Government of South Australia
Department of Planning, Transport and Infrastructure

Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM)

MASTEM Version 3 User Guidelines

Cube Base/Voyager

June 2019

Disclaimer

The application of this guideline does not guarantee that the outputs will be ‘fit-for-purpose’. This guideline only provides a framework for scenario development, testing and subsequent model auditing. Some models, particularly models to be used for financial analysis will require more stringent standards and it is the responsibility of the modeller to ensure that the models they develop are fit for their intended purpose.

This document should only be considered relevant in SA and for no other purpose than as a guide for modellers and managers undertaking work for South Australian Department of Planning, Transport and Infrastructure (DPTI).

DPTI and the authors of this guideline accept no liability or responsibility for any errors or omissions or for any damage or loss arising from the application of the information provided.

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Introduction

The Department of Planning, Transport and Infrastructure (DPTI) works as part of the community to deliver effective planning policy, efficient transport, and valuable social and economic infrastructure. As part of this task DPTI must ensure that the effects of all planned interventions on the strategic road network and proposed developments which are likely to impact this network are thoroughly understood before they are implemented. Comprehensive and accurate modelling which is fit for the intended purpose is necessary to ensure these interventions and proposals can be:

- fully assessed for impacts and benefits
- effectively designed to satisfy the original objectives and mitigate any adverse impacts
- clarified to avoid confusion or misinterpretation as the design is developed, and
- effectively and efficiently implemented and operated

A common definition of the term 'model' in its most general form is:

> "A model can be defined as a simplified representation of a part of the real world……which concentrates on certain elements considered important for its analysis from a particular point of view."[1]

It is important to be aware of the simplifications and assumptions that have been made in creating any model and to understand how these affect overall model performance. These simplifications and assumptions can derive from decisions made by the modeller during model development or calibration, or can be inherent to the particular choice of modelling software used.

DPTI uses a range of analytical tools to assess road network performance and to plan future development of the network. The Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM) is DPTI's preferred strategic travel demand model built within the Cube software package by Citilabs. This guide has been developed to provide broad guidance on the overall process of using MASTEM within the Cube package.

This guide covers the broad areas of model structure, model inputs, model outputs, documenting and auditing, and is to be used as the primary guide for development of modelling scenarios for use within DPTI. It draws upon experience and expertise from across the Agency and the industry more broadly and forms a comprehensive source of best practice.

It is intended that this guide will be regularly reviewed and updated so that it remains current, useful and relevant for users. This version of the guide relates to Cube 6.4.x and MASTEM V3.1.x, which are the current versions used within DPTI. Before undertaking any travel demand modelling, practitioners should ensure that they have the latest version of this document – which is available on DPTI's internet site – and that they discuss their modelling proposal with appropriate staff within DPTI.

In April 2009, the then Department of Transport, Energy and Infrastructure (DTEI) now the Department of Planning Transport and Infrastructure (DPTI), appointed the consultant AECOM to update the Metropolitan Adelaide Strategic Evaluation Model (MASTEM) – then

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[1] Ortúzar J de D & Willumsen L G, *Modelling Transport*, 4th Ed., Ch1, Wiley, London, 2011, p2.

MASTEM V2.2.2. This work was to focus on the enhancement of the model's public transport modelling capabilities and included an expansion of the model coverage to Mount Barker area as well as other areas identified for future development by the 30 Year Development Plan for Greater Adelaide. The model developed as a result of this work is designated as MASTEM V3.0.

In late 2010, DPTI began a major review of the consultant's work with a view to further developing the model for production use within the Agency and by external Consultants. This process has resulted in significant corrections/changes to the model developed by AECOM. As part of this work, significant changes were made to the Foundation Network aimed at improving the accuracy of the Highway assignment processes, as well as significant changes to the MASTEM Reporting Tool. The model developed as a result of this work is designated as MASTEM V3.1 and is the subject of this Guideline.

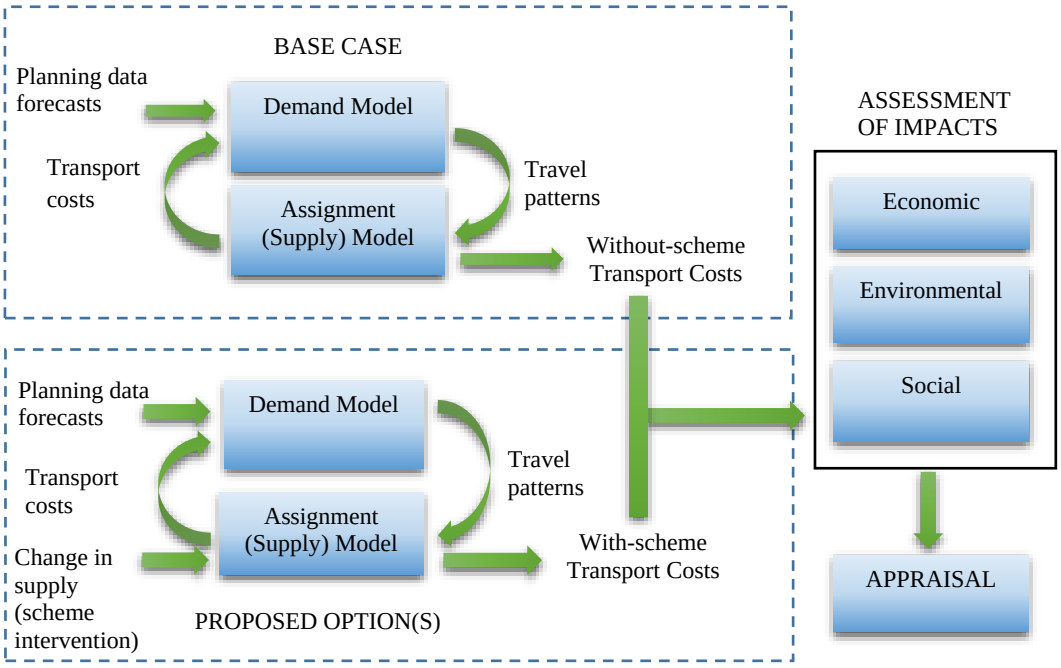
1.0 Travel Demand Models

At the highest level, travel demand models link estimates of travel demand and transportation system performance to land-use patterns, socio-demographics, employment, transportation infrastructure, and transportation policies. Most travel demand models – including MASTEM - represent the classical "four-step" strategic modelling process involving trip generation, trip distribution, mode choice, and trip assignment. This process broadly answers the following four questions:

- How many people are going to travel?
- Where are they going to travel to and from?
- What transportation mode are they going to use to get there?
- What route will they take to get there?

1.1 General principles

Figure 2.1 shows the mechanisms of a traditional supply and demand model for a given forecast year.



Adapted from Transport for London – Transport Analysis Guidance, Guidance for the SRO

Figure 1.1 Mechanisms of a transport model

Two broad mechanisms are used in traditional transport demand models. These are the modelling of supply and demand.

Supply conditions are modelled using network models of the transport system in order to calculate the costs of travelling in terms of monetary cost and time (referred to as 'generalised cost'). It effectively calculates the choices of route that people take to get from their origin to destination. Supply models can exist for different modes, such as highway and public transport (bus, tram and train). The scope of the intervention(s) being assessed will determine the requirements of each.

Demand models are required to ascertain the change in travel behaviour of individuals in reaction to the changes in cost from the changed supply conditions. For example, where car congestion on the roads increases over time, people may decide to shift to public transport modes, travel to alternative locations or even travel less. The demand model takes these responses into consideration and simulates the choices that people make given the options that are available to them.

The demand model is fed with future year planning data, for example forecasts of future population, dwellings, employment and education, which drive future travel demand. The supply model then provides updated travel costs for individuals, based on the forecast level of demand (e.g. more people on the road will cause higher transport costs for existing users). The model seeks to balance supply and demand i.e. when small changes in costs do not cause significant changes in demand and vice versa. This state is referred to as equilibrium. It is important to achieve equilibrium since failure to do so will produce misleading results that are not a reliable basis for intervention appraisal.

1.2 Scenario Testing / Forecasting

Models can also be used to run “what if?” scenarios where changes in input assumptions may be tested. This can help in assessing options before a preferred intervention is brought forward. It can also be used to present “sensitivity tests” around the final appraisal results to account for uncertainty that may occur in real life.

Assessment of any intervention (transport or otherwise) requires an appreciation of expected future benefits and disbenefits. Being in the future, these benefits and disbenefits cannot be measured or observed at the time the decision needs to be made, and so they need to be estimated by comparing two forecasts – one excluding the intervention, the other including the intervention and no other changes.

These two forecasts are generally called the ’base case’ forecast and ’project case’ forecast respectively (see figure 2.1). Often, separate pairs of forecasts are required for at least two forecast years, to take into account changes in both demographic and other transport infrastructure over time.

The appraisal uses the model outputs to assess the impacts of the intervention in terms of economic costs and benefits, environmental impacts such as noise and air quality, and social impacts such as severance, accessibility and distributional equity. To assess the transport and social impacts of any intervention the ‘base case’ is usually based on a supply model where no changes have been made above ‘business as usual’ conditions. The ‘project case’ then adds the intervention(s) being tested. To assess the economic impacts of any intervention the ‘base case’ is usually based on a supply model where no changes have been made above either ‘do nothing’ or ‘do minimum’ conditions. Again, the ‘project case’ then adds the intervention(s) being tested.

In order for forecasts to be credible, the assumptions need to be realistic. Also, as different transport intervention often compete for a common budget, it is important that the forecasting assumptions are consistent and unbiased so that the budget can be allocated on a fair basis.

Good practice requires that modifications to the transport network are tested under different input assumptions (compiled as alternative scenarios or sensitivity tests) to highlight any risks to the benefits or impacts of the intervention. Alternative scenarios or sensitivity tests should cover any significant sources of uncertainty, but their use should be proportionate.

2.0 MASTEM V3

2.1 MASTEM Process

The Metropolitan Adelaide Strategic Transport Evaluation Model (MASTEM) is a comprehensive multi-modal urban travel demand model suite, which is used to prepare forecasts of travel demand for selected future years (i.e. 2021, 2026, 2031 and 2036) that are consistent with the State Government's demographic and land use policies and plans.

MASTEM uses a looping process to achieve overall equilibrium between transport supply and demand which captures the network and system wide impacts of changes in either supply (through transport system changes) or demand (through changes in demography or land use). It is emphasised that MASTEM balances overall travel demand which is unaffected by localised system capacity constraints. Figure 3.1 illustrates the modelling process adopted by MASTEM.

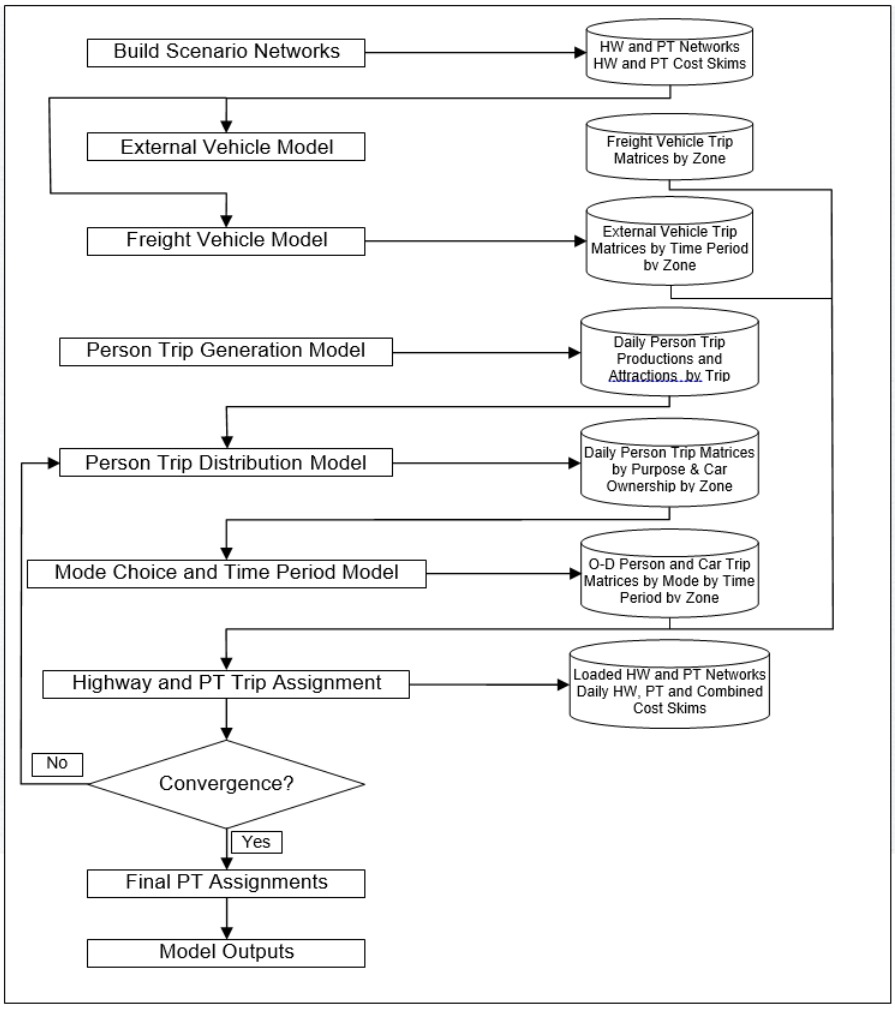


Figure 2.1 MASTEM Process

The outputs of the MASTEM comprise multi-modal forecasts of average weekday as well as the AM peak, PM peak, Day Time and Night Time periods for both Highway and Public Transport (PT) demand. AM and PM peak-hour as well as Day Time and Night Time typical hour Highway demands are also provided. These outputs provide typical travel demand and travel patterns for each origin and destination zone (Traffic Analysis Zone (TAZ)) throughout

the scope of the model on both the arterial (and major local) road network and the Adelaide Metro (train, tram and bus) public transport system. Average weekday demands for walking and cycling are also provided.

2.2 Differences between MASTEM V2 and MASTEM V3

2.2.1 General Model Changes

Key changes in MASTEM V3 in comparison to MASTEM V2 include:

- Time periods: Four model time periods have been developed within MASTEM V3:
    - AM peak period – 7 am to 9 am for both Highway and PT
    - Day Time period – 9 am to 4 pm for Highway and 9 am to 3 pm for PT
    - PM peak period – 4 pm to 7 pm for Highway and 3 pm to 6 pm for PT
    - Night Time period – 7 pm to 7 am for Highway and 6 pm to 7 am for PT

  It should be noted that for both of Highway and PT travel, daily results are reported. In addition, for Highway travel, results are reported for the AM peak hour (nominally 8 am to 9 am), the PM peak hour (nominally 5 pm to 6 pm) as well as a "typical hour" for each of the day time and night time periods, whereas for PT travel, results are reported for the four model time periods.

- Model Zones: The number of model zones has been increased from 320 to 634 by splitting a number of large zones and also by expanding the model coverage to include Mount Barker, Roseworthy, Gawler East and part of the Barossa Valley.

- Model Inputs: All scenario specific model inputs are via Catalog Keys.

2.2.2 Model Application Changes

- Build Scenario Networks application: This application was changed so that the primary input is now a foundation network for the model run, rather than a series of link and node files. This network can either be a standalone *.net file or part of a Geodatabase (*.gdb), which may also include many of the other scenario specific network related inputs such as the Highway Junction files and the PT Lines files. A further key change to the model inputs is that only one PT Lines file incorporating all necessary data for all model time periods (those described above plus the complete day) is now required. This application was also modified to generate many of the files necessary to support the extraction of model outputs.

- External and Freight Vehicle Model applications: Both of these applications were modified to provide for the expanded zone system and to simplify the processing of these applications.

- Person Trip Generation Model application: This application was created by merging a number of related applications, many of which contained only one or two programs. The steps now included in this application are:
    - Household Stratification by Residents, Workers and Dependants
    - Car Ownership Model
    - Household Stratification by Car Ownership
    - Trip End Generation
    - Travel Market Segmentation

The approach adopted to the balancing of trip productions and attractions in both the Trip End Generation and the Travel Market Segmentation processes balances trip ends separately across the MASTEM V2 model coverage and the added zones within the Mount Barker area and the Gawler East/Barossa Valley/Roseworthy area.

- Trip Distribution Model application: This application was modified so that the generalised cost are now based on the composite daily cost for Highway and PT modes so that the trip distribution process can take into account traffic congestion on the Highway network and also improvements to the PT system.
- Mode Choice Model application: This application was modified so that the input skim cost for both Highway and PT represent generalised cost and generalised time as appropriate. A sub-mode choice model which splits the daily PT demand into walk/ride/walk trips and park & ride trips has been added. The application has also been modified to reflect the change from three time periods across the day to four.
- Highway and PT Trip Assignment application: This application now includes both Highway and PT assignments which are carried out for each of the four time periods. The Highway assignment process now includes park and ride cars and buses. The application was also modified to extract congested network attributes from the Highway assignments for input into the PT assignment process and also to consider the effect of bus priority at signalised intersections. The PT assignment process was significantly modified to:
    - enable the assignment for the three user class demand matrices separately
    - consider the effect of parking capacity on park and ride demand
    - apply different mid-block speeds for express buses and stopping buses
    - include the effect of dedicated bus lanes and of bus priority at signalised intersections
    - include the effect of crowding on the operation of the PT system (optional process that needs to be selected prior to running a scenario)

2.2.3 Model Results

- Model Outputs: All scenario specific model outputs are accessible via the MASTEM Reporting Tool which provides a convenient way to access/analysis any required model outputs.
- A multi-faceted MASTEM Reporting Tool which is based on Microsoft Excel has also been developed which enables:
    - the reporting a range of model performance / calibration summary statistics
    - the reporting of a range of Highway and PT assignment summary statistics
    - the analysis of a range of Highway and PT assignment results

The components of this tool can be accessed from the Scenario Reporting application, although it should be noted that it may be necessary to allow / activate Excel macro operation.

For details of the initial development of MASTEM Version 3 refer to “Enhanced Public Transport Modelling, Model Development and Validation Report”[2] prepared by AECOM in March 2010. For further details of the re-development of this initial version refer to “Metropolitan Adelaide Strategic Transport Evaluation Model, MASTEM Version 3, Model Re-development, Calibration / Validation Report”[3] updated by DPTI in February 2018.

2.3 Model Structure

The following sections provide an overview in a graphical and tabular form to describe the applications and programs used within the MASTEM model. The full MASTEM model graphical flow-chart style user interface can be seen in Appendix A.

2.3.1 Overview

Figure 3.2 shows the overall model structure of MASTEM V3.

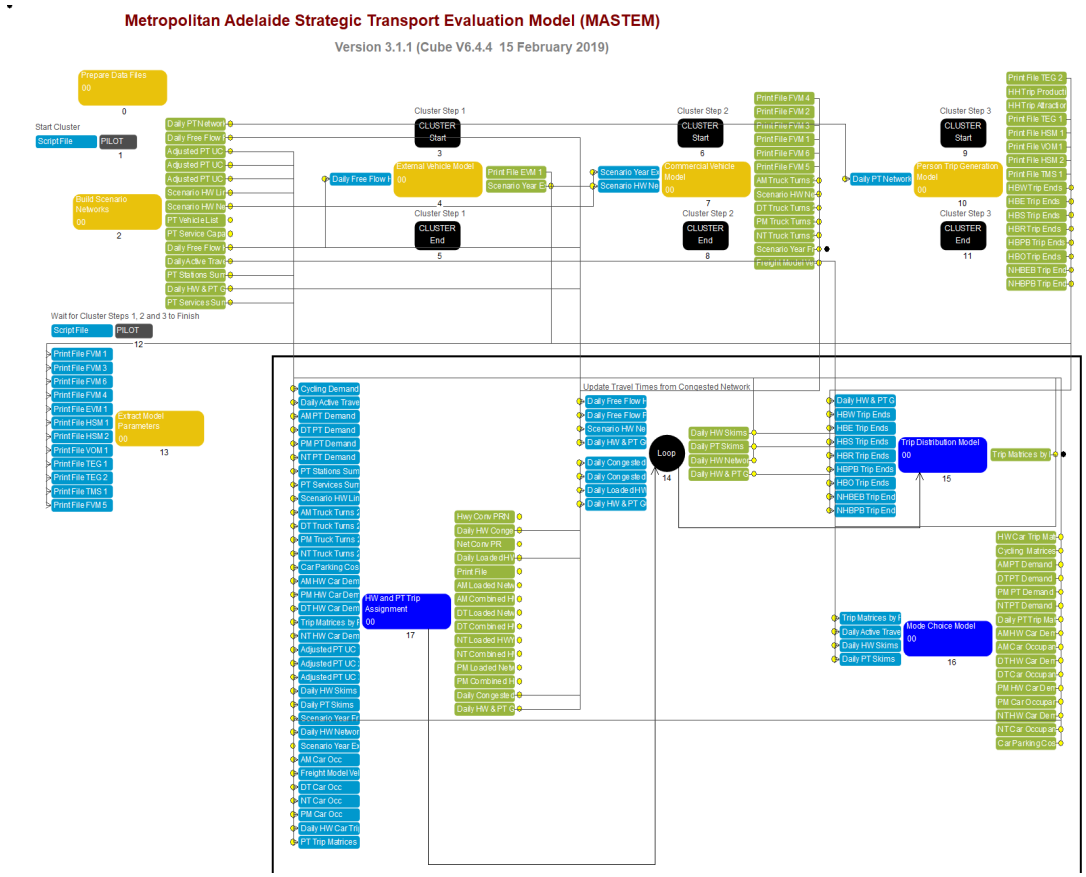


Figure 2.2 MASTEM main modal structure

The following applications/programs are describe in more details in the next sections.

- Build Scenario Networks (Box 2)
- External Vehicle Model (Box 4)
- Commercial Vehicle Model (Box 7)

[2] Department of Transport, Energy and Infrastructure (2009), Enhanced Public Transport Modelling, Model Development and Validation Report, prepared by AECOM.
[3] Department of Planning, Transport and Infrastructure, MASTEM V3.1, Model Re-Development and Validation Report (2018)

- Person Trip Generation Model (Box 10)
- Trip Distribution Model (Box 15)
- Mode Choice Model (Box 16)
- Highway ad Public Transport Trip Assignment (Box 17)

Within the MASTEM model structure a number of Pilot, Cluster and Loop programs are used. These programs enable a more dynamic and efficient modelling process. They are:

- Pilot: Starts the Cube Cluster nodes and waits until all of the previous Clusters steps are complete.
- Cluster: Starts/Ends the processing of the associated applications/programs in parallel.
- Loop: Controls the model looping process and updates the files for the next loop.

2.3.2 Prepare Data Files

This application, prebuild contains a number of programmes which were developed to assist the creation of a range of input data files. Some of these may be useful when developing project specific model inputs. Note: This application and programs are not run as part of the modelling process. For the model flowchart see Appendix A: Figure A.1.

2.3.3 Build Scenario Networks

Figure 3.3 shows the application program for the Build Scenario Networks.

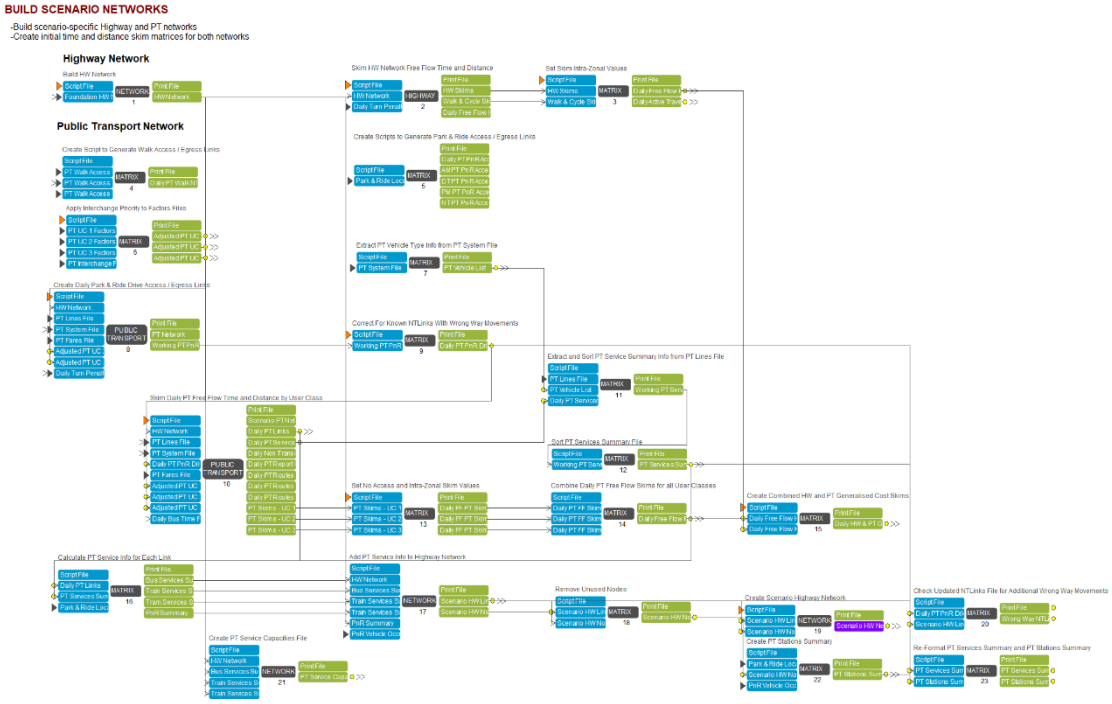


Figure 2.3 Build Scenario Networks Applications

Table 3.1 describes the functions of each program in the Build Scenario Networks. The first column is the program and associated box run order number. The second column being the description, describing what the program does.

Table 2-1 Description of Build Scenario Network Programs

Program (No.)	Description
NETWORK (1)	Set all link and node attributes for the model year, calculate link variables including free flow speed (FFS) and travel time (T0), walking times and capacity for each time period.
HIGHWAY (2)	Calculate the initial uncongested skim of Highway time and distance, as well as Active Travel time and distance.
MATRIX 3	Calculate uncongested intra-zonal skim values for Highway and Active Travel.
MATRIX 4	Create script to generate daily walk access/egress non-transit links – user class 1.
MATRIX 5	Create script to generate daily PnR access/egress non-transit links – user classes 2 and 3.
MATRIX 6	Apply PT interchange priority to PT factors files for each user class
MATRIX 7	Extract PT vehicle characteristics from PT system file.
PUBLIC TRANSPORT 8	Generate the P & R non-transit links based on free flow Highway time.
MATRIX 9	Correct generated non-transit links which use one-way Highway links in the reverse direction – this is to overcome a known CUBE issue.
PUBLIC TRANSPORT 10	PT daily assignment to calculate initial free flow daily skims for all user classes.
MATRIX 11	Extract PT service descriptions from PT lines file.
MATRIX 12	Sort PT services summary file.
MATRIX 13	Calculate uncongested no access and intra-zonal skim values for all PT user classes.
MATRIX 14	Combine daily uncongested skims for all PT user classes.
MATRIX 15	Combine daily uncongested generalised cost skims for Highway and PT.
MATRIX 16	Calculate PT service descriptions for each link.
NETWORK 17	Add PT service descriptions to scenario Highway network.
MATRIX 18	Delete any unused nodes from scenario Highway network.
NETWORK 19	Create scenario Highway network
MATRIX 20	Check PnR non-transit links
NETWORK 21	Create PT service capacities file.
MATRIX 22	Create PT stations summary file.
MATRIX 23	Re-format PT services summary and PT stations summary files for some components of the MASTEM Reporting Tool.

2.3.4 External Vehicle Model

Figure 3.4 shows the External Vehicle Model application programs.

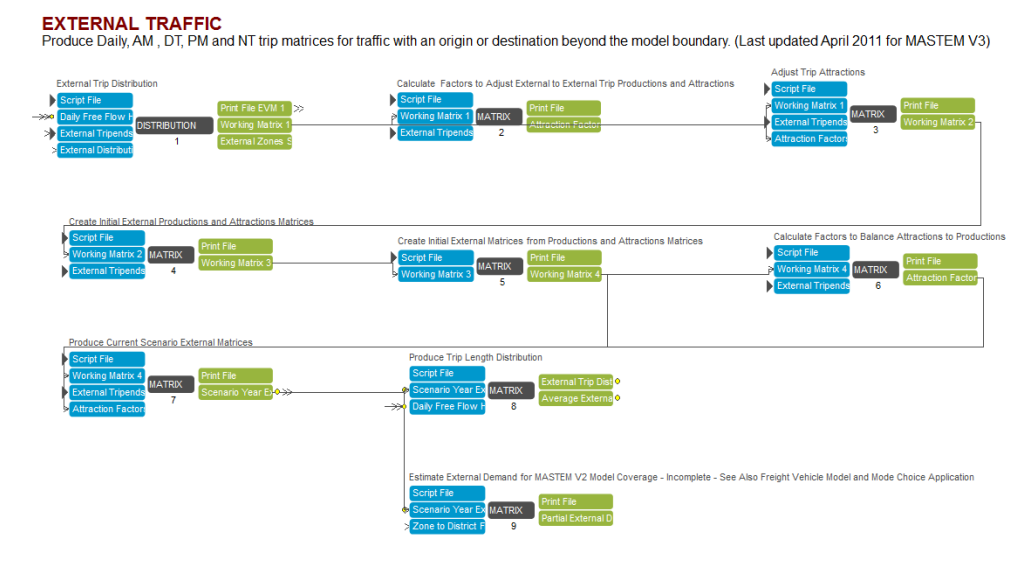


Figure 2.4 External Vehicle Model

Table 3.2 describes the function of each program in the External Vehicle Model.

Table 2-2 Description of External Vehicle Model Programs

Program (No.)	Description
DISTRIBUTION 1	Distribution for external trips for scenario year – based on scenario year external trip ends file and external distribution parameters.
MATRIX 2	Calculate factors to match external to external trip productions and attractions.
MATRIX 3	Apply factors to match external to external trip productions and attractions.
MATRIX 4	Create initial external production and attraction matrices.
MATRIX 5	Create initial external vehicle trip matrices.
MATRIX 6	Calculate factors to balance attractions to productions.
MATRIX 7	Create scenario year external vehicle demand matrices.
MATRIX 8	Calculate external trip length distributions.
MATRIX 9	First step to estimate external vehicle demand for MASTEM V2 model coverage.

2.3.5 Commercial Vehicle Model

The Commercial Vehicle Model application includes two groups, one for commercial cars – comprising business cars and light goods delivery vehicles - and one for trucks as shown in figure 3.5. The detailed commercial vehicle model structure can be seen in Appendix A: Figures A.4.1 and A.4.2 for the light business vehicles and truck sub-groups respectively.

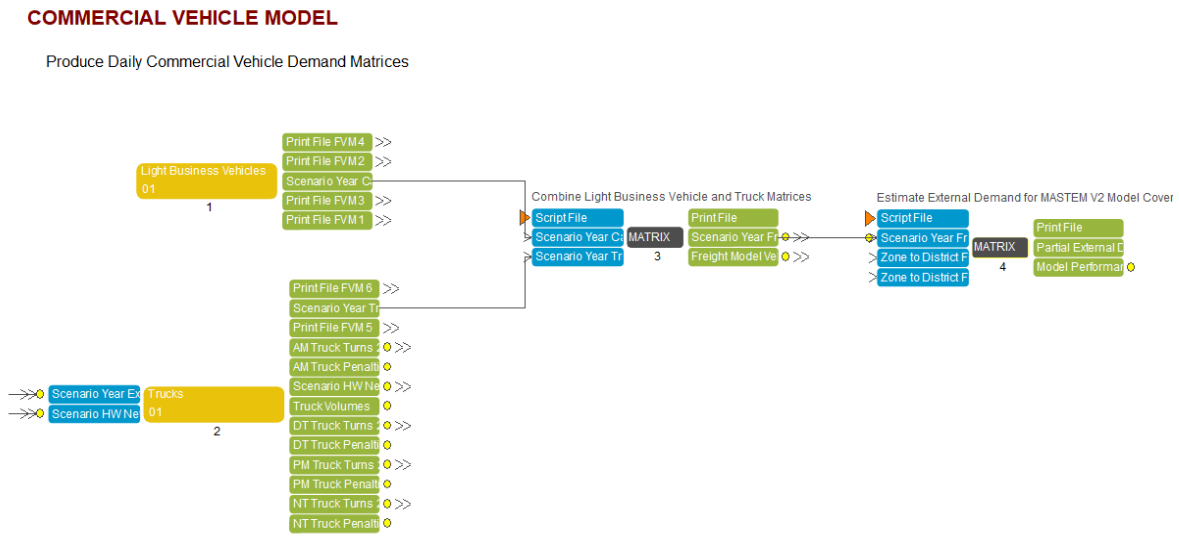


Figure 2.5 Commercial Vehicle Model Overview

Table 3.3 describes the function of each program in the Commercial Vehicle Model for both components - light business vehicles and trucks.

Table 2-3 Description of Commercial Vehicle Model Programs

Program (No.)	Description
Commercial Cars 1	Application group to calculate scenario year commercial cars matrix.
NETWORK 1	Add commercial car screenline data to 2006 Highway network.
DISTRIBUTION 2	Generate initial 2006 commercial car matrix – based on 2006 trip ends and commercial car friction factors.
MATRIX 3	Add external commercial cars and set confidence levels.
HIGHWAY 4	Generate 2006 commercial car screenline intercept file.
ANALYST 5	Generate final 2006 commercial car matrix.
MATRIX 6	Remove external commercial cars and calculate final scenario year trip ends.
FRATAR 7	Create scenario year commercial cars matrix.
Trucks 2	Application group to calculate scenario year truck matrix.
NETWORK 1	Add truck screenline data to 2006 Highway network.

Program (No.)	Description
DISTRIBUTION 1	Generate initial 2006 truck matrix – based on 2006 trip ends and truck friction factors.
MATRIX 3	Add external trucks and set confidence levels.
HIGHWAY 4	Generate 2006 truck screenline intercept file.
ANALYST 5	Generate final 2006 truck matrix.
MATRIX 6	Adjust scenario year truck trip ends to match BITRE growth rates.
MATRIX 7	Remove external trucks and calculate final scenario year trip ends.
FRATAR 8	Create scenario year truck matrix.
MATRIX 3	Combine commercial cars and trucks scenario year matrices
MATRIX 4	Second step to estimate external vehicle demand for MASTEM V2 model coverage.

