TE TUPU NGĀTAHI
SUPPORTING GROWTH

Technical Note

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Warkworth DBC: Approach to Transport Modelling

Purpose

This technical note has been prepared to summarise the transport modelling approach for the Warkworth DBC.

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Disclaimer

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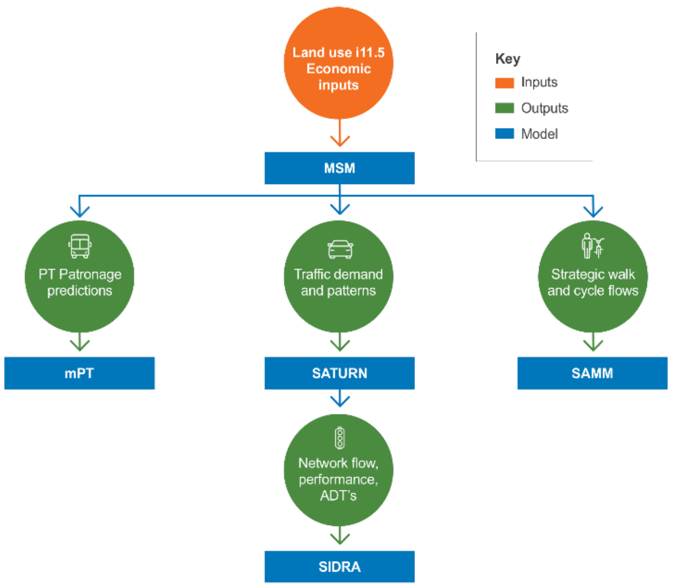
1 Introduction

The following appendix outlines the various modelling specifications used to develop the network models for the Warkworth DBC. This includes the model inputs and outputs for the four main strategic models MSM, MPT, SATURN and SAMM developed for the Warkworth area. This hierarchy is shown in Figure 1. In addition, the last section within this appendix outlines the combination of projects and facilities included within the Recommended and Do-minimum options tested within each of these three strategic models.

Figure 1: Modelling Hierarchy and Associated Outputs



1.1 MSM

The Macro Strategic Model (MSM) is a region-wide model which analyses the forecast land use and informs trip generation, trip distribution and mode choice at regional level. The MSM model responds to the network assumptions, forecasted land use and regional economic policy inputs to predict regional traffic patterns and PT patronages. The outputs from the MSM model are used as:

- Traffic demand inputs for the traffic simulation model SATURN, which analyses them at a mesoscopic level
- PT Patronage growth for the MPT model, which analyses these ata more local evel
- Active mode inputs for the SAMM model

The MSM is a four-step multi-modal model. This model was originally developed based on extensive data collected in 2006. Using observed data, and a full model validation exercise it was recently updated to reflect 2016 inputs and data. The MSM produces demands for five periods of the day, and separate assignment models exist for the morning (AM) and evening (PM) peak and weekday inter-peak (IP) periods.

- The model itself comprises of the following key modules:
- Trip generation: This is where the number of person-trips are estimated as a function of the land use data (population, employment, school roll etc.)
- Mode Choice: This is where the choice of recommended travel mode is determined, based on the relative costs of the various modes. The MSM modes for mode choice are car (driver and passenger combined) and passenger transport. Trips by car are converted into vehicle trips later in the model. The model also estimates the number of active mode trips, such as walking and cycling, although these are not fully modelled through to link flows.
- Trip Distribution: This is where the trips produced in each zone (generally by households), are matched to a recommended destination. This distribution is predicted as a function of the relative attractiveness for each destination zone and the travel costs to reach each destination.
- Time of Day: This is where the proportion of daily trip making occurring in each period is calculated. These proportions change in response to changes in travel costs to represent peak spreading.
- Trip Assignment: This is where the resulting travel demand, in the form of origin to destination trip tables, are loaded to the road and public transport networks. For the road assignment, an iterative process is used to firstly identify the lowest-cost route between each origin and destination followed by an estimation of the speeds and delays on each route between origin and destination, followed by an estimation of speeds and delays on each route associated with the predicted traffic flows on the route.

1.1 General Network Assumptions

The following general network assumption have been made in the MSM model:

- All committed developments and respective infrastructure upgrades planned as outlined in the ATAP (Auckland Transport Alignment Project) 2.0 and RLTP (Regional Land Transport Plan) have been coded in the future MSM model
- The access points (MSM zone connectors) for each model option scenarios in the business case areas were reviewed and refined accordingly to reflect the future infrastructure upgrades

The future local bus services for each model option scenarios, were updated based on inputs from the AT Metro, specifically related to routes, frequencies, bus capacities and bus speeds.

