) and rail infrastructure by KiwiRail.

Because most infrastructure funding and therefore planning is conducted by the three tiers of government identified above, existing New Zealand models are often developed with relevance and intended use for a particular tier of Government. For this reason, the current New Zealand transportation models are considered at national, regional, and local levels.

2.2. Sectors

For the purposes of this project, the transportation industry has been categorised by transportation mode, using the following classifications:

- Land transport, including all movements on roads and all active modes;
- Rail transport, including both intracity rail and intercity rail;
- Maritime, including international movements (imports and exports) and coastal transhipments; and
- Aviation.

A major consideration for each of the above sectors is whether a specific trip within the sector is transporting either freight or people, and the contribution each of the sectors has to specific industries for example goods (freight), services (labour supply) or other trip purposes such as for tourism or recreation.

To ensure all sectors and transport users for a specific purpose are included in this project, a stakeholder communication plan has been separately set out to manage relationships with all sectors of the transportation industry.

2.3. Stakeholders

A group of stakeholders was established within the stakeholder communication plan to consult regarding the transportation models currently in use within the sectors they work in. The stakeholders contacted and their involvement within the industry is set out in Table 1. Note, MoT is involved across all sectors and is considered the project owner rather than a stakeholder.

The contact details for the relevant project stakeholders are available in the Stakeholders Communication Plan.
Table 1: Stakeholders consulted about transportation modelling work within a sector of the industry.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Involvement and Relevant Work</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Transport</strong></td>
<td></td>
</tr>
<tr>
<td>NZTA</td>
<td>Has developed a wide range of land transport-based research, with other key areas such as economics, land use and behavioural patterns regularly included in research.</td>
</tr>
<tr>
<td></td>
<td>Key stakeholder for land transport in New Zealand.</td>
</tr>
<tr>
<td>Greater Wellington Regional Council</td>
<td>Development of the WTSM and WPTM models in the Wellington Region.</td>
</tr>
<tr>
<td>Auckland Transport</td>
<td>Development of the ATM2 project, including ART3, ASP3 and APT.</td>
</tr>
<tr>
<td>Waikato Regional Council</td>
<td>Development of WRTM and work in the SPII program with MBIE.</td>
</tr>
<tr>
<td>Southland District Council</td>
<td>Development of the ENP</td>
</tr>
<tr>
<td>Transport Futures Ltd</td>
<td>Development of the Transport Strategy Review Model.</td>
</tr>
<tr>
<td><strong>Maritime Transport</strong></td>
<td></td>
</tr>
<tr>
<td>Maritime NZ</td>
<td>Key stakeholder for maritime transport in New Zealand.</td>
</tr>
<tr>
<td>Ports Authorities</td>
<td>Potential to contribute to NZNTM at a regional level.</td>
</tr>
<tr>
<td><strong>Rail Transport</strong></td>
<td></td>
</tr>
<tr>
<td>KiwiRail</td>
<td>Key stakeholder for rail transport in New Zealand.</td>
</tr>
<tr>
<td></td>
<td>Potential to contribute to NZNTM at a national level.</td>
</tr>
<tr>
<td><strong>Air Transport</strong></td>
<td></td>
</tr>
<tr>
<td>Civil Aviation Authority</td>
<td>Key stakeholder for air transport in New Zealand.</td>
</tr>
<tr>
<td>Airports Association</td>
<td>Potential to contribute to NZNTM at a regional level.</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>Local Government NZ</td>
<td>Potential to contribute to NZNTM at a local level.</td>
</tr>
<tr>
<td>Treasury</td>
<td>Potential to contribute to NZNTM at a national level.</td>
</tr>
<tr>
<td>Ministry of Business, Innovation and Employment</td>
<td>Potential to contribute to NZNTM at a national level.</td>
</tr>
<tr>
<td></td>
<td>Key work includes the energy outlook model, the tourism flows model, and the Sustainable Pathways II modelling.</td>
</tr>
</tbody>
</table>
Key stakeholders for each transportation sector were contacted to gather their views and potential contributions to a NZNTM. The non-Land Transport mode sectors (i.e. Maritime and Air Transport) are set out in the following subsections. NZ wide Land Transport models will be discussed in Section 3.

2.3.1. Maritime Transport – Maritime NZ

Contact Person: Nicole Brown.

Relevance of an NZNTM to the industry: At this point in time, a New Zealand National Transport Model (NZNTM) would perhaps not be as relevant or useful within the Maritime Sector as it would be for some other transport sectors. Maritime NZ sees a need to develop more capabilities within the Maritime sector around data collection and forecasting to ensure a NZNTM would represent activity in and be of use to the Maritime sector.

Data within the industry: Maritime NZ has huge difficulties obtaining any reliable and accurate data from the ports, even if this is only data around the number of accidents had by port employees. It is likely that any data useful for inputs to the NZNTM would come from the ports rather than Maritime NZ. There would need to be stringent confidentiality measures in place before any data could be obtained from the ports, due to the commercially sensitive nature of the data.

Models within the industry: Maritime NZ currently does not use any models that could be of relevance to the NZNTM project; however, the ports may have their own models – this would require further investigation from either Maritime NZ or the NZNTM team.

Other comments: Maritime NZ’s current focus is on data flows and collection.

2.3.2. Air Transport – Civil Aviation Authority (CAA)

Contact Person: Jack Stanton.

Relevance of an NZNTM to the industry: CAA would see a use for a NZNTM in terms of safety planning in emerging risk areas. This is particularly relevant for scenic flights (e.g. for parachuting), where recent research has suggested that there are far more passengers on these flights than the flying hours data would indicate. This would help CAA allocate more inspectors to some areas which have higher needs than anticipated.

CAA would like to investigate comparisons between airfreight and road freight estimates near the airport, and is interested in modelling the transition between the two modes.

Data within the industry: There is some data available within the industry, including:

- Volume of accidents by airline and airport;
- Volume of flying hours;
- Financial data from passenger levies;
- Passenger numbers on trunk routes (e.g. Auckland to Wellington) from the AVSEC security check; and
- Data owned by airlines or airports, which is commercially sensitive.
**Models within the industry:** There are no detailed models within the industry; however, the airports and airline companies have their own models that they use for their own purposes. Typically, these models are not available for CAA, the Airports Association or MoT; however, the airports and airline companies often approach industry bodies and MoT with model outputs and forecasts when they are applying for funding.

As for the Maritime sector, models which are developed and owned by the airports and airline companies contain commercially sensitive data and there would need to be stringent confidentiality measures in place to gain access to these models.

A problematic consideration is the accuracy of the models developed by private organisations within the sector. For example, Auckland Airport and Hamilton Airport may both be projecting a 20% growth in passenger arrivals and departures; however it is unlikely that both of these projections are accurate. The airports are geographically close so any future increases in passengers would likely be spread between the two airports.

A rudimentary financing model is currently under development, with funding based upon passenger numbers (levy per passenger). Some smaller airlines (for example Sounds Air) don’t pay passenger levies, so modelling done in this area would not provide the full picture of all airline activities.

CAA are aware of a project currently under development by MoT and MBIE around the growth and distribution of international passenger numbers.

**Other comments:** It is particularly difficult to estimate the volume of freight carried by air, since there is no data collected about the actual freight volumes – all freight data collected is in the form of flying hours. One method around this is to make assumptions around how full freight flights are, to create freight volumes from the flying hours.

Unlike the land transport sector where certain types of vehicles are associated with the transport of people or freight by commodity, there are no particular patterns between aircraft model and commodity being transported. Old passenger aircraft often have seats stripped out and are used for freight, and freight is sometimes carried in the cargo areas of passenger flights. The exception to this rule is that most mail is carried on turboprop planes. This report does not specifically address safety aspects of the various transport modes.

### 3. New Zealand Models

As discussed above, NZ is broken down into three levels of governance, local, regional and national governance. Many transportation models have been developed for a specific level of governance, meaning current NZ models have been split into national models, regional models and local models.