2.3.6 The Person Trip Generation Model

The Person Trip Generation Model application includes a number of discrete steps. These include Household Stratification by Residents, Workers and Dependants, the application of the Car Ownership Model, Household Stratification by Car Ownership and Trip End Generation as seen in figure 3.6 below.

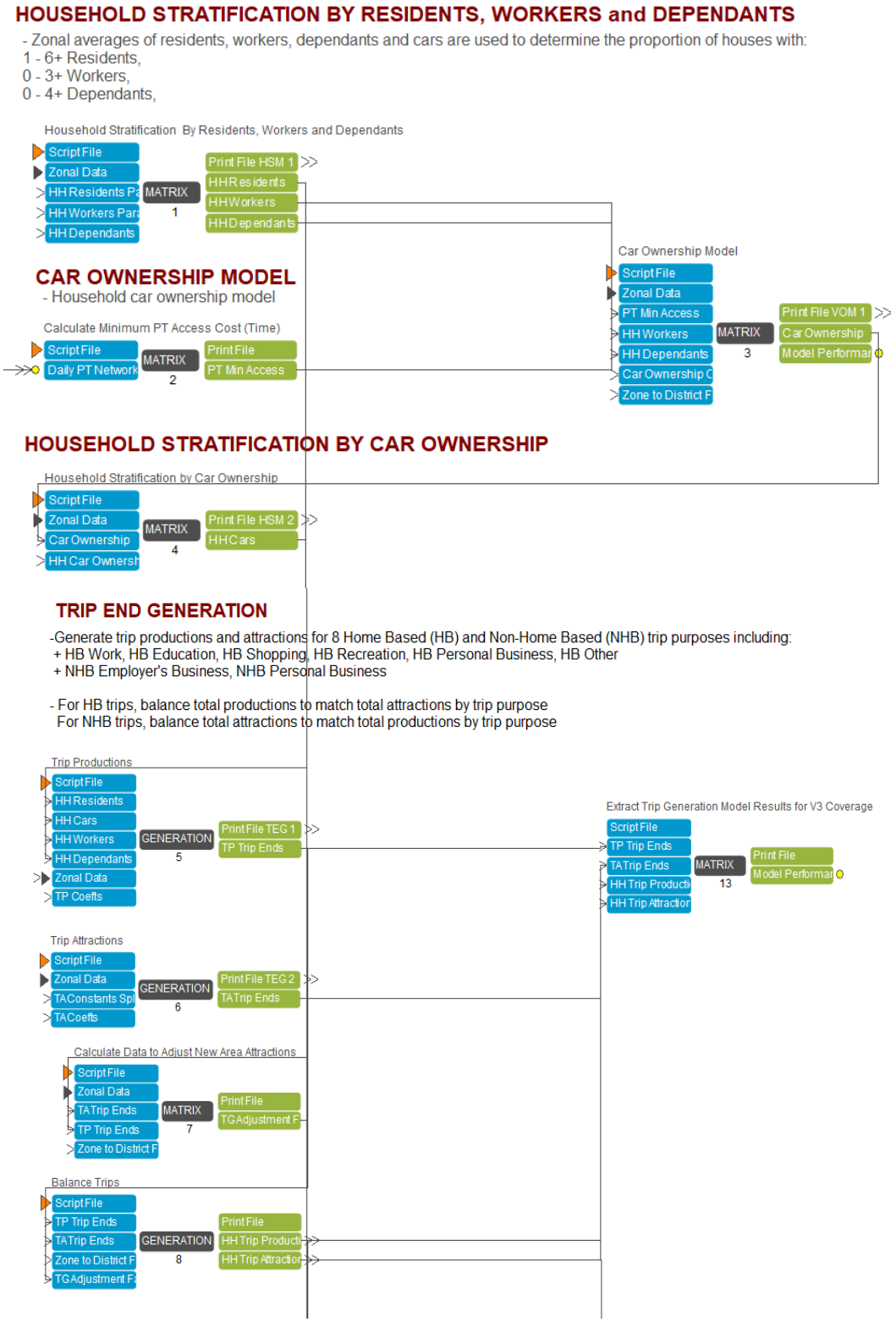


Figure 2.6 Person Trip Generation Model Application – part A

The remaining discrete step of the Person Trip Generation Model being Travel Market Segmentation can be seen in figure 3.7.

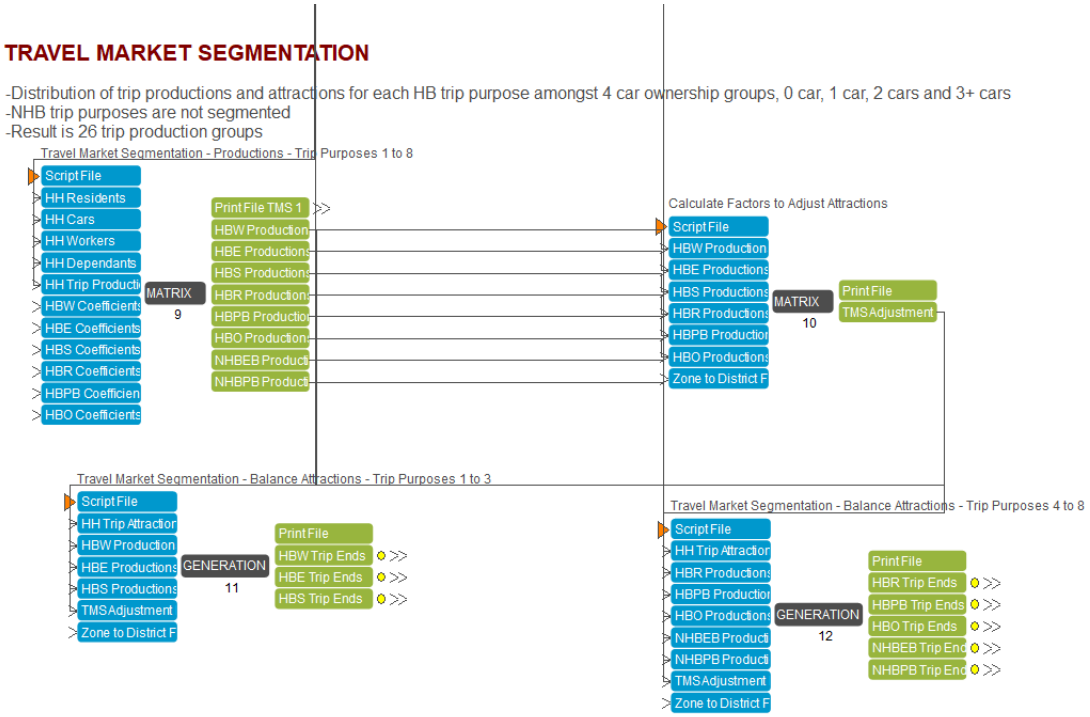


Figure 2.7 Trip Generation Model Application – part B

Table 3.4 describes the function of each of the Person Trip Generation model programs.

Table 2-4 Description of Person Trip Generation Model Programs

Program (No.)	**Description**
MATRIX 1 – *Household stratification model section*	Calculate the proportion of households by residents (1-6+), workers (0-3+) and dependants (0-4+) for each zone.
MATRIX 2 – *Car ownership model section*	Calculate minimum PT access cost.
MATRIX 3	Apply Car Ownership Model and extract model performance details.
MATRIX 4 – *Household stratification by car ownership model section*	Calculate the proportion of households by car ownership (0-3+) for each zone.
GENERATION 5 – *Trip end generation model section*	Generate trip productions.
GENERATION 6	Generate trip attractions.
MATRIX 7	Calculate factors to adjust attractions in new areas.
GENERATION 8	Balance attractions to productions within new areas.
MATRIX 9 – Travel market segmentation model section	Split productions into 8 trip purposes for each zone.
MATRIX 10	Calculate to adjust attractions.
GENERATION 11	Balance total attractions to total productions for trip purposes 1 to 3.
GENERATION 12	Balance total attractions to total productions for trip purposes 4 to 6, maintaining the relative proportions of attractions for each zone and total attractions to total productions for trip purposes 7 and 8, then setting the productions to equal the attractions for each zone.
MATRIX 13 – Trip end generation model section	Produce model performance statistics for MASTEM V3 model coverage.

2.3.7 Trip Distribution Model

Figure 3.8 shows the Trip Distribution Model application and Table 3.5 describes the function of each program.

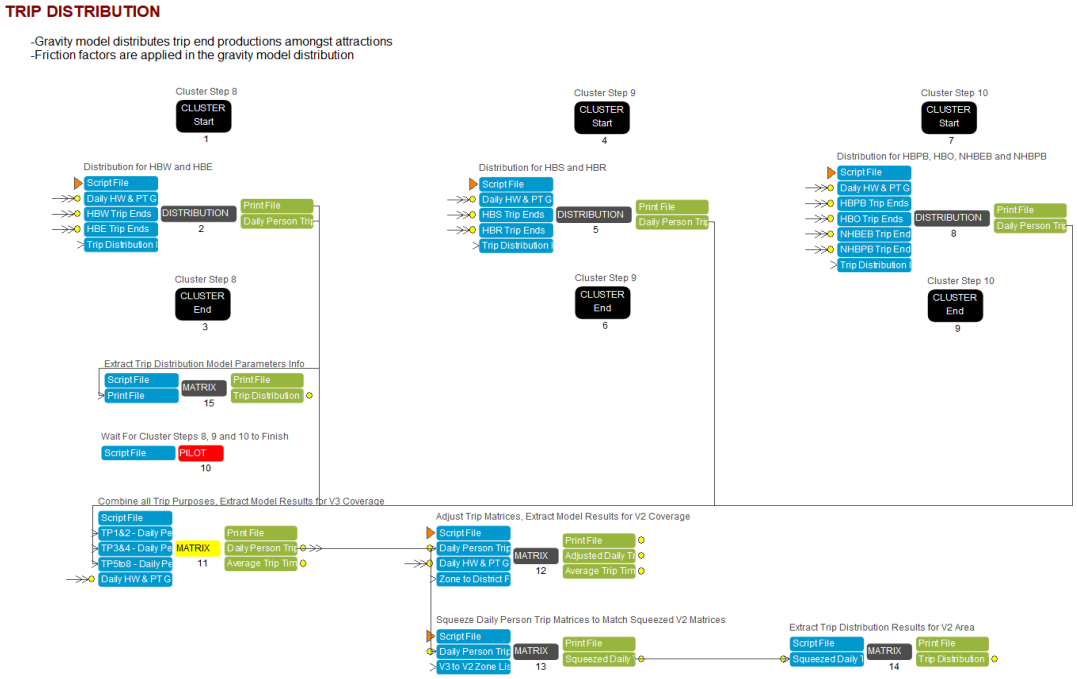


Figure 2.8 Trip Distribution Model Application

Table 2-5 Description of Trip Distribution Model Programs

Program (No.)	Description
CLUSTER Start 1, 4 and 7	Enable CUBE Cluster to run the three distribution steps in parallel.
CLUSTER End 3, 6 and 9	
PILOT 10	
DISTRIBUTION 2	Distribute HBW and HBE trip ends based on congested HW and PT generalised cost skims and trip distribution parameters.
DISTRIBUTION 5	Distribute HBS and HBR trip ends based on congested HW and PT generalised cost skims and trip distribution parameters.
DISTRIBUTION 5	Distribute HBPB, HBO, NHBEB and NHBPB trip ends based on congested HW and PT generalised cost skims and trip distribution parameters.
MATRIX 11	Combine all trip purpose matrices, calculate trip length distributions and extract Trip Generation and Distribution Model results for MASTEM V3 coverage.
MATRIX 12 and 13	Adjust all trip purpose matrices, calculate trip length distributions and extract Trip Generation and Distribution Model results for MASTEM V2 coverage.
MATRIX 14	Extract the Trip Purpose parameters file name.

2.3.8 Mode Choice Model

The Mode Choice Model application initially performs the mode split – into car driver/passenger, public transport, walking and cycling. The outputs of this process is then further processed in two separate groups, which split the PT and Highway daily demand matrices into the four time periods (see Appendix A: Figure A.8.1 for the detailed Public Transport and Highway time period demand subgroup model programs). Figure 3.9 shows the Mode Choice Model applications and Table 3.6 describes the function of each program.

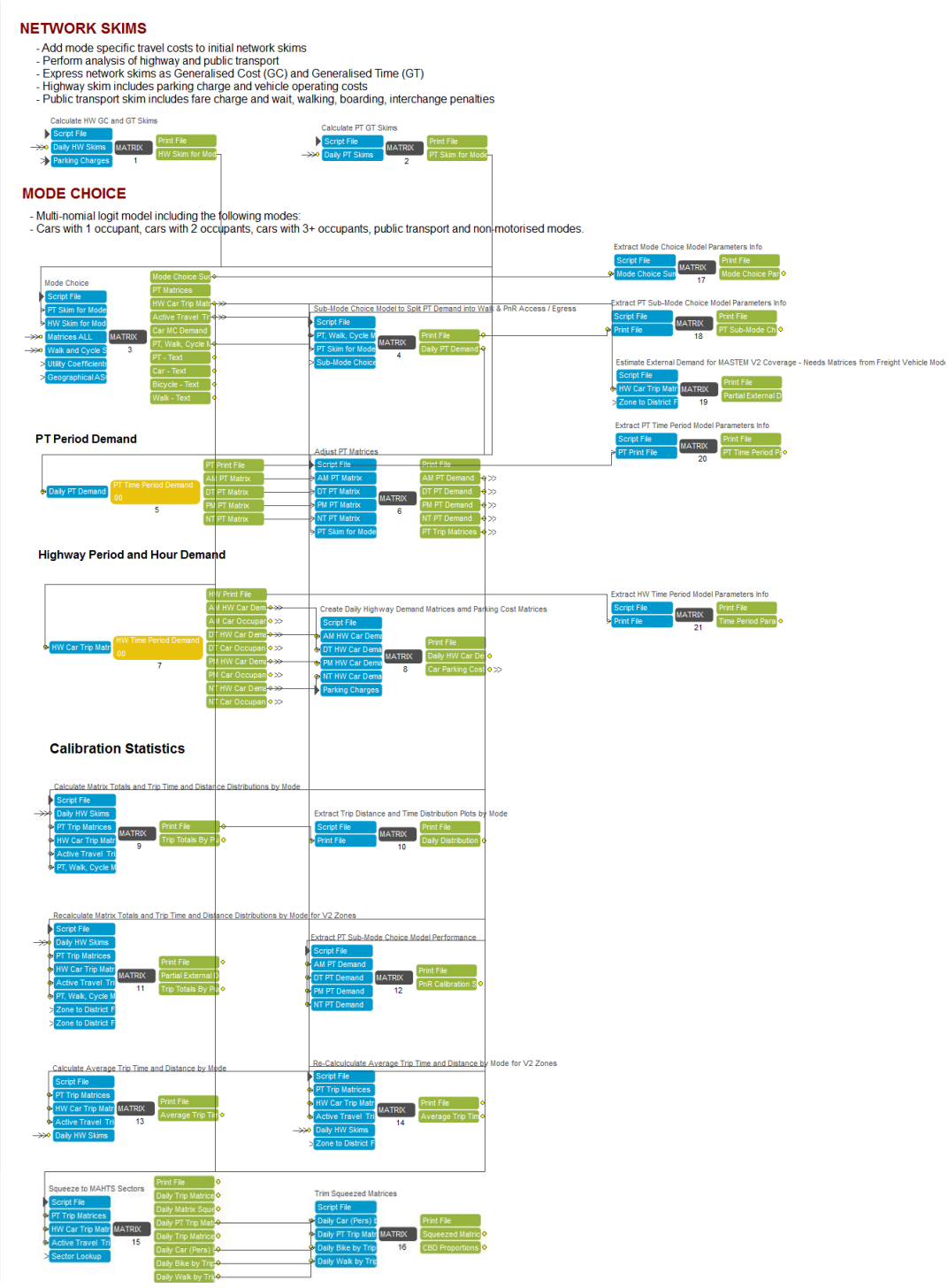


Figure 2.9 Mode Choice Model Application

Table 2-6 Description of Mode Choice Model Programs

Program (No.)	Description
MATRIX 1	Calculate Highway generalised cost and time skims from daily Highway skims and parking charges.
MATRIX 2	Calculate PT generalised time skims from daily PT skims.
MATRIX 3	Apply mode choice model producing daily trip matrices for PT, Highway, Walking and Cycling for each market segment by car ownership.
MATRIX 4	Apply PT sub0mode choice model producing daily trip matrices for each PT user class.
PT Time Period Demand 5	Split daily PT trip matrices into four time period matrices
CLUSTER Start 1, 4, 7 and 10 CLUSTER End 3, 6, 9 and 12 PILOT 13	Enable CUBE Cluster to run the 4 matrix steps in parallel.
MATRIX 2	Produce AM time period PT trip matrices.
MATRIX 5	Produce DT time period PT trip matrices.
MATRIX 8	Produce PM time period PT trip matrices.
MATRIX 11	Produce NT time period PT trip matrices.
MATRIX 6	Adjust PT time period matrices for user classes 2 and 3.
HW Time Period Demand 7	Split daily Hwy trip matrices into four time period matrices
CLUSTER Start 1, 4, 7 and 10 CLUSTER End 3, 6, 9 and 12 PILOT 13	Enable CUBE Cluster to run the 4 matrix steps in parallel.
MATRIX 2	Produce AM time period Highway trip matrices.
MATRIX 5	Produce DT time period Highway trip matrices.
MATRIX 8	Produce PM time period Highway trip matrices.
MATRIX 11	Produce NT time period Highway trip matrices.
MATRIX 8	Create daily Highway demand and parking cost matrices
MATRIX 9 to 16 – *Calibration Statistics*	Produce Mode Choice Model results for both MASTEM V3 and V2 coverage.
MATRIX 17 to 21	Extract all Mode Choice parameters files names.

2.3.9 Highway and Public Transport (PT) Trip Assignment

The Highway and PT Trip Assignment application includes six groups; one for each of the four time periods, one to update the scripts which generate the Park & Ride non-transit links to include congested Park & Ride penalties if further model loops are required and one to undertake the final PT assignment and then to extract assignment summary statistics if no further model loops are required. Figure 3.10 shows the Highway and PT Assignment Model applications. Further detail of the four subgroups for the time period part of the Highway and PT Assignment Model Application (AM, Day Time (DT), PM and Night Time (NT)) can be seen in Appendix A: – Figures A.9.1 - A.9.4.

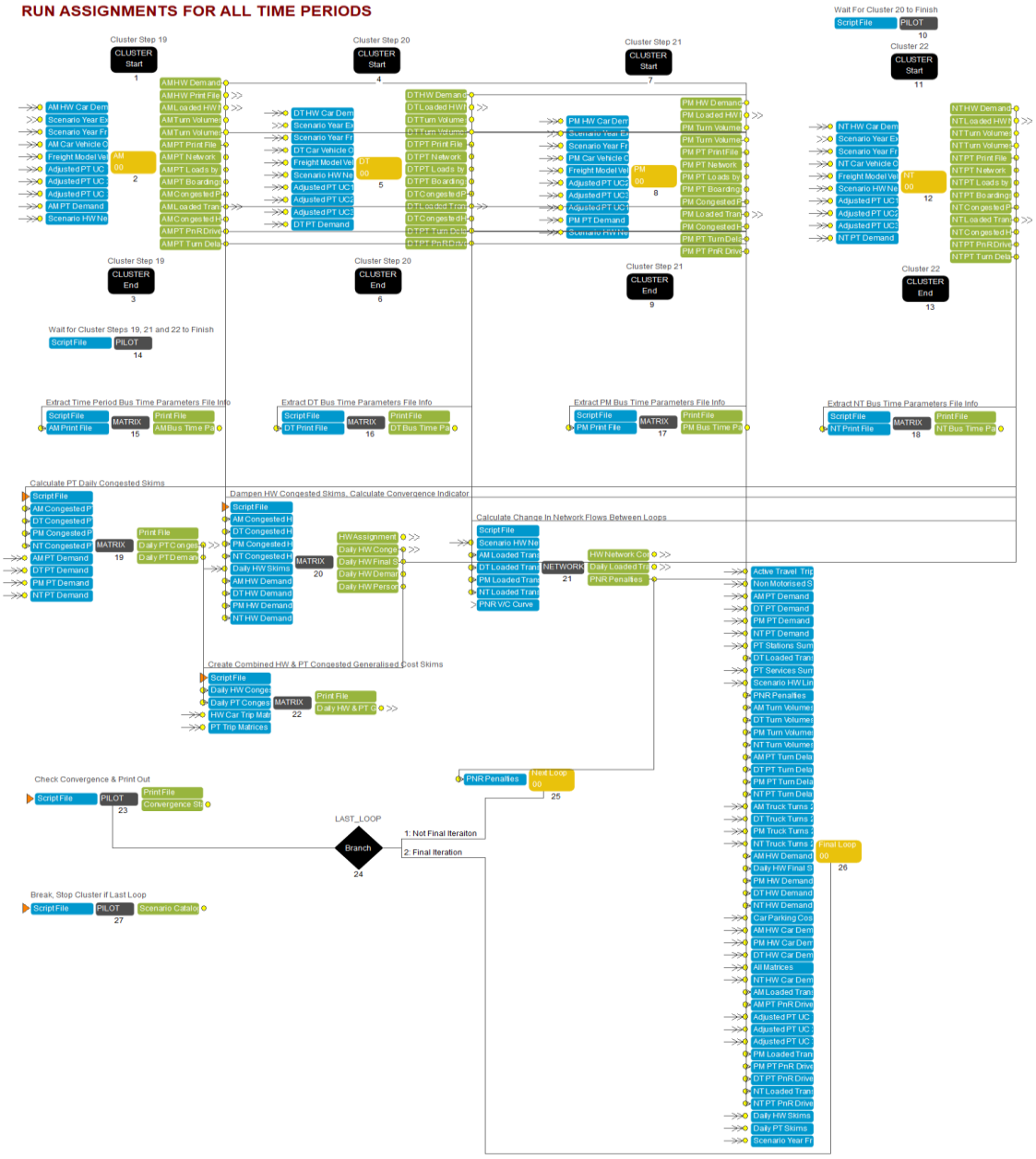


Figure 2.10 Highway and PT Assignment

The following tables describes the function of each program in the Highway and Public Transport Trip Assignment model application. Table 3.7 describes the main program structure of the Highway and PT Trip Assignment model. The remaining tables describe each of the four time periods (AM, DT, PM and NT), the next Loop and their associated programs within the Highway and PT Trip Assignment model.

Table 2-7 Description of Highway and PT Trip Assignment Model Programs

Program (No.)	**Description**
CLUSTER Start 1, 4, 7 and 11 CLUSTER End 3, 6, 9 and 13 PILOT 10 and 14	Enable CUBE Cluster to run the AM, PM and DT / NT assignment steps in parallel.
AM 2	*See AM Time period – figure A.9.1 and table 3.3.9.2*
DT 5	*See DT Time period – figure A.9.2 and table 3.3.9.3*
PM 8	*See PM Time period – figure A.9.3 and table 3.3.9.4*
NT 12	*See NT Time period – figure A.9.4 and table 3.3.9.5*
MATRIX 15 to 18	Extract all Bus Travel Time parameters files names
MATRIX 19	Calculate PT daily congested skims.
MATRIX 20	Dampen Highway daily congested skims, calculate model loop convergence indicators and assemble Highway user benefit matrices.
NETWORK 21	Calculate change in network flows between model loops.
MATRIX 22	Combine Highway and PT congested generalised cost skims.
PILOT 23	Check and print model loop convergence indicators.
Branch 24	Checks if final iteration or not
Next Loop 25	*See Next Loop – figure A.9.5 and table 3.3.9.6*
Final Loop 26	*See Final Loop – figure 3.3.10 and table 3.3.10.1*
PILOT 27	Stops processing if model loop convergence has been satisfied, then prints out the Scenario Catalogue and closes the CUBE Cluster nodes.

Table 2-8 Description of the AM Time Period Model Programs

Program (No.)	Description
AM 2	**AM Model Application – figure**
MATRIX 1	Prepares the AM peak hour and peak period HW demand matrices.
NETWORK 2	Builds the AM HW network
HIGHWAY 3	Undertakes the AM peak hour HW assignment.
HIGHWAY 4	Skims the time and distance paths for the final HW assignment iteration.
MATRIX 5	Calculates the intra-zonal time and distance skim values.
NETWORK 6	Extracts the loaded HW link and node files from the loaded HW network.
MATRIX 7	Calculates all link flow totals and adds temporary link attributes.
NETWORK 8	Create a list of all links with PT priority.
MATRIX 9	Determine the number of phases for all signalised locations with PT priority.
MATRIX 10	Calculate reduced delays for all turns with PT priority.
MATRIX 11	Update the turn volume and delay file with current PT delays.
NETWORK 12	Convert junction movement delays to weighted average approach delays.
MATRIX 13	Create updated turn delay file.
PUBLIC TRANSPORT 14	Create congested AM Park & Ride access / egress links.
MATRIX 15	Correct Park & Ride egress links with wrong way movements.
MATRIX 16	Check the updated NT Links file for additional wrong way movements.
PUBLIC TRANSPORT 17	Undertake AM period PT assignment using the congested HW network.
NETWORK 18	Create the AM loaded transport network.
MATRIX 19	Set no access and intra-zonal skim values.
MATRIX 20	Combine AM PT congested skims for all user classes.

Table 2-9 Description of the DT Time Period Model Programs

Program (No.)	Description
DT 5	**DT Model Application- figure**
MATRIX 1	Prepares the DT typical hour and period HW demand matrices.
HIGHWAY 2	Undertakes the DT typical hour HW assignment.
HIGHWAY 3	Skims the time and distance paths for the final HW assignment iteration.
MATRIX 4	Calculates the intra-zonal time and distance skim values.
NETWORK 5	Extracts the loaded HW link and node files from the loaded HW network.
MATRIX 6	Calculates all link flow totals and adds temporary link attributes.
NETWORK 7	Create a list of all links with PT priority.
MATRIX 8	Determine the number of phases for all signalised locations with PT priority.
MATRIX 9	Calculate reduced delays for all turns with PT priority.
MATRIX 10	Update the turn volume and delay file with current PT delays.
NETWORK 11	Convert junction movement delays to weighted average approach delays.
MATRIX 12	Create updated turn delay file.
PUBLIC TRANSPORT 13	Create congested DT Park & Ride access / egress links.
MATRIX 14	Correct Park & Ride egress links with wrong way movements.
MATRIX 15	Check the updated NT Links file for additional wrong way movements.
PUBLIC TRANSPORT 16	Undertake DT period PT assignment using the congested transport network.
NETWORK 16	Create the DT loaded PT network
MATRIX 16	Set no access and intra-zonal skim values.
MATRIX 19	Combine DT PT congested skims for all user classes.

Table 2-10 Description of the PM Time Period Model Programs

Program (No.)	Description
PM 8	**Refer to Figure 3.13 and Table 3.10**
MATRIX 1	Prepares the PM peak hour and peak period HW demand matrices.
NETWORK 2	Builds the PM HW network
HIGHWAY 3	Undertakes the PM peak hour HW assignment.
HIGHWAY 4	Skims the time and distance paths for the final HW assignment iteration.
MATRIX 5	Calculates the intra-zonal time and distance skim values.
NETWORK 6	Extracts the loaded HW link and node files from the loaded HW network.
MATRIX 7	Calculates all link flow totals and adds temporary link attributes.
NETWORK 8	Create a list of all links with PT priority.
MATRIX 9	Determine the number of phases for all signalised locations with PT priority.
MATRIX 10	Calculate reduced delays for all turns with PT priority.
MATRIX 11	Update the turn volume and delay file with current PT delays.
NETWORK 12	Convert junction movement delays to weighted average approach delays.
MATRIX 13	Create updated turn delay file.
PUBLIC TRANSPORT 14	Create congested AM Park & Ride access / egress links.
MATRIX 15	Correct Park & Ride egress links with wrong way movements.
MATRIX 16	Check the updated NT Links file for additional wrong way movements.
PUBLIC TRANSPORT 17	Undertake PM period PT assignment using the congested HW network.
NETWORK 18	Create the PM loaded transport network.
MATRIX 19	Set no access and intra-zonal skim values.
MATRIX 20	Combine PM PT congested skims for all user classes.

Table 2-11 Description of the NT Time Period Model Programs

Program (No.)	Description
NT 12	**Refer to Figure 3.14 and Table 3.11**
MATRIX 1	Prepares the NT typical hour and period HW demand matrices.
HIGHWAY 2	Undertakes the NT typical hour HW assignment.
HIGHWAY 3	Skims the time and distance paths for the final HW assignment iteration.
MATRIX 4	Calculates the intra-zonal time and distance skim values.
NETWORK 5	Extracts the loaded HW link and node files from the loaded HW network.
MATRIX 6	Calculates all link flow totals and adds temporary link attributes.
NETWORK 7	Create a list of all links with PT priority.
MATRIX 8	Determine the number of phases for all signalised locations with PT priority.
MATRIX 9	Calculate reduced delays for all turns with PT priority.
MATRIX 10	Update the turn volume and delay file with current PT delays.
NETWORK 11	Convert junction movement delays to weighted average approach delays.
MATRIX 12	Create updated turn delay file.
PUBLIC TRANSPORT 13	Create congested NT Park & Ride access / egress links.
MATRIX 14	Correct Park & Ride egress links with wrong way movements.
MATRIX 15	Check the updated NT Links file for additional wrong way movements.
PUBLIC TRANSPORT 16	Undertake NT period PT assignment using the congested transport network.
NETWORK 17	Create the NT loaded PT network
MATRIX 18	Set no access and intra-zonal skim values.
MATRIX 19	Combine NT PT congested skims for all user classes.

Table 2-12 Description of the Next Loop Model Programs

Program (No.)	Description
Next Loop 25	
MATRIX 1	Updates the scripts which are used to generate congested Park & Ride access / egress links by including congested Park and Ride penalties.

2.3.10 Final Loop

The following section within the Highway and PT Trip Assignment application describes the Final Loop. As mentioned previously within this document the final loop is undertaken to produce the final PT assignment and then extract the assignment summary statistics once no more model loops are required. The Final Loop includes eight groups, they are:

- Final PT Trip assignment
- Model Calibration Statistics
- PT Assignment Statistics
- Highway Assignment Statistics
- Highway Trip Distributions
- MASTEM User Benefit Calculation Tool (MUBCT)
- Scenario Reporting

Figure 3.11 shows the Final Loop subgroup of the Highway and PT Assignment Model applications. Further detail of the eight subgroups for the Final Loop; Final PT Trip Assignment, Model Calibration Statistics, PT Assignment Statistics, PT Trip Distributions, HW Assignment Statistics, HW Trip Distributions, MUBCT Matrices and Scenario Reporting are located within Appendix A: – Figures A.9.5.1 to A.9.5.7.

The following tables describes the function of each program as part of the Final Loop within the Highway and Public Transport Trip Assignment model application. Table 3.13 describes the main programs of the Final Loop, whilst the remaining tables describe each of the eight subgroups (see dot points above) and their associated programs within the Final Loop of the Highway and PT Trip Assignment model.