1.2 MSM Outputs

There are a number of outputs from the transport modelling, including:

- Demand patterns (Origin-Destination travel) and facility usage (flows)
- Network performance
- Travel times and costs (real and perceived) for economic analysis
- Delays, queues and Level of Service (LoS) for design and assessment

- Aggregate travel statistics on travel such as Vehicle Kilometres Travelled (VKT), Passenger Kilometres Travelled (PKT) and total travel costs
- Flow and performance for environmental analysis
- Inputs to vehicle emissions models
- Inputs to noise analysis

2 MPT

The MPT (Macro Public Transport Model) is a regional public transport model based upon an observed base year public transport matrix plus data from the MSM. The MPT model has the same network as MSM, and the public transport trips and demand comes from MSM. The low level of base year (2016) patronage make this level less useful for significant growth areas than MSM, however it was used as a cross check on the MSM outputs.

2.1 MPT model specifications and details

The transport network of MPT model is identical to MSM network. After the import of network from MSM, only zone connectors are required to be coded in the MPT model. The following are the basic inputs from MSM to MPT:

- PT Patronage
- Mode split
- Link speed, capacity

2.2 MPT Base model preparation

The following sections outline the structure and operation of the MPT model in the base year, 2016, and in forecasting, both base mode and option mode.

2.3 Base Year Model 2016

In the base year only parts of the full model processes are run, such as

- the observed 2016 PT trip matrix is imported,
- generalised costs by mode are generated,
- the observed matrix is split into trip matrices by mode with the mode split model,
- the PT matrices by mode are assigned,
- the crowding model with iterations as indicated until convergence (optional),
- outputs are produced.

2.4 Forecasting

There are two main steps in forecasting: firstly, the model is run in “base” mode to create a future base/reference scenario, and secondly the model is run in “option” mode in which the changes in cost due to the project are incorporated via the pivot model.

Base Mode steps shown are:

- the future reference network is set up
- the future demographic effects are incorporated by way of growth factoring
- generalised costs are created
- base PT composite costs are generated for use in the pivot model in option mode
- school bus trips are imported (not presently used in model)
- mode split is undertaken to produce trips by PT mode
- each PT mode is assigned
- outputs are produced

3 SATURN

SATURN is a mesoscopic traffic simulation and assignment model used to undertake a variety of area wide strategic assessments through to more detailed local area assessments. It can be used as a conventional model for the analysis of traffic-management schemes over localised networks as well as for major investment improvements at a regional level. The SATURN model ensures factual representation of vehicle flow patterns and congestion on midblock sections and intersections in the form of 'arrival' flows rather than 'demand' flows. Additionally, it is used as a high-level junction simulation model that evaluates the traffic flow behaviour on junctions.

It represents 'congested assignment' of multiple user classes modelled separately, including bus priority and high occupancy vehicle lanes..

3.1 SATURN Outputs

There are a number of outputs from the SATURN model, including:

- Vehicular flow pattern -Actual flow, Demand flow, Queued flow
- Network performance- Link and Node delays, Queue Statistics, V/C Ratios
- Mid-block capacities and speeds
- Aggregate travel statistics on travel such as Total Travel Time(hrs), Distance Travelled (kms)

4 SAMM

The Strategic Active Mode Model (SAMM) has been developed to fit within the existing suite of regional travel demand models operated by the Auckland Forecasting Centre (AFC). It derives land use and network data directly from the Macro Strategic Model (MSM) while using the same refined zone system as used in the Macro PT Model (MPT). The model has a strong interface with MSM to provide key inputs but can be operated independently to assess specific changes to the active mode network.

Both the walk and cycle models adopt a fairly traditional '4-step' demand model structure including trip generation, distribution, mode shift and assignment

The purpose of the model was identified by the AFC as follows:

- To enable an objective measure of walk and cycle responses to infrastructure changes, demographic changes and to changes in other modes at a regional level.