#### 3.1. National Models

A number of national transportation models, developed by various agencies, were reviewed as part of this project. The name of each model reviewed, along with the model user, sector and purpose are shown in Table 2.
Table 2: Name, organisation, sector and purpose of all national transport models reviewed for this project.

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Sectors</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Tourism Flows Model</td>
<td>MBIE</td>
<td>Aviation, land transport</td>
<td>The Tourism Flows Model was designed to take inputs from current tourism datasets and other datasets in New Zealand, to show current and future tourism demands on public infrastructure.</td>
</tr>
<tr>
<td>Energy Outlook Models</td>
<td>MBIE</td>
<td>Land transport, aviation, maritime</td>
<td>The series of models which are used for energy outlook modelling were created or used alongside each other in order to create forecasts of energy demand, supply, prices and greenhouse gas emissions from the sector.</td>
</tr>
<tr>
<td>Development of a New Zealand Car Ownership and Traffic Forecasting Model</td>
<td>NZTA</td>
<td>Land transport</td>
<td>To standardise vehicle ownership modelling within various transport models around New Zealand. Vehicle ownership models form an important part of regional models in New Zealand, which are used for forecasting transport demands and constraints in a range of work areas.</td>
</tr>
<tr>
<td>National long-term land transport model</td>
<td>NZTA</td>
<td>Land transport</td>
<td>This model was created to evaluate a range of transport scenarios, considering long-term trends in population, land use, technology, economic growth and income, economic structure and policy.</td>
</tr>
<tr>
<td>Drivers of demand for transport</td>
<td>NZTA</td>
<td>Land transport</td>
<td>To investigate the relationship between economic activity and road freight volumes, and between light vehicles and income.</td>
</tr>
<tr>
<td>The Transport Strategy Review Model</td>
<td>Transport Futures Ltd</td>
<td>Land transport</td>
<td>To test policy and strategy scenarios, for both a nationwide environment, and for specific projects or transport corridors.</td>
</tr>
<tr>
<td>The ANZ Truckometer</td>
<td>ANZ Bank</td>
<td>Land transport</td>
<td>The Truckometer was developed as a proxy measure of current economic performance and economic forecasts up to six months ahead.</td>
</tr>
<tr>
<td>The National Freight Demands Study</td>
<td>MoT</td>
<td>Land transport, maritime, rail</td>
<td>To develop a comprehensive understanding of the freight industry, considering freight commodity, mode and region. The study is able to forecast demands up to 2042. The information available within the study is intended to be used by local and central government for infrastructure planning.</td>
</tr>
<tr>
<td>The Freight Information Gathering System (FIGS)</td>
<td>MoT</td>
<td>Maritime, rail</td>
<td>The system was developed to collect freight transportation data in, out and around New Zealand in a consistent manner, with a number of data reports being published on a quarterly and annual basis. The data published from FIGS is intended to be used to advise central and local government planning and policy.</td>
</tr>
</tbody>
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Econometric Models for Public Transport Forecasting

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Land transport</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZTA</td>
<td></td>
<td>To provide current elasticities for public transport policy and planning, using data from historic public transport patronage volumes and planning initiatives.</td>
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</table>

Development of a Public Transport Investment Model

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<thead>
<tr>
<th>Project Number</th>
<th>Land transport</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZTA</td>
<td></td>
<td>This model was developed for central and regional governments to optimise the price (fares and subsidies) of public transport.</td>
</tr>
</tbody>
</table>

The contribution of public transport to economic productivity

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Land transport</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NZTA</td>
<td></td>
<td>To incorporate the effect of ‘agglomeration economies’ or the effects observed in productivity gains when a large number of workplaces are grouped in a small area into the NZTA project economic evaluation procedures.</td>
</tr>
</tbody>
</table>

The models set out in Table 2 are described in further detail below.

3.1.1. The Tourism Flows Model

**Developed by:** The model was created by Covec Ltd and Eagle Technology with funding from the Ministry of Tourism.

**Sectors:** Aviation, land transport.

**Intended Use:** The Tourism Flows Model was designed to take inputs from current tourism datasets and other datasets in New Zealand, to show current and future tourism demands on public infrastructure. The model was originally created as a planning tool for local government; however its uses have expanded to include national planning and forecasts by a number of organisations such as the Department of Conservation, NZTA, and the Ministry of Tourism.

**Model Structure, Outputs and Feedback Loops:** The Tourism Flow Model has two parts, being the tourism flows module (where tourists go and what mode and corridor choices they choose) and the tourism activity module (what activities tourists undertake at their destination).

The model takes inputs from the Domestic Travel Survey (DTS) and the International Visitor Survey (IVS) conducted by the Ministry of Economic Development, in addition to traffic counts at telemetry sites on State Highways. Data was also provided by Air New Zealand to supplement the DTS and IVS data, so that stopovers could be included in the analysis rather than assuming all air trips are direct from origin to destination. Information was provided over 9 years for the IVS data and 6 years for the DTS data in order to create forecasts, with data from both surveys aggregated both geospatially and temporally to account for statistical anomalies and seasonal discrepancies.

Outputs from the dynamic module include the current and future volumes of trips anticipated on state highways, aviation corridors and on other modes (for example the Interislander Ferry, rail, tramping), while outputs from the static module include the number of visits made, the number of nights spent at a location, and the amount of expenditure at the location.
The Tourism Flow model is broken into 128 separate spatial areas for consideration as an origin or destination within New Zealand, and international travellers are identified as originating from eight geographical areas around the world. Each spatial area is known as a ‘Tourism Flow Area’ or TFA, taking into consideration the 185 areas used in the IVS, the 9,800 locations used in the DTS, and the 67 territorial local authorities for tourism planning and funding purposes.

Due to the nature of the DTS and IVS, the Tourism Flows Model is not able to consider stopover trips for road-based travel, for example trips made to Cambridge and Taihape while driving from Auckland to Wellington. This results in the under-estimation of tourism trips and expenditure in some areas. The mode category ‘other’ cannot be spatially represented in terms of trips on public infrastructure due to the multimodal nature of trips in this category, and the complexities around allocating multimodal trips onto the correct transport corridor for that mode.

Some of the TFA’s used in the model did not have enough trips originating from within the area for the data to be statistically robust, so that adjacent low-volume areas were subsequently amalgamated to meet statistical requirements.

References: (Vuletich, 2006), (Vuletich & Becken, 2007).

3.1.2. Energy Outlook Models

Developed by: Ministry of Business, Innovation and Employment (MBIE).

Sectors: Land Transport, aviation, maritime.

Intended Use: The series of models which are used for energy outlook modelling were created or used alongside each other in order to create forecasts of energy demand, supply, prices and greenhouse gas emissions from the sector. The models are used for making decisions around where new energy infrastructure (including generation, storage and transmission) needs to be located in New Zealand. The series of models are also capable of projecting emissions, for the purpose of meeting policy requirements such as those set out in the Kyoto Protocol.

Model Structure, Outputs and Feedback Loops: The models included as part of the energy outlook modelling include:

- The Vehicle Fleet Model (VFM);
- The Supply and Demand Energy Model (SADEM);
- The electricity Grid Expansion Model (GEM);
- The electricity price forecast model; and
- Oil and gas models.

Figure 2 shows the structure and interrelations between each of the models. For the purposes of developing a national transport and economic model based on the land transport, maritime, aviation and rail sectors, the relevant models are the VFM, SADEM, and the oil and gas models.

The electricity sector may need to be included at a later date to future-proof a national transport model against significant industry changes, such as increasing use of electric or plug in hybrid electric vehicles, electric trains and electric buses.
Figure 2: Energy Outlook Modelling Structure, from the Review of MED’s Demand Forecasting Methodology (Dean, 2011).
The SADEM model includes a number of sub-models, representing demand forecasts by different sectors of the economy. These are residential, commercial, general industry and specific industry. In terms of transportation sectors, the aviation and maritime sector energy demands are included in the SADEM model, while the land transport sector is independently considered using the vehicle fleet model. Demands in the SADEM model are calculated considering household numbers (residential) and GDP (commercial and general industry).