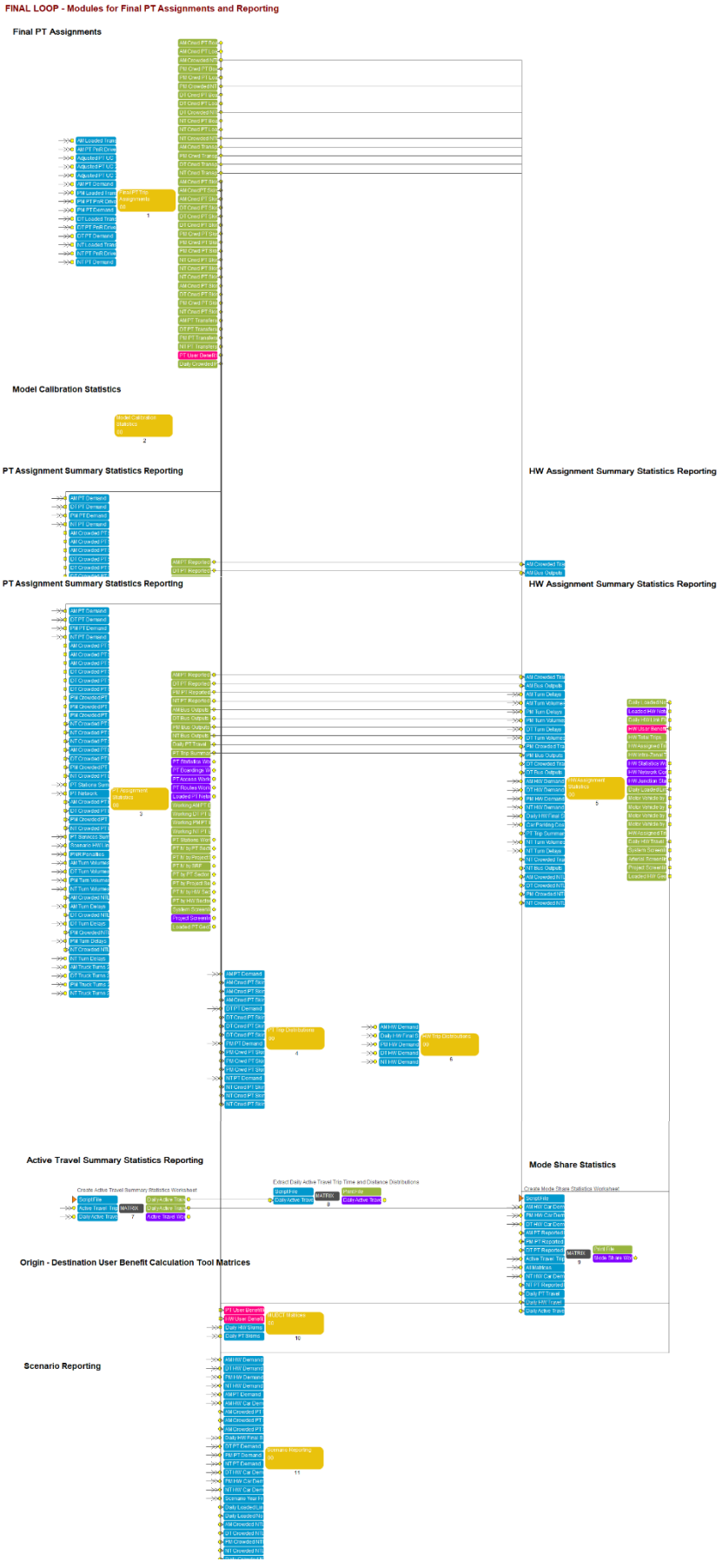


Figure 2.11 Final Loop - Hwy and PT Trip Assignment Model

Table 2-13 Description of the Final Loop Model Programs

Program (No.)	Description
FINAL LOOP 26	
Final PT Assignment 1	*See Final PT Assignment – figure A.9.5.1 and table 3.3.10.2*
Model Calibration Statistics 2	*See Model Calibration Statistics – figure A.9.5.2 and table 3.3.10.3*
PT Assignment Statistics 3	*See PT Assignment Statistics – figure A.9.5.3 and table 3.3.10.4*
PT Trip Distributions 4	*See PT Trip Distributions – figure A.9.5.4 and table 3.3.10.5*
HW Assignment Statistics 5	*See HW Assignment Statistics – figure A.9.5.5 and table 3.3.10.6*
HW Trip Distributions 6	*See HW Trip Distributions – figure A.9.5.6 and table 3.3.10.8*
MATRIX 7	Creates the Active Travel summary statistics worksheet.
MATRIX 8	Extracts the Active Travel trip time and distance distributions.
MATRIX 9	Creates the mode share worksheet.
MUBCT Matrices 10	*See MUBCT Matrices – figure A.9.5.7 and table 3.3.10.9*
Scenario Reporting 11	*See Scenario Reporting – figure A.9.5.7 and table 3.3.10.10*

Table 2-14 Describes the Final PT Trip Assignment Model Programs

Program (No.)	Description
Final PT Trip Assignments 1	
CLUSTER Start 1, 8, 15 and 22 CLUSTER End 7, 14, 21 and 28 PILOT 29	Enable CUBE Cluster to run the AM, PM, DT and NT PT assignment steps in parallel.
PUBLIC TRANSPORT 2	AM period crowded PT assignment.
MATRIX 3	Extract AM period PT transfers.
NETWORK 4	Update PT assignment results in AM crowded transport network.
MATRIX 5	Set intra-zonal skim values for all AM period PT crowded skims.
MATRIX 6	Combine all AM period PT crowded skims.
PUBLIC TRANSPORT 9	DT period crowded PT assignment.
MATRIX 10	Extract DT period PT transfers.
NETWORK 11	Update PT assignment results in DT crowded transport network.
MATRIX 12	Set intra-zonal skim values for all DT period PT crowded skims.
MATRIX 13	Combine all DT period PT crowded skims.
PUBLIC TRANSPORT 16	PM period crowded PT assignment.
MATRIX 17	Extract PM period PT transfers.
NETWORK 18	Update PT assignment results in PM crowded transport network.
MATRIX 19	Set intra-zonal skim values for all PM period PT crowded skims.
MATRIX 20	Combine all PM period PT crowded skims.
PUBLIC TRANSPORT 23	NT period crowded PT assignment.
MATRIX 24	Extract NT period PT transfers.
NETWORK 25	Update PT assignment results in NT crowded transport network.
MATRIX 26	Set intra-zonal skim values for all NT period PT crowded skims.
MATRIX 27	Combine all NT period PT crowded skims.
MATRIX 30	Combine all time period PT user benefit matrices.

Table 2-15 Describes the Model Calibration Statistics Programs

Program (No.)	Description
Model Calibration Statistics 2	
MATRIX 1	Create external vehicle model summary statistics.
MATRIX 2	Re-formant person trip generation model parameters files.
MATRIX 3	Re-formant trip distribution model parameters files.
MATRIX 4	Re-formant mode choice model summary statistics for each mode for MASTEM V2 coverage.
MATRIX 5	Re-formant mode choice model summary statistics for each mode for MASTEM V3 coverage.
MATRIX 6	Re-formant PT sub-mode choice model summary statistics.
MATRIX 7	Re-formant mode choice model trips by trip purpose by car ownership for MASTEM V2 coverage.
MATRIX 8	Re-formant mode choice model trips by trip purpose by car ownership for MASTEM V3 coverage.
MATRIX 9	Re-formant mode choice model trips by trip purpose for CBD trips.

Table 2-16 Describes the PT Assignment Statistics Programs

Program (No.)	Description
PT Assignment Statistics 3	
MATRIX 1	Add PT route and corridor info from PT Lines file and Park and Ride congested penalties into PT crowded boarding files.
MATRIX 2	Create the PTOMS worksheets.
MATRIX 3	Generate AM and DT period PT in-vehicle summary files.
MATRIX 4	Generate PM and NT period PT in-vehicle summary files.
MATRIX 5	Create PT summary statistics worksheets.
NETWORK 6, 7, 8 and 9	Create the loaded PT network.
NETWORK 0	Saves the loaded PT network as a component of an existing scenario geodatabase.
MATRIX 10	Create PT node results file and PT stations summary worksheet.
MATRIX 11	Create PT route results files and bus turn volumes files for each time period.

Program (No.)	Description
MATRIX 12	Create PT link results files for each time period.
NETWORK 13	Create Daily PT link results file.
NETWORK 14	Create PT in-vehicle summary statistics worksheets by PT sector and strategic role and function.
NETWORK 15 and MATRIX 16	Create the PT screenlines worksheets.
MATRIX 17 to 24	Update the Highway time period turn volumes files with buses and Park and Ride cars.

Table 2-17 Describes the PT Trip Distributions Programs

Program (No.)	Description
PT Trip Distributions 4	
MATRIX 1	Create AM time period PT trip time and distance distributions.
MATRIX 2	Create DT time period PT trip time and distance distributions.
MATRIX 3	Create PM time period PT trip time and distance distributions.
MATRIX 4	Create NT time period PT trip time and distance distributions.
MATRIX 5	Create Daily PT trip time and distance distributions.
MATRIX 6	Re-format AM time period PT trip time and distance distributions.
MATRIX 7	Re-format DT time period PT trip time and distance distributions.
MATRIX 8	Re-format PM time period PT trip time and distance distributions.
MATRIX 9	Re-format NT time period PT trip time and distance distributions.
MATRIX 10	Re-format Daily PT trip time and distance distributions.
MATRIX 11	Combine all re-formatted time period PT trip time and distance distributions.

Table 2-18 Describes the Highway Assignment Statistics Programs

Program (No.)	Description
HW Assignment Statistics 5	
MATRIX 1	Create AM time period Park and Ride car link file.
MATRIX 2	Create DT time period Park and Ride car link file.
MATRIX 3	Create PM time period Park and Ride car link file.
MATRIX 4	Create NT time period Park and Ride car link file.

Program (No.)	Description
MATRIX 5	Create AM time period junction results.
NETWORK 6	Calculate all AM time period Highway assignment results.
MATRIX 7	Create DT time period junction results.
NETWORK 8	Calculate all DT time period Highway assignment results.
NETWORK 9	Extract DT time period mid-block V/Cs.
MATRIX 10	Calculate maximum DT time period mid-block V/Cs for each Highway section link pair.
MATRIX 11	Create PM time period junction results.
NETWORK 12	Calculate all PM time period Highway assignment results.
MATRIX 13	Create NT time period junction results.
NETWORK 14	Calculate all NT time period Highway assignment results.
NETWORK 15	Extract NT time period mid-block V/Cs.
MATRIX 16	Calculate maximum NT time period mid-block V/Cs for each Highway section link pair.
NETWORK 17, 19 & 20, MATRIX 18	Create the loaded Highway network.
NETWORK 0	Saves the loaded HW network as a component of an existing scenario geodatabase.
NETWORK 21 and MATRIX 22	Calculate the peak hour GEH statistics.
MATRIX 23 and 24 and NETWORK 25	Create the Highway summary results worksheets.
NETWORK 26	Create the Highway summary statistics worksheets by Highway sector and Strategic Role and Function.
MATRIX 27	Create the Highway summary statistics worksheets by link group by Highway sector.
MATRIX 28	*See HW screenlines & travel times – figure A.9.5.5.1 and table 3.3.10.7*
MATRIX 0	Extract Highway turning movements in standard DPTI format.

Table 2-19 Describes the Highway Screenlines and Travel Times Statistics Programs

Program (No.)	Description
HW Screenlines & Travel Times 28	
NETWORK 1 and MATRIX 2	Create the Highway screenlines worksheets.
NETWORK 3 and MATRIX 4	Create the Highway travel time worksheets.
MATRIX 5	Create Highway junction performance results

Table 2-20 Describes the Highway Trip Distributions Programs

Program (No.)	Description
HW Trip Distributions 6	
MATRIX 1	Create AM time period Highway trip time and distance distributions.
MATRIX 2	Re-format AM time period Highway trip time and distance distributions.
MATRIX 3	Create DT time period Highway trip time and distance distributions. Create
MATRIX 4	Re-format DT time period Highway trip time and distance distributions.
MATRIX 5	PM time period Highway trip time and distance distributions.
MATRIX 6	Re-format PM time period Highway trip time and distance distributions.
MATRIX 7	Create NT time period Highway trip time and distance distributions.
MATRIX 8	Re-format NT time period Highway trip time and distance distributions.
MATRIX 9	Create Daily Highway trip time and distance distributions.
MATRIX 10	Re-format Daily Highway trip time and distance distributions.
MATRIX 11	Combine all re-formatted time period Highway trip time and distance distributions.

Table 2-21 Describes the MUBCT and Accessibility Calculations Programs

Program (No.)	Description
MUBCT Matrices 10	
MATRIX 1	Combines the HW and PT User Benefits matrices to create a combined User Benefit matrix.
MATRIX 2 and 3	Calculates an accessibility metric

Table 2-22 Describes the Scenario Reporting Programs

Program (No.)	Description
Scenario Reporting 11	***All of the programs have been set to zero so as not to run as part of the modelling run time.***
1. PILOT 0	Starts the Calibration Results component of the MASTEM Reporting Tool.
2. PILOT 0	Starts the Summary Assignment Results component of the MASTEM Reporting Tool.
3. PILOT 0	Starts the Screenlines Results component of the MASTEM Reporting Tool.
4. PILOT 0	Starts the PT Lines Results component of the MASTEM Reporting Tool.
5. NETWORK 0	Compares two scenario Highway networks.
6. NETWORK 0	Compares two loaded Highway networks.
7. MATRIX 0	Compares two sets of junction delays.
8. NETWORK 0	Compares two loaded PT networks.
9. MATRIX 0	Creates the O-D matrices for MATSAM Model.

4.0 Model Inputs

4.1 Catalog Keys

Each model run is defined by a series of CUBE Catalog Keys. These keys have been arranged in three groups:

- General Model Parameters,
- Highway Inputs, and
- Public Transport Inputs.

All of the keys within each of these groups are described below in a graphical and tabular format. (See Appendix B: for further detail of the Scenario Manager Catalog Key screens).

4.1.1 General Model Parameters

These catalog keys define the scenario specific inputs that control the overall modelling process. Figure 4.1 shows the CUBE Scenario Manger screen for this group and Table 4.1 describes each of the catalog keys.

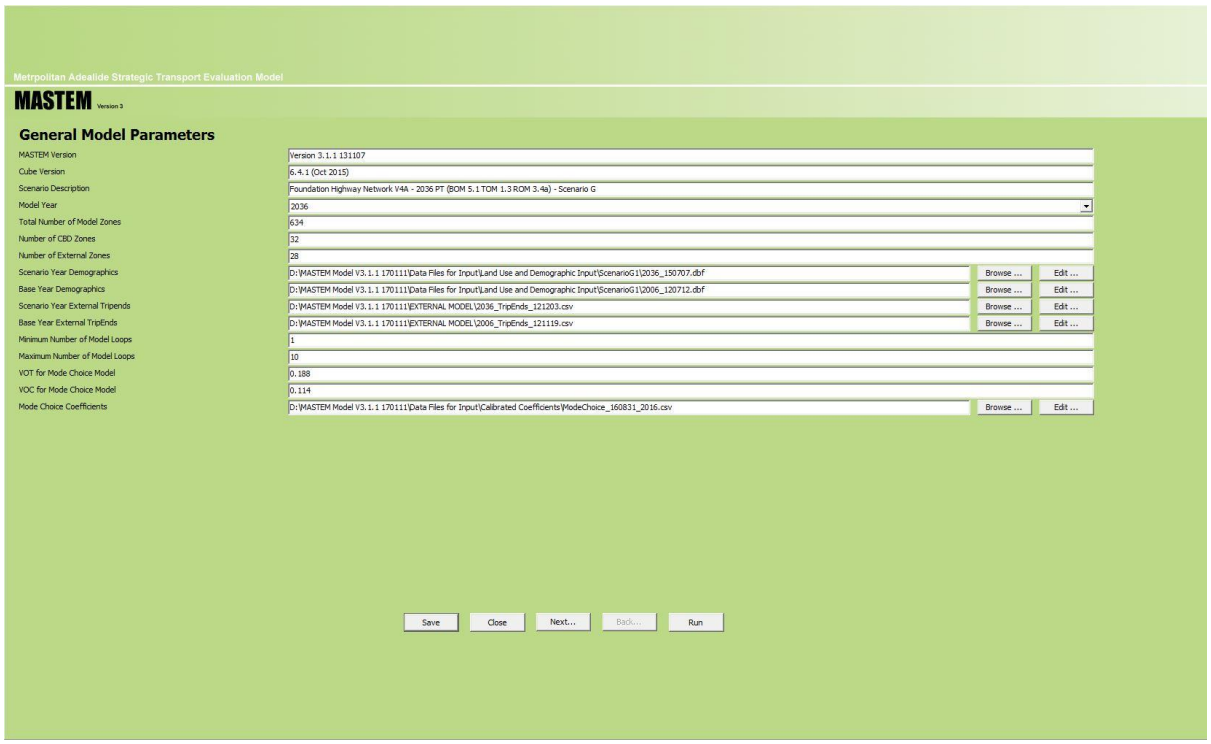


Figure 4.1 Scenario Manager – General Model Parameters

Table 4-1 General Model Parameters – Catalog Keys

Catalog Key Prompt	Description
MASTEM Version	A character key that describes the specific MASTEM version used.
CUBE Version	A character key that describes the CUBE version used.
Scenario Description	A character key that describes the scenario to be run.
Model Year	An integer number key that selects the model year.
Total Number of Model Zones	An integer number key that defines the total number of traffic activity zones.
Number of CBD Zones	An integer number key that defines the number of traffic activity zones within the Adelaide CBD.
Number of External Zones	An integer number key that defines the number of traffic activity zones for the External Vehicle Model.
Scenario Year Demographics	A file name key that identifies the input demographic data file for the model year.
Base Year Demographics	A file name key that identifies the input demographic data file for the Freight Vehicle Model base year (2006).
Scenario Year External Trip Ends	A file name key that identifies the input trip ends data file for the External Vehicle Model for the model year.
Base Year External Trip Ends	A file name key that identifies the input trip ends data file for the Freight Vehicle Model for the base year (2006).
Minimum Number of Model Loops	An integer number key which defines the minimum number of loops through the Trip Distribution, Mode Choice and Trip Assignment processes.
Maximum Number of Model Loops	An integer number key which defines the maximum number of loops through the Trip Distribution, Mode Choice and Trip Assignment processes.
VOT for Mode Choice Model	A real number key that defines the ***value of time*** used in the Mode Choice Model (Dollars per minute).
VOC for Mode Choice Model	A real number key that defines the ***vehicle operating cost*** used in the Mode Choice Model (Dollars per kilometre).
Mode Choice Coefficients	A file name key that identifies the mode choice coefficients data file for the Mode Choice Model for the model year.

4.1.2 Highway Inputs

These catalog keys define the scenario inputs required for Highway assignments. Figure 4.2 shows the CUBE Scenario Manger screen for this group and Table 4.2 describes each of the catalog keys.

Figure 4.2 Scenario Manager - Highway Inputs

Table 4-2 Highway Inputs - Catalog Keys

Catalog Key Prompt	Description
Input Foundation Network	A file name key that identifies the input Foundation Network. This may be a *.NET, *.MDB or *.GDB. Table A.1 of Appendix A describes the Foundation Network node and link attributes.
Foundation Network Shape File	A file name key that defines the shape file associated with the Foundation Network. All links except for zone connectors and walk only links should have a defined shape. The length of each link should match the ArcGIS calculated length rather than the CUBE calculated length.
DT and NT Junction File	A file name key that identifies the input junction file (*.IND) for the DT and NT time.
AM Junction File	A file name key that identifies the input junction file (*.IND) for the AM time period.
PM Junction File	A file name key that identifies the input junction file (*.IND) for the PM time period.
DT and NT Turn Penalty File	A file name key that identifies the input turn penalty file (*.PEN) for the DT and NT time periods.
AM Turn Penalty File	A file name key that identifies the input turn penalty file (*.PEN) for the AM time period.
PM Turn Penalty File	A file name key that identifies the input turn penalty file (*.PEN) for the PM time period.
Time Factor for Highway Assignment	A real number key that defines the time cost factor for path building paths during the Highway assignment process.
Distance Factor for Cars in Highway Assignment	A real number key that contains the distance cost factor for building paths for cars during the Highway assignment process.
Distance Factor for Trucks in Highway Assignment	A real number key that contains the distance cost factor for building paths for trucks during the Highway assignment process.
Car Parking Cost File	A file name key that identifies the car parking cost file which defines the cost of parking for work and non-work purposes.
Vehicle or PCU Assignment	A character key selected by radio buttons that determines whether a “Vehicle” or “Passenger Car Unit” (PCU) equivalent Highway assignment is undertaken.

4.1.3 Public Transport Inputs

These catalog keys define the scenario inputs required for Public Transport assignments. Figure 4.3 shows the CUBE Scenario Manger screen for this group and Table 4.3 describes each of the catalog keys.

Figure 4.3 Scenario Manager - Public Transport Inputs

Table 4-3 Public Transport Inputs - Catalog Keys

Catalog Key Prompt	Description
PT Lines File	A file name key that identifies the input PT Lines file (*.LIN). Appendix B describes the PT Lines file attributes.
PT Factors File – Walk / Ride / Walk Trips	A file name key that identifies the input PT Factors file (*.FAC) which defines the factors controlling the PT assignment for User Class 1 – walk / ride / walk PT trips (see figure 4.4).
PT Factors File – Drive / Ride / Walk Trips	A file name key that identifies the input PT Factors file (*.FAC) which defines the factors controlling the PT assignment for User Class 2 – drive / ride / walk PT trips (see figure 4.4).
PT Factors File – Walk / Ride / Drive Trips	A file name key that identifies the input PT Factors file (*.FAC) which defines the factors controlling the PT assignment for User Class 3 – walk / ride / drive PT trips (see figure 4.4).
PT System File	A file name key that identifies the input PT System file (*.PTS) which defines the wait curves, crowd curves, vehicle classifications and modes.
Directory for PT NTL Scripts	A file name key which identifies the directory to which the script files required to generate all model run PT Non-Transit Links are saved. Note: This catalog key is not updated by Cube when the model directory path changes and will need to be checked and updated.
PT NTL Modes File	A file name key which identifies the file (*.DBF) defining the PT access / egress modes.
PT NTL Origin Nodes File	A file name key which identifies the file (*.DBF) defining the origin nodes for each PT access / egress mode.
PT NTL Destination Nodes File	A file name key which identifies the file (*.DBF) defining the destination nodes for each PT access / egress mode.
PT Daily Fares File	A file name key which identifies the Daily Fares file (*.FAR) defining the fare structures used for the Daily PT assignment during the Build Scenario Networks application.
PT Peak Periods Fares File	A file name key which identifies the Peak Periods Fares file (*.FAR) defining the fare structures used for the AM and PM time periods PT assignments.
PT Off Peak Periods Fares File	A file name key which identifies the Off-Peak Periods Fares file (*.FAR) defining the fare structures used for the DT and NT time periods PT assignments.
Park Kiss and Ride Stations File	A file name key which identifies the Park and Ride Stations file (*.DBF) defining the PT mode, PnR name, PnR capacity, PnR node, Gate node, Stop node, PNR penalty, PnR Vehicle Occupancy (not used) and catchment nodes for each park and ride facility to be modelled.

Catalog Key Prompt	Description
Park Kiss and Ride Vehicle Occupancy File	A file name key which identifies the Park and Ride Vehicle Occupancy file (*.DBF) defining the PnR Vehicle Occupancy for each time period. Note that the values defined in this file are used rather than the values defined in the Park Kiss and Ride Stations file.
PT Interchanges File	A file name key which identifies the PT Interchanges file (*.DBF) defining the PT interchange nodes with a medium and high level of connectivity.
Run Crowding Model in Final PT Assignments Only	A Boolean key defined by a check box which activates the Crowding Model in the final PT assignments.
Run Crowding Model Inside Model Loop	A Boolean key defined by a check box which activates the Crowding Model in the PT assignments during the model loop process.
Maximum Number of Crowding Models Iterations	An integer key that defines the maximum number of iterations for the PT crowding model.

- User Class 1 allows only walk-in and walk-out modes;
- User Class 2 allows only drive-I (drive access) mode; and
- User Class 3 allows only drive-out (drive egress) mode.

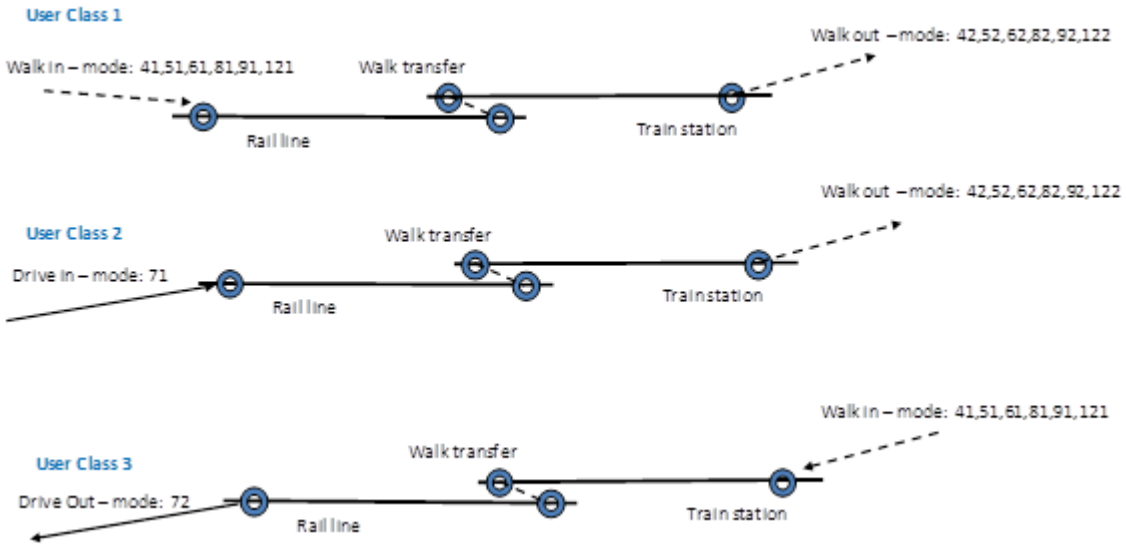


Figure 4.4 Access modes applicable for three public transport user classes

5.0 Developing/Running Scenarios

5.1 Overview

In developing and running a scenario in MASTEM there are a number of areas that need to be defined and checked depending on the type of scenario being tested – such as a new road link/capacity change; new public transport line (bus, tram or train).

Before any modelling work occurs there needs to be a clear picture of the relationship between the base case and project options within the business case. Meaning that if the base case to project case testing is to be used for a transport model outcome (e.g. testing different policy options) or an economic model (e.g. providing a benefit to cost output) or both is required.

As with any strategic model and scenario testing there are a number of variables that can be changed/developed for testing – these are described below.

5.2 Socio-Demographics

The socio-demographics contain five parts

- Population;
- Households;
- Employment (see table 5.1 for details of the employment types);
- Education (see table 5.2 for details of the education types); and
- Household characteristics such as – household size (persons/ household) residential works per household, residential dependents per household, cars per household.

The socio-demographic inputs are set within MASTEM (developed by the Departments land use forecasting team) and must be used as is. However, it is possible for some sensitivity testing to be done with the socio-demographics datasets. For this to occur there needs to be a clear and precise understanding of the methodology and the reason for developing and running an alternative socio-demographics dataset. This does not mean that the original socio-demographic dataset is not used, but rather there is now a number of the alternative socio-demographic datasets, which will be run as part of a sensitivity test. Note: Any socio-demographic datasets developed must be discussed and approved by DPTI.

Table 5-1 MASTEM Job Type Categories

Abbreviation	Definition (ANZSIC)	Job Types
Z_SER	Service	All mining, accommodation & food, finance & insurance, rental, hiring & real estate, administrative & support, public administration & safety, health care & social assistance services
Z_MAN	Manufacturing	Manufacturing services
Z_TEC	Technical/Trade	Electricity, gas, water & waste, construction, information media & telecommunications, professional, scientific & technical services
Z_TRA	Transport	Transport postal & warehousing and wholesale trade services
Z_RET	Retail	Retail services

Abbreviation	Definition (ANZSIC)	Job Types
Z_EDU	Education	Education & training services
Z_ENT	Entertainment	Arts & recreational services
Z_OTH	Other	Agriculture, fishing, forestry, other services and inadequately described/Not stated

Table 5-2 MASTEM Education Type Categories

Abbreviation	Definition	Education Types
Z_PE	Primary	Primary enrolments
Z_SE	Secondary	Secondary enrolments
Z_TE	Tertiary	Tertiary enrolments

5.3 Highway Network

5.3.1 Links and Nodes

All highway and public transport (PT) networks are stored within a network file under the "Network [1]" application within the build scenario networks 'Application Manager". This network file is a master file that contains all highway and PT links/nodes for all model years (2006, 2011, 2016, 2021, 2026, 2031 and 2036).

When developing a scenario that requires either a modification to or development of a new network a copy of the FoundationNetwork_V4A_ITLUP Base_"xxxx".NET file should be used.

In modifying or developing a new transport network the modeller needs to ensure that all fields within the new base transport network have been coded and documented in the associated report (see Appendix B for Network node and link attribute names and descriptions).

In addition to the above the node table needs to be checked to ensure that the node attributes are correct, in particular the "farezone" attribute, which is part of the public transport fare system (see section 5.4.5 – PT Fares Files" for further detail).

As part of any changes to the network file the associated GIS shape file (Foundation_Network_V4A_Matched_Shapes.shp) should also be copied and updated to provide a true shape output. As part of this process in ArcMap the distance field needs to be calculated and then the distance field within the MASTEM FoundationNetwork_V4A_ITLUP Base_"xxxx".NET updated to match this new distance. Note: The distance field calculated in Cube should not be used at any stage.

5.3.2 Junctions and Turn Penalties

The junction modelling in Cube/MASTEM is critical to overall performance and operation of the model and has a significant influence on traffic flows through the network and a clear process to verify that all junctions are working as intended should be included as part of broader modelling processes.

The junction model within MASTEM should closely emulate SCATS performance, although this will be limited to some extent by the limitations of the CUBE junction modelling. The junction model should be robust under a range of possible scenarios / time periods in order to minimise the effort required to effectively develop this critical component of the model. The significant limitations imposed by the CUBE platform emphasises the need for a clearly documented review / verification process as part of any modelling work.

There are two files that make up the junction modelling aspect within MASTEM. They are

- *{time period}* Junction Files; and
- *{time period}* Penalty Files

The Junction File describes the layout and operation of all signal controlled junctions within MASTEM. A junction file exists for each time period and model year e.g. Time period - AM, PM, Daily, Model years - 2006, 2011, 2016, 2021, 2026, 2031 and 2036. When developing a new network, which either modifies existing or creates any new intersections the original junction files need to be copied and saved as a new version for the scenario being testing. As part of modifying / updating or creating a new junction description within the junction file a description of the modifications / updates or additions needs to be included (see junction file for details) and associated report. As outlined above, the same description – i.e. lane arrangement, phasing etc. – should be used for the 3 time periods junction files for all relevant model year's dependent of the time frame of the change.

As outlined above, there is a requirement to check the performance of the signal controlled junctions to determine whether or not any further changes need to be made to the operation of any of the signal controlled junctions.

This checking is simplified by using the output files from the "Highway Junction Performance" application *(see matrix 5 under HW Assignment Statistics – HW Statistics & Travel Times)* within the model. The preferred method is to run both the Foundation Network scenario and the alternative scenario and compare the two Highway Junction Performance outputs. If changes are required, they should be made to the junction files which can be tested by running relevant time period assignment application steps. Note that the full model will need to be rerun once a final set of junction files have been developed.

Turn penalty files may be used to ban movements or to add delay to specific movements. Again, model outputs need to be checked to confirm that is the turn penalty files are working as intended.

Further details of junction modelling requirements can be found in Appendix D.

5.3.3 Parking Costs

This input parking costs file contains parking charges at designation zones for work and non-work purposes. These costs are for the full day and should be expressed as zonal averages in cents, and in 2006 prices.

Values currently vary by zone and purpose:

- Work: $5.55 to $9.05 (all day)
- Non-work: $0.90 to $2.05 (1hr)

The following assumptions derived from the Metropolitan Adelaide Household Travel Survey, 1999 (MAHTS) have been adopted:

- 31% pay for parking in CBD for work
- 32% pay for parking in CBD for non-work; and
- 13% have free car for work purposes.

These input assumptions can be modified but the methodology adopted and justification will need to be clearly documented.

5.4 Public Transport System

There are number of input files that can be modified / updated or created to assist scenario testing. The input transport system network file is accessed via the "Network [1]" application within the build scenario networks 'Application Manager". This network file is a master file that contains all highway and PT links / nodes for all model years (2006, 2011, 2016, 2021, 2026, 2031 and 2036). When updating / changing the PT system, it is important to comply with the node numbering protocol defined in Appendix B and Appendix C.

5.4.1 PT Lines

The PT lines file (*LIN) stores in a text-based format the PT routes, services and operations. Within the line file there are a number of fields that need to be filed in and checked if any modifications are made to the public transport system (see Appendix C for field details).

Table 5-3 - Public Transport Line file Inputs

PT Attribute	Data Table	Description
Name	Line	Short route name for PT service. Note: A specific convention must be applied in order for the reporting tool to report statistics correctly. The convention is different for bus, train and tram services. The convention is described in Section x.
LongName	Line	Long Name description of PT service
Mode	Line	Mode of PT service where: 1 = Non-CBD Bus 2 = Train 3 = Tram 4 = CBD Bus; and 5 = CBD Express Bus
Headway[1]	Line	AM Headway
Headway[2]	Line	DT Headway (DT = Day Time)
Headway[3]	Line	PM Headway
Headway[4]	Line	NT Headway (NT = Night Time)
Headway[5]	Line	Daily Headway
Operator	Line	Operator ID number that corresponds to the operator list inside the PT system file

PT Attribute	Data Table	Description
Vehicle Type	Line	Vehicle ID number that corresponds to the Vehicle List inside the PT system File. Note: Each vehicle types has its own seat capacity, crush capacity, load distribution factors and crowding curve.
Fare System	Line	Fare System to be applied to the PT service.
UserN1	Line	Bus Corridor Identification Field 1 (refer to Appendix C Table x for description of Bus Corridor IDs).
UserN2	Line	Bus Corridor Identification Field 2 (refer to Appendix C Table x for description of Bus Corridor IDs).
UserN3	Line	Bus Corridor Identification Field 3 (refer to Appendix C Table x for description of Bus Corridor IDs).
NNTime	Node	In vehicle time between current and previous stop node
Dwell	Node	Dwell time that occurs at stop node
UserA1	Line	Independent ID code which has come from our PTOM (Public Transport Operating Model) e.g. ID #99
UserA2	Line	Is a PT (Bus, Train, Tram) ID identifier of a specific philosophy e.g. 1.0 actual time table
UserA3	Line	Year

5.4.2 Walk Access

When modifying / updating or building a new PT service one needs to ensure that the centroid (TAZ) is connected with a walk link (Link Type 15 – [LT15]) to the associated PT node (e.g. train station, bus or tram stop). However, due to the location of the centroid and the associated PT node the walk link has the potential to have a far greater distance than excepted.

As part of this process in modifying / updating or developing walk links to PT nodes the distance field needs to change, so a more representative walk link from the build-up urban area to a PT node is captured. The process for doing this needs to consider the land use of the zone, in particular the density of the built-up environs in relation to the PT node as well as the level of service at that PT node.

For example, if a new walk link from a centroid to a Train Station has a Cube distance value of 1000 metres, but the built-up urban area and future land information shows that the majority of the built-up urban area is within 300 metres of the PT node then the actual distance show be defined within 300 to 500 metres.

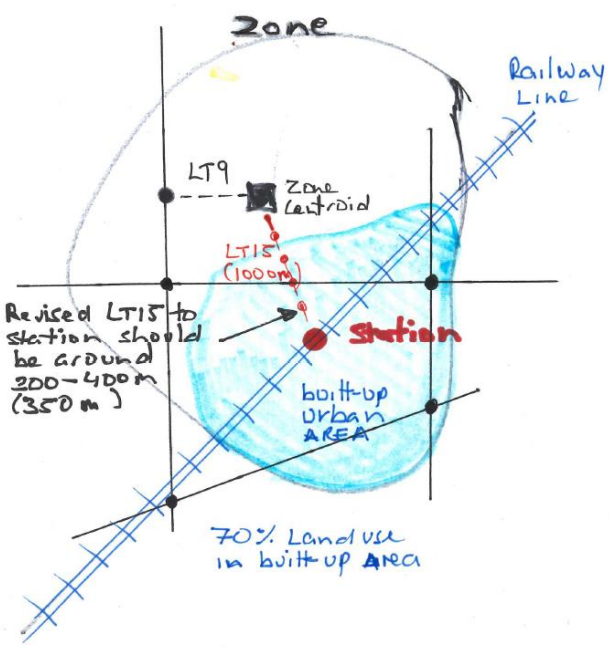


Figure 5.1 - Walk Link Distance for Built-Up Urban Area

5.4.3 PT Factors File

The PT factors file (*FAC) contains all the PT factor parameters for controlling the public transport Walk user class assignment. There are 3 files for each model year - user classes:

- UC1 = Walk/Ride/Walk trips
- UC2 = Drive/Ride/Walk trips; and
- UC3 = Walk/Ride/Drive trips

(See figure 4.4 for further detail)

Within these user class files contains a number of factors (see PTFactors_UC1_YYYY file in MASTEM):

- BRDPEN [1] = Boarding penalty is a mode specific boarding penalty in minutes
- RUNFACTOR [1] = Run factor mode-specific weighting factor applied to transit in-vehicle times and non-transit leg times.
- WAITFACTOR [1] = Node-specific wait-time weighting factor, applied to nodes.
- XFERPEN = Transit mode to transit mode transfer penalty, in minutes.
- IWAITCURVE = Wait curve used to calculated the initial wait time for trips starting at nodes specified.
- XWAITCURVE = Wait-curve number used to calculate wait times for trips that involve transfers to nodes specified.