The scope of travel represented in the model is as follows:

- It only represents active travel where walking or cycling are the primary mode used. Multi-modal trips using active modes and either PT or car modes remain represented via the MSM and MPT models, and are generally not included in SAMM (with the exception of active trips that use a Ferry to cross the harbour)
- A trip based model that represents movement via Origin-to-Destination trip matrices
- Represents typical weekday, daily trips (based on March data)
- Represents travel done for transportation reasons, rather than recreational or sport. However, it does estimate additional 'recreational' flows on key high-amenity coastal cycle routes
- It covers the whole Auckland Region, consistent with the MSM and MPT models

The model is targeted as a 'strategic demand' model, with a focus on estimating active-mode travel from demographic and network inputs, rather than via the direct use of observed travel patterns. This requirement means it is focussed more on developing a robust process to estimate overall demand patterns, rather than detailed calibration to count data. This approach means it is also suitable for use in greenfield areas where existing activity and data would not reflect the planned future state. The model provides a suitable platform for localised refinement and calibration as may be required for assessment of specific projects.

4.1 SAMM specifications and details

The SAMM requires export of network and trip data from MSM. After the network import the local or regional cycle network are coded in SAMM, the links are made less/more attractive for the active mode trips by specifying an added attribute termed as 'cycle facility'. The following inputs are imported from MSM:

- Land use data
- Active trip ends by purpose
- Network
- Link speed
- Auxiliary volumes
- Home based Work Car and PT generalised cost and daily person matrix

After the import from MSM the following refinement is done in SAMM for assignment of Active Modes

- Coding of cycle and walk links
- Assigning cycle facility type to the cycle network
- Hilliness factor and amenity factor
- Refinement of zone connectors

The trip generation, distribution, mode shift and assignment models all attempt to replicate travel choices using 'perceived' travel costs. These costs are equivalent to the 'Generalised' costs used in the MSM multi-modal model and are based on actual travel times with adjustments to account for user perceptions. For cyclists this includes perceptions of facility provided, the type of road it operates on and the amenity and hilliness of the route. The walk model uses a similar approach but with fixed walk speed and without differentiation by facility or road type. Use of such costs mean that the cycle demands will respond to changes in the speed, quality, amenity and hilliness of each section, while walking will respond to amenity and hilliness.

5 Station Access Modelling

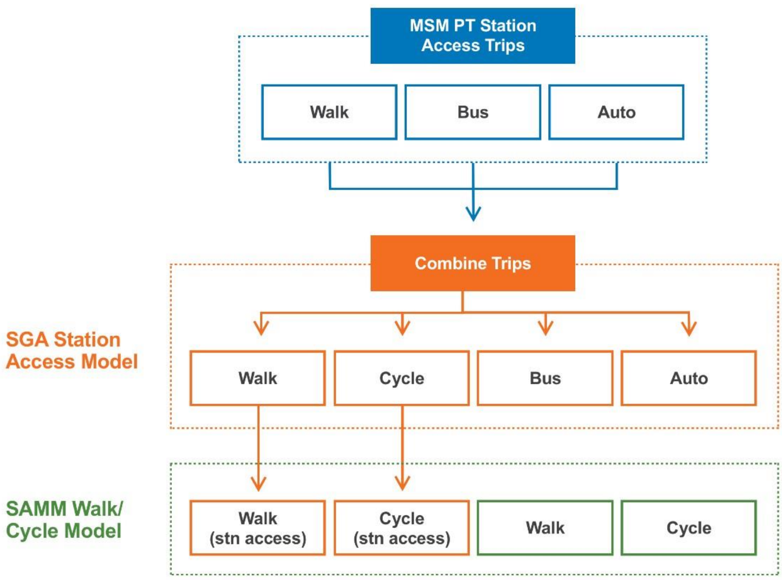
Te Tupu Ngātahi uses the Auckland Forecasting Centre's Strategic Active Mode Model (SAMM) to estimate volumes of walking and cycling trips on the future networks. As mentioned above SAMM only includes where walking and cycling is the main mode. Public transport trips are estimated using the Macro Strategic Model (MSM), which uses simple functions to represent access to stations. Access to stations is represented in MSM as:

- Direct walk-up trips
- Transfer trips from other PT services, such as local buses
- Auto-access trips, representing kiss-and-ride and park-and-ride. This access mode is only represented at major stations with formal Park and Ride facilities

The approach to this work is to develop a new tool that estimates the potential walk and cycle trips accessing major stations. The primary tool for estimating PT trips remains the MSM. For economic analysis purposes, the station-access tools are ignored, as station access is included in PT benefits extracted from MSM.

The total trips accessing stations from MSM is retained, with the station access tool effectively only reallocating them between sub-modes. The walk and cycle station-access trips are then passed to the SAMM model (as origin-destination matrices). This concept is indicated in Figure 7-1 below.