Inputs into SADEM include historic energy data from MBIE’s Energy Data File (EDF), in addition to inputs provided by the VFM, GEM and oil models. SADEM is not able to model any connections between the price of oil and GDP, due to the way the model is structured.

The VFM or Vehicle Fleet Emissions Model was originally developed to forecast the quantity of emissions produced by the vehicle fleet in the future; however, the model is also used to project future fleet composition and usage.

In terms of model structure for the VFM, the fleet composition section of the model includes classifications such as vehicle age, engine size, type of fuel, ownership (private or commercial), country or origin, and whether the vehicle is new, used or imported. The usage composition of the VFM includes VKT per annum data separated by vehicle fleet classes and usage conditions, including road type and driving conditions.

Data inputs into the VFM include vehicle registrations and licencing data from NZTA, while the final output is an emissions forecast. Emissions projections from the VFM are made up to 2040, and are based on trends developed from population and age data from Statistics NZ, vehicles per capita trends such as whether car ownership in New Zealand has reached its ‘saturation rate’, GDP per capita, fuel price and other vehicle ownership costs.

**Resource Requirements and Scale:** The energy outlook models are run in both excel and MATLAB, with data being provided by NZTA, Statistics NZ and from the Energy Data File compiled by MBIE.

**References:** (Dean, 2011), (Conder, 2009).

### 3.1.3. Development and Application of a New Zealand Car Ownership and Traffic Forecasting Model

**Developed by:** Booz and Company, funded by NZTA.

**Sectors:** Land transport.

**Intended Use:** This research was conducted from an NZTA desire to standardise vehicle ownership modelling within various transport models around New Zealand. Vehicle ownership models form an important part of regional models in New Zealand, which are in turn used for forecasting transport demands and constraints in a range of work areas.

**Model Structure, Outputs and Feedback Loops:** It was recommended from a review of New Zealand and international modelling practices that the best option for the creation of consistent car ownership models is to develop a static disaggregate model. This is based around car ownership and travel patterns depending on household factors such as income, structure, area type and other factors, including how the household factors change through time. Figures 3 and 4 show the recommended
car ownership model framework, and how the car ownership models can be implemented into a traffic forecasting model.

Figure 3: The recommended car ownership model framework (Conder, 2009).

Figure 4: Traffic forecasting model as developed from the recommended car ownership model (Conder, 2009).

There are issues associated with this approach, as a static disaggregate model would require inputs from household and demographic modelling. This would require significant investments of time and costs, so in the short term a New Zealand Modelling Framework has been recommended based on the MoT Vehicle Fleet Emissions Model.
Resource Requirements and Scale: Data for motor vehicle registrations were obtained from Statistics NZ, after a review of data consistency and over/under estimations which could result from the data collection methods and allowing for regional car ownership rates to be developed. Ideally data from the MoT household travel surveys could be used for the model; however the data collected does not cover a range of years wide enough to develop a statistically robust time-series for future trends analysis. It was recommended that the household travel survey undergo a review to ensure it will provide all data inputs required for the development of future transport models.

References: (Conder, 2009).

3.1.4. National Long-term Land Transport Demand Model

Developed by: New Zealand Institute of Economic Research, funded by NZTA.

Sectors: Land Transport.

Intended Use: This model was created to evaluate a range of transport scenarios, considering long-term trends in population, land use, technology, economic growth and income, economic structure and policy. The intention of the model is to consider how transport patterns and scenarios could change through time, rather than to estimate specific future transport demands.

Model Structure, Outputs and Feedback Loops: The model is a hybrid between typical four-stage models used in regional transport modelling (for example WRTM) and econometric models which assume an elasticity between transport demand and other factors (for example the Transport Strategy Review Model). The formation of a hybrid model requires fewer spatial zones than typically used in a four-stage model, with the model structured into 12 regions throughout New Zealand.

The model dimensions (including inputs and outputs) are shown in Figure 5.
The model assumes that any constraints that occur on future transport demands will be removed by an effective road investment programme, so that future transport demands are effectively unconstrained. This does not allow for the inclusion of any transport demand management policies or projects, such as congestion charging and is unlikely to occur in practice (in cities) due to induced traffic or travel.

The model produces transport demands in a time series format, as shown in Figure 6.
The model forecasts significant growth in travel demand in comparison to other forecasts created in recent times. This could be attributed to the assumptions around unlimited supply of road space to accommodate future transport demands.

The model did not test whether the forecasted travel demands would produce enough funding from the fuel excise tax and road user charges to enable the land transport fund road transport projects which fulfil the model assumption of unlimited supply for road space.

**Resource Requirements and Scale:** The model runs in an excel workbook, with the majority of the model inputs and assumptions at the discretion of the model user so that a wide range of scenarios can be tested.

**References:** (Stephenson & Zheng, 2013).

### 3.1.5. Drivers of Demand for Transport

**Developed by:** Frontier Economics (Australia) and funded by NZTA.

**Sectors:** Land transport, economics.

**Intended Use:** This research was conducted with the aim of investigating the relationship between economic activity and road freight volumes, and between passenger vehicles and income. It was concluded in NZTA Research Report 520 (National long-term transport demand model) that there was little information relevant to New Zealand about the statistical relationship between the two economic parameters and traffic volumes, especially with regard to how any relationships had changed through time. NZTA was of the view that the relationships developed in this research could be used to forecast road traffic volumes.

**Model Structure, Outputs and Feedback Loops:** The data used to develop econometric models includes traffic volumes at state highway telemetry sites, VKT measured from road user charges and the certificate of fitness odometer readings for heavy vehicles and from the warrant of fitness odometer readings for light vehicles, and tonne-kilometres-travelled, which takes weigh-in-motion data into account when considering VKT for heavy vehicles.

A new method was also proposed for calculating VKT, which involves calculating the AADT volumes from the telemetry count sites and multiplying the AADT by the length of the state highway across the national state highway network.

A literature review was conducted to assess current New Zealand transport models and relevant data, selection of the type of econometric model to use to forecast demand, and a data exploration exercise to learn what data cleaning needs to be completed before any data can be used for econometric modelling. Additional research found that tonne-kilometres travelled is the best indication of transport demand in relation to economic activity, and that economic activity was to be measured as real GDP or GDP per capita.

In terms of road freight activity, it was recommended that freight demand should be modelled by vehicle type within heavy vehicle class types, as a proxy to measure economic activity within different industries such as the goods industry (agriculture, forestry, etc.) versus the services industry. This
allows for long-term structural changes in the economy to be accounted for, and for the type and level of correlation between VKT and economic activity with a specific industry to be determined.

For light vehicle activity, it was recommended that NZTA use regional indices for the correlations between light vehicle VKT and income, as some regions have vastly different average incomes to others.

A range of models for further options analysis and further testing were recommended for the ‘model development’ section of this project.

Resource Requirements and Scale: Data inputs are available from NZTA and MoT.

References: (Simic & Bartels, 2013).

3.1.6. The Transport Strategy Review Model

Developed by: Transport Futures Limited.

Sectors: Land Transport, including active modes, public transport and private vehicle transport.

Intended Use: To provide the capability for Transport Futures to test policy and strategy scenarios, for both specific projects or transport corridors, and considering a nationwide environment. The model can be tailored for use in transport corridor studies and also has the ability to perform project economic evaluation. The model is based on research around price and behavioural elasticities, and is intended to be used as a supplement for detailed engineering models.

The Strategy Review Model has a base year of 2010 and a future year of 2020, so all projections made by the model only refer to these two years.

Model Structure, Outputs and Feedback Loops: The Strategy Review Model was developed to focus on the impact of policies and strategies on several key transport indicators, including:

- Average journey time (minutes);
- Proportion of congested travel (percentage of vkt at LOS E or F);
- Annual vkt per capita (km);
- Public transport patronage (total trips and proportion of all trips);
- Walking and cycling (total trips and proportion of all trips); and
- Single vehicle occupancy distance per capita (km).