5.4.4 PT System File

The PT system file (*PTS) stores wait curves, crowd curves, PT vehicle classifications and mode definitions.

5.4.5 PT Fares Files

The PT Fares files (*.FAR) contain the information about the fare structures used within the time periods of the model's PT assignment. There are 3 main fare types within MASTEM – being free, cost-fare and a zone-base cost in which certain nodes by PT mode have been designated free for that section.

The cost-fare type has two levels, which relate to the short distance trip (fare), applicable for two section (approximately 3km) trips and the remainder longer distance trips.

In developing a PT network there is a requirement that to ensure that the PT lines file and the associated links and node files have been correctly updated to include the requirements of the fare system built within MASTEM.

5.4.6 PT Park, Kiss and Ride Stations Files

These files (*.DBF) contains for each park and ride facility, the facilities capacity, catchment, PnR node, Gate Node, Stop node, Vehicle Occupancy and PnR penalty. When developing a Park and Ride facility one needs to ensure that the correct node and link naming convention is used as well as updating the associated files.

The park and ride layout has been coded so that nodes represent parking facilities and different link types to represent driving access between the road system and car park, as well as walking links connecting the car park and railway station. The Park and Ride (PnR) facility is connected to the road system through driving access links, which are of the same type of the surrounding road network (e.g. Link type = 7). The PnR is connected to the gate by a walk link of link type 20. The gate is connected to the railway station (or similar) by link type 21.

The link between a PnR site and Gate (LT20) is also used to store the parking capacity of the facility, which the model would use to compare against the arrival demand to determine additional delay for using PnR (see Appendix C for further detail).

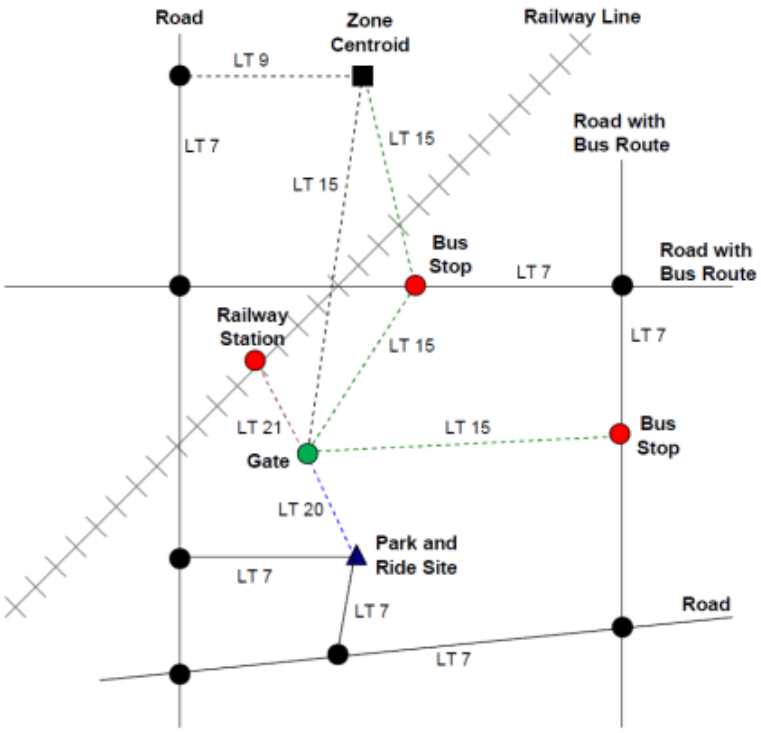


Figure 5.2 - Representation of Park and Ride Function

Node numbers:

- Park and Rides (PnR) = 7,000 – 7,499;and
- Park and Ride (PnR) gates = 7,500 – 7,999

The PnR penalty relates to a general parking inconvenience to indicate the inconvenience of searching for a parking space and walking from the car park to the station (in minutes). This penalty is to discourage passengers from using PnR who are within the walking catchment of a station.

The parking catchment has been developed from PnR surveys of vehicle number plates, which have been associated with the best fit MASTEM zone.

5.4.7 PT Interchanges File

The PT interchange priority file (*.DBF) contains a list of interchange nodes with a medium and high level of connectivity. The list of interchange nodes must be sorted in ascending order. This list has bus, train and tram interchange priorities and has a separate file for each of the model years.

The level of connectivity defined relates to the transfer wait curve (XWC type).

The PT interchange type defined as follows:

1 = normal connection – transfer penalty: 5 minutes (within modes) – 7 minutes (between modes); (the default)
2 = good connection – transfer penalty: 2.5 – 4.5 minutes; and
3 = excellent connection – transfer penalty: 0 – 2 minutes.

The normal interchange represents the existing interchange facilities. The excellent connecting interchange would be reserved for future scenarios, where new interchanges would be built or improved in such a way that there would be connecting, comfortable and seamless transfers between services.

Since the transfer penalty is associated with mode, while transfer curves are associated with the node, means that to model future interchange conditions by node level the 5 minute transfer penalty has to be associated with the normal transfer wait curve, and the two other transfer wait curves (good and excellent) have their own wait curves.

5.5 Public Transport priority

5.5.1 Bus Lanes

A bus lane facility that allows a bus to have its own lane during certain time periods. A bus lane is represented in the network by using the link attribute:

BUS_LANE with the following codes:

1 = Bus Lane – All day
2 = Bus Lane – Peaks only
3 = Bus Lane – AM peak only
4 = Bus Lane – PM peak only; and
5 = Bus Lane – AM peak, Daytime, PM peak only

For the road links that have bus lanes, it is assumed the bus lane will operate at the free speed as they do not have to interact with general traffic mix. In these cases, bus travel time is set equal to the free flow travel time plus intersection delay.

5.5.2 Junction Priority

The highway assignment produces output turn penalty files that summarise the delay for each movement at each intersection. These outputs can be linked into the PT module as an input so that PT paths and in-vehicle time will consider the turn delay.

A link attribute, BUS_PRIORITY has been coded in the highway network to identify the approaches having bus priority. In the situation where bus priority exists, the bus will experience considerable less delay at the intersection compared to other vehicles. As soon as a bus arrives at an intersection, it will be given priority to make its movement within the next phase.

6.0 Model Outputs

6.1 Scenario Reporting

This application provides four Pilot steps that can be used to extract summarised model outputs for a range of different purposes via a series of Microsoft Excel workbooks. The available Pilot steps enable the following workbooks to be created:

- the Calibration Results workbook which includes a set of calibration results worksheets
- the Summary Assignment Results workbook which includes a set of both Highway and Public Transport assignment results worksheets
- the Screenline Results workbook which includes a set of worksheets to assist the assessment of both Highway and Public Transport screenline flows
- the Public Transport Lines Results workbook which contains a set of worksheets to assist the assessment of the Public Transport system

Double clicking the Pilot step opens the specific Microsoft Excel workbook. In all cases the first available worksheet is essentially the same as shown in Figures 6.1 to 6.4.

Figure 6.1 Scenario Reporting - Calibration Results Workbook - Start Worksheet

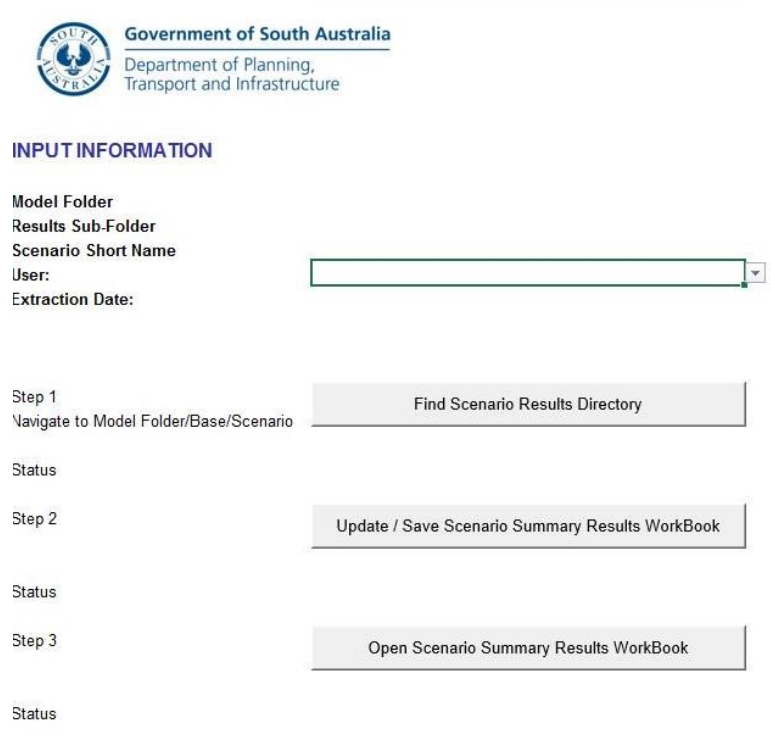


Figure 6.2 - Scenario Reporting - Summary Results Workbook, Start Worksheet

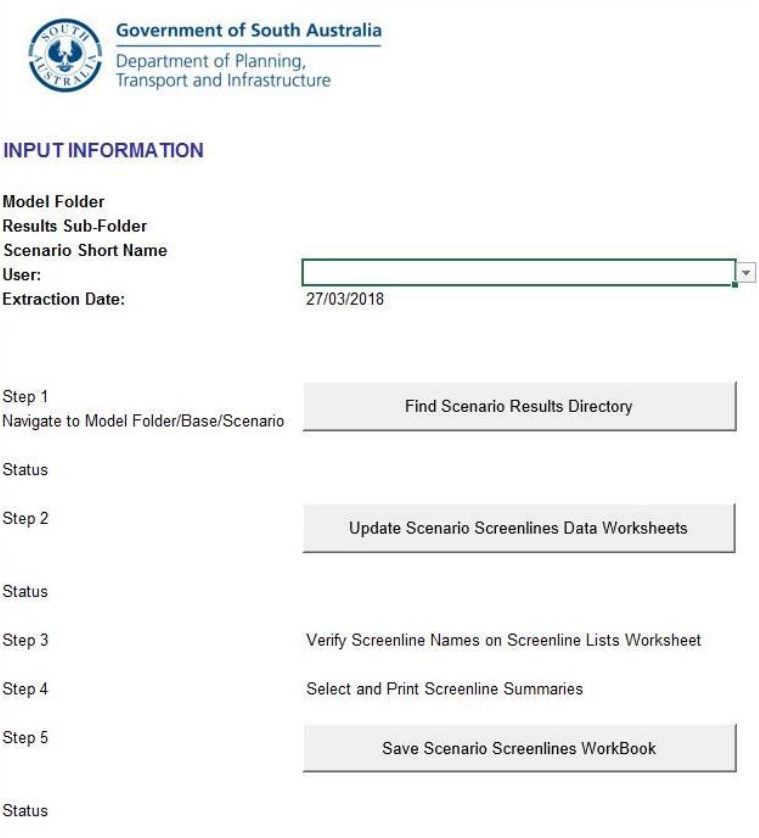


Figure 6.3 - Scenario Reporting - Screenlines Results Workbook, Start Worksheet

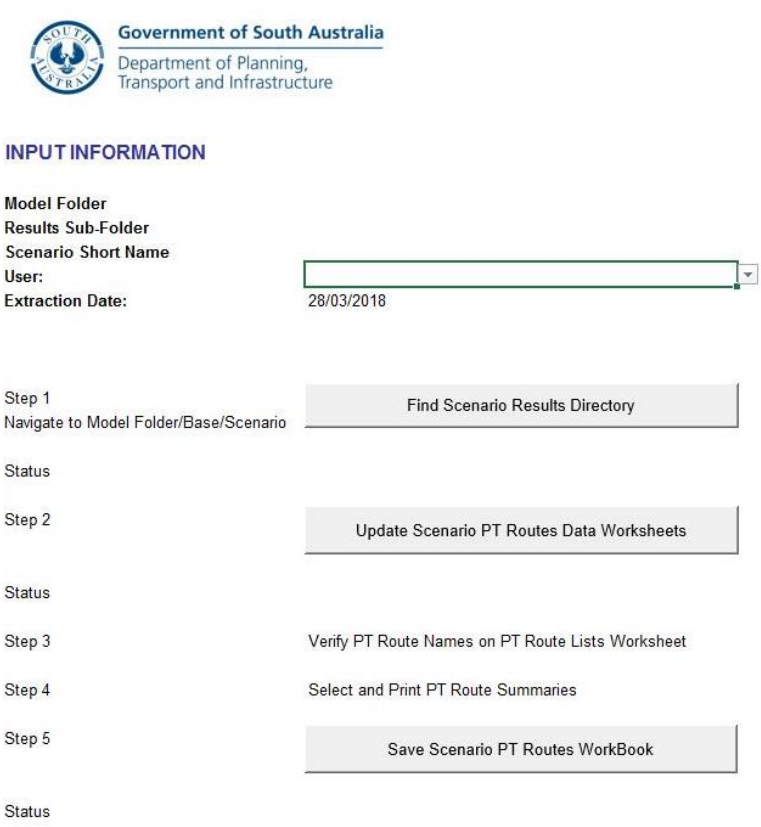


Figure 6.4 - Scenario Reporting – PT Lines Workbook – Start Worksheet

In all cases the first step is to “Find Scenario Results Directory” by clicking the button and then using the navigation pane to select the directory for the specific scenario and selecting the SCENARIO_S_”year”_”scenario_name” file e.g. SCENARIO_S_2016_Do Nothing. This file will be located under the MASTEM Model/Base/specific year of the scenario/The Scenario. For example MASTEM Model V3.1.1 190215/Base/2016/S_2016_Do Nothing/Scenario_S_2016_Do Nothing (CSV file format).

The following steps involve clicking the subsequent buttons so that the Excel macro runs the processes required. This will then create and new Excel file e.g. Calibration_Results_S_2016_Do Nothing, which will be located in the Results folder/ Base/ Year/ Scenario e.g. Results/ Base/ S_2016/ S_2016_Do Nothing/Calibrated_Results_S_2016_Do Nothing (xlsm). This will be similar for the other worksheet outputs.

6.2 Loaded Highway and Pubic Transport Networks

These two networks contain scenario specific modelling outputs. The Loaded HW and PT Networks contained a summary of specific highway based or public transport based model results by time period. A sample of these attributes and there descriptions has been summarised in Table 6.1 and Table 6.2 respectively below (For a full list of the attributes of the highway and PT networks see Appendix B and C).

Table 6.1 show a sample of the link attributes contained within the final loaded highway network.

Table 6-1 Link Attribute List for Final Loaded Highway Network

Link Attribute Name	Description
AADT	Average Annual daily travel for modelled scenario – two way
AADFL	Average Annual daily flow for modelled scenario – one way
AADCARS	Average Annual daily car for modelled scenario – one way
AADTRUCKS	Average Annual daily trucks for modelled scenario – one way
AADCARP	Average Annual daily car passengers for modelled scenario – one way
AMTOTAL	Total traffic for AM peak hour for modelled scenario – two way
AMFLOW	Flow for AM peak hour for modelled scenario – one way
AM_CAR	Cars for AM peak hour for modelled scenario – one way
AM_TRCK	Trucks for AM peak hour for modelled scenario – one way
AM_BUS	Buses for AM peak hour for modelled scenario – one way
AM_CARP	Car passengers for AM peak hour for modelled scenario – one way
AM_BUSP	Bus passengers for AM peak hour for modelled scenario – one way
D_VC	Weighted average V/C ratio across the day
D_CONGT	Weighted average travel time across the day
D_CONGS	Weighted average travel speed across the day
D_BUSS	Weighted average travel time for buses across the day
AM_DIRVC	V/C for AM peak hour in the direction of travel
AM_CONGT	Congested travel time for the AM peak hour
AM_CONGS	Congested travel speed for AM peak hour
AM_BUSS	Congested travel speed for buses during the AM peak hour
DT_MAXVC	Maximum V/C for DT typical hour considering both directions of travel. Note: This is only done for DT and NT periods.
D_BHDWY	Average bus headway across the day
D_BLOAD	Average bus occupancy across the day
AM_P_BHDWY	Average bus headway for the AM peak period
AM_P_BLOAD	Average bus occupancy for the AM peak period

Table 6.2 show a sample of the link attributes contained within the final loaded public transport network.

Table 6-2 Link Attributes List for Final Loaded Public Transport Network

Link Attribute Name	Description
AMBUSES	Number of buses for the AM peak period
AMBHDWY	Average bus headway for the AM peak period
AMBPASS	Number of bus passengers for the MA peak period
AMBLOAD	Average bus occupancy for the AM peak period
AMBSPD_1	Average speed for mode 1 buses during the AM peak period (see Appendix C1 for bus types)
AMBSPD_4	Average speed for mode 4 buses during the AM peak period (see Appendix C1 for bus types)
AMBSPD_5	Average speed for mode 5 buses during the AM peak period (see Appendix C1 for bus types)
AMBUS_SCAP	Total AM period bus seated capacity for the link
AMBUS_CCAP	Total AM period bus crush capacity for the link
AMTRAINS	Number of trains for the AM peak period
AMTRNHDWY	Average trains headway for the AM peak period
AMTRNPASS	Number of train passengers for the MA peak period
AMTRNLOAD	Average train occupancy for the AM peak period
AMTRNSPD	Average train speed during the AM peak period
AMTRN_SCAP	Total AM period train seated capacity for the link
AMTRN_CCAP	Total AM period train crush capacity for the link
AMTRAMS	Number of trams for the AM peak period
AMTRMHDWY	Average trams headway for the AM peak period
AMTRMPASS	Number of tram passengers for the MA peak period
AMTRMLOAD	Average tram occupancy for the AM peak period
AMTRMSPD	Average tram speed during the AM peak period
AMTRM_SCAP	Total AM period tram seated capacity for the link
AMTRM_CCAP	Total AM period tram crush capacity for the link

6.3 Report Tool Overview and Its Contents

The reporting spreadsheet takes the outputs from a specific model run and in an automated fashion produces reporting statistics for all modes, Car, PT, walk and Bike (see section 7.1 Scenario Reporting above on how to produce the Summary Statistics Workbook). The contents of the reporting tool and the statistics that each worksheet shows has been summarised in the Table 6.3.

Table 6-3 Reporting Tool Contents

Worksheet Name	Statistics Shown	Comment
Main	N/A	Used to import data
List	N/A	Contains a list Route IDs and their corresponding Route name for train and tram routes
Contents	Contains for each “Model data” sheet the Cube file’s name, location, last modified date and the import date	
T1-Summary	Worksheet Same sheet as original reporting tool, it contains	Statistics summary for all modes – Statistics do not include intrazonal data
T2 Catalog	List of inputs used for each of the model’s input keys	
T3-PT	Boardings Same as original reporting tool, it shows PT boardings by PT mode, Bus Corridor, Train and Tram Route and Bus Service by time of day	Statistics do not include intrazonal data
T4-Mode	Share Results Same as original reporting tool, it shows person trips by mode and trip purpose, plus by trip purpose and house type	Statistics do not include intrazonal data
T5-Vehicle Statistics	Same as original reporting tool. It shows the total number of trips, VKT and VHT by time of day for Car Person, Car Vehicle, All vehicles, All person, all internal vehicle trips, all car trips and all HCV trips. Statistics have also been summarised to include and excluding intrazonal data	
T6-PT Statistics	Same as original reporting tool, it shows boardings, PKT, PHT, VHT, VKT by time period and by train, tram and bus.	Statistics have been summarised to include and excluding intrazonal data
T7-NonMotor Statistics	Same as original reporting tool, it shows statistics for walk and bike modes total trips, VHT and VKT by time of day.	Statistics have been summarised to include and excluding intrazonal data
T8-Highway Screenline	Same as original reporting tool, summaries vehicle flows for AM, PM DT and NT peak hour	

Worksheet Name	Statistics Shown	Comment
T9-PT Screenline	Display for each road in both the Highway and PT screenlines the total PT load, PT capacity and the Volume to Capacity Ratio by time period and direction.	
T10-PT Access	Same as original reporting tool, summarises trips, PKT, PHT for all non-transit access modes by origin and destination, time period and PT mode	
Economic Summary Table	Summarises all modal statistics required for economic evaluation	
Access Stats	Summarises daily trips, PKT, PHT for the all non-transit access modes by origin and destination and PT mode. It also summarises the total wait and transfer time	
Summary Stats PT	Summarises PT Trips, Boardings, PHT, PKT, VHT and VHT by time period by PT mode	
Summary Stats_Non_PT	Summarises car, car person, commercial vehicle, walk and bike Trips, VKT and VHT by Time Period	Statistics do not include intrazaonal data
Tram Lines Report	Summarises average service time, average service distance, passengers, PKT, PHT, PT vehicles, VHT and VKT for each tram Route by direction	
Train Lines Report	Summarises average service time, average service distance, passengers, PKT, PHT, PT vehicles, VHT and VKT for each train Route by direction	
Station Access and Transfer	Summarises for each gate link within the model, walk Park and Ride and Kiss and Ride demand by time period.	Assumption for calculating the Kiss and Ride demand is that PNR vehicle occupancy is 1, thus the remainder of the total vehicle occupancy is caused by the Kiss and Ride demand
TRAMLine-Direction	Summarises total Boardings, alightings, walk access boardings, Park and Ride boardings, VHT, VKT, PKT, passenger minutes travelled, Passengers per Vehicle Kilometre, Passengers per Vehicle hour, load, capacity and volume to capacity ratio along the length of each Train Route by time of day.	To change routes use the Route ID drop select box at the top of the sheet
TrainLine-Direction	Summarises total Boardings, alightings, walk access boardings, Park and Ride boardings, VHT, VKT, PKT, passenger minutes travelled, Passengers per Vehicle Kilometre, Passengers per Vehicle hour, load, capacity and volume to capacity	To change routes use the Route ID drop select box at the top of the sheet

Worksheet Name	Statistics Shown	Comment
	ratio along the length of each Tram Route by time of day	
TRAMLine-TwoWay	Summarises total Boardings, alightings, walk access boardings, Park and Ride boardings for each Tram Route's stop by time of day	To change routes use the Route ID drop select box at the top of the sheet
TrainLine-TwoWay	Summarises total Boardings, alightings, walk access boardings, Park and Ride boardings for each Train Route's stop by time of day	To change routes use the Route ID drop select box at the top of the sheet
Tram_Service_Summary	Summarises Boardings, VHT, VKT, Passengers per Vehicle Kilometre, Passengers per Vehicle hour, maximum load, capacity and volume to capacity ratio for each Train Service by time of day	
Train Service Summary	Summarises Boardings, VHT, VKT, Passengers per Vehicle Kilometre, Passengers per Vehicle hour, maximum load, capacity and volume to capacity ratio for each Tram Service	
Bus_Service_Summary	Summarises Boardings, VHT, VKT, Passengers per Vehicle Kilometre, Passengers per Vehicle hour, maximum load, capacity and volume to capacity ratio for each Bus Service	

Note: PKT= Passenger Kilometres Travelled, PHT=Passengers Hour Travelled, VKT=Vehicle Kilometres Travelled, VHT=Vehicle Hour Travelled

6.4 MASTEM User Benefit Calculation Tool (MUBCT)

6.4.1 MASTEM Outputs

Within MASTEM two matrix files are produced for each scenario year and option. These two files are: -

- PT_USER_BENEFIT_TOOL_DATA_S_"YYYY".MAT
  - PT matrix file contains 55 matrices
- HW_USER_BENFIT_TOOL_DATA_S_"YYYY".MAT
  - HW matrix file contains 70 matrices

As part of the MASTEM process a single matrix files is produced, which is used as an input into the MUBCT model, which is a separate Cube based model. This file can be found under the MUBCT Matrices application [1] as shown in Appendix A Figure A9.5.7. The file is: -

- COMBINED_USER_BENEFIT_MATRICES_S_"YYYY".MAT
  - The combined matrix file contains 125 matrices

6.4.2 MUBCT

The MUBCT was developed in the Cube Voyager and Microsoft Excel software platforms. User-benefit calculations are not always required after every run of MASTEM, thus the MUBCT was been developed as a separate post-processing tool that forms part of the MASTEM suite.

The tool resides in the MASTEM 'Results' folder along with the summary statistics reporting. To provide consistency with the summary statistics reporting, the results from the MUBCT have been developed with a similar style including a catalogue key report, specific to the MUBCT catalogue key.

The version of MUBCT currently used operates using the following software:

- MASTEM Model V3.1.1 (15/02/2019)
- CUBE Voyager 6.4.4 (18 June 2018) and Microsoft Excel 2013

To use and run the MUBCT the previous MASTEM Combined user benefit matrices for a Base Case and Project Case scenario is required as inputs as shown in Figure 6.5 MASTEM USER BENEFIT CALCULATION TOOL – Main Input page. The yellow highlights and red circle identify the Base Case matrices input required and the Project Case matrices input respectively. For example - the BC Combined User Benefit Matrices S_2036 file and PC Combined User Benefit Matrices S_2036 file from the MASTEM scenario runs that have been completed.

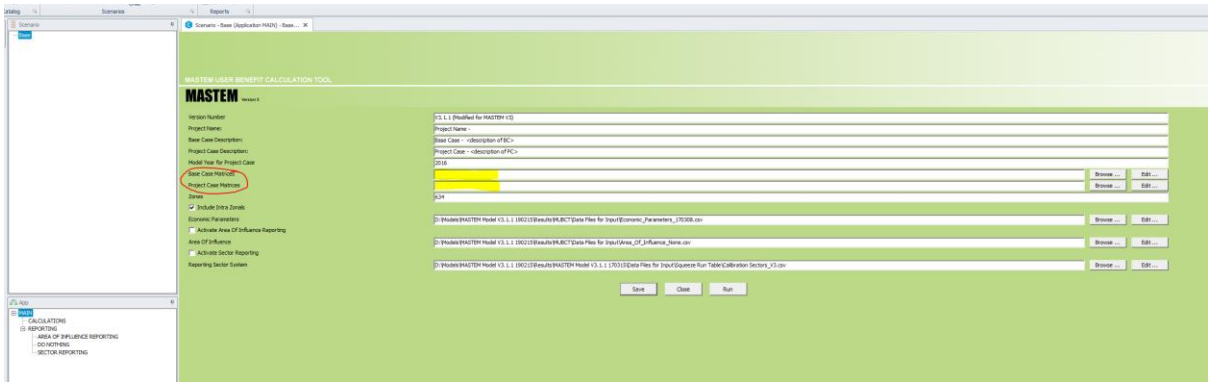


Figure 6.5 - MUBCT - Main input page

For a full list of the attributes and screen shots can be seen in Appendix E a long with the "Technical Report' by SMEC for the original Origin-Destination User Benefit Tool (ODUBT)[4] – now MUBCT. Note that this report is for MASTEM V2.3, however the same methodology and calculations (formulas and parameters) have been used in this version for MASTEM V3.1.1.

It is emphasised that the MUBCT summary outputs are produced by the deactivated Run MUBCT Reporting Tool – Summary Results application on the Reporting page which can only be done once the model run has finished.

6.5 Using Model Outputs

As with any model, care must be taken when using outputs for either subsequent analysis or to input into another model. As part of this process all model outputs need to be subject to a review process to ensure that they are fit for purpose.

7.0 Model Auditing

7.1 MASTEM Audit Checklist

All scenarios developed either by / for DPTI or by / for others and requiring DPTI involvement, are to be audited at defined hold points during this model development process. This audit is to be undertaken by a suitably qualified and experienced modeller who is wholly independent of the project team. The primary purpose of this audit is to ensure that all models have been developed and validated to the specified standard, they are sufficiently accurate and robust given their intended purpose and DPTI is able to use the model outputs / results with confidence.

At each hold point relevant model parameters / characteristics should be checked to ensure that acceptable values / approaches have been adopted. A checklist has been developed to assist this process and a copy is included as Appendix F. At each hold point the auditor is to complete the relevant column in the checklist and return the checklist to DPTI for the Agency's response to the issues identified by either the audit or the operational review to be added. The checklist is then to be provided to the modeller to make any necessary changes and to add the modeller's response to the issues identified.

Suggested hold points - which may not apply to all scenarios - are:

- Coded / developed scenario networks for base case (Hwy, PT, Junctions);
- Coded / developed scenario networks for project case (Hwy, PT, Junctions);
- Junction performance outputs

[4] SMEC Origin-Destination User Benefit Tool (ODUBT) – Technical Report August 2015, Available in Appendix E of this document.