Figure 2: Station Access Modelling Tool



The MSM and SAMM models are operated by the AFC and have been through detailed review processes. The Te Tupu Ngātahi Station-access tool is only used to provide estimates of cycle/walk demand near major stations specific to Te Tupu Ngātahi areas. As such, it is not part of the formal AFC-owned models and it has not been independently reviewed.

The key steps in its operation are as follows:

- Obtain station access trips from MSM peak-period models. Including from direct walk-up and auto-access links)
- Combine to daily estimates (SAMM operates only at a daily level)
- Obtain car and bus travel times from MSM
- Get walk and cycle perceived travel costs from SAMM
- Create generalised costs for each mode, by applying assumed modal constants
- Allow for impact of electric bikes as a sub-mode of cycling
- Apply a logit choice model that re-estimates the split between the four access modes
- Extract car and cycle station access trips and assign in SAMM to get link flows

6 SIDRA

Signalised (and unsignalised) Intersection Design and Research Aid (SIDRA) is a micro-analytical tool used for evaluating intersection performance. It has a comprehensive, lane-based network modelling approach applicable to all types on intersections-signal, priority or sign control and roundabouts. SIDRA allows the modelling of various movement classes (Light vehicle, Heavy vehicle, Buses, Bicycle, Large Trucks, Light Rail/ Trams) with distinctive vehicle features to be assigned to designated lanes, segments and signal phases.

The Te Tupu Ngātahi SIDRA model is used to analyse the form and function of proposed intersections along strategic corridors. Based on the demand flow outputs from the SATURN Model, the intersection turning flows are determined. The performance measures of the intersection in terms of capacity, delay, Level of Service (LOS), queue length on approach lanes and optimum vehicle-pedestrian signal phasing is calculated.

Capacity Analysis

The capacity of an intersection to operate satisfactorily depends on the volumes of turning traffic and the distribution of traffic on the various approach legs at the intersection. The key output measures which determine the operational performance of an intersection are as follows:

- LOS- The Level of Service measures 'control delay' on intersections in seconds. For satisfactory intersection performance the LOS for major movement should be lower than 'D' and for minor movement LOS should be lower than 'E'. The LOS definition (Highway Capacity Manual 2010) used are given below:

- DOS- The Degree of Saturation is the ratio of demand flow to capacity. The movement DOS is the largest DOS for any lane of the movement. The desirable degree of saturation for Signalised Intersection should be less than 0.9 and for Roundabouts it should be less than 0.85
- Queue Length- It is used to determine the length of auxiliary through lanes or storage in turn lanes.

Table 1: LOS Categories for Intersections

Level of Service	Control delay per vehicle in seconds (d) including geometric delay	
	Signalised Intersections	Priority Controlled and Roundabouts
A	d ≤ 10	d ≤ 10
B	10 < d < 20	10 < d < 15
C	20 < d < 35	15 < d < 25
D	35 < d < 55	25 < d < 35
E	55 < d ≤ 80	35 < d ≤ 50
F	d > 80	d > 50

7 Recommended and Do-Minimum Networks

The proposed Warkworth DBC projects and improvements have been identified in order to support growth in Warkworth and unlock the future land use. In addition to these projects, there are several key strategic projects that integrate with this network including:

- Te Honohono ki Tai - Matakana link road
- Ara Tūhono – Pūhoi to Warkworth Motorway
- Hill Street Roundabout Upgrade

It is the combination of these projects and the proposed Te Tupu Ngātahi projects that will enable the key transport and land use integration outcomes for the Warkworth community.

The inclusion of the key inter-dependent strategic projects in the Do-minimum network is to account for the fact that those projects are being developed by Waka Kotahi, so are not included as part of the Te Tupu Ngātahi improvements package.

The following changes between the Do-minimum (Do-min) and recommended transport network (Recommended Option) are noted below:

- Road Network: The Do-minimum network includes the existing arterial and local road connections within Warkworth. The recommended network includes the existing network and new links along the Wider Western Link Road, Western Link Road – South, Western Link Road – North and Sandspit Road Link.
- PT Services: The PT network within the Do-minimum consists of three routes that travel along SH1, Matakana Road and Sandspit Road respectively. The frequency of these routes ranges between 30 minutes and 60 minutes during the weekday. In comparison, there are several high-frequency routes (10 minutes to 15 minutes during the weekday) within the recommended

transport network. These routes cover most of the urban area within Warkworth and travel along both the existing and new corridors within the network.

- Active Mode Connections: There is a full cycle network along both existing and new connections within the Warkworth recommended transport network. The connections present in the Do-minimum network are existing/planned facilities along SH1 between Hudson Road and Woodcocks Road.