The outputs of the model are based on each of the key transport indicators detailed above and are shown as an increase or decrease with reference to the amounts observed in 2010, as a base year. The inputs include a number of parameters, including:

- Car travel costs (fuel, maintenance, etc.);
- Road investment (changes in the scale of road programmes);
- Public transport fares (farebox revenue);
- Public transport service frequency (changes in the level of network capacity);
- Network speed management investment (changes in levels of investment);
- Intelligent transport systems investment (changes in levels of investment);
Walking and cycling investment (changes in the level of walking and cycling programmes);
- High occupancy vehicles investment (changes in the level of high occupancy vehicle).

The model structure in terms of required inputs and outputs is shown in Figure 7 below.

All the inputs are in terms of percentage change from the base year 2010 to the projection year 2020, for example a scenario where car travel costs increase by 20%, road investment decreases by 25%, public transport fares increase by 25%, public transport frequency increases by 25% and walking and cycling investment increases by 25%.

The model then applies a number of demand elasticities, such as ‘research demonstrates that increasing walking and cycling investment by 25% increases the proportion of walking and cycling trips by 3%’. Figure 8 below shows the model outputs, and the interface through which the model is used.
In addition to outputting a percentage change anticipated in the projection year 2020, the Strategy Review Model also provides graphs showing the contribution each input variable makes to the anticipated change in 2020.

The Strategy Review Model is an excellent starting point for testing policy and strategy scenarios in a simplistic manner; however the model does not account for population changes, behavioural changes or land use changes which could occur between the analysis years of 2010 and 2020. The model is also somewhat limited by the input year of 2010 and the output year of 2020, so is not able to test long ranging or short term effects of a policy or strategy change.

Resource Requirements and Scale: As the Strategy Review Model currently exists; it requires no particular data inputs, as the inputs and calculations are fixed to the 2010 base year. This is an advantage for quick calculations or an initial check for a particular scenario; however the model would need updating to include data for other base years to widen the scope of scenarios which could be tested.

3.1.7. The ANZ Truck-o-meter

Developed by: ANZ Bank

Sectors: Land transport, economics.

Intended Use: The model was originally developed as a proxy measure of economic activity and forecasting for New Zealand. Traditionally, economists use GDP as a measure of the performance for an economy; however GDP reports are only available on a quarterly basis and take some time to compile, which creates a delay between the levels of economic activity and real-time knowledge of the economy. The Truckometer can measure current economic performance and can create economic forecasts up to six months ahead. The model is currently used to create monthly reports on the state of the economy in New Zealand, which are published on ANZ’s website.

Model Structure, Outputs and Feedback Loops: Inputs to the model include light traffic volumes (less than 3.5 tonnes) from 10 roads around the country for the forecasting ahead by 6 months, and heavy traffic volumes (greater than 3.5 tonnes) on 11 roads around New Zealand. Information around any traffic disruptions are also input into the model, to inform of any unusual traffic patterns which could affect the model outputs. The traffic volumes are included in a time-series format to develop trends through time.

The model then performs statistical analysis on the traffic volumes data to clean out any noise, reduce level-shifts, and any traffic disruptions or other volatilities in the data. Each of the sites around New Zealand where the traffic volumes are collected from are then weighted to develop both the light traffic and heavy traffic indices, which are respectively used for forecasting the economic outlook 6 months ahead and as a quarterly measure of ‘economic momentum’.

The data is then seasonally adjusted, to account for New Zealand industries which have uneven spending or production patterns, such as agricultural and dairy seasons, and consumer spending leading up to Christmas. Both the raw data and the seasonally adjusted data are plotted in a time series graph, to show current and future economic possibilities.

Resource Requirements and Scale: Data is provided from NZTA telemetry sites around New Zealand.


3.1.8. The National Freight Demands Study

Developed by: MoT.

Sectors: Road transport, maritime, rail transport.

Intended Use: The study was completed to develop a comprehensive understanding of the freight industry, considering freight commodity, mode and region. The study captures both the current freight task in New Zealand and is able to forecast demands up to 2042. The study was updated in 2014 from the original study created in 2008 to reflect changes in the economy resulting from the Global Financial Crisis. The information available within the study is intended to be used by local and central government for infrastructure planning.
**Model Structure, Outputs and Feedback Loops:** The model is structured to include 29 specific commodities within the New Zealand economy, considering the size of the commodity market, the regional distribution of the market, where commodities are produced/imported, where they are consumed/exported and whether they are stored at any distribution centres. Expected road traffic volumes are calculated for each commodity and region, and are compared to NZTA State Highway data.

Road volumes expected from the commodity dataset are split either onto maritime or rail transport for major corridors, such as Auckland to Christchurch. Mode shares are different depending on the direction freight travels along a corridor. An assumption made within this stage of the model is that all freight which travels on the road will also travel on either Maritime or rail modes (or both). A study of future factors, opportunities and constraint affecting the industry was also created including technology changes, the impact of the global financial crisis, supply chain innovation, and many other possibilities.

Future forecasts are made from economic forecasts (foreign consumption, population, regional economic activity, GDP per capita, and energy demand), demand forecasts (aggregate demand and cement demand) and supply forecasts (dairy production capacity, arable and grazing production capacity, log availability, fish availability and horticulture supply). Freight forecasts are then made by commodity, mode and region in tonne-kilometres, and inter-regional flows by commodity and mode are calculated.

**Resource Requirements and Scale:** This model uses the data gathered in the Freight Information Gathering System and is modelled in excel.

**References:** (Paling, King, Small, Associates, & Deloitte, 2014).

### 3.1.9. Freight Information Gathering System (FIGS)

**Developed by:** MoT.

**Sectors:** Maritime, rail.

**Intended Use:** The system was developed to collect freight transportation data in, out and around New Zealand in a consistent manner, with a number of data reports being published on a quarterly and annual basis. The data published from FIGS is intended to be used to advise central and local government planning and policy, but is also available freely to members of the public and corporations on MoT’s website.

**Model Structure, Outputs and Feedback Loops:** Data inputs are received from Statistics New Zealand for international trade data, from the ten container ports for commodity data, from KiwiRail to inform of freight movements via rail, and from Coastal Oil Logistics Ltd for coastal oil shipments.

Commodity data from the ports is consolidated by the information technology firm B2BE. The ports notify B2BE when containers are loaded onto or removed from ships, and when they enter or leave the port grounds. The data is then collated by B2BE and is provided to MoT on a weekly basis. MoT then consolidate the data from all sources and publish reports so that no commercially sensitive
information is published. Data is presented as a timeseries, so that emerging patterns in the freight sector can be established. An example of the data published by MoT is shown in Figure 9.

![Image of commodity export data](image)

**Figure 9:** Example of data output summary for the Freight Information Gathering System (MoT, 2014).

Future improvements for the system are planned, such as including data for road transport and air transport in the system. The coastal transhipments data collection could also be improved. The Freight Demands Study conducted by MoT to forecast future patterns for freight movements around New Zealand relies heavily on data provided by FIGS, so future improvements within FIGS could lead to a wider range of forecasts created in the Freight demands Study.

**Resource Requirements and Scale:** Data inputs are provided from a number of commercially sensitive sources, such as from various container-shipping ports around New Zealand. Data provided by Statistics New Zealand is freely available on their website.

**References:** (MoT, 2014), (Reid, 2012).

### 3.1.10. Econometric Models for Public Transport Forecasting

**Developed by:** DMK Consulting, funded by NZTA.

**Sectors:** Road transport, rail transport.

**Intended Use:** This research was conducted to provide current elasticities for public transport policy and planning, using data from historic public transport patronage volumes and planning initiatives. The analysis was conducted using a within-corridor format, so that mode and price changes were
compared along a particular transport corridor rather than as a city or regional network to calculate elasticities.

Model Structure, Outputs and Feedback Loops: The model inputs bus and rail patronages, fare price and revenue from Auckland and Wellington and bus patronages fare price and revenue from Hamilton and Tauranga, alongside other variables which can impact on travel demand and mode, such as fuel price.