Appendix A – MASTEM Model Structure

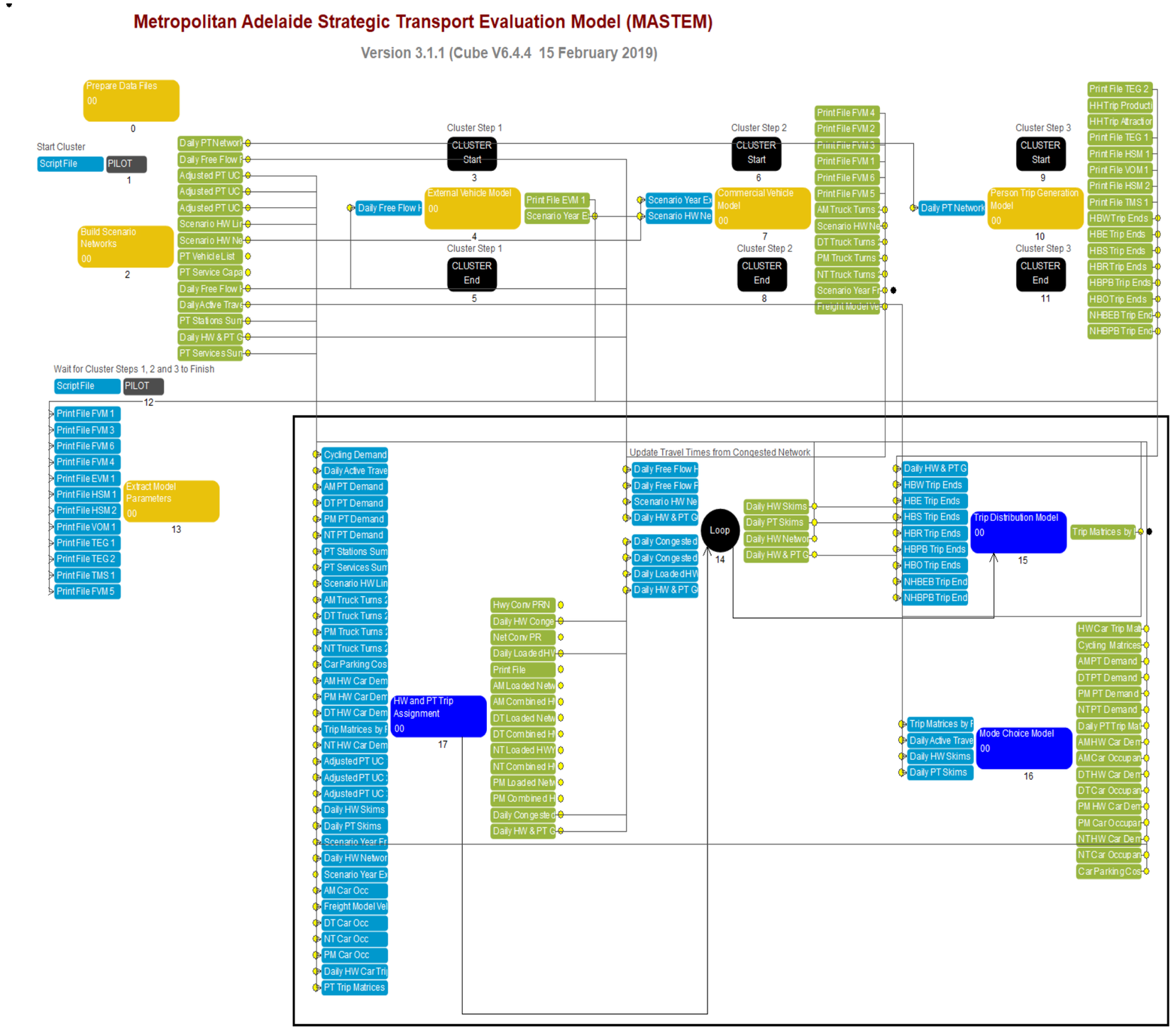


Figure A.0 - MASTEM main modal structure

DATA PREPARATION

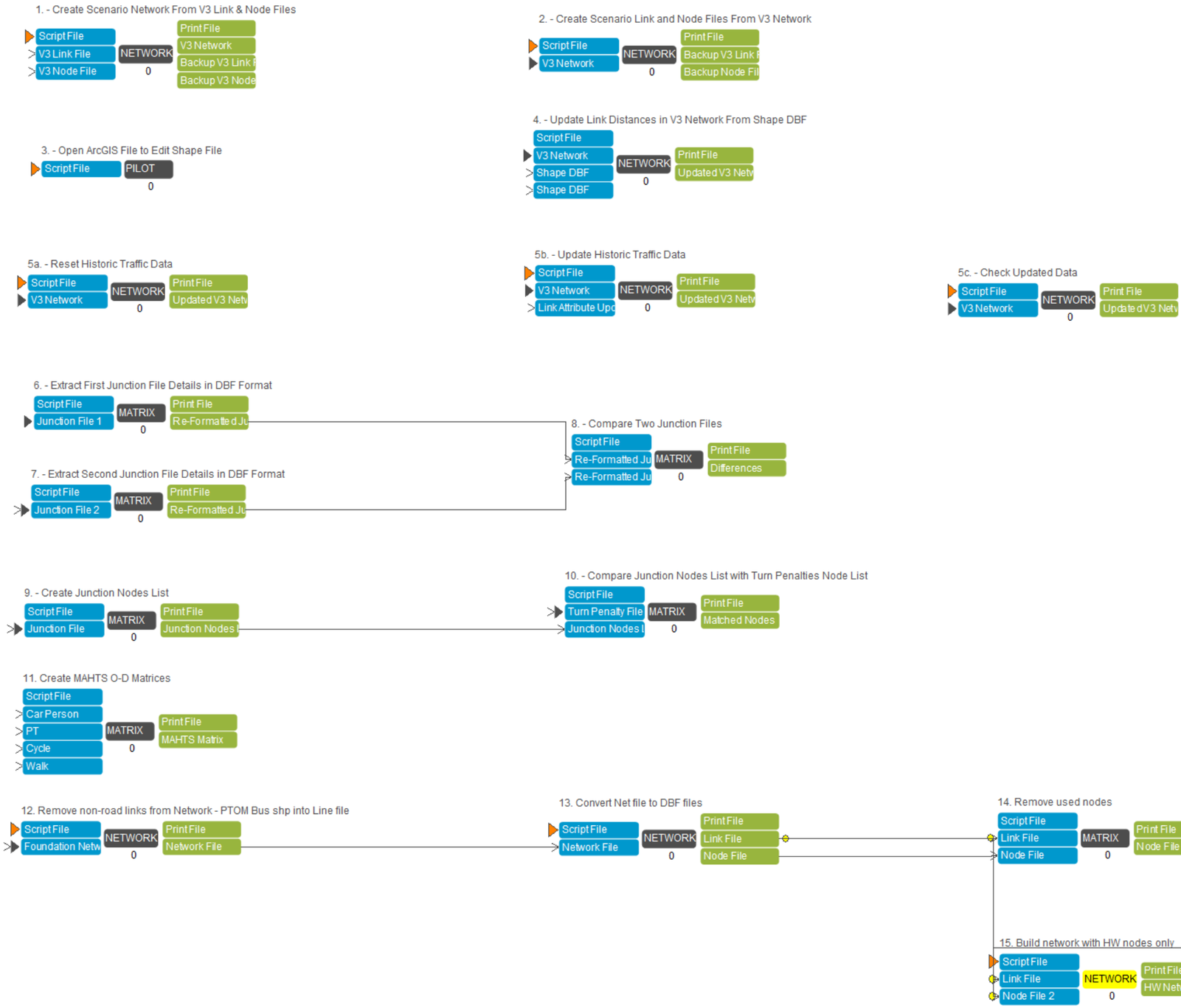


Figure A.1 - Data Preparation Applications

BUILD SCENARIO NETWORKS

-Build scenario-specific Highway and PT networks
-Create initial time and distance skim matrices for both networks

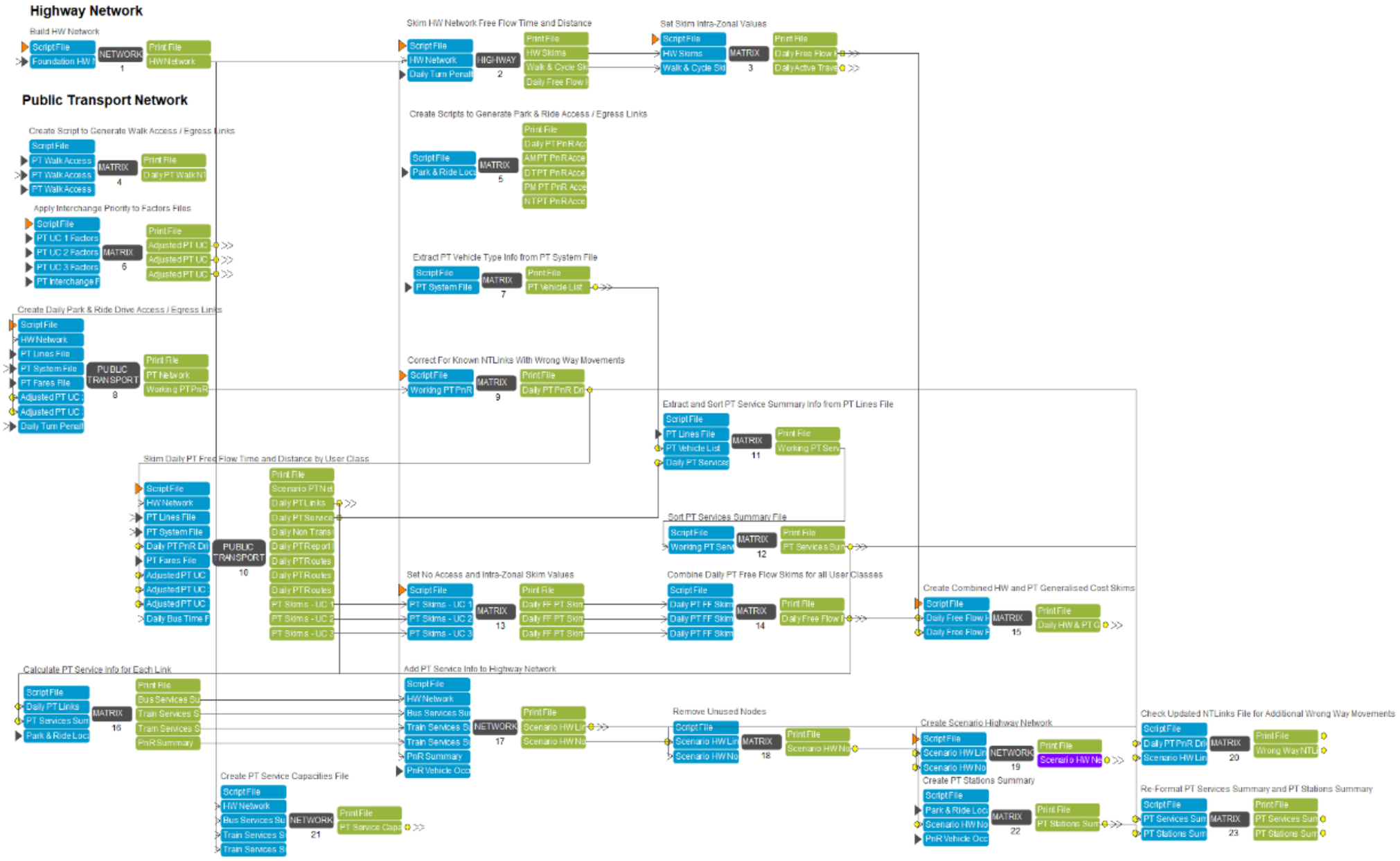


Figure A.2 - Build Scenario Networks Applications

EXTERNAL TRAFFIC

Produce Daily, AM , DT, PM and NT trip matrices for traffic with an origin or destination beyond the model boundary. (Last updated April 2011 for MASTEM V3)

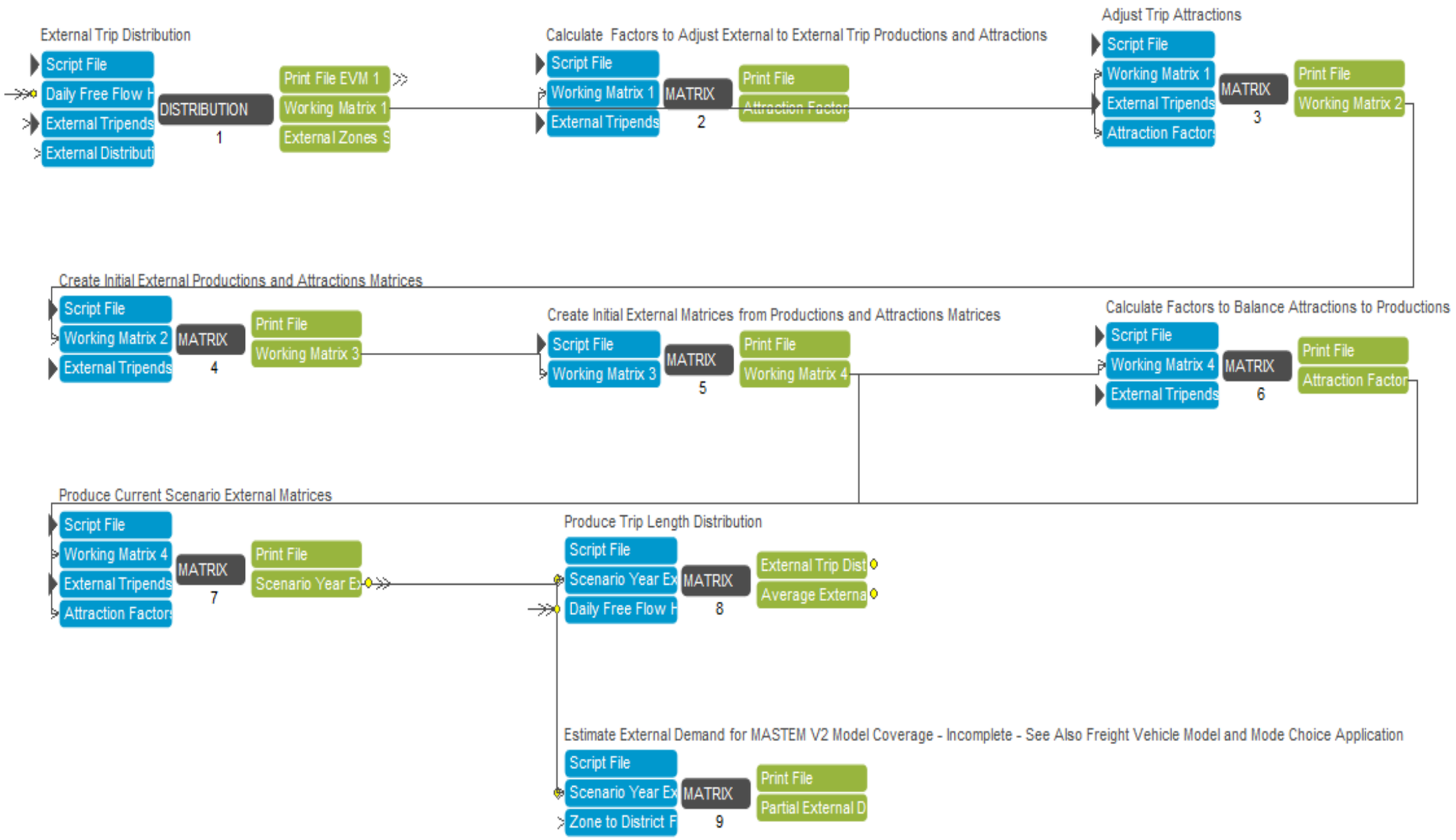


Figure A.3 - External Vehicle Model Applications

COMMERCIAL VEHICLE MODEL

Produce Daily Commercial Vehicle Demand Matrices

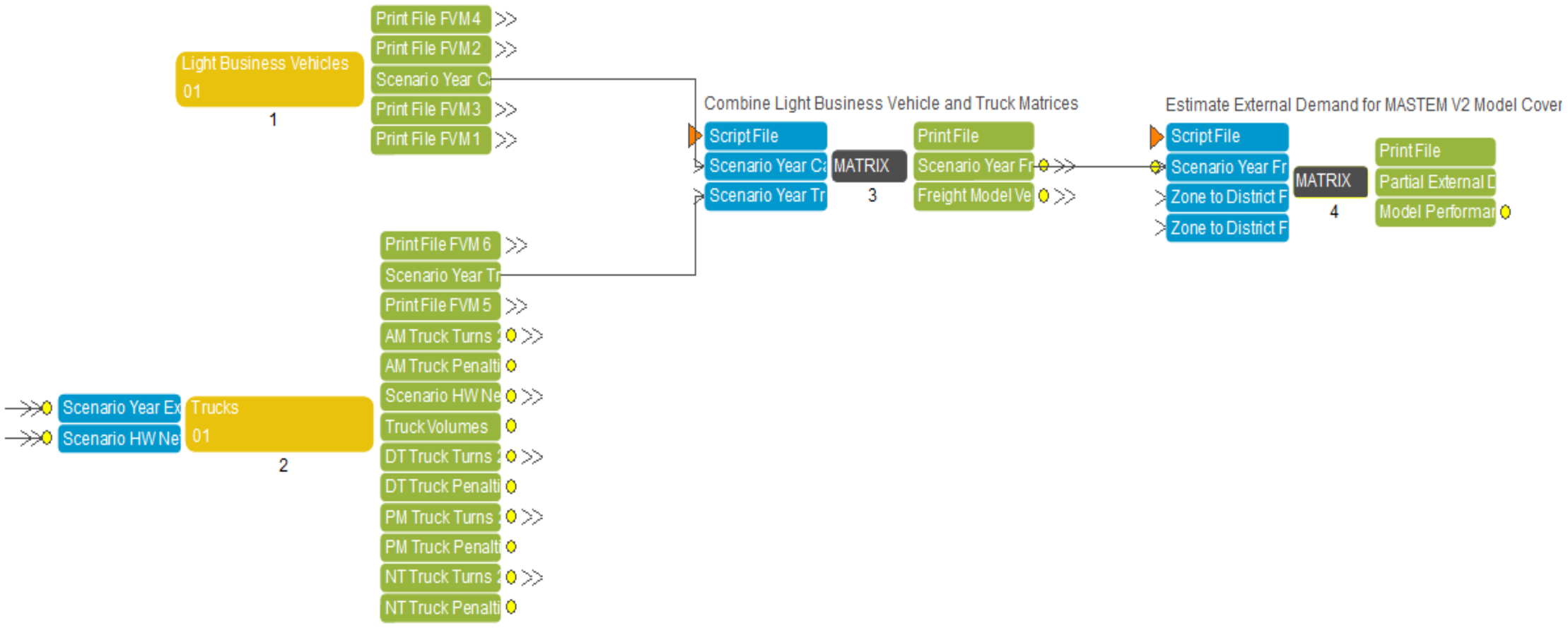


Figure A.4 - Commercial Vehicle Model Overview

COMMERCIAL VEHICLE MODEL: Light Business Vehicles - excludes NHBEB Cars

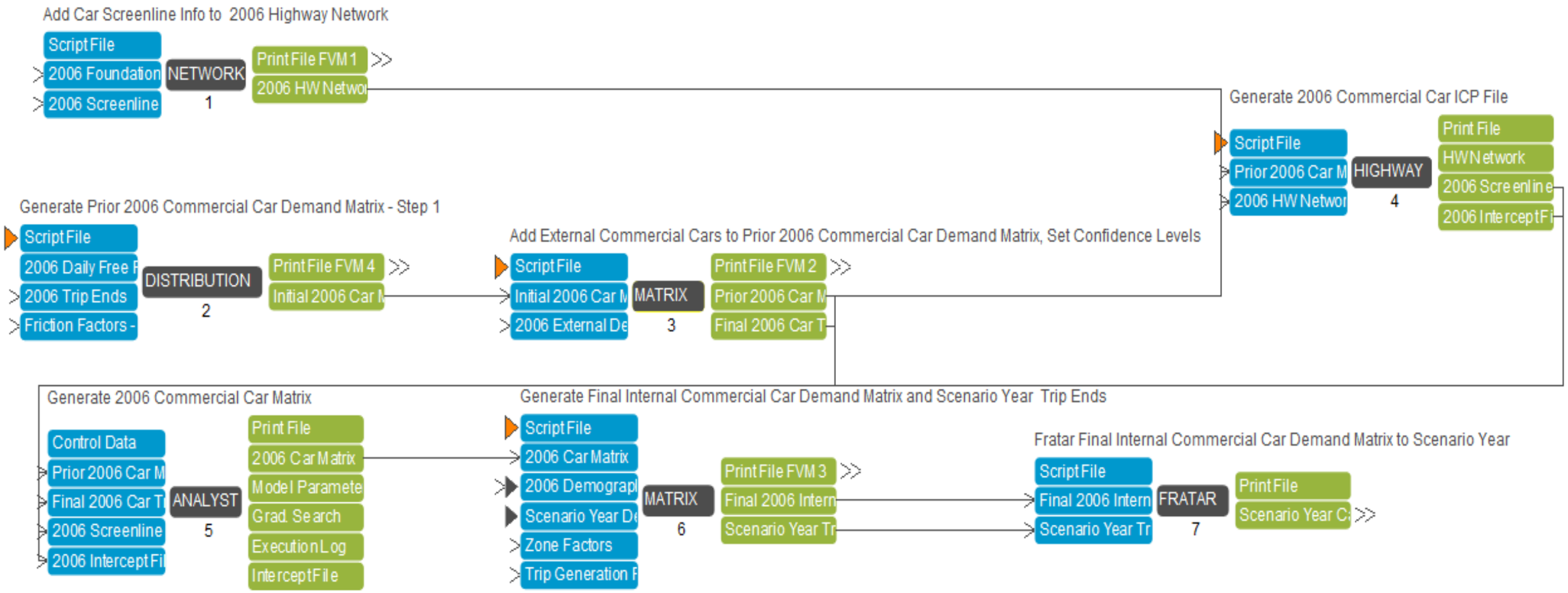


Figure A.4.1 - Light Business Vehicle Model Applications

COMMERCIAL VEHICLE MODEL: Trucks

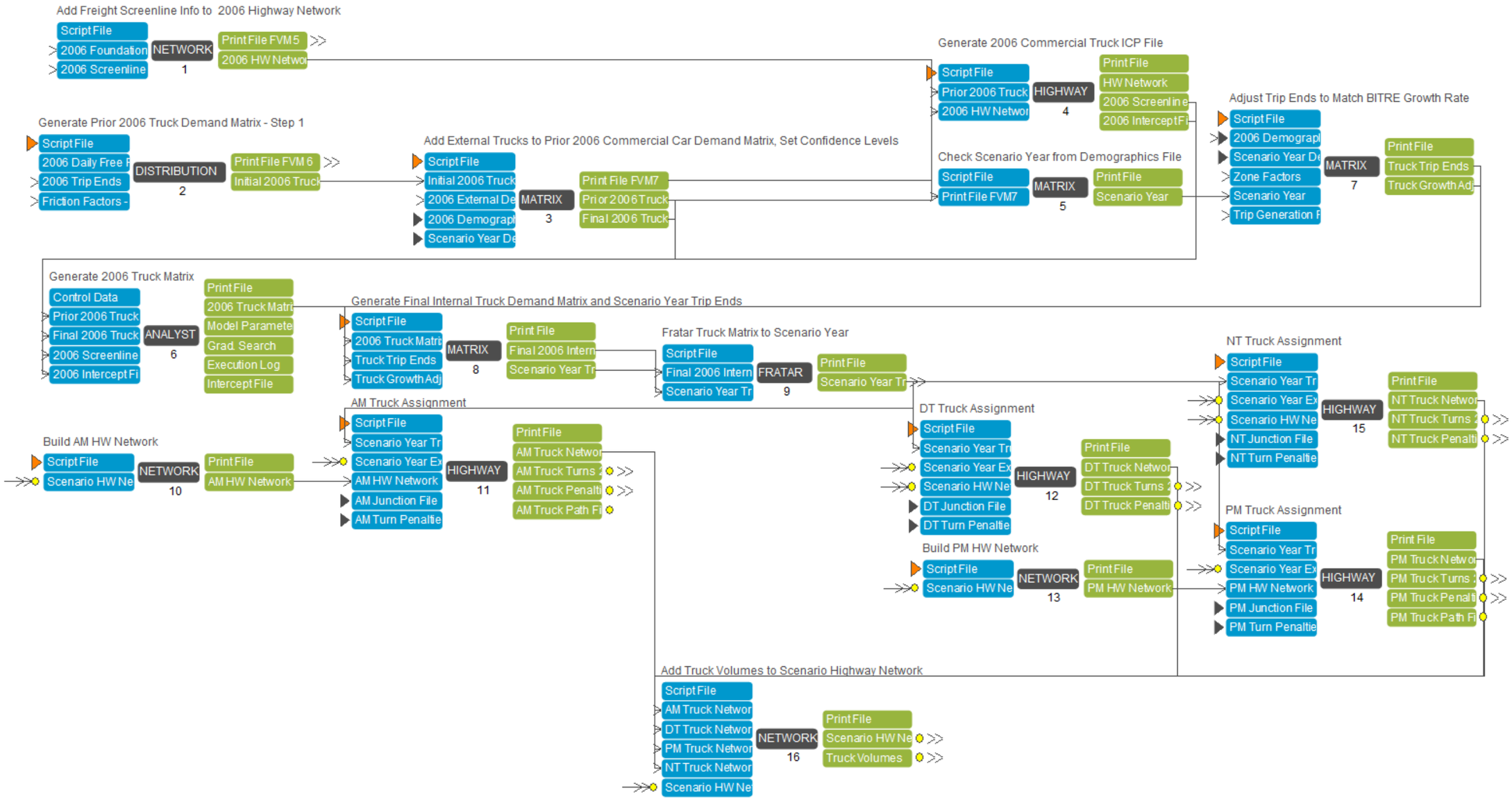
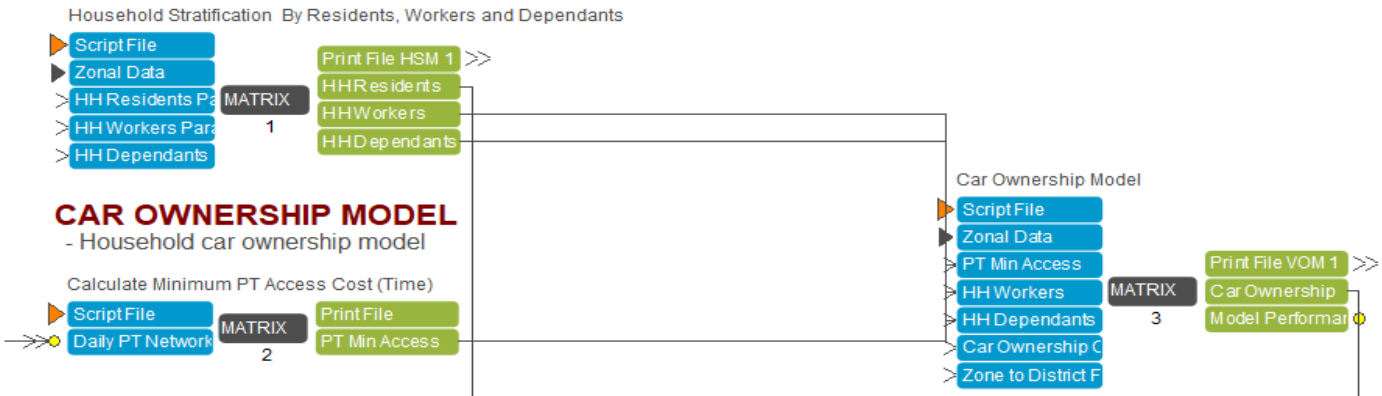


Figure A.4.2 - Truck Vehicle Model Applications

HOUSEHOLD STRATIFICATION BY RESIDENTS, WORKERS and DEPENDANTS

- Zonal averages of residents, workers, dependants and cars are used to determine the proportion of houses with:
1 - 6+ Residents,
0 - 3+ Workers,
0 - 4+ Dependants,



CAR OWNERSHIP MODEL

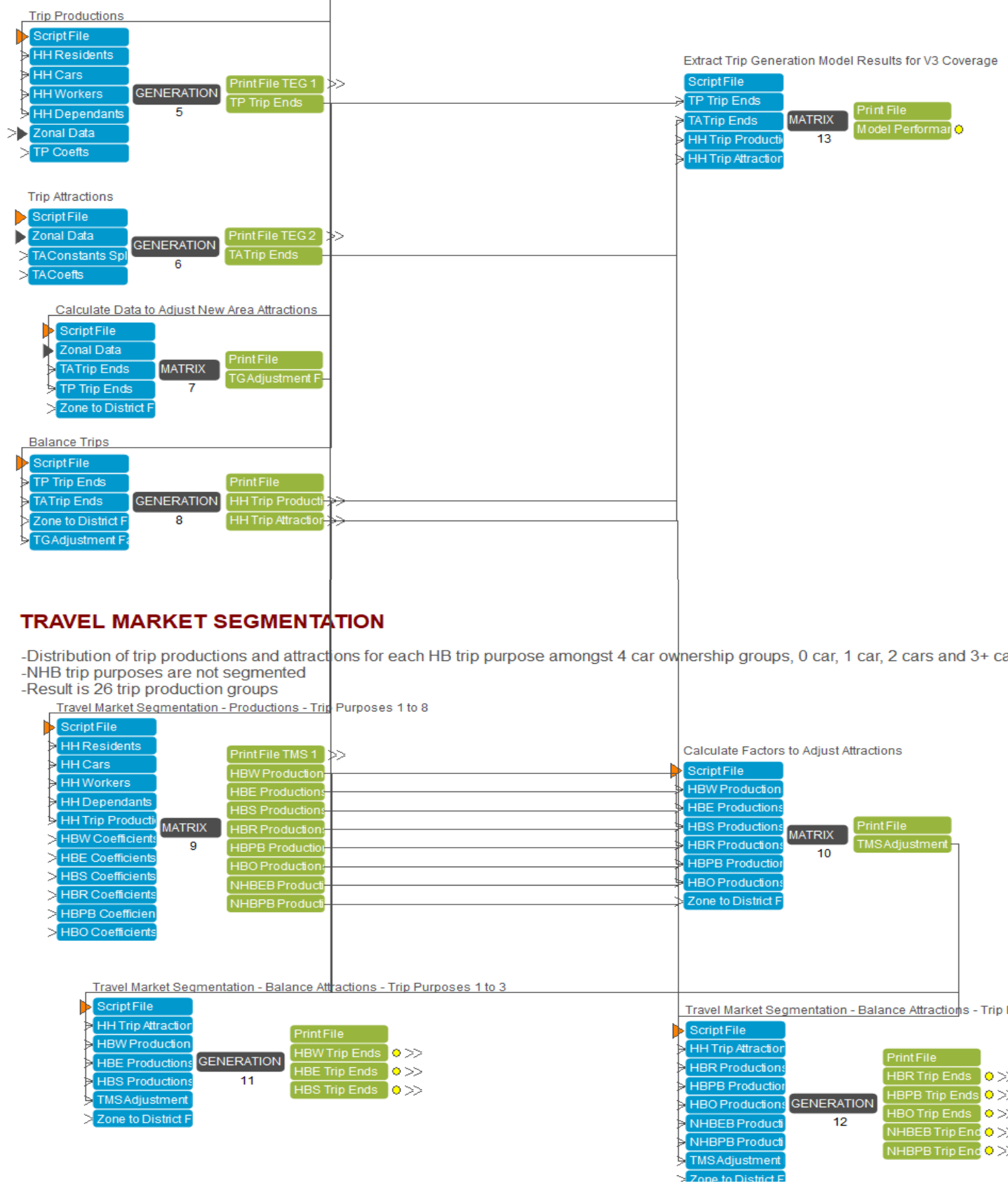
- Household car ownership model

HOUSEHOLD STRATIFICATION BY CAR OWNERSHIP

TRIP END GENERATION

-Generate trip productions and attractions for 8 Home Based (HB) and Non-Home Based (NHB) trip purposes including:
+ HB Work, HB Education, HB Shopping, HB Recreation, HB Personal Business, HB Other
+ NHB Employer's Business, NHB Personal Business

- For HB trips, balance total productions to match total attractions by trip purpose
For NHB trips, balance total attractions to match total productions by trip purpose



TRAVEL MARKET SEGMENTATION

-Distribution of trip productions and attractions for each HB trip purpose amongst 4 car ownership groups, 0 car, 1 car, 2 cars and 3+ cars
-NHB trip purposes are not segmented
-Result is 26 trip production groups

Figure A.5 - Person Trip Generation Model Application

External Vehicle Model Parameters Information

Extract External Vehicle Model Parameters Info

Freight Vehicle Model Parameters Information

Extract 2006 Foundation Network and 2006 Car Screenlines Info

Extract 2006 Truck Screenlines Info

Extract Truck Friction Factors Info

Extract Trip Generation Model Factors Info

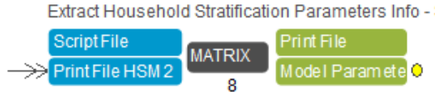
Extract 2006 Skim Info and Car Friction Factors Info

Extract Vehicle Ownership Parameters Info

Household Stratification Model Paramenters Information

Extract Household Stratification Parameters Info - Step 1

Extract Household Stratification Parameters Info - Step 2



Extract Trip Purpose Parameters Info

Trip Generation Model Paramenters Information

Extract Trip Productions Parameters Info

Extract Trip Attractions Parameters Info

Figure A.6- Extract Model Parameters Application

TRIP DISTRIBUTION

-Gravity model distributes trip end productions amongst attractions
-Friction factors are applied in the gravity model distribution

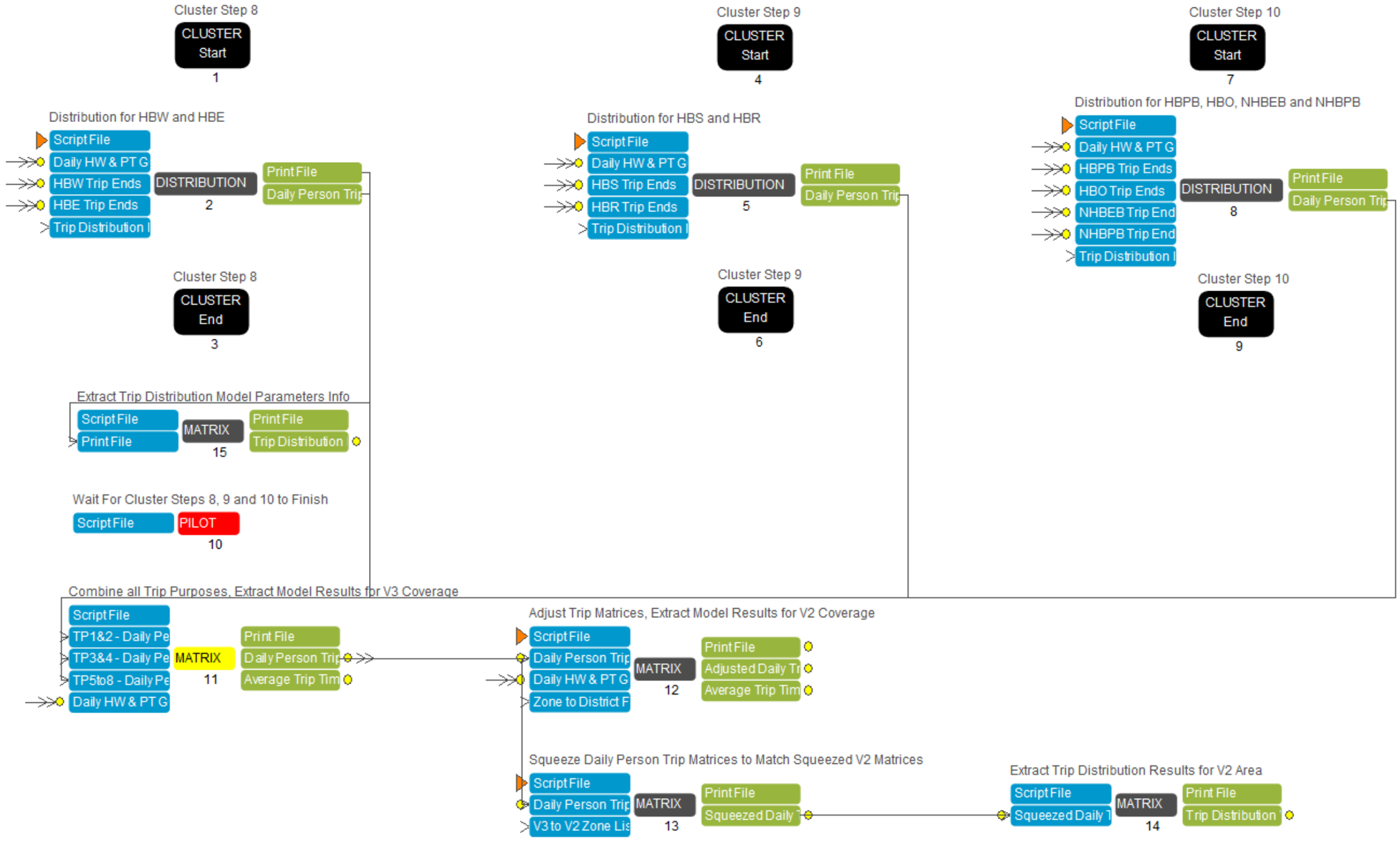


Figure A.7 - Trip Distribution Model Application

NETWORK SKIMS

- Add mode specific travel costs to initial network skims
- Perform analysis of highway and public transport
- Express network skims as Generalised Cost (GC) and Generalised Time (GT)
- Highway skim includes parking charge and vehicle operating costs
- Public transport skim includes fare charge and wait, walking, boarding, interchange penalties

MODE CHOICE

- Multi-nomial logit model including the following modes:
- Cars with 1 occupant, cars with 2 occupants, cars with 3+ occupants, public transport and non-motorised modes.

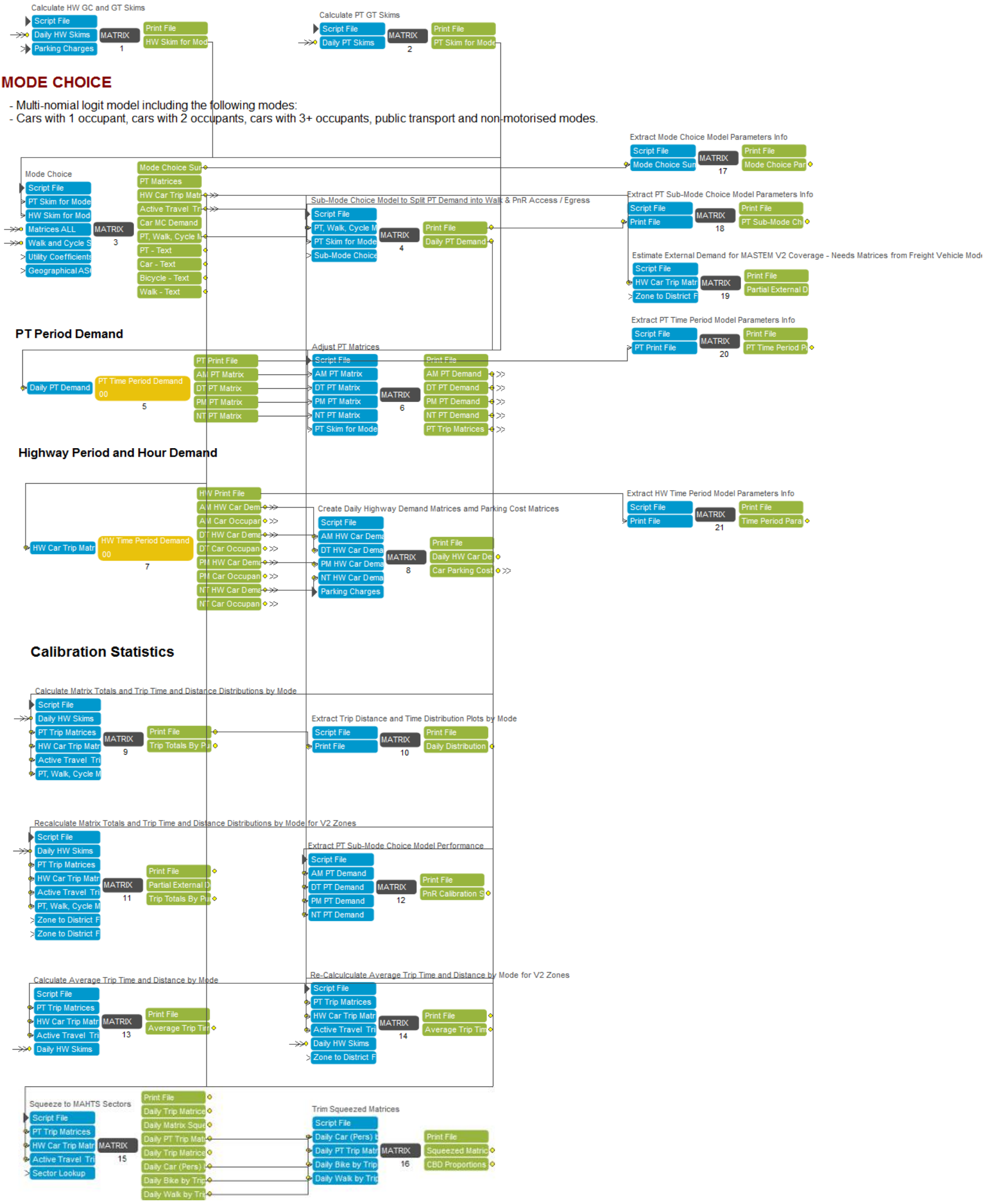
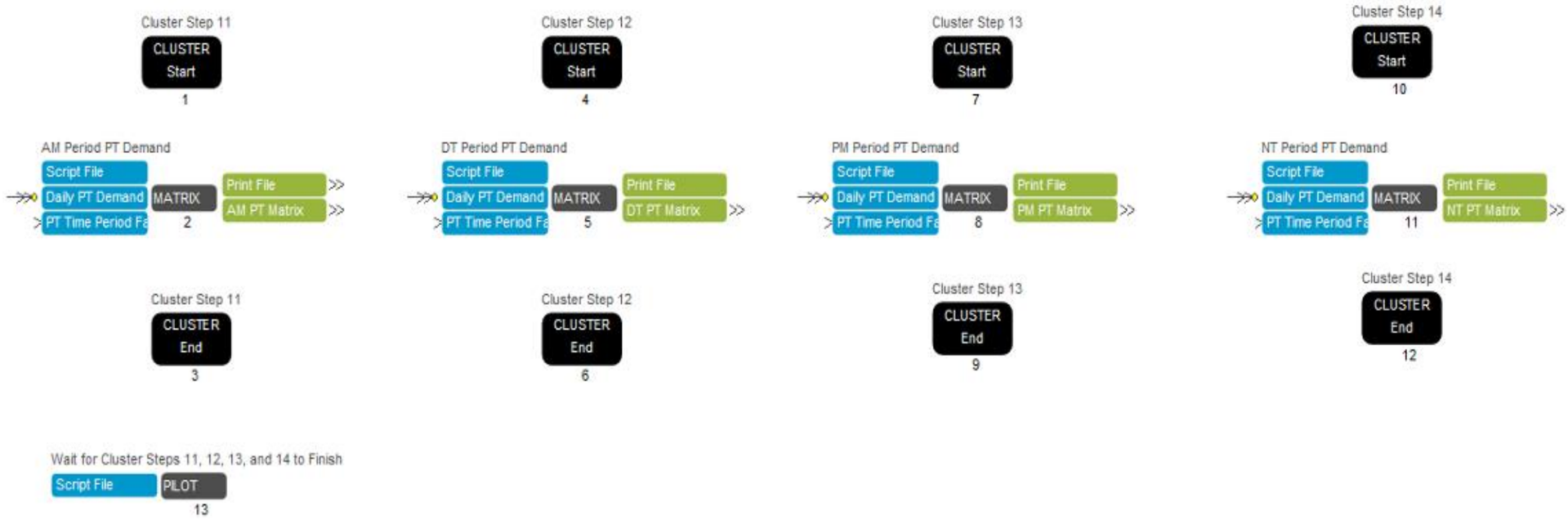


Figure A.8 - Mode Choice Model Application

MODE CHOICE: PT Time Period Demand



MODE CHOICE: Highway Time Period Demand

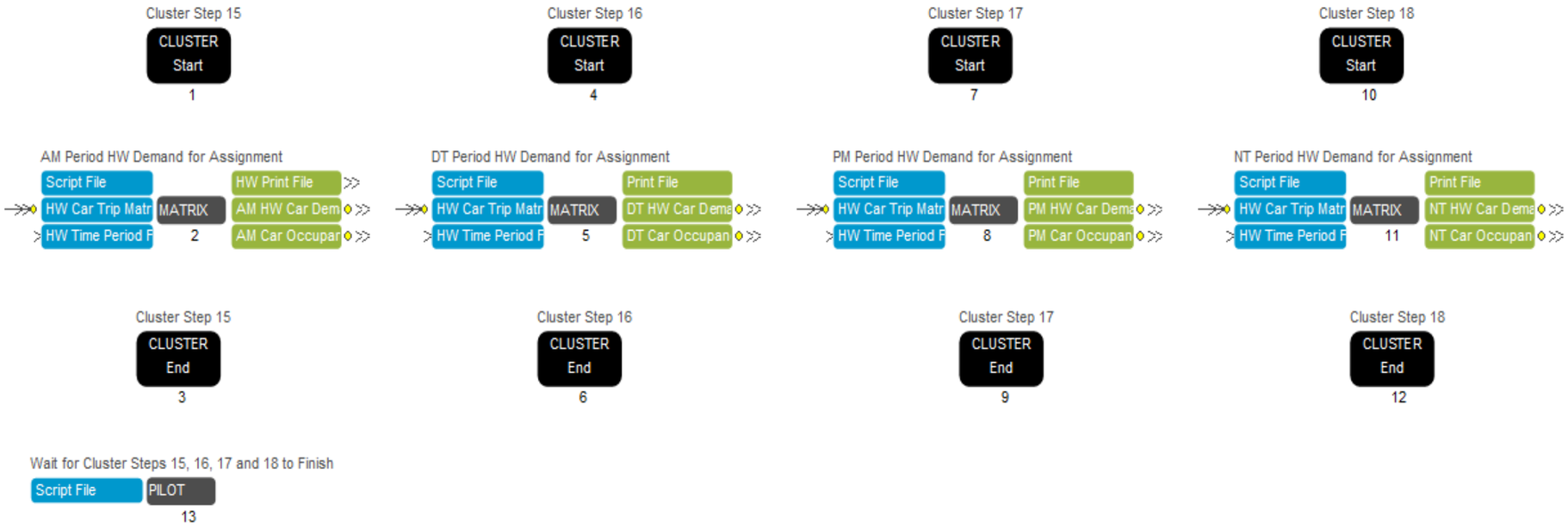


Figure A.8.1 - Mode Choice PT & Hwy Time Period Demand Model Applications

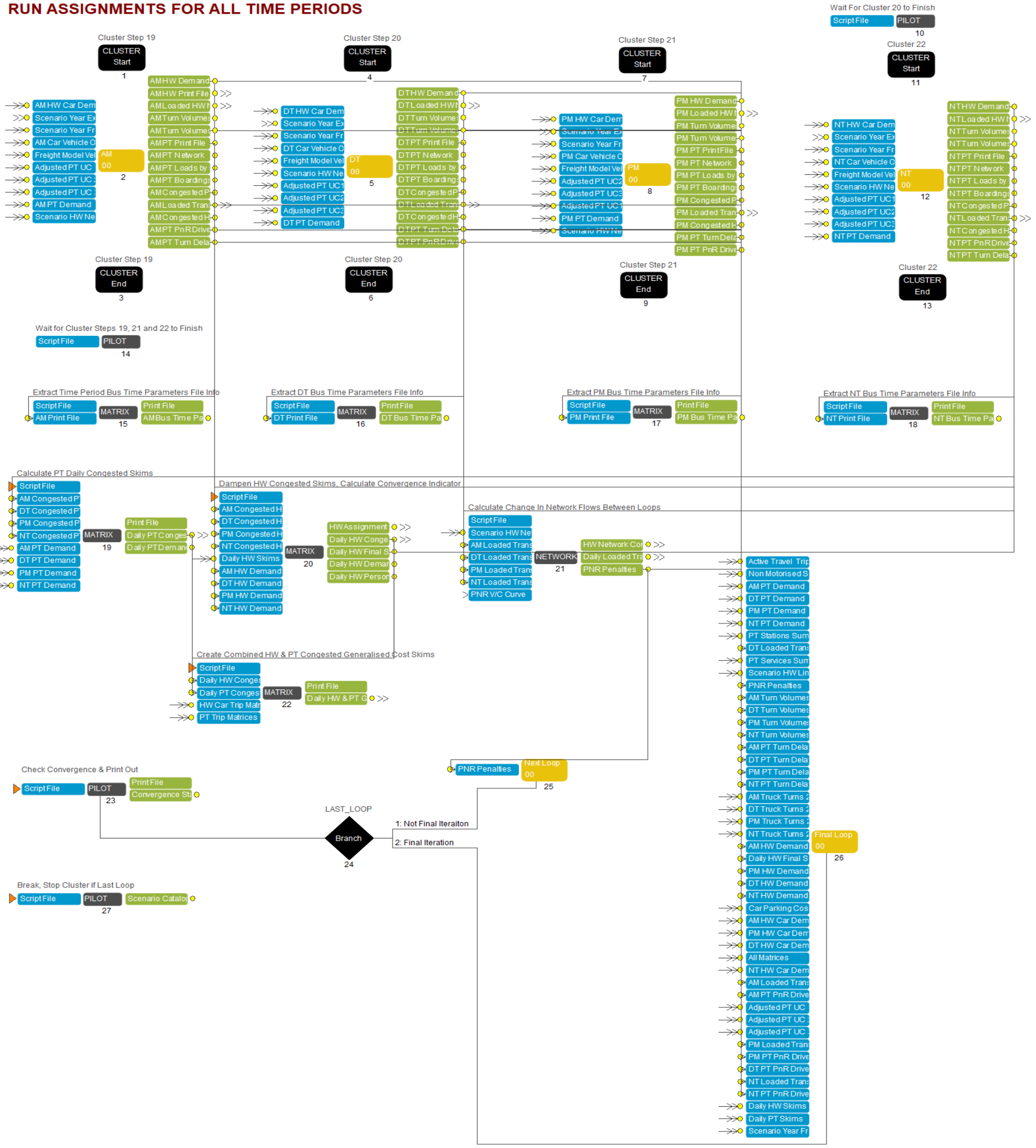


Figure A.9 - Highway and Public Transport Trip Assignment Model Applications

AM Peak Hour Highway Assignment

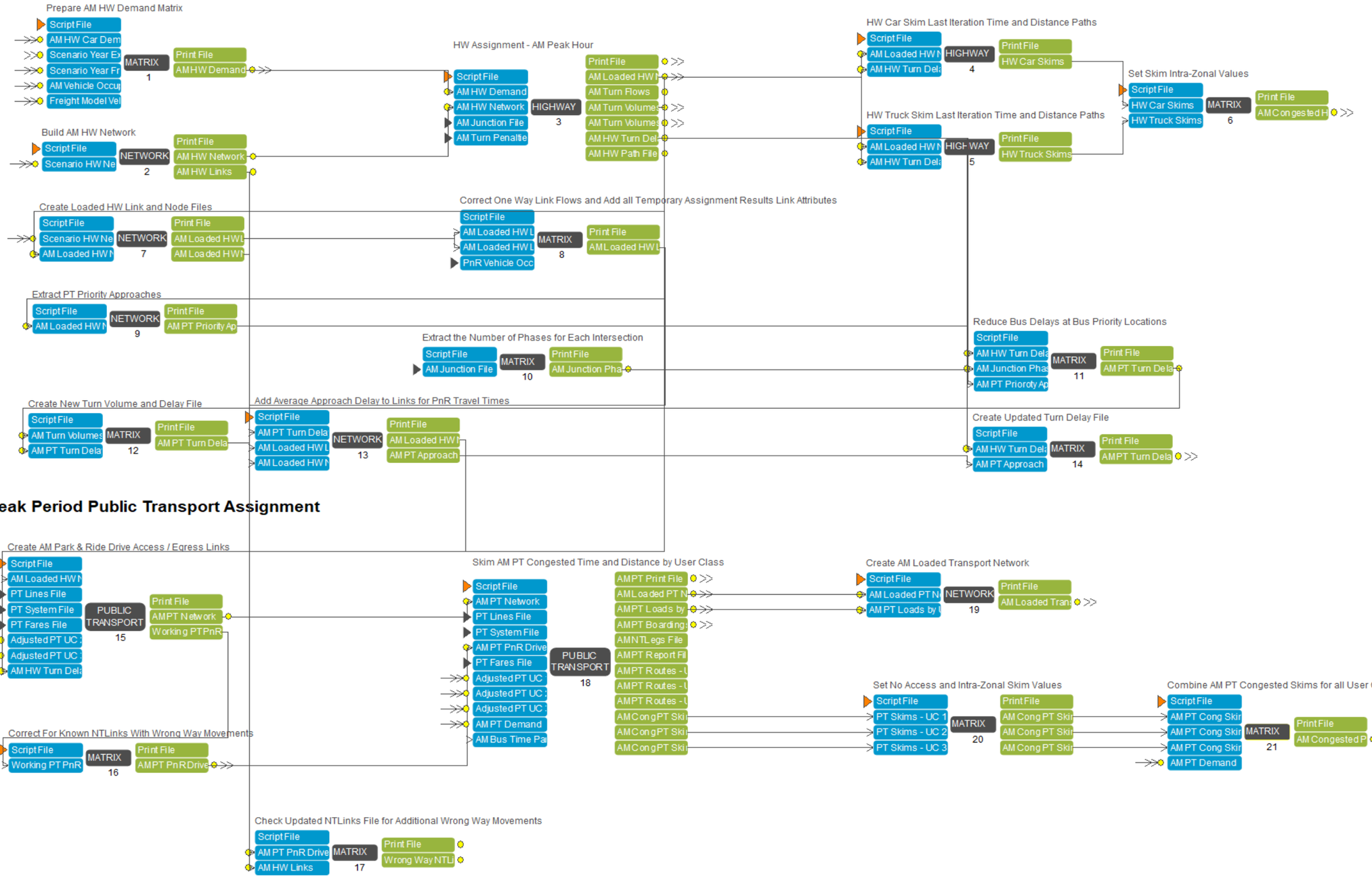
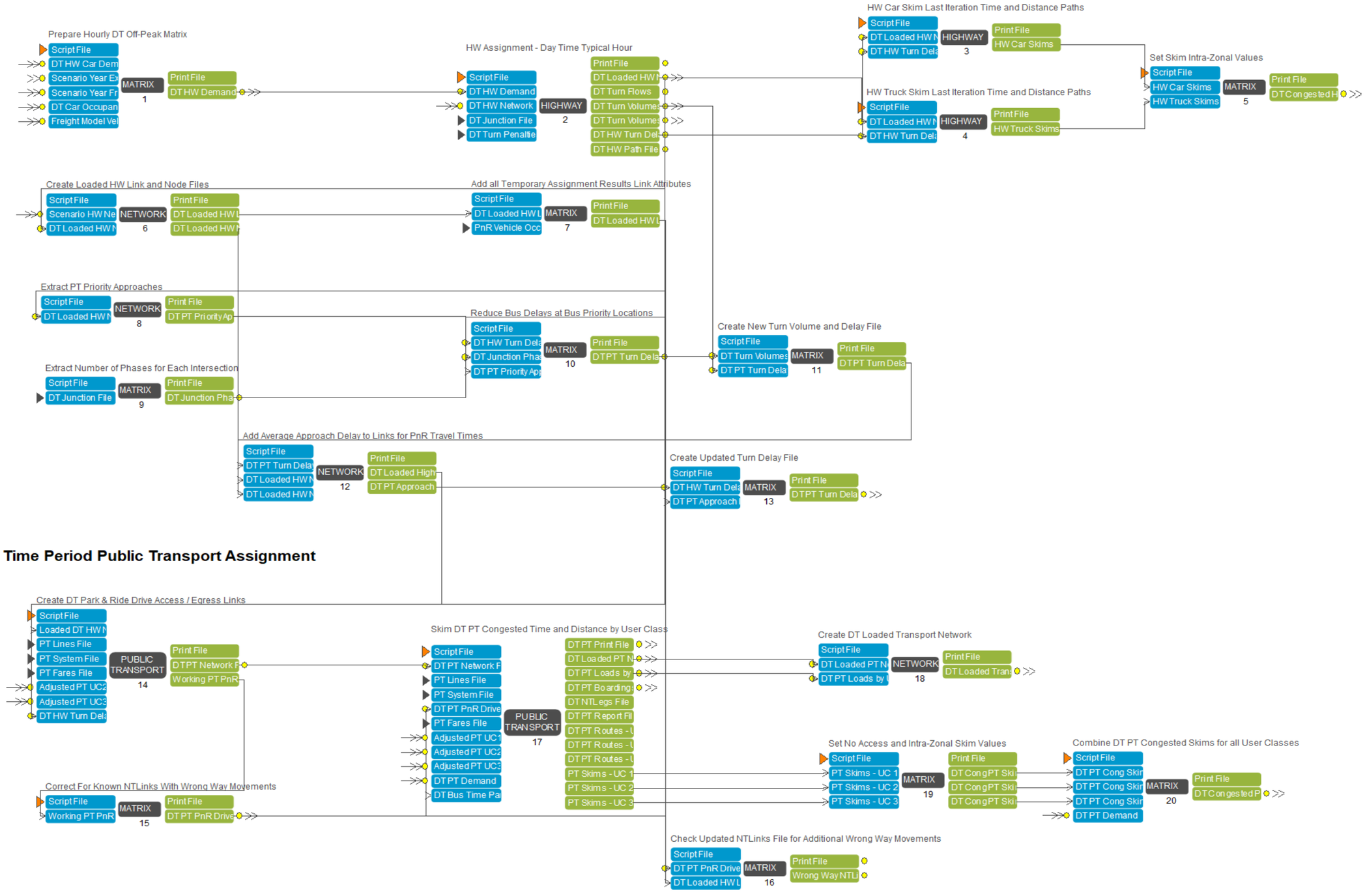


Figure A.9.1 - AM Time Period Highway and Public Transport Assignment Model Applications

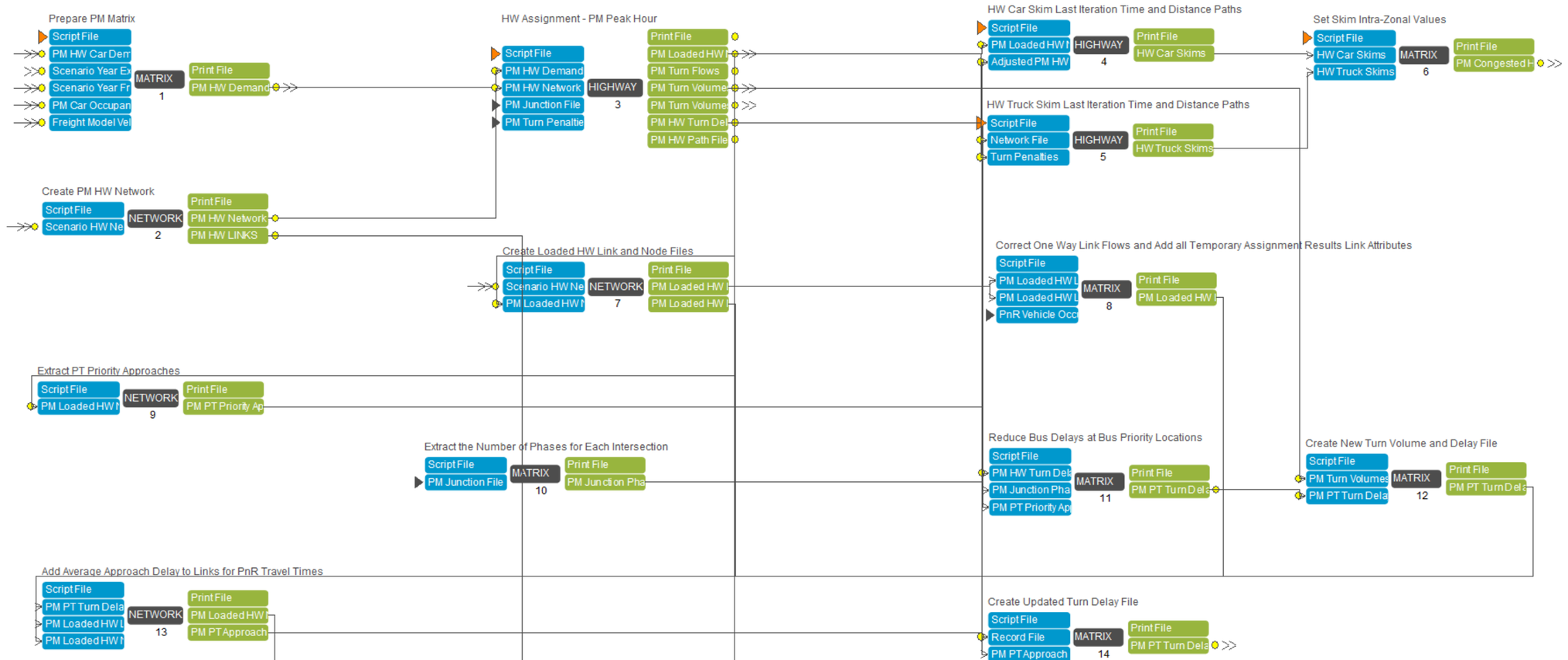
Day Time Typical Hour Highway Assignment



Day Time Period Public Transport Assignment

Figure A.9.2 DT Time Period Highway and Public Transport Assignment Model Applications

PM Peak Hour Highway Assignment



PM Peak Period Public Transport Assignment

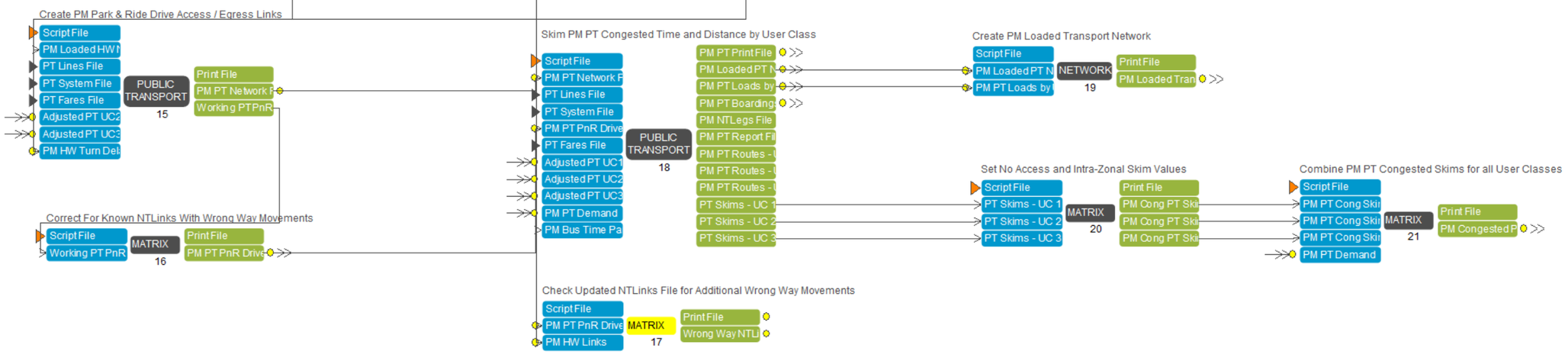
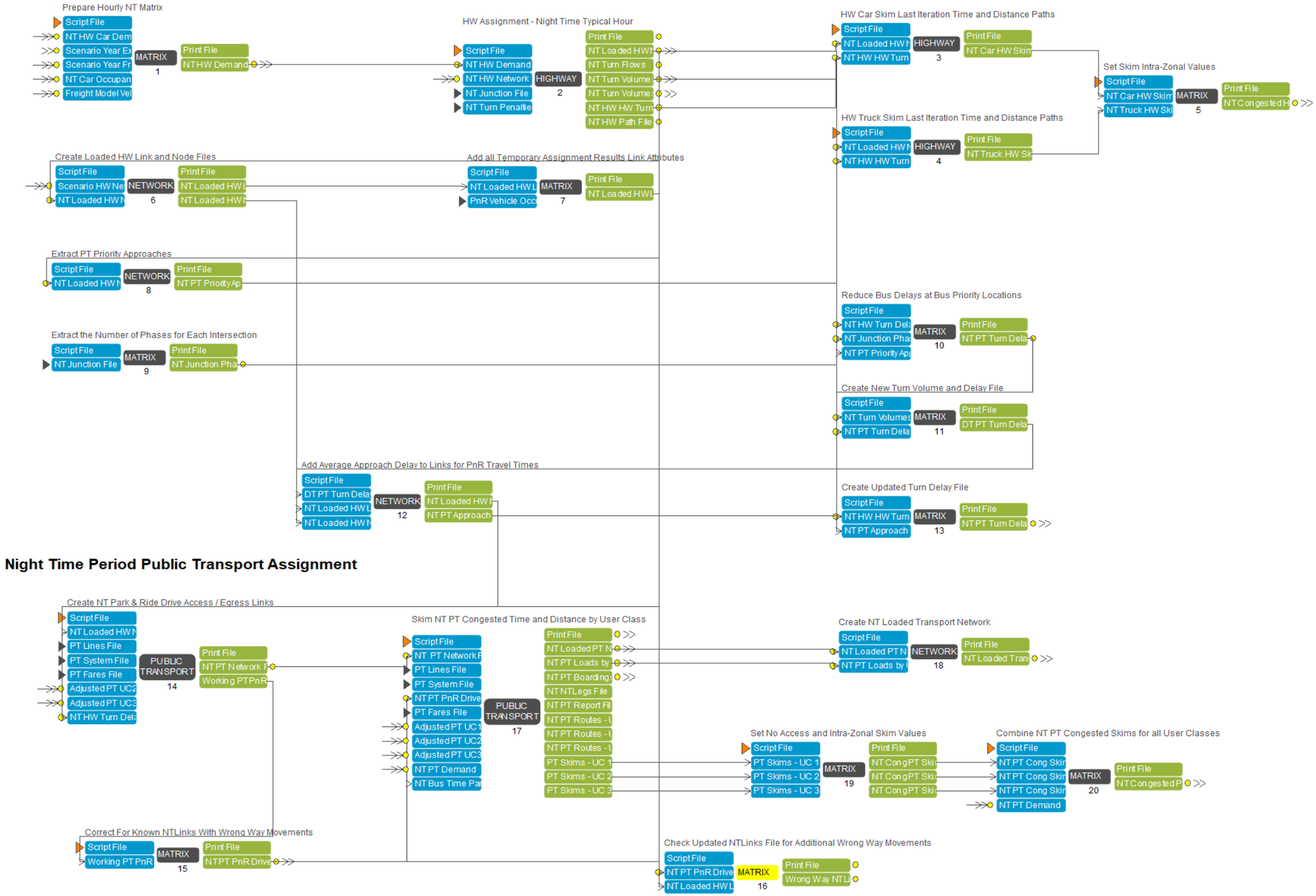


Figure A.9.3 PM Time Period Highway and Public Transport Assignment Model Applications

Night Time Typical Hour Highway Assignment



Night Time Period Public Transport Assignment

Figure A.9.4 NT Time Period Highway and Public Transport Assignment Model Applications