A range of elasticities were established from the historic data, including the following:

- The impact of a certain percentage increase in fares on the revenue and patronage within each city, for example, ‘On the Auckland rail network, a 10% increase in fares caused a 9% fall in patronage and only a 1% increase in revenue’;
- The impact of the petrol price increasing above $2.00 per litre in 2008, for example ‘A 10% increase in real petrol prices caused a 2% - 3% increase in bus patronage’ in Hamilton and Tauranga; and
- A range of findings considering service elasticities at specific times of day, such as ‘a 100% increase in interpeak bus frequency caused a 40% - 50% increase in patronage’.

A number of other findings around historic events were discussed, such as how enhancements to the rail lines in Auckland in combination with bus strikes detracted patronage from bus routes, and how the introduction of a two hour free transfer on the bus network in Hamilton led to an increased amount of interpeak travel.

Resource Requirements and Scale: Data for this research was provided by the regional or city council within each of the geographical areas examined.

References: (Kennedy, 2013).

3.1.11. Development of a Public Transport Investment Model

Developed by: Logic Partners, David Lupton and Associates Ian Wallis Associates, funded by NZTA.

Sectors: Land transport.

Intended Use: This model was developed for central and regional governments to optimise the price (fares and subsidies) of public transport.

Model Structure, Outputs and Feedback Loops: The model inputs include:

- Trip data pertaining to the region in which the analysis is being conducted, with data sources being provided by the regional model (e.g. WRTM) and from the regional council for financial and bus operational statistics;
- Unit costs including the operating costs, social costs and social benefits for each mode taken from the Surface Transport Costs and Charges Study conducted by MoT; and
- Elasticity’s derived from the relevant regional transport model and from nation-wide best practice studies.
The model is able to output both the optimal fare for different ticket types and travel periods (Glaister-Lewis analysis) and the impact of a one cent reduction in price per km for each mode on subsidised, bus passengers, car drivers or passengers and the environment (Parry-Small analysis). Outcomes such as public transport revenue, fare recovery and mode share are also available.

The model is available on the NZTA website in an excel workbook and is set up with the ability to load new sets of regional data and assumptions easily into the model. Data from the WRTM and Waikato Regional Council are currently loaded into the model for testing.

**Resource Requirements and Scale:** Data is available on request from regional councils – confidentiality agreements need to be signed to gain access to data as the data is sensitive to bus companies operating within the region being tested.

**References:** (Allison, Lupton, & Wallis, 2013a), (Allison, Lupton, & Wallis, 2013b).

### 3.1.12. The Contribution of Public Transport to Economic Productivity

**Developed by:** Tim Hazeldine, Stuart Donovan and John Bolland

**Sectors:** Land transport.

**Intended Use:** This model was developed to incorporate the effect of ‘agglomeration economies’ or the effects observed in productivity gains when a large number of workplaces are grouped in a small area into the NZTA Economic Evaluation Manual. Agglomeration economies occur when a decrease in administrative costs results from the labour division/sharing and specialisation allowed when a large workforce is available in a small spatial area (high workforce density).

Public transport is recognised as one of the drivers which encourage the development of agglomeration economies in Central Business Districts. This is related to the reduction in demand for parking caused by public transport, which in turn creates more land availability for workplace formation and increases employment density. A reduction in commuting costs and public health costs from using public transport can also contribute to agglomeration economies.

**Model Structure, Outputs and Feedback Loops:** The model is developed on the Venables model for agglomeration economies, where employment density is a function of the willingness of employees to travel to the CBD for employment, or ‘commuter costs’. Some additions to the Venables model have been included, such as:

- The effect of public transport incentives around fares, services and capacity, considering the impact changes in the incentives have on mode choice and therefore congestion and travel speeds; and
- Changes in land use resulting in the demand for parking caused by private vehicles entering the CBD.

The model has been formulated in an excel spreadsheet available to download from the NZTA website.
The model requires a number of inputs from the user, such as the income tax rate, the preference of people to work in the CBD, the number of trips per day and workdays per year, the average worker’s wage outside the CBD in comparison to an increase in wages resulting from working inside the CBD (wage premiums), the average price of a commute by a particular mode along with price elasticities, average travel time and many other parameters.

The model outputs various measures resulting from a particular public transport incentive (refer to Figure 10 below):

- **A** – the increase in productivity resulting from an incentive by CBD employees who were working in the CBD prior to any incentives being implemented;
- **B** – the increase in tax caused by new CBD workers resulting from the incentive, with higher taxes resulting from higher wages in the CBD and landlord rent increases from higher rents;
- **D** – the higher residential rents in and near to the CBD resulting from a public transport incentive; and
- **E** – the benefit of private vehicle users to a road network with less congestion.

A graphical representation of the model outputs are shown in Figure 10.

Figure 10: Outputs from the model (Hazeldine, Donovan, & Bolland, 2013a).

The model is tested using data from both the double-tracking and electrification of the rail corridor in Waikanae, and the bus rapid transit corridor through central Auckland from Britomart to the University, Hospital and Newmarket, with sensitivity testing conducted for the Auckland bus rapid transit corridor.

A number of assumptions made in the model are discussed in the technical report, such as whether cities with multiple employment hubs can be effectively modelled, the strength of the relationship between transport and agglomeration economies, whether public transport incentives reduce demand for car parking, and discussing the effect of incentives which operate in two directions, thus reducing transport costs both into and out of the CBD which could result in decentralisation.
**Resource Requirements and Scale:** Data inputs are generally project-specific, and would require development alongside particular public transport incentives with relevance to the project or area in which the incentives are being implemented.

**References:** (Hazeldine et al., 2013a), (Hazeldine, Donovan, & Bolland, 2013b).

### 3.2. Regional Models

Regional transportation models developed by a number of different authorities are reviewed as part of this project. The name of each model reviewed along with the model user, sector and purpose are shown in Table 3.

**Table 3: Name, organisation, sector and purpose of all national transport models reviewed for this project.**

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Sectors</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Pathways II</td>
<td>MBIE</td>
<td>All</td>
<td>Planning and decision-making tool for local authorities, balancing pressures such as transport, health, education, employment, water quality and biodiversity.</td>
</tr>
<tr>
<td>Waikato Integrated Scenario Explorer (WISE)</td>
<td>Creating Futures</td>
<td>All</td>
<td>These models were created for transport planning purposes, including forecasting changes in travel demand resulting from changes in land use, household structure and car ownership, planning future transport infrastructure and services, and assessing the effectiveness of transport projects and policy changes.</td>
</tr>
<tr>
<td>Auckland Transport Models Project (ATM2)</td>
<td>Auckland Council</td>
<td>Land transport</td>
<td></td>
</tr>
<tr>
<td>Waikato Regional Transportation Mode (WRTM)</td>
<td>Local Authority Shared Services (LASS)</td>
<td>Land transport</td>
<td></td>
</tr>
<tr>
<td>Wellington Models (WTSM and WPTM)</td>
<td>Greater Wellington Regional Council</td>
<td>Land transport</td>
<td></td>
</tr>
</tbody>
</table>

There are also regional models in Southland (including parts of Otago), Christchurch and Hawkes Bay. The regional models as set out in Table 3 are described in further detail below.

#### 3.2.1. Sustainable Pathways 2 (SP2)

**Developed by:** Ecological Economics Research New Zealand, funded by MBIE.

**Sectors:** All
**Intended use:** SP2 is currently under development as a planning and decision-making tool for local authorities, taking pressures such as transport, health, education, employment, water quality and biodiversity into account. SP2 has been developed to separately cover the Auckland and Wellington regional areas.

**Model Structure:** The model has a number of work streams, including Mediated Modelling, Spatial Dynamic Modelling and Embedding Scenario Modelling into Urban Practice Planning.

Mediated Modelling is an approach to the development of a model where the model stakeholders and end users are involved continually throughout the development of the model. The model has a focus on inter-linkages, unintended consequences and changes through time, with stakeholder’s ideas on past and future trends and patterns as a major input into the model. The model is updated through a series of workshops throughout the project, with stakeholders attending each of the workshops. The model is not spatially based; the intention is that information from the Mediated Model can be fed into other components of the SP2 models project.