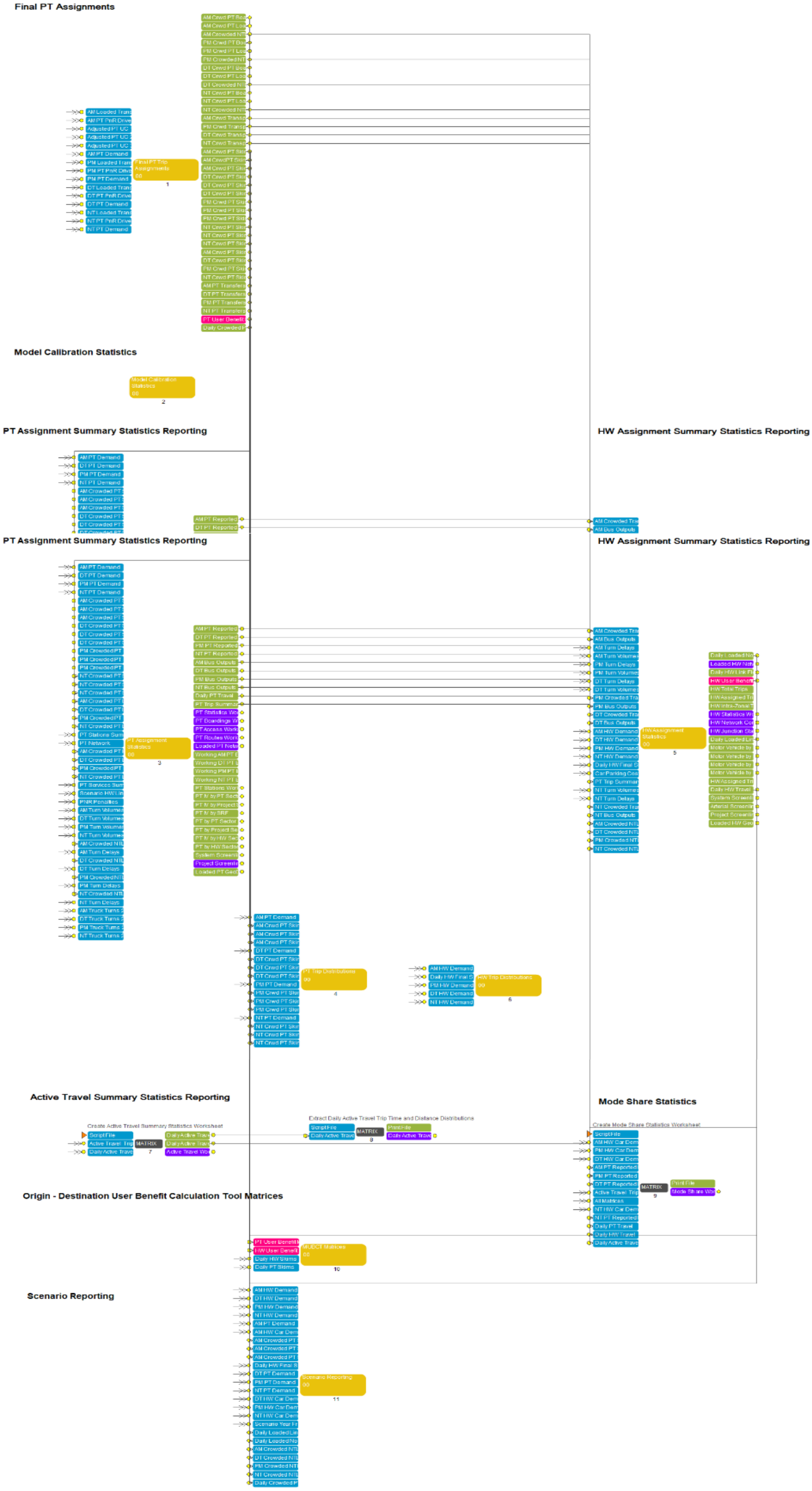


Figure A.9.5 Final Loop Subgroup of the Hwy and PT Trip Assignment Model

Final PT Assignments for All Time Periods

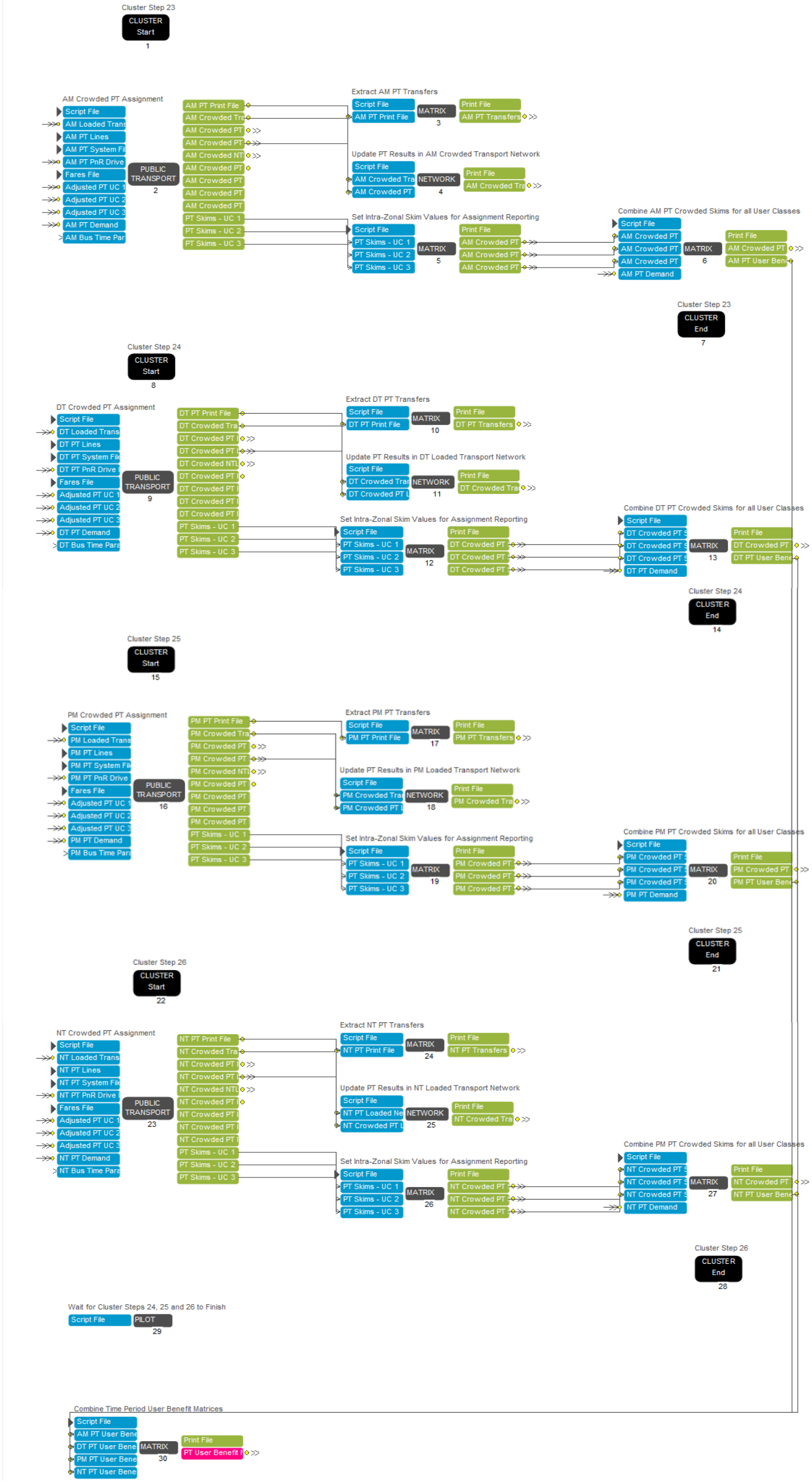


Figure A.9.5.1 Final PT Trip Assignment Model

Model Calibration Statistics

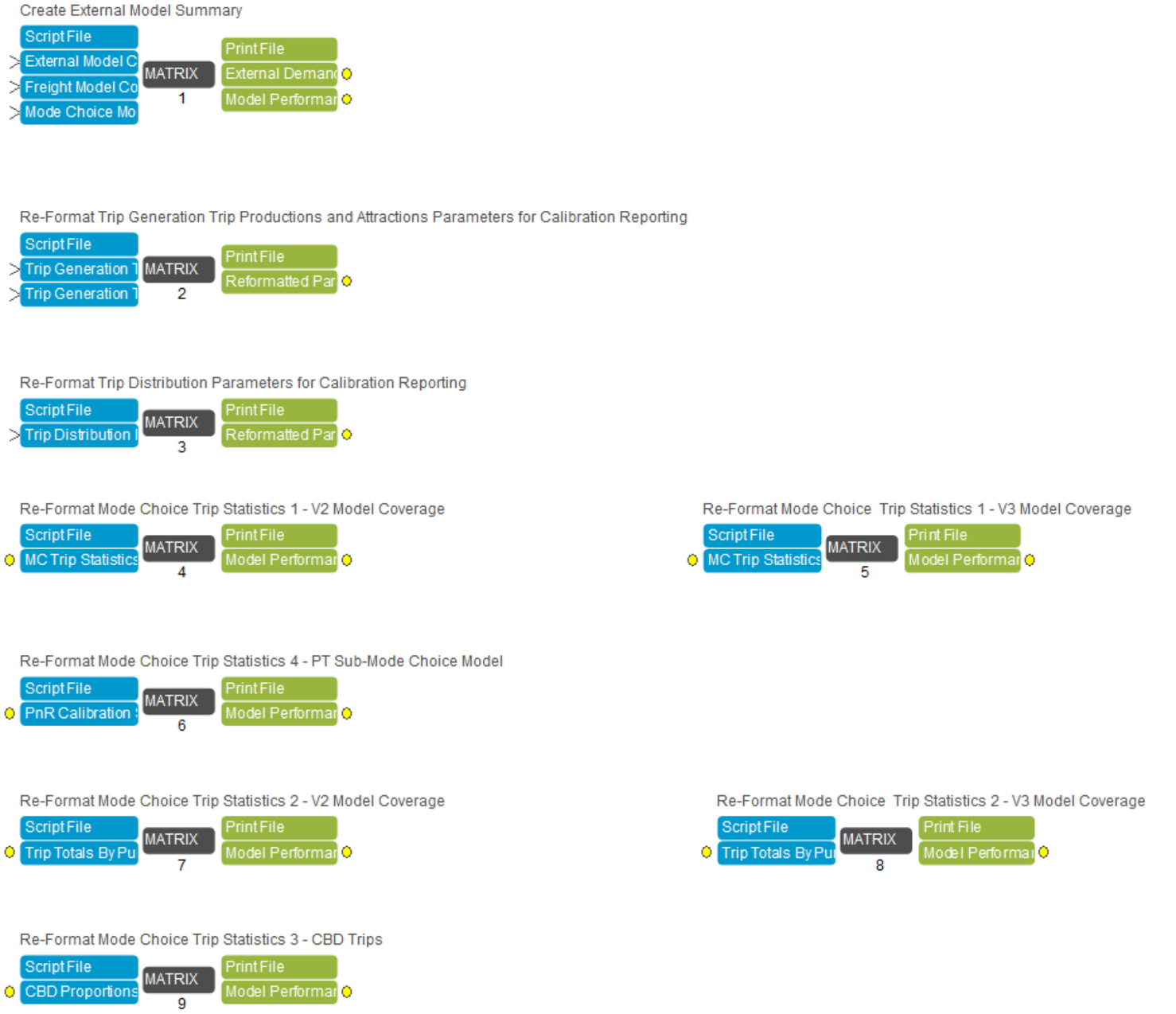


Figure A.9.5.2 Model Calibration Statistics

Public Transport Assignment Summary Statistics

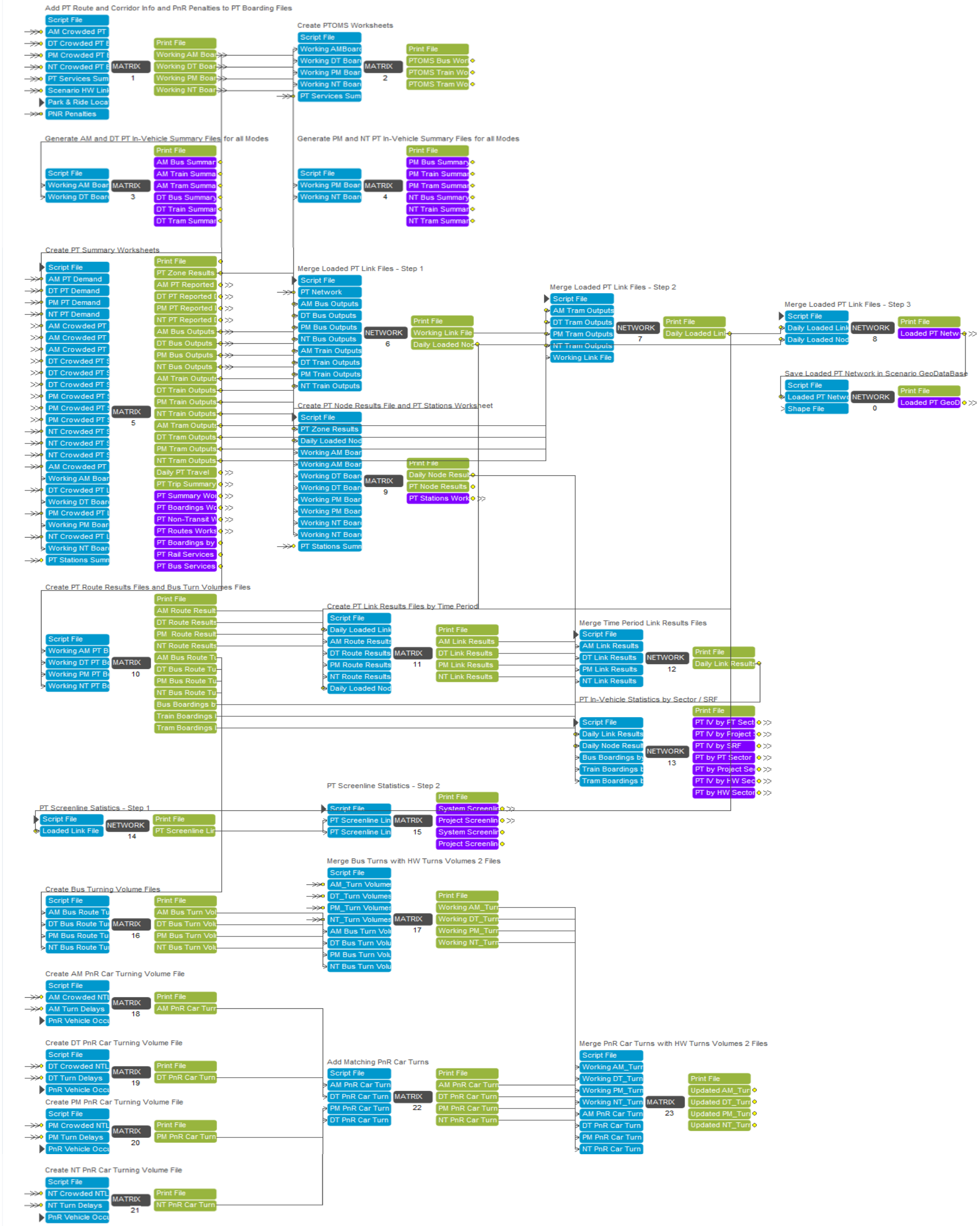


Figure A.9.5.3 PT Assignment Summary Statistics

Public Transport Trip Time and Distance Distributions

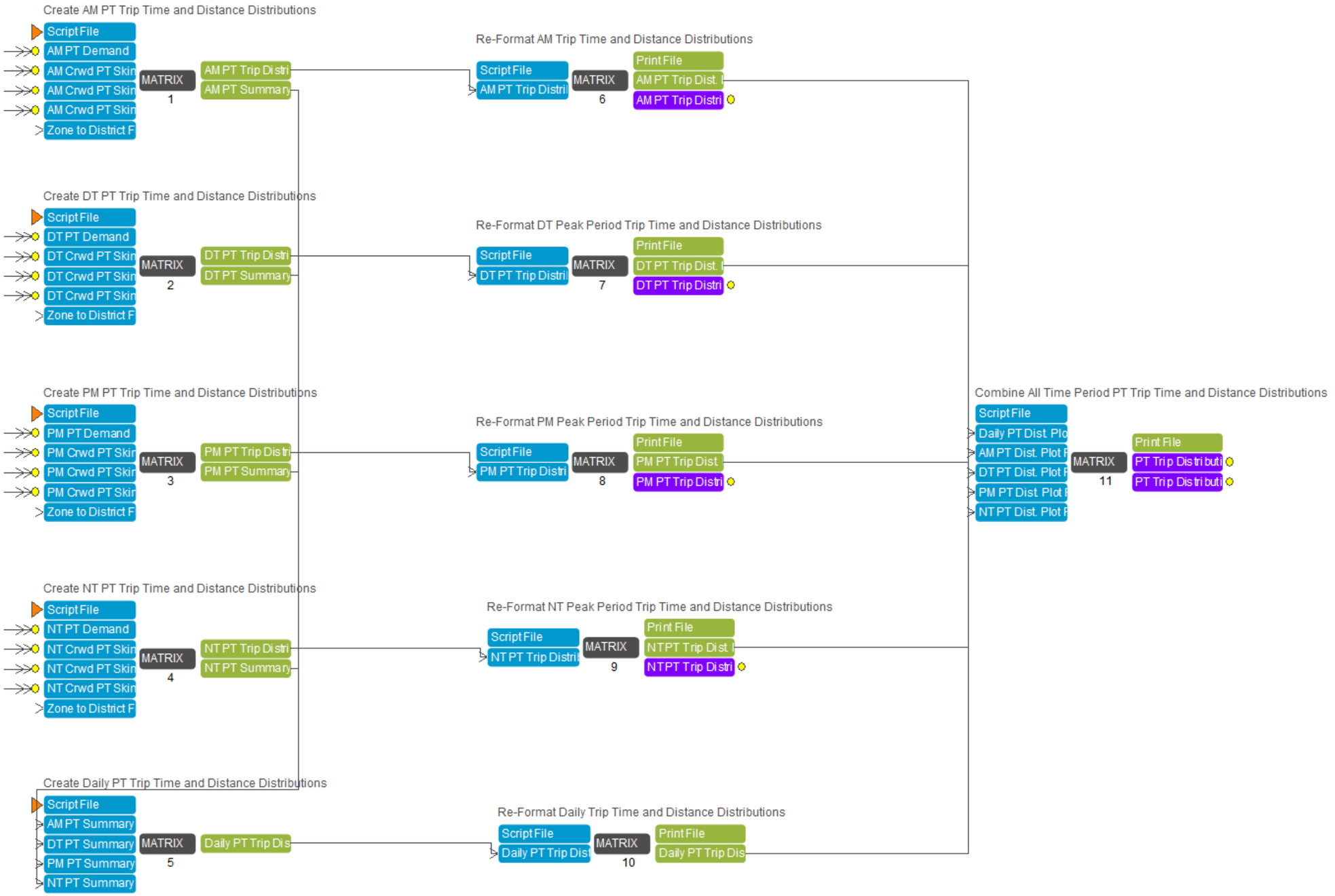


Figure A.9.5.4 PT Trip Time and Distance Distributions

Highway Assignment Summary Statistics

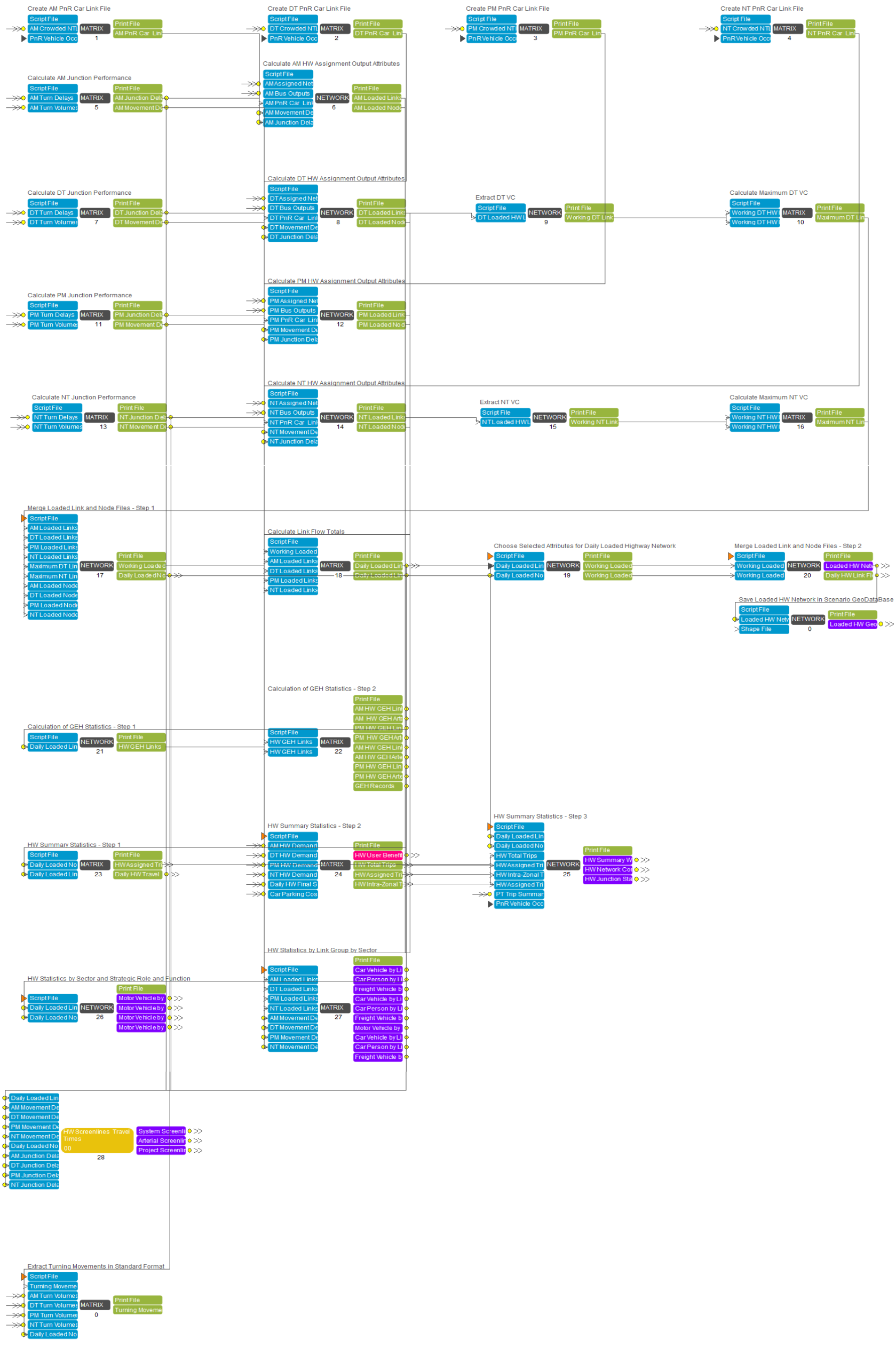


Figure A.9.5.5 Highway Assignment Summary Statistics

Highway Screenlines

Highway Travel Times

Highway Junction Performance

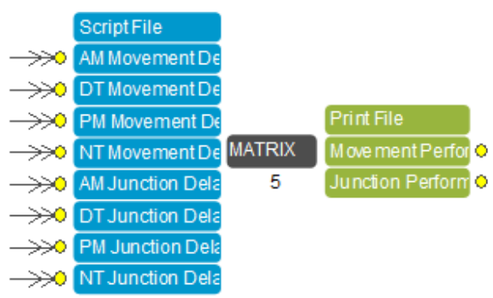


Figure A.9.5.5.1 Highway Screenlines and Trave Times Statistics

Highway Trip Time and Distance Distributions

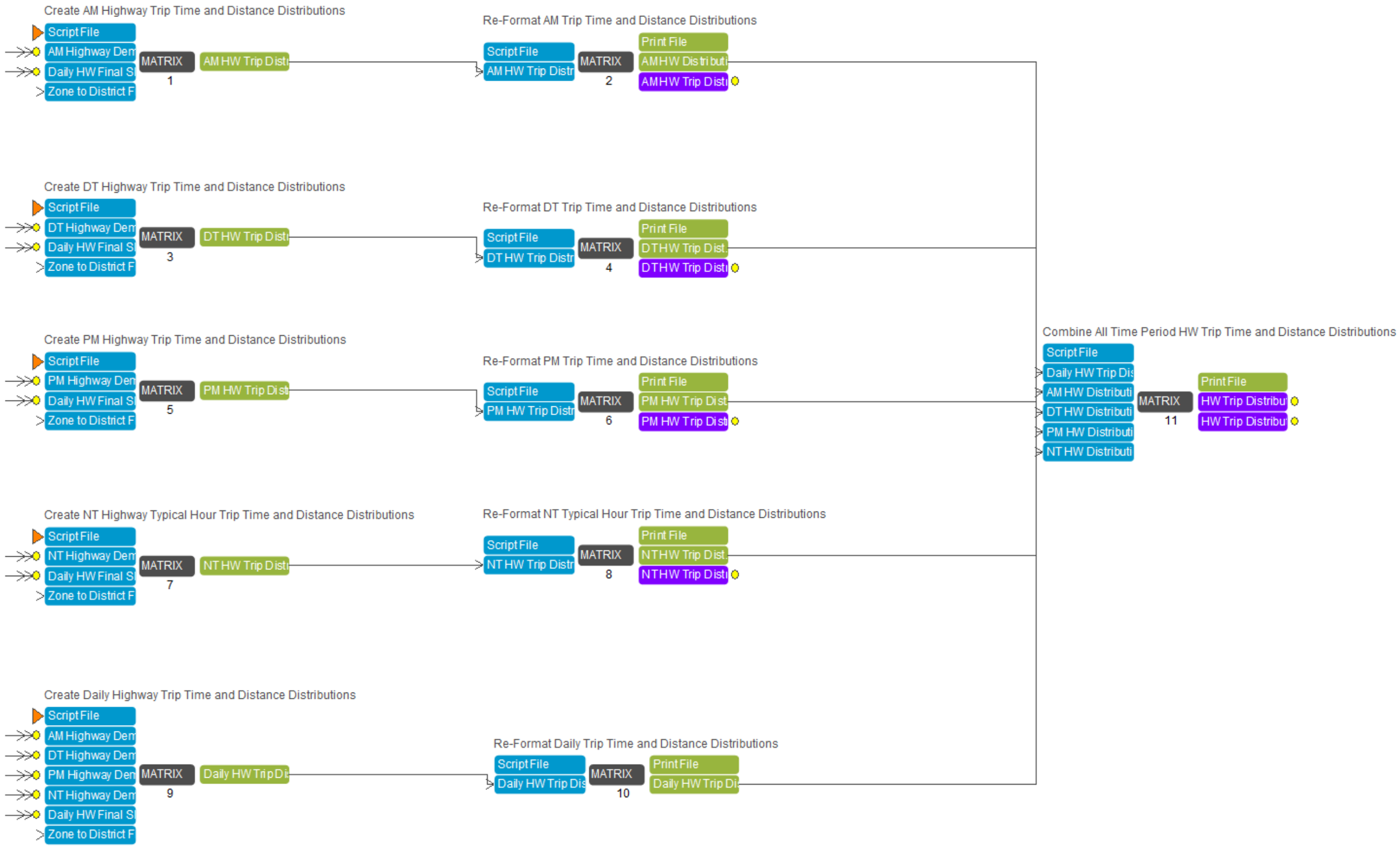
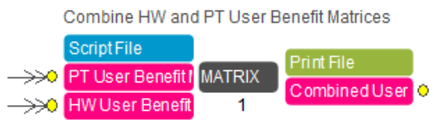


Figure A.9.5.6 Highway Trip Time and Distance Distributions

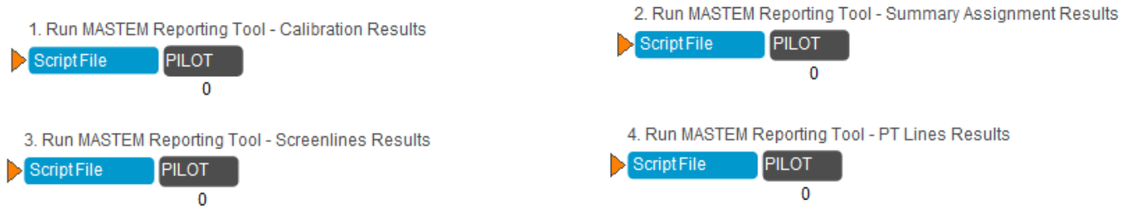
MASTEM User Benefit Calculation Tool - Highway and PT Matrices



Accessibility Analysis

Scenario Reporting

MASTEM Reporting Tool



Compare Two Networks

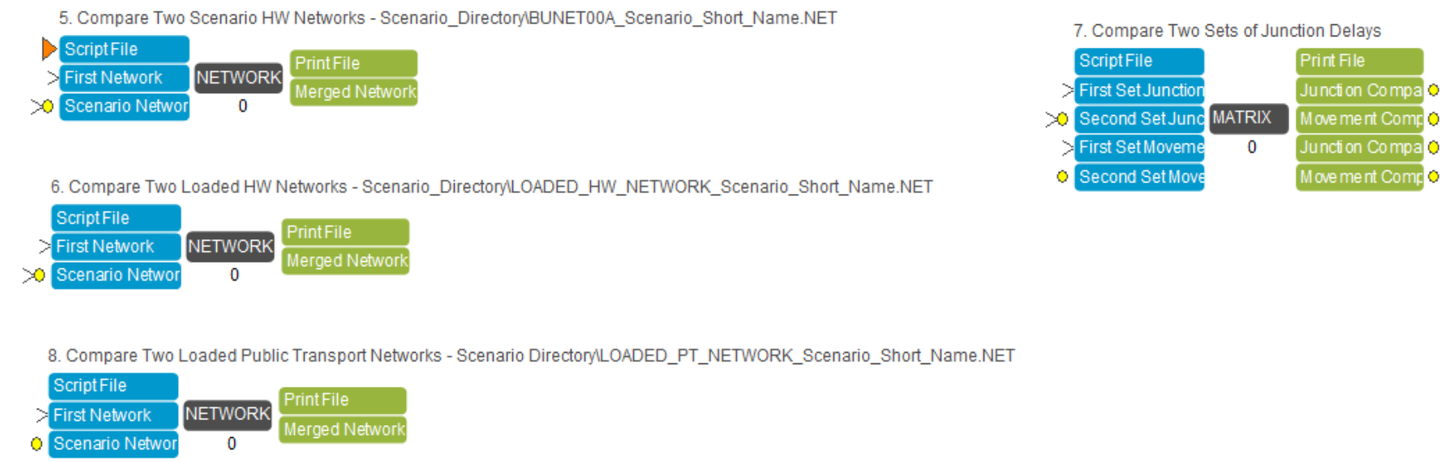


Figure A.9.5.7 MASTEM User Benefit Calculation Tool, Accessibility Analysis and Scenario Reporting

Appendix B – Foundation Network Updating

B1: Foundation Network Node and Link Attributes

All node and link attributes included in the Foundation Network are listed in Table B1. This table also includes references to the definitions of these attributes where necessary.

Table B1 - Foundation Network Node and Link Attributes

Attribute Name	Attribute Description	Reference
Node Attributes		
N	Node number	See schema in B.2
X	X Co-ordinate of node	Based on the GDA 1994 MGA Zone 54 co-ordinate system
Y	Y Co-ordinate of node	
NODE_Desc	Text description of node	
NODE_Type	Type of Node	See list in Table B.3
NODE_TZ	Traffic Activity Zone for node	
NODE_JC	Local Government Area for node	See list in Table B.5
NODE_HWSEC	Highway system sector for node	See list in Table B.6
NODE_PTSEC	PT system sector for node	See list in Table B.7
NODE_PRSEC	Project specific sector for node	
NODE_PRCOR	Project specific corridor for node	Not used
NODE_RF_{Year}	Strategic Role and Function for node	See list in Table B.9
NODE_RF		Defined during Network Build
Link Attributes		
A	A node for link	
B	B node for link	
LINK_DESC	Text description of link	
DISTANCE	Link length in Km	See B.3.1
LINK_TYP_{Year}	Type of link	See list in Table B.4
LINK_TYPE		Defined during Network Build
HCV_R_{Year}	Truck route factor for link	1 = RAVNet link -2 = ACC link

Attribute Name	Attribute Description	Reference
		0 = Otherwise
HCV_ROUTE		Defined during Network Build
LINK_TZ	Traffic Activity Zone for link	
LINK_JC	Local Government Area for link	See list in Table B.5
LINK_HWSEC	Highway system sector for link	See list in Table B.6
LINK_PTSEC	PT system sector for link	See list in Table B.7
LINK_HWTT	HW travel time route for link	See definition in Table B.8
LINK_PRSEC	Project specific sector for link	
LINK_PRCOR	Project specific corridor for link	
LINK_PRSL	Project specific screenline code for link	
LINK_RF_{Year}	Strategic Role and Function for link	See list in Table B.9
LINK_RF		Defined during Network Build
LINK_{Year}	Determines if link is present in modelled year	1 = Present, 0 = Deleted
AM_LINK	Determines if link is present in AM peak period	1 = Present, 0 = Deleted
PM_LINK	Determines if link is present in PM peak period	1 = Present, 0 = Deleted
BUS_P_{Year}	Determines if there is bus priority on this approach to the link's B-node	0 = N/A 1 = all day 2 = both peaks 2 = am only 4 = pm only 5 = both peaks and day time
BUS_PTY		Defined during Network Build
BUS_L_{Year}	Determines if there is bus lane on this link	0 = N/A 1 = all day 2 = both peaks 3 = am only 4 = pm only 5 = both peaks and day time

Attribute Name	Attribute Description	Reference
BUS_LANE		Defined during Network Build
CW_{Year}	Defines Clearway conditions for this section	0 = N/A 1 = all day 2 = both peaks 3 = am only 4 = pm only 5 = both peaks and day time
CLWY		Defined during Network Build
ST	Defines wether the following attributes represent free flow speed or time	S = Speed T = Time
FFS_T_[Year]	Free flow speed or time for link	Speed in Km/h or Time in minutes
FFS		Defined during Network Build
T0		Defined during Network Build
WALK_COST		Defined during Network Build
CI_{Year}	Capacity Index for link	See list in Table B.4
CI		Defined during Network Build
LANE_{Year}	Number of lanes for link – the maximum number of lanes available across all time periods – includes bus lanes and clearway lanes	See examples in Table B.10
LANES		Defined during Network Build
CAPACITY		Defined during Network Build
AM_CAP	AM peak hour capacity – veh/hr	Defined during Network Build
DT_CAP	DT typical hour capacity – veh/hr	Defined during Network Build
PM_CAP	PM peak hour capacity – veh/hr	Defined during Network Build
NT_CAP	NT typical hour capacity – veh/hr	Defined during Network Build
SL_FLAG	Determines if the link is part of a system screenline	1 = included 0 = excluded
SL_DESC	Text description for screenline link	

Attribute Name	Attribute Description	Reference
SL_NUM	Numeric code to define screenline attributes for link	See description in B.10
AWDT_06_	2006 AWDT – two way	
AWDFL_06_	2006 AWD Flows – one way	
AWDCC_06_	2006 AWD non home based business cars - two way	Not currently used
AWDCCFL_06_	2006 AWD non home based business cars - one way	Not currently used
AWDTK_06_	2006 AWD freight vehicles – two way	Not currently used
AWDTKFL_06_	2006 AWD freight vehicles – one way	Not currently used
AADT_06_	2006 AADT – two way	
AADFL_06_	2006 AAD Flow – one way	
AMTOT_06_	2006 AM peak hour traffic – two way	
AMFL_06_	2006 AM peak hour flow – one way	
PMTOT_06_	2006 PM peak hour traffic – two way	
PMFL_06_	2006 PM peak hour flow – one way	

B.2: Foundation Network Node Numbering Schema

The node numbering schema developed for MASTEM V3 is defined in Table B.2.1. To ensure that the model works correctly, it is important to adhere to this schema when developing new scenarios.

Table B2.1 - Foundation Network Node Numbering Schema

Node Numbers	Description
2 - 32	CBD zones
33 – 606	Other internal zones
607 - 634	External zones
1000 - 6999	Highway network nodes – including bus stops
7000 - 7499	Park and Ride nodes
7500 - 7999	Park and Ride gate nodes
9000 - 9299	Tram network nodes
9300 - 9999	Train network nodes

It should also be noted that some nodes within these ranges now have specific uses, for example nodes numbered from 5001 to 5899 are used for all pedestrian actuated signals included in the Foundation Network, 6501 to 6599 are used for train crossings, and 6601 to 6699 are used for tram crossings. Node numbers 6700 to 6999 are intended to be used for any additional nodes required for project specific networks.

Table B2.2 - Specific Node Numbering Schema

Node Numbers	Description
5001 – 5899	Pedestrian actuated signals
6501 – 6999	Train crossings
6601 – 6699	Tram crossings
6700 – 6999	Project specific networks

B.3: Foundation Network Node and Link Attribute Definitions

B.3.1 Link Distance

It is important that the link distance is uniformly applied. All link distances have been copied from the link shape file and have been calculated within ArcGIS using the GDA 1994 MGA Zone 54 co-ordinate system with transverse Mercator projection. Particularly for curvilinear links this gives quite different link distances that the default CUBE calculated distance. It is necessary that all new / modified link distances are calculated in the same way. To simplify this process a copy of an ArcGIS *.mxd file containing the DPTI road centreline database and the MASTEM V3 shape file has been provided. This can be accessed from program 3 of the Prepare Data Files application.

B.3.2 Node and Link Reporting Tool Attributes

The node attributes NODE_TYPE, NODE_JC, NODE_HWSEC, NODE_PTSEC, NODE_RF_{Year} are defined in Tables B.3, B.5, B 6, B.7 and B.9 respectively, with the link attributes LINK_TYPE, LINK_JC, LINK_HWSEC, LINK_PTSEC, LINK_HWTT, LINK_RF_{Year} and SL_NUM being defined in Tables B.4, B.5, B.6, B.7, B.8, B.9 and B.10 respectively. All of these attributes are used by the MASTEM Reporting Tool to ensure that the various reports are generated consistently for different scenarios.