The Spatial Dynamic Model takes feedback through time from a range of regional models including factors such as population demographics, economics, labour, transport, land use, energy, and water. The changes through time are modelled in a number of spatial areas, by region, district (territorial local authority) and local areas (50m x 50m cells in Auckland and 100m x 100m in Wellington). Spatial models for each factor are aggregated into the following areas:

- Local areas – land use, terrestrial biodiversity;
- Territorial local authorities – population and demographics;
- Region – hydrology, water quality, economics, transport; and
- National and international – climate change scenarios.

The geospatial integration of the various models is used to develop land use and economic activity relationships for use in the Embedding Scenario Modelling.

The Embedding Scenario Modelling involves using the Spatial Dynamic Model to create a number of scenarios for testing and evaluation, including a gap analysis to identify whether any new models need to be created.

A screenshot of the Wellington land uses in SP2 is shown in Figure 11.

![Figure 11: Land uses in the SP2 model for the Wellington region.](image)

**References:** (van den Belt, 2010).
3.2.2. Waikato Integrated Scenario Manager (WISE)

**Developed by:** the Creating Futures Project, funded by the New Zealand Foundation for Research, Science and Technology.

**Sectors:** All.

**Intended Use:** WISE was developed to develop plans and policy in the Waikato region. It incorporates economic, demographic, land use and environmental data to model various future scenarios and scenario impacts. WISE is similar to the SP2 models in Auckland and Wellington.

**Model structure, outputs and feedback loops:** WISE consists of a number of models at varying levels of spatial aggregation. These models are shown in Figure 12.

![Figure 12: WISE models and their level of spatial aggregation (Creating Futures, 2014)](image)

Many of the models used in WISE also contain sub models. The models are updated on an annual basis, with a base year of 2006 and a modelled future year of 2050. A number of scenarios are considered within the model, with some scenario land use projections in 2050 shown in Figure 13.
Figure 13: From left to right, scenarios testing a dairy expansion of 4% annually, a diversification of land uses for non-dairy production, and demand for residential land in rural areas increases seven-fold. All projections were made to the year 2050 (van den Belt, 2010).

A demonstration WISE model is available on the Creating Future website.

References: (Creating Futures, 2014).

3.2.3. ATM2 (ART3 and ASP3)

Developed by: SKM and Beca, funded by Auckland Council

Sectors: Land transport.

Intended Use: These two models are the Auckland Regional Transport model and the Auckland Strategic Planning model. There is a separate Auckland Passenger Transport (APT) model, which is generally not considered as part of the ATM2 framework. The models were originally developed to forecast future transport demands within the Auckland region, taking into account the current and future land uses in the ASP3 model, and current and future transport scenarios in the ART3 model. The model covers the Auckland region including Tuakau and Pokeno.

Model Structure, Outputs and Feedback Loops: ART3 and ASP3 both have feedback loops into each other, creating a ‘Land Use Transport Integration’ (LUTI) model. A structural diagram of the models is shown in Figure 14.
Inputs to the ASP3 model include population and employment projections from the Economic Futures Model and Population Futures model owned by Auckland Council, which are updated using Census data. Inputs are also received from the planning and policy database, including existing use and capacity available by activity areas, for example residential or commercial activities.

ART3 model is a four-step model, following the trip generation, trip distribution, mode choice and route assignment stages for cars and public transport. Inputs include the existing road network including location and operational characteristics such as average speed and capacity, future project models such as AMETI and AWHC.

The feedback loops between each of the ART3 and ASP3 models take into account factors which can affect a person’s personal transport choices, such as accessibility, transport costs and environmental factors. Outputs from both models include traffic flows on the road network split by mode and time of day, and the land use impacts resulting from the traffic flows.

Capacity or supply within the model is kept in balance by running the model through iterations from the route assignment back to the trip generation and mode choice steps within the four-stage model; however the road capacity is not constrained as one of the intended uses of the model is to identify pinch points across all modes for future transport planning projects.

**Resource Requirements and Scale:** ART3 runs on EMME software and ASP3 runs on DELTA software. A significant investment is required to gather the land use data for the projection year, as a complete set of land use data is only able to be used to obtain a transport forecast for one specific year in the future.

ASP3 is updated from the land use database every year, and ART3 is updated every five years or when a new census is undertaken. Future work is also planned to develop a multi-modal model for trips to and from the Airport within the land transport network.

**References:** (Simmonds, SKM, & Beca, 2008), (Davies, Valero, & Young, 2009), (Valero, 2012).
3.2.4. Waikato Regional Transportation Model (WRTM)

Developed by: TDG, funded by Local Authority Shared Services (LASS) and NZTA

Sectors: Land transport.

Intended Use: The model was created for transport planning purposes, including forecasting changes in travel demand resulting from changes in land use, household structure and car ownership, planning future transport infrastructure and services, and assessing the effectiveness of transport projects and policy changes.

The transport model was originally developed in 2007 to replace several three-stage and four-stage models owned by territorial local authorities within the Waikato Region. It was built to address issues the region faces such as a poor regional road crash record, being a net exporter of goods, and having 16% of the Nation’s State Highways located within the region.

Model Structure, Outputs and Feedback Loops: There are two models - a standard four stage model of the Morning peak and interpeak, and a three stage model covering the evening peak as well. There are feedback loops with assignment outputs feeding into distribution and modal split, with the model iterating until convergence. The model structure is shown in Figure 15.

Inputs to the model include population, household and employment information from Census data, and local planning land use data. The model uses meshblocks or meshblock groups as zones to develop sufficient spatial detail, and assigns trips to the road and public transport networks. Model outputs include network flows in the target year, depending on what data sets were fed into the model.

Resource Requirements and Scale: The model is built in the software program ‘TRACKS’ and is updated every five years, or when new Census data becomes available. The model is able to produce forecasts for any particular year; however the data collection exercise to forecast to a particular year is extensive, as for other similar regional transport models.

References: (Dowsett, 2010), (Smith, 2010).
3.2.5. Wellington Transport Strategy Model (WTSM) and Wellington Public Transport Model (WPTM)

**Developed by:** SKM and Beca, funded by Greater Wellington Regional Council.

**Sectors:** Land transport.

**Intended Use:** The two strategic transport models used in the Wellington Region are the Wellington Transport Strategy Model (WTSM) and the Wellington Public Transport Model (WPTM).

WTSM was created for transport planning purposes, including forecasting changes in travel demand resulting from changes in land use, household structure and car ownership, planning future transport infrastructure and services, and assessing the effectiveness of transport projects and policy changes.

The WPTM model was developed in 2011 when regional council needed a detailed model with a higher degree of complexity for public transport trips. At the time, Greater Wellington were in the process of developing the Public Transport Spine Study, the Wellington Bus Review, and the Wellington Northern Corridor RoNS programme alongside NZTA.

**Model Structure, Outputs and Feedback Loops:** The model is a standard four stage model with feedback loops from assignment outputs feeding into distribution and modal split, with the model iterating until convergence.

The model structure is shown in Figure 16.

![WTSM Structure Diagram](image)

**Figure 16:** WTSM Structure (Ballantyne et al., 2010).

**Resource Requirements and Scale:** The model is built in the software program ‘EMME’ and is generally rechecked every five years, or when new Census data becomes available. The model is able to produce forecasts for any particular year; however the exercise to produce the input land use for a particular year is extensive, as for other similar regional transport models and hence three forecast years are generally produced.

**References:** (Sargent, 2012), (Ballantyne, 2014).
3.3. Local Models

Local transportation models developed by a number of different authorities are reviewed as part of this project. Although many of the models below cover more than one local territorial authority, none of these models are able to represent all movements within a region so are classified as local models. The name of each model reviewed along with the model user, sector and purpose are shown in Table 4.

Table 4: Name, organisation, sector and purpose of all national transport models reviewed for this project.

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Sectors</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic network plan</td>
<td>Southland District Council</td>
<td>Land transport</td>
<td>The model was originally developed as a road funding and maintenance tool for Southland District Council, to deal with a fast-growing rural economy with a low population base, which causes issues in terms of funding roads within the district.</td>
</tr>
<tr>
<td>Four-step models:</td>
<td>Various</td>
<td>Land transport</td>
<td>These models were created for transport planning purposes, including forecasting changes in travel demand resulting from changes in land use, household structure and car ownership, planning future transport infrastructure and services, and assessing the effectiveness of transport projects and policy changes.</td>
</tr>
<tr>
<td>Whakatane. Nelson, Timaru</td>
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<tr>
<td>Napier/Hastings, Christchurch, Dunedin.</td>
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</tr>
<tr>
<td>Three-step models:</td>
<td>Various</td>
<td>Land transport</td>
<td></td>
</tr>
<tr>
<td>Franklin, Whangarei, Tauranga,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotorua, Taupo, Invercargill, Heretaunga, Kapiti, Upper Hutt, Hutt City, Palmerston North, Queenstown</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The local models as set out in Table 4 are described in further detail below.

3.3.1. Economic Network Plan

**Developed by:** MWH, NZTA, and developed and funded by Southland District Council.

**Sectors:** Land transport.

**Intended Use:** The model was originally developed as a road funding and maintenance tool for Southland District Council, to deal with a fast-growing rural economy with a low population base, which causes issues in terms of funding roads within the district. The Economic Network Plan takes an asset management view of the road network within the District, so that funding is prioritised based on the costs of maintaining a road with respect to the economic value that road has to the district.

A number of other rural districts are identified around New Zealand where the Economic Network Plan modelling methodology could be applied, based on the district having a low population and large
numbers of sealed roads, which are costly to maintain. The district identified were Waimate, Tararua, Central Hawkes Bay, Otorohanga, Hurunui and Rangitikei.

**Model Structure, Outputs and Feedback Loops:** Input datasets to the model include:

- Land use, in terms of export value per hectare per annum;
- Economic flows in terms of value of export receipts per annum (data from Statistics NZ);
- Whole of life cost of assets;
- Vehicle volumes (AADT);
- Crash statistics; and
- Resilience information, including historic records of floods, liquefaction potential, and lifeline infrastructure identification.

Modelling work is completed to identify land use patterns and how they contribute to economic activity, so that transportation demands and route assignments of economic goods can be made between specific land use areas. This allows the roads to be sorted in terms of their economic worth, with roads carrying a high value of economic goods having a high economic worth. Prioritisation created from ranking the roads is then compared against the existing funding plan for each road, to identify discrepancies between how much funding a road is planned to receive and its economic worth.

The model outputs are in the form of a funding strategy for Southland District Council for each road, with the strategy being essentially either more funding, less funding or the same amount of funding required in the future for a particular road.

**Resource Requirements and Scale:** All data used in the model is available on request from either Southland District Council, Statistics New Zealand, or NZTA. Southland District Council have also made a testing version of the GIS software (run in Citrix) available for further investigations.

**References:** (Maughan, Byett, & Harrison, 2012).

### 3.3.2. Four Step Local Transport Models

Four step models follow the modelling stages of zonal trip end generations, mode choice, trip distribution (or trip distribution followed by mode choice), and route choice assignment, with the intended use for the models being transport infrastructure and policy planning, demand forecasting and project evaluation within the transport network. Local four step transport models in New Zealand are listed below:

- Whakatane developed in TRACKS by TDG
- Nelson developed in TRACKS by TDG
- Napier and Hastings developed in CUBE TRIPS by GHD
- Christchurch developed in CUBE by TDG
- Timaru developed in TRACKS by TDG
- Dunedin, developed in TRACKS by TDG.

Four step transport models create transport forecasts based on person-trips.
The key difference between four step models and three step models is that four step models include mode choice within the model which will consider public transport and other modes, which requires a set of plans from the relevant local authority regarding the shape of the public transport network, service frequencies and fares for the model forecast year.

This can cause some difficulties, as it necessitates forecasting public transport services for the future (particularly for buses) since public transport has lower infrastructure needs than private vehicle transport. The reduced infrastructure needs for public transport means that there is more opportunity for change of the public transport network at the large scale through to the forecast year.

For smaller cities and towns which have a less developed network of public transport services, it is not necessary to incorporate public transport trips into the model since public transport trips would make up a small proportion of total trips. For this reason, three step models are often used in smaller New Zealand centres.

References: (Ballantyne, 2014), (Ballantyne et al., 2010).

3.3.3. Three Step Local Transport Models

Three step transportation models are created for the same purpose as four step transport models, except that in three step models public transport and use of modes other than vehicles is excluded. Some of the three step models in New Zealand are:

- Whangarei, developed in TRACKS by TDG
- Franklin, developed in TRACKS by TDG
- Tauranga, developed in CUBE Voyager software by Beca
- Whakatane, developed in TRACKS by TDG
- Rotorua, developed in TRACKS by TDG
- Taupo, developed in TRACKS by TDG
- Heretaunga developed in TRACKS by TDG
- Upper Hutt, developed in TRACKS by TDG
- Invercargill, developed in TRACKS
- Palmerston North developed in CUBE by Beca
- Queenstown Lakes, developed in TRACKS by TDG
- Gore, developed in TRACKS.

Three step models create transport forecasts based on vehicle trips (rather than person trips as in four step models), and public transport or other modes are not included in the modelling. Figure 16 shows the structure of a typical three step forecasting model, with the structure shown used in the Tauranga Transport Model.
Three step models are used more often in smaller centres where travel by public transport does not form a high portion of all travel, in comparison to larger centres.

References: (Ballantyne, 2014), (Ballantyne et al., 2010).

4. Data and Resources

The development of transportation models around NZ has resulted in significant investments in the gathering of data and the implementation of software systems required to process data into meaningful outputs for transportation demand forecasting, infrastructure and services planning and policy testing. It is the view of MoT that a NZNTM will largely be developed from data used in existing models around NZ, with gaps in the existing data identified at a later stage of this project.

Table 5 shows various sources and types of data currently available in NZ, which has been used in the development of the models reviewed in this report.

Table 5: Datasets currently used in New Zealand transportation models.

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Owner and availability</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household travel survey</td>
<td>Ministry of Transport – available from Statistics NZ by region and main urban area</td>
<td>Travel information by mode, distance and trip leg and time, also normalised in per capita totals. Can consider work trips separately.</td>
</tr>
<tr>
<td>Household travel survey</td>
<td>Auckland (2006 survey)</td>
<td>Travel information collected on an activity basis for all sampled</td>
</tr>
<tr>
<td>Resource Type</td>
<td>Data Source</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Household members and their trips</td>
<td>Waikato (2008 survey), Wellington (2001 survey), Christchurch (2006 survey), Dunedin (ongoing 2014 survey)</td>
<td>Household members and all of their trips made on specified survey days (covering all modes and purposes).</td>
</tr>
<tr>
<td>Census, employment and household surveys</td>
<td>Statistics NZ – available on website</td>
<td>Demographic information around population, migration, income, employment, area type, age distribution, and household structure</td>
</tr>
<tr>
<td>Traffic counts</td>
<td>Road controlling authorities, including NZTA and territorial local authorities.</td>
<td>Available on request from territorial local authorities, and in State Highway traffic volumes on NZTA website.</td>
</tr>
<tr>
<td>Planning databases and GIS viewers</td>
<td>Local and regional government.</td>
<td>Spatial format for land uses and transport corridors, also considering natural disaster potentials.</td>
</tr>
<tr>
<td>Vehicle registrations and licensing data</td>
<td>NZTA – available on request</td>
<td>Vehicle ownership models, traffic forecasts and emission modelling.</td>
</tr>
<tr>
<td>VKT from Road User Charges, Certificate of Fitness and Warrant of Fitness odometer readings</td>
<td>Statistics NZ – available on website.</td>
<td>Traffic forecasts and emission modelling.</td>
</tr>
<tr>
<td>Bus and rail service patronage, e.g. from Hop or Snapper</td>
<td>Regional council, bus or rail operator company (e.g. NZ Bus, Tranzmetro).</td>
<td>Establish patronage on particular bus and rail services by time of day, boardings per kilometre, etc.</td>
</tr>
<tr>
<td>Public transport fare prices, revenues and subsidies</td>
<td>Regional council, bus or rail operator company (e.g. NZ Bus, Tranzmetro).</td>
<td>Establish the operational costs and benefits public transport services.</td>
</tr>
<tr>
<td>Freight Information Gathering System (FIGS)</td>
<td>MoT – available on website.</td>
<td>Establish tonne-kilometres of various freight commodities travelling around NZ, separated by mode and region.</td>
</tr>
<tr>
<td>Road Safety Data</td>
<td>NZTA – available from the Crash Analysis System (CAS) upon purchase of a CAS user licence.</td>
<td>Road safety.</td>
</tr>
<tr>
<td>RAMM</td>
<td>RAMM – available upon purchase or a</td>
<td>Asset management.</td>
</tr>
<tr>
<td>License</td>
<td>Domestic Travel Survey</td>
<td>Statistics NZ – available on website.</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Air New Zealand flight data and estimates of competitor movements</td>
<td>Air New Zealand, available on request through MBIE channels.</td>
</tr>
<tr>
<td></td>
<td>Imports and exports data tables</td>
<td>Statistics NZ – available on website.</td>
</tr>
</tbody>
</table>

From the review of models conducted earlier, it is common practice to develop three step or four step models in modelling platforms such as EMME, TRACKS or CUBE. Excel is used over almost all applications for data storage, manipulation and presentation, and in some cases has been used to develop new models using excel macros (VBA) and add-ins.

Econometric models often use statistical data software such as Stata to process data and develop demand elasticity’s and seasonally adjusted time-series data, and MATLAB to manage large datasets which cannot be managed and manipulated in Excel.

For spatially based models, GIS software platforms such as ArcGIS and Citrix are used to view data and spatial relationships.

5. **Modelling Software and Applications**

It is generally accepted internationally that there are three levels of modelling, namely macroscopic, mesoscopic and microscopic (refer to Figure 18).

**Macroscopic** models are applied at an aggregate level where the mathematics deal with the traffic stream overall.

**Microscopic** traffic flow simulates the behaviour of individual vehicles. Conceptually, it would seem that microscopic traffic flow would be more accurate, as it would be based on driver behaviour rather than simply flow characteristics.

Recently, there has been an intermediate level termed **mesoscopic** which simply means somewhere between the other two levels. To further complicate the issue, there are models that tend toward the macroscopic end where ‘packets’ of vehicles are tracked through the journey at set time intervals – say 5 minutes. There are other models that tend toward the micro end where individual vehicles are tracked in each time slice.
Figure 18: Macro, Meso and Micro Level Transportation Planning Models (Barcelo, Casas, & Perarnau, 2005)

These levels cover the range of model uses. Macroscopic models are used to investigate the big strategic questions – how many lanes do we need on a motorway, what are the infrastructure needs for a major subdivision? Generally, at this level, the network representation is coarse, with only the major arterials included.

In contrast microscopic models are used to look at operational issues – will a particular intersection design operate successfully, what should the lane disciplines on the approaches be? The zone systems are very fine, and all roads and lanes are included in the network.

Meso models fit between these two, with the model form and degree of detail dependent on the particular problems to be investigated.

In New Zealand, there are only a handful of software packages used at a local or regional level. These include:

- **Emme.** Software developed by the University of Montreal, and now maintained and marketed by Inro. It is primarily macro software with the option of a dynamic assignment which moves it
into the macro end of mesoscopic. It does not support junction modelling. Inro produce a mesoscopic modelling package called Dynameq – while there has been some testing in NZ, it has not been applied.

- **Cube.** Software maintained and marketed by USA based Citilabs. It can run macro models, or mid-range meso models with junction delays and dynamic assignment. Citilabs produce a mesoscopic modelling package called Avenue – it is not used in NZ at present (there may have been one application in NZ).

- **Tracks.** Software maintained and marketed by New Zealand firm Transportation and Traffic Systems. It can run macro models, or mid-range meso models with junction delays and dynamic assignment.

- **Aimsun.** Software maintained and marketed by TSS from Spain. It can run macro, meso and micro models. It is currently marketing its “hybrid” tool which is a mesoscopic assignment where pockets can be microsimulated.

- **Paramics.** Software maintained and marketed by Scottish firm SIAS. It runs micro models.

- **Vissim.** Software maintained and marketed by German firm PTV. It runs micro models. PTV also have a macro model Visum but that has not been used in NZ.

Other software packages and their intended uses include:

- **Traffic assignment:** SATURN.
- **Microscopic simulation:** CORSIM and INTEGRATION.
- **Mesoscopic simulation:** CONTRAM, DYNAMIT, DYNEMO and DYNASMART.
- **Online traffic control:** SCATS and SCOOT.
- **Signal timing:** TRANSYT.
- **Intersection level of service (LOS) and capacity analysis:** SIDRA, ARCADY, OSCADY, PICADY, HCS.
- **Parking analysis:** PARKSIM.

References: (Smith, 2014), (Ranjitkar, 2014).

### 6. Conclusions

The following conclusions have been made from the information in this report:

- The capabilities of the transportation industry in NZ have been developed largely around the governing and funding structures within NZ, rather than around industry sectors by mode. This means models and data generally relate to either a national, regional or local geographic context, rather than a particular travel mode (road, rail, air, etc.).

- There are several different types of transportation models in NZ, including the traditional three-step and four-step models used in local and regional contexts, econometric models used for policy testing, hybrid models using a combination of the four-step and econometric models, and new modelling techniques with a stakeholder focus, such as the SP2 model.

- There are some cross-industry issues around modelling the movement of goods/freight, or people for the purpose of work or recreation. The freight sector tends to model outputs in terms of tonne-kilometres while other models tend to model output units of person-trips.
Modelling of commercial vehicles within the large cities is on a vehicle basis rather than commodities, which offers a weaker link to economic growth and sector changes.

- The most complex transportation models in NZ are formed from a group of purpose-built submodels, such as ATM2 involving the use of ART3 (the transport model) and ASP3 (the land use allocation model) to form an integrated land use-transport model.

- The way data obtained during the household travel surveys is used to build models may need to be reconsidered in order to establish a stronger connection between household travel patterns and particular household structures and sizes. This was mentioned in both the National Long-term Transport Demand Model and the NZ Car Ownership and Traffic Forecasting Model.

- It is not possible to convert three step models in smaller centres to four step models in larger centres. Three step models are measured in vehicle trips whereas four step models are measures in person-trips to account for the effect of public transport.

- Model zones and the aggregation of particular areas to create model zones is a key consideration to the development of many models. If a National New Zealand Transportation Model is intended to be used among other areas of the industry outside MoT, the zone boundaries used in the model need to be relevant to the industry.

- There are ongoing industry discussions surrounding best practice for modelling supply restrictions (e.g. transport corridor space) in the network to estimate future demand. Demand models will generally have unrestricted supply of corridor space in order to estimate the true demand and enable determination of where infrastructure or service upgrades may be required. Project models will almost all generally restrict the supply in terms of the transport network to the demands, as their purpose is to identify network deficiencies and infrastructure requirements.

- Capabilities are being developed to account for behavioural changes in the population and structural changes in the economy over time, with some of the more complex models requiring data inputs to determine behavioural and economic structure changes.

We trust this report will be useful in comparing the capabilities of the New Zealand transportation industry with international capabilities, and for assessing the way forward towards the development of a New Zealand National Transportation Model.
7. References


Smith, G. (2014, 4 September 2014). [Local and Regional Transport Modelling Packages in New Zealand].


van den Belt, M. (2010, 29 June). [Sustainable Pathways II - Integrating state-of-the-art research with policy to enable better decisions in spatial planning].