Table B3 - Foundation Network Node Definitions

NODE_TYPE	Description
1	Traffic Activity Zone
2	Signalised Intersection / Junction
3	Pedestrian Crossing
4	Train Crossing
5	Tram Crossing
6	Roundabout
7	Priority Intersection / Junction
8	Mid-block
10	Train Stations
20	Tram Stops

Table B4 - Foundation Network Link Definitions

Description		Location	LINK_ TYPE	CI_ {Year}	Capacity (v/h/lane)
Freeway			1	1	2200
Expressway				2	2000
Arterial road, high speed			2	3	1900
Arterial road, medium speed			3	4	1800
Arterial road, low speed	Divided	Outer North and South	4	5	1700
		Suburban		6	1500
	Undivided	Outer North and South		8	1350
		Suburban		9	1200
	Divided	ACC	5	7	1200
	Undivided			10	800
Local collector / distributor	Divided	Not ACC	6	16	1350
	Undivided	Outer North and South		11	1200
		Suburban		12	1000
	All	ACC	7	13	600
Other local streets			8	15	500
Zone centroid connector			9	20	
Tram line			10		
Train line			11		
Bus only highway link			12		
O-Bahn link			13		
Walk Links			15		
Walk Link from Park and Ride to Gate			20		
Walk Link from Gate to PT Stop Node			21		
Drive Link from Highway Network to Park and Ride		Outer North and South	22	11	1200
		Suburban		12	1000

Table B5- Foundation Network Local Government Area

NODE_JC / LINK_JC	Location
1	Adelaide
2	Unley
3	Burnside
4	Norwood, Payneham and Saint Peters
5	Campbelltown
6	Walkerville
7	Prospect
8	Port Adelaide, Enfield
9	Charles Sturt
10	West Torrens
11	Holdfast Bay
12	Marion
13	Mitcham
14	Onkaparinga
15	Adelaide Hills
16	Mount Barker
17	Tea Tree Gully
18	Salisbury
19	Munno Para
20	Barossa Valley
21	Gawler
22	Light
32	External

Table B6 - Foundation Network Highway System Sectors

NODE_HWSEC / LINK_HWSEC	Traffic Activity Zone List
1	1 to 32
2	42 to 48, 50, 51, 159 to 172, 240 to 243, 257, 286, 287, 310 to 313, 595, 596, 601, 618, 619
3	49, 52 to 79, 173 to 175, 184 to 188, 317 to 325, 578, 579, 594
4	33 to 35, 80 to 105, 176 to 183, 189 to 212, 260, 288 to 293, 314 to 316, 326 to 360, 435, 436, 535 to 539, 547 to 549, 561 to 570, 580, 583, 584, 586 to 591, 602
5	36 to 41, 106 to 156, 275, 285, 294 to 309, 540 to 543, 574 to 577, 585, 592, 593, 605
6	157, 158, 214 to 239, 244 to 255, 276, 277, 367 to 410, 501 to 531, 544, 550 to 560, 571 to 573, 581, 582, 597, 607 to 617, 632
7	256, 258, 259, 411 to 434, 463 to 500, 595, 604, 620 to 626, 633, 634
8	213, 261 to 274, 278 to 284, 361 to 366, 437 to 462, 532 to 534, 545, 546, 598 to 600, 603, 606, 627 to 631

Table B7 - Foundation Network Public Transport System Sectors

NODE_PTSEC / LINK_PTSEC	Traffic Activity Zone List
1	214 to 222, 229, 244 to 255, 367 to 410, 501 to 525, 527 to 531, 544, 550 to 558, 571 to 573, 581, 582, 607 to 616, 632
2	38 to 46, 125, 127 to 132, 135 to 137, 149 to 163, 226 to 228, 285 to 287, 297 to 299, 526, 543, 577, 585, 592, 593
3	108 to 112, 118, 119, 126, 133, 134, 138 to 148, 275, 295, 296, 300 to 309, 540 to 542, 574 to 576, 605
4	164 to 172, 223 to 225, 230 to 243, 257, 276, 277, 310 to 313, 377, 559, 560, 595 to 597, 601, 617 - 619
5	33 to 37, 86 to 94, 105 to 107, 113 to 117, 120 to 124, 294, 602
6	1 to 32
7	47 to 74, 173 to 175, 256, 414 to 416, 499, 594, 620
8	83, 95 to 104, 191 to 195, 202, 203, 290, 293, 328, 329, 338, 341, 536 to 539, 561 to 570, 583, 584, 586 to 591
9	75 to 85, 176 to 184, 186, 190, 196 to 201, 204 to 212, 288, 289, 291, 292, 314 to 319, 330 to 337, 339, 340, 342 to 360, 535, 547 to 549, 578 to 580
10	260, 261, 264, 271, 284, 362, 435, 436, 439, 440, 442, 444, 598 to 600, 603
11	185, 187 to 189, 262, 320 to 327, 437, 438, 441, 627, 628
12	258, 259, 411 to 413, 417 to 434, 463 to 498, 500, 604, 621 to 626, 633, 634
13	213, 263, 265 to 270, 272 to 274, 278 to 283, 361, 363 to 366, 443, 445 to 462, 532 to 534, 545, 546, 606, 629 to 631

Table B8 - Foundation Network Highway Travel Time Specification

Digit	Description		Value
1 and 2	Travel Time Route Number		nn
3 and 4	Link Sequence Number		nn
5	Link Direction	First Direction	1
		Return Direction	2

Highway travel times are usually measured between junctions / intersections with approach delays at the first junction / intersection being excluded. To ensure that approach delays at the final junction / intersection are included the route must be extended by an additional link with the link sequence number set to 99. Travel times on this link are not included. The links for both directions must be numbered sequentially in the direction of travel from the first junction / intersection to the final terminating link. The choice of route direction is discretionary but must be consistently applied for each travel time route.

Table B9 - Foundation Network Strategic Role and Function

Digit	Strategic Role and Function	Value
1	Strategic Route	0 = No 1 = Yes
2	Primary Freight Route	0 = No 1 = Yes
3	Secondary Freight Route	0 = No 1 = Yes
4	Primary PT Corridor	0 = No 1 = Yes
5	Secondary PT Corridor	0 = No 1 = Yes
6	Primary Commuter Route	0 = No 1 = Yes
7	Secondary Commuter Route	0 = No 1 = Yes

Table B10 - Foundation Network Screenline Specification

Digit	Description		Value
1 and 2	Screenline Number		nn
3 and 4	Link Sequence Number		nn
5	Link Direction	Northbound or Eastbound	1
		Southbound or Westbound	2

Note that this specification applies to both Highway and Public Transport Links which should be numbered within the same set.

B3.3 Link Capacity Attributes

Link capacity for each time period is calculated from the number of available lanes during each time period and the lane capacity determined by CI {Year} (the capacity Index for each model year) which is defined in Table B.4 above. The number of lanes coded should be the maximum number of lanes available for any traffic during any of the time periods. MASTEM will adjust this input value depending on the input clearway and bus lane attribute values, both of which are applied differently. In general, a bus lane will reduce the number of available lanes during the time periods it operates whereas a clearway will reduce the number of available lines during the time periods it does not operate. Table B.11 provides some examples taken from the Foundation Network.

Table B11 - Foundation Network Number of Lanes

Location	Description	LANE_{Year}	BUS_L_{Year}	CW_{Year}
Botanic Road Both directions	Full time Bus lane plus two traffic lanes	3	1	0
Currie Street Both directions	AM, DT, PM Bus lane plus one traffic lane	2	5	0
Pultney Street South of Angas Street Northbound	AM Clearway AM Bus lane Plus two traffic lanes	3	3	3
Pultney Street South of Angas Street Southbound	PM Clearway PM Bus lane Plus two traffic lanes	3	4	4
Flinders Street, Kent Town Westbound	AM Clearway	2	0	3
Flinders Street, Kent Town Eastbound	PM Clearway	2	0	4

B.4: Loaded Highway Network Node and Link Attributes

The link and node attributes included in the Loaded Highway Network are listed in Table B.12. These attributes summarise the performance of the Highway system in some detail. It should be noted that Highway performance statistics are reported for the full day, the AM and PM peak hours and the DT and NT typical hours.

Table B12 - Loaded Highway Network Attributes

Attribute Name	Attribute Description	Reference
Node Attributes		
N	Node number	See schema in B.2
X	X Co-ordinate of node	Based on the GDA 1994 MGA Zone 54 co-ordinate system
Y	Y Co-ordinate of node	
NODE_Desc	Text description of node	
NODE_Type	Type of Node	See list in Table B.3
NODE_TZ	Traffic Activity Zone for node	
NODE_JC	Local Government Area for node	See list in Table B.5
NODE_HWSEC	Highway system sector for node	See list in Table B.6
NODE_PTSEC	PT system sector for node	See list in Table B.7
NODE_PSEC	Project specific sector for node	
NODE_PRCOR	Project specific corridor for node	Not used
NODE_RF	Strategic Role and Function for node	See list in Table B.9
D_AVE_DEL	Average delay over the full day – sec/veh	
D_TOT_DEL	Total Delay for the full day – veh hrs	
AM_VC	Estimated V/C ratio for the AM peak hour	
AM_LOS	HCM LoS for the AM peak hour	
AM_AVE_DEL	Average delay for the AM peak hour – sec/veh	
AM_MAX_DEL	Maximum average movement delay for the AM peak hour – sec/veh	
AM_TOT_DEL	Total delay for the AM peak hour – veh hrs	
DT_VC	Estimated V/C ratio for the DT typical hour	
DT_LOS	HCM LoS for the DT typical hour	

Attribute Name	Attribute Description	Reference
DT_AVE_DEL	Average delay for the DT typical hour – sec/veh	
DT_MAX_DEL	Maximum average movement delay for the DT typical hour – sec/veh	
DT_TOT_DEL	Total delay for the DT typical hour – veh hrs	
PM_VC	Estimated V/C ratio for the PM peak hour	
PM_LOS	HCM LoS for the PM peak hour	
PM_AVE_DEL	Average delay for the PM peak hour – sec/veh	
PM_MAX_DEL	Maximum average movement delay for the PM peak hour – sec/veh	
PM_TOT_DEL	Total delay for the PM peak hour – veh hrs	
NT_VC	Estimated V/C ratio for the NT typical hour	
NT_LOS	HCM LoS for the NT typical hour	
NT_AVE_DEL	Average delay for the NT typical hour – sec/veh	
NT_MAX_DEL	Maximum average movement delay for the NT typical hour – sec/veh	
NT_TOT_DEL	Total delay for the NT typical hour – veh hrs	
Link Attributes		
A	A node for link	
B	B node for link	
LINK_DESC	Text description of link	
DISTANCE	Link length in Km	See B.3.1
LINK_TYPE	Type of link	See list in Table B.4
HCV_ROUTE	Truck route factor for link	1 = RAVNet link -2 = ACC link 0 = Otherwise
LINK_TZ	Traffic Activity Zone for link	
LINK_JC	Local Government Area for link	See list in Table B.5
LINK_HWSEC	Highway system sector for link	See list in Table B.6

Attribute Name	Attribute Description	Reference
LINK_PTSEC	PT system sector for link	See list in Table B.7
LINK_HWTT	Highway travel time route for link	See definition in Table B.8
LINK_PRSEC	Project specific sector for link	
LINK_PRCOR	Project specific corridor for link	
LINK_PRSL	Project specific screenline code for link	
LINK_RF	Strategic Role and Function for link	See list in Table B.9
CI	Capacity Index for link	See list in Table B.4
LANES	Maximum number of lanes across all time periods	
AM_CAP	AM peak hour capacity – veh/hr	
DT_CAP	DT typical hour capacity – veh/hr	
PM_CAP	PM peak hour capacity – veh/hr	
NT_CAP	NT typical hour capacity – veh/hr	
FFS	Uncongested travel speed	
T0	Uncongested travel time	
WALK_COST	Walk travel time	
SL_FLAG	Determines if the link is part of a system screenline	1 = included 0 = excluded
SL_DESC	Text description for screenline link	
SL_NUM	Numeric code to define screenline attributes	See description in B.10
AWDT_06_	2006 AWDT – two way	
AWDFL_06_	2006 AWD Flows – one way	
AWDCC_06_	2006 AWD non home based business cars - two way	
AWDCCFL_06_	2006 AWD non home based business cars - one way	
AWDTK_06_	2006 AWD freight vehicles – two way	
AWDTKFL_06_	2006 AWD freight vehicles – one way	
AMTOT_06_	2006 AM peak hour traffic – two way	
AMFL_06_	2006 AM peak hour flow – one way	

Attribute Name	Attribute Description	Reference
PMTOT_06_	2006 PM peak hour traffic – two way	
PMFL_06_	2006 PM peak hour flow – one way	
AWDT	AWDT for modelled scenario – two way	
AWDFL	AWD flow for modelled scenario – one way	
AWDCARS	AWD cars for modelled scenario – one way	
AWDTRCKS	AWD trucks for modelled scenario – one way	
AWDBUSES	AWD buses for modelled scenario – one way	
AWDCARP	AWD car passengers for modelled scenario – one way	
AWDBUSP	AWD bus passengers for modelled scenario – one way	
AADT	AADT for modelled scenario – two way	
AADFL	AAD flow for modelled scenario – one way	
AADCARS	AAD cars for modelled scenario – one way	
AADTRCKS	AAD trucks for modelled scenario – one way	
AADCARP	AAD car passengers for modelled scenario – one way	
AMTOTAL	Total traffic for AM peak hour for modelled scenario – two way	
AMFLOW	Flow for AM peak hour for modelled scenario – one way	
AMCAR	Cars for AM peak hour for modelled scenario – one way	
AMTRCK	Trucks for AM peak hour for modelled scenario – one way	
AMBUS	Buses for AM peak hour for modelled scenario – one way	
AMCARP	Car passengers for AM peak hour for modelled scenario – one way	
AMBUSP	Bus passengers for AM peak hour for modelled scenario – one way	
DTTOTAL	Total traffic for DT typical hour for modelled scenario – two way	

Attribute Name	Attribute Description	Reference
DTFLOW	Flow for DT typical hour for modelled scenario – one way	
DTCAR	Cars for DT typical hour for modelled scenario – one way	
DTTRCK	Trucks for DT typical hour for modelled scenario – one way	
DTBUS	Trucks for DT typical hour for modelled scenario – one way	
DTCARP	Car passengers for DT typical hour for modelled scenario – one way	
DTBUSP	Busr passengers for DT typical hour for modelled scenario – one way	
PMTOTAL	Total traffic for PM peak hour for modelled scenario – two way	
PMFLOW	Flow for PM peak hour for modelled scenario – one way	
PMCAR	Cars for PM peak hour for modelled scenario – one way	
PMTRCK	Trucks for PM peak hour for modelled scenario – one way	
PMBUS	Buses for PM peak hour for modelled scenario – one way	
PMCARP	Car passengers for PM peak hour for modelled scenario – one way	
PMBUSP	Bus passengers for PM peak hour for modelled scenario – one way	
NTTOTAL	Total traffic for NT typical hour for modelled scenario – two way	
NTFLOW	Flow for NT typical hour for modelled scenario – one way	
NTCAR	Cars for NT typical hour for modelled scenario – one way	
NTTRCK	Trucks for NT typical hour for modelled scenario – one way	
NTBUS	Buses for NT typical hour for modelled scenario – one way	

Attribute Name	Attribute Description	Reference
NTCARP	Car passengers for NT typical hour for modelled scenario – one way	
NTBUSP	Bus passengers for NT typical hour for modelled scenario – one way	
D_VC	Weighted average V/C ratio across the day	
D_CONGT	Weighted average travel time across the day	
D_CONGS	Weighted average travel speed across the day	
D_BUSS	Weighted average travel time for buses across the day	
AM_DIRVC	V/C for AM peak hour in the direction of travel	
AM_CONGT	Congested travel time for AM peak hour	
AM_CONGS	Congested travel speed for AM peak hour	
AM_BUSS	Congested travel speed for buses during the AM peak hour	
DT_MAXVC	Maximum V/C for DT typical hour considering both directions of travel	
DT_DIRVC	V/C for DT typical hour in the direction of travel	
DT_CONGT	Congested travel time for DT typical hour	
DT_CONGS	Congested travel speed for DT typical hour	
DT_BUSS	Congested travel speed for buses during the DT typical hour	
PM_DIRVC	V/C for PM peak hour in the direction of travel	
PM_CONGT	Congested travel time for PM peak hour	
PM_CONGS	Congested travel speed for PM peak hour	
PM_BUSS	Congested travel speed for buses during the PM peak hour	
NT_MAXVC	Maximum V/C for NT typical hour considering both directions of travel	
NT_DIRVC	V/C for NT typical hour in the direction of travel	
NT_CONGT	Congested travel time for AM peak hour	
NT_CONGS	Congested travel speed for NT typical hour	

Attribute Name	Attribute Description	Reference
NT_BUSS	Congested travel speed for buses during the NT typical hour	
D_BHDWAY	Average bus headway across the day	
D_BLOAD	Average bus occupancy across the day	
AM_P_BHDWY	Average bus headway for the AM peak period	
AM_P_BLOAD	Average bus occupancy for the AM peak period	
DT_P_BHDWY	Average bus headway for the DT period	
DT_P_BLOAD	Average bus occupancy for the DT period	
PM_P_BHDWY	Average bus headway for the PM peak period	
PM_P_BLOAD	Average bus occupancy for the PM peak period	
NT_P_BHDWY	Average bus headway for the NT period	
NT_P_BLOAD	Average bus occupancy for the NT period	

B.5: Loaded PT Network Node and Link Attributes

The link and node attributes included in the Loaded PT Network are listed in Table B.13. These attributes summarise the performance of the PT system in some detail. It should be noted that Highway performance statistics are reported for the full day, the AM and PM peak periods and the DT and NT periods.

Table B13 - Loaded Public Transport Network Attributes

Attribute Name	Attribute Description	Reference
Node Attributes		
N	Node number	See schema in B.2
X	X Co-ordinate of node	Based on the GDA 1994 MGA Zone 54 co-ordinate system
Y	Y Co-ordinate of node	
NODE_Desc	Text description of node	
NODE_Type	Type of Node	See list in Table B.3
NODE_TZ	Traffic Activity Zone for node	
NODE_JC	Local Government Area for node	See list in Table B.5
NODE_HWSEC	Highway system sector for node	See list in Table B.6
NODE_PTSEC	PT system sector for node	See list in Table B.7

Attribute Name	Attribute Description	Reference
NODE_PRSEC	Project specific sector for node	
NODE_PRCOR	Project specific corridor for node	Not used
NODE_RF	Strategic Role and Function for node	See list in Table B.9
Link Attributes		
A	A node for link	
B	B node for link	
LINK_DESC	Text description of link	
DISTANCE	Link length in Km	See B.3.1
LINK_TYPE	Type of link	See list in Table B.4
LINK_TZ	Traffic Activity Zone for link	
LINK_JC	Local Government Area for link	See list in Table B.5
LINK_HWSEC	Highway system sector for link	See list in Table B.6
LINK_PTSEC	PT system sector for link	See list in Table B.7
LINK_HWTT	Highway travel time route for link	See definition in Table B.8
LINK_PRSEC	Project specific sector for link	
LINK_PRCOR	Project specific corridor for link	
LINK_PRSL	Project specific screenline code for link	
LINK_RF	Strategic Role and Function for link	See list in Table B.9
FFS	Uncongested link speed	
WALK_COST	Walk time for link	
SL_FLAG	Determines if the link is part of a system screenline	1 = included 0 = excluded
SL_DESC	Text description for screenline link	
SL_NUM	Numeric code to define screenline attributes	See description in B.10
AWDT_06_	2006 AWDT – two way	
AWDFL_06_	2006 AWD Flows – one way	

Attribute Name	Attribute Description	Reference
AWDCC_06_	2006 AWD non home based business cars - two way	
AWDCCFL_06_	2006 AWD non home based business cars - one way	
AWDTK_06_	2006 AWD freight vehicles – two way	
AWDTKFL_06_	2006 AWD freight vehicles – one way	
AADT_06_	2006 AADT – two way	
AADFL_06_	2006 AAD Flow – one way	
AMTOT_06_	2006 AM peak hour traffic – two way	
AMFL_06_	2006 AM peak hour flow – one way	
PMTOT_06_	2006 PM peak hour traffic – two way	
PMFL_06_	2006 PM peak hour flow – one way	
AWDBUSES	Number of buses for each week day	
AWDBHDWY	Average bus headway for each week day	
AWDBPASS	Number of bus passengers for each week day	
AWDBLOAD	Average bus occupancy for each week day	
AWDBSPD_1	Average speed for mode 1 buses across each week day	
AWDBSPD_4	Average speed for mode 4 buses across each week day	
AWDBSPD_5	Average speed for mode 5 buses across each week day	
AMBUSES	Number of buses for the AM peak period	
AMBHDWY	Average bus headway for the AM peak Period	
AMBPASS	Number of bus passengers for the AM peak period	
AMBLOAD	Average bus occupancy for the AM peak period	
AMBSPD_1	Average speed for mode 1 buses during the AM peak period	
AMBSPD_2	Average speed for mode 4 buses during the AM peak period	
AMBSPD_3	Average speed for mode 5 buses during the AM peak period	

Attribute Name	Attribute Description	Reference
AMBUS_SCAP	Total AM period bus seated capacity for the link	
AMBUS_CCAP	Total AM period bus crush capacity for the link	
DTBUSES	Number of buses for the DT period	
DTBHDWY	Average bus headway for the DT Period	
DTBPASS	Number of bus passengers for the DT period	
DTBLOAD	Average bus occupancy for the DT period	
DTBSPD_1	Average speed for mode 1 buses during the DT period	
DTBSPD_4	Average speed for mode 4 buses during the DT period	
DTBSPD_5	Average speed for mode 5 buses during the DT period	
DTBUS_SCAP	Total DT period bus seated capacity for the link	
DTBUS_CCAP	Total DT period bus crush capacity for the link	
PMBPASS	Number of bus passengers for the PM peak period	
PMBLOAD	Average bus occupancy for the PM peak period	
PMBSPD_1	Average speed for mode 1 buses during the PM peak period	
PMBSPD_4	Average speed for mode 4 buses during the PM peak period	
PMBSPD_5	Average speed for mode 5 buses during the PM peak period	
PMBUS_SCAP	Total PM period bus seated capacity for the link	
PMBUS_CCAP	Total PM period bus crush capacity for the link	
NTBUSES	Number of buses for the NT period	
NTBHDWY	Average bus headway for the NT Period	
NTBPASS	Number of bus passengers for the NT period	
NTBLOAD	Average bus occupancy for the NT period	
NTBSPD_1	Average speed for mode 1 buses during the NT period	

Attribute Name	Attribute Description	Reference
NTBSPD_4	Average speed for mode 4 buses during the NT period	
NTBSPD_5	Average speed for mode 5 buses during the NT period	
NTBUS_SCAP	Total NT period bus seated capacity for the link	
NTBUS_CCAP	Total NT period bus crush capacity for the link	
AWDTRAINS	Number of trains for each week day	
AWDTRNHDWY	Average train headway for each week day	
AWDTRNPASS	Number of train passengers for each week day	
AWDTRNLOAD	Average train occupancy for each week day	
AWDTRNSPD	Average train speed for each week day	
AMTRAINS	Number of trains for the AM peak period	
AMTRNHDWY	Average train headway for the AM peak period	
AMTRNASS	Number of train passengers for the AM peak period	
AMTRNLOAD	Average train occupancy for the AM peak period	
AMTRNSPD	Average train speed for each the AM peak period	
AMTRN_SCAP	Total AM period train seated capacity for the link	
AMTRN_CCAP	Total AM period train crush capacity for the link	
DTTRAINS	Number of trains for the DT period	
DTTRNHDWY	Average train headway for the DT Period	
DTTRNPASS	Number of train passengers for the DT period	
DTTRNLOAD	Average train occupancy for the DT period	
DTTRNBSPD	Average train speed for each the DT period	
DTTRN_SCAP	Total DT period train seated capacity for the link	
DTTRN_CCAP	Total DT period train crush capacity for the link	
PMTRNPASS	Number of train passengers for the PM peak period	
PMTRNBLOAD	Average train occupancy for the PM peak period	
PMTRNSPD	Average train speed for each the PM peak period	

Attribute Name	Attribute Description	Reference
PMTRN_SCAP	Total PM period train seated capacity for the link	
PMTRN_CCAP	Total PM period train crush capacity for the link	
NTTRNPASS	Number of train passengers for the NT period	
NTTRNLOAD	Average train occupancy for the NT period	
NTTRNSPD	Average train speed for each the NT period	
NTTRN_SCAP	Total NT period train seated capacity for the link	
NTTRN_CCAP	Total NT period train crush capacity for the link	
AWDTRMPASS	Number of tram passengers for each week day	
AWDTRMLOAD	Average tram occupancy for each week day	
AWDTRMBSPD	Average tram speed for each week day	
AMTRAMS	Number of trams for the AM peak period	
AMTRMHDWY	Average tram headway for the AM peak period	
AMTRMPASS	Number of tram passengers for the AM peak period	
AMTRMLOAD	Average tram occupancy for the AM peak period	
AMTRMSPD	Average tram speed for each the AM peak period	
AMTRM_SCAP	Total AM period tram seated capacity for the link	
AMTRM_CCAP	Total AM period tram crush capacity for the link	
DTTRMPASS	Number of tram passengers for the DT period	
DTTRMLOAD	Average tram occupancy for the DT period	
DTTRMSPD	Average tram speed for each the DT period	
DTTRM_SCAP	Total DT period tram seated capacity for the link	
DTTRM_CCAP	Total DT period tram crush capacity for the link	
PMTRMPASS	Number of tram passengers for the PM peak period	
PMTRMLOAD	Average tram occupancy for the PM peak period	
PMTRMSPD	Average tram speed for each the PM peak period	
PMTRM_SCAP	Total PM period tram seated capacity for the link	
PMTRM_CCAP	Total PM period tram crush capacity for the link	

Attribute Name	Attribute Description	Reference
NTTRMPASS	Number of tram passengers for the NT period	
NTTRMLOAD	Average tram occupancy for the NT period	
NTTRMSPD	Average tram speed for each the NT period	
NTTRM_SCAP	Total NT period tram seated capacity for the link	
NTTRM_CCAP	Total NT period tram crush capacity for the link	

Appendix C – Public Transport Input Files Updating

C.1: Public Transport Lines Files

The Public Transport Lines File for each model run follows standard Cube practice, however some attributes need to be carefully and consistently defined as noted below:

Table C1 - PT Line File Attributes

PT Attribute		Description
Line Name		The short route name for each PT service should follow the following convention:-.
	Bus	All bus services should start with the allocated bus route identifier.
	Train	All train services should start with two characters identifying the rail line as follows: - BL – Belair Line GA – Gawler Line GR – Grange Line NO – Noarlunga Line SO – Seaford Line OH – Outer Harbor Line TN – Tonsley Line FN – Flinders Line
	Tram	All tram services are prefixed by “CTEX_” followed by two characters identifying the starting and ending points e.g. CTEX_GE = Glenelg – Entertainment Centre
		All services should be postfixed by a single character identifying the service direction as follows: - A – a service operating in an anti-clockwise direction C – a service operating in a clockwise direction D – a service originating in the “Primary” centre e.g. City to Glenelg U – a service destination for the “Primary” centre e.g. Glenelg to City
LongName		A description of each service – Glenelg to City – All stops
Mode		The mode for each service should be defined as follows: - Mode = 1 Bus service, non-city Mode = 2 Train service Mode = 3 Tram service Mode = 4 Bus service, city all stops Mode = 5 Bus service, City limited stop
Operator		Line operator identifier corresponding to the list in the PT System File
Headway[1]		Average service headway during the AM peak period (7-9am – 2hrs)
Headway[2]		Average service headway during the DT period (9-3pm – 6hrs)
Headway[3]		Average service headway during the PM peak period (3-6pm – 3hrs)
Headway[4]		Average service headway during the NT period (6-midnight – 6hrs)

PT Attribute		Description
Headway[5]		Average service headway during the full service period (7am to Midnight – 17hrs)
Vehicle Type		Vehicle type identifier corresponding to the list in the PT System File. Note: Each vehicle type has a unique seat capacity, crush capacity, load distribution factors and crowding curve.
FareSystem		Fare system identifier corresponding to the list in the PT System File.
UserN1/UserN2/UserN3		Public transport corridor identifier corresponding to the following list: -.
	Bus Services	1 - Anzac Highway services 2 – Arndale Centre services 3 – Circle line services 4 – Dequetteville Terrace services 5 – Glen Osmond Road services 6 – Goodwood Road services 7 – Henley Beach Road services 8 – Lower North East Road services 9 – Main North Road services 10 – Marion Regional Centre services 11 – Noarlunga Regional Centre services 12 – O-Bahn services 13 – Port Road services 14 – Salisbury Interchange services 15 – South Road services 16 – The Parade services 17 – Unley Road services 18 – West Lakes Regional Centre services 19 – Mount barker local services 20 – Gawler local services 21 – Other services
	Train Services	1 – Belair line services 2 – Gawler line services 3 – Grange line services 4 – Noarlunga line services 5 – Outer Harbor line services 6 – Tonsley line services 7 – Seaford line services 8 – Flinders Medical/Uni line services 9 – Hackham line services 10 – Roseworthy line services 11 – Concordia line services 12 – Aldinga line services 13 – Other services
	Tram Services	1 – Glenelg services 2 – West Lakes services 4 – Henley Beach services 5 – Grange services

PT Attribute		Description
		6 – Airport services 7 – Magill services 8 – Modbury services 9 – Port Adelaide services 10 – Other services
NNTime		Public transport vehicle travel time from the previous timed node to the current node.
Dwell Node		Public transport vehicle stop time at the current node. *Note: All CBD limited stop bus services (defined by mode = 5) must have a defined stopping pattern with this node attribute defined for each stop node and all other nodes defined as non-stopping nodes.*
UserA1/UserA2/UserA3		Public transport model operation identifiers
	UserA1	Public Transport Operating Model (PTOM) identifier corresponding to the following (further information can be sourced from DPTI Knet #11661321 – Public Transport Foundation Network description report): 16 = reflects the actual bus operating timetable for 2011 99 = reflects the actual bus operating timetable for 2016 101 = reflects the actual train operating timetable for 2016 102 = reflects the actual tram operating timetable for 2016 98 = reflects a proposed future bus timetable for 2021 103 = reflects a proposed future train timetable for 2021 104 = reflects a proposed future tram timetable for 2021 100 = reflects a proposed future bus timetable for 2026 107 = reflects a proposed future train timetable for 2026 103 = reflects a proposed future tram timetable for 2026 116 = reflects a proposed future bus timetable for 2031 110 = reflects a proposed future bus timetable for 2036 108 = reflects a proposed future train timetable for 2036 105 = reflects a proposed future tram timetable for 2036
	UserA2	Is a PT (Bus, Train, Tram) ID identifier of a specific philosophy e.g. 1.0 actual time table 1.0 = actual timetable 1.1 = revised actual timetable 6.0 = Future operating timetable model based on ITLUP 6.2 = Same as 6.0 but with a major revision 6.2.1 = same as 6.2 but with a minor revision
	UserA3	Year (YYYY)

The file header information which identifies changes made in developing each of the Public Transport Lines Files should also be updated as show in figure C1 below.

```
;;<<PT>><<LINE>>;;
;;BOM 1.1 added by CM updated 160907 for MASTEM V3.1.1
;;Built for MASTEM V3.1.1
;;BOM 1.1 is based on PTOM ID #99, which represent Jan 2016 timetables.
;;ROM 1.1 added by CM updated 160418 for MASTEM V3.1.1
;;Built for MASTEM V3.1.1
;;The Seaford/Tonsley line have been revised to the Feb 2015 timetable.
;;Millswood and the Showgrounds stations added.  Showgrounds replaces Keswick - essentially relocated
;;Belair line is running the peak flow setup AS IN TIMETABLE OCT 2014
;;Gawler line have been revised to the Feb 2013 timetable
;;Outer Harbor/Grange have been revised to the Feb 2014 timetable
;;Rail timetable changes designed to represent current timetable as of 2015 - see knet#
;;Developed from Jan 2016 PT timetables and PTOM ID#xx (still needs to be added to PTOM)
;;TOM 1.1 added by CM 160713 for MASTEM V3.1.1
;;Built for MASTEM V3.1.1
;;Tram as of Jan 2016
;;Free fare structure has been setup (split services for free fare have been removed) - consisting of -
;;      1) Glenelg to City boundary (node - 9003) - Fare cost
;;      2) City boundary (node - 9003) to City boundary AEC (node - 9029) - Fare free cost
;;      3) City boundary (node - 9003) to Glenelg - Fare cost
;;      4) City boundary AEC (node - 9029) to City boundary (node - 9003) - Fare free cost
;;
```

Figure C1 - PT Line File Header Information

C.2: Park and Ride (PnR) Locations File

The Public Transport Park and Ride access schema as defined in Section 5.4.6 and below in figure C.2.

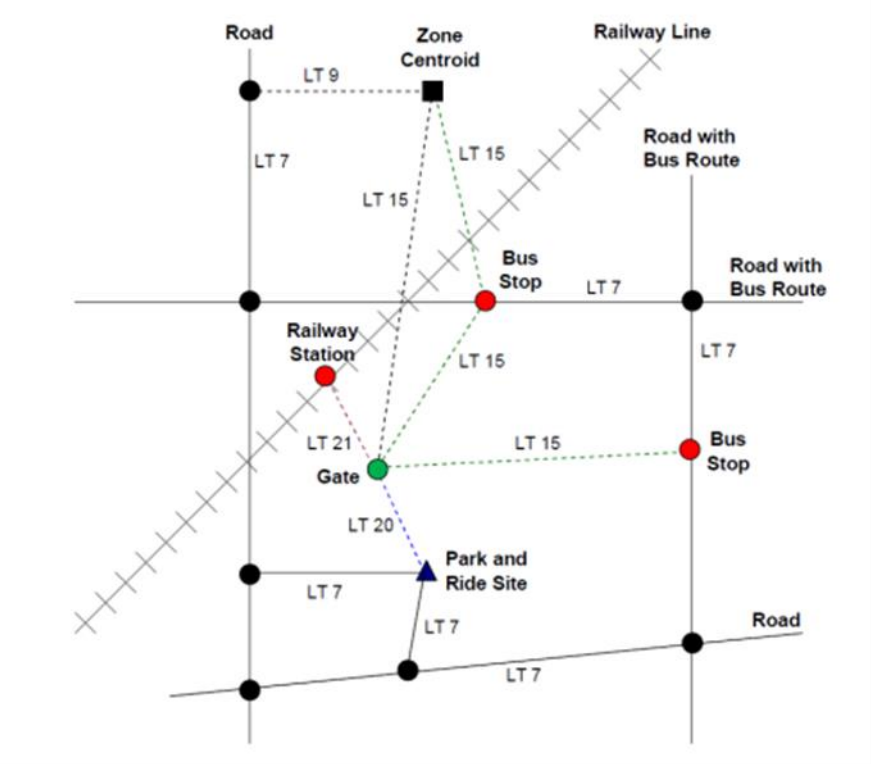


Figure C2 - Representation of Park and Ride Function

Each Park and Ride requires the following information to be defined in the PnR Locations File for each scenario (see figure C3 for a snapshot of the Park & Ride Location File and Table C2 for a description of the Park and Ride Location File attributes).

	A	B	C	D	E	F	G	H	
	MODE	PNR_NAME	PNR_CAP	PNR_NODE	GATE_NODE	STOP_NODE	PENALTY	PNR_VEH_OC	CATCHMENT
	Bus	Aberfoyle Park	200	7000	7500	4427	10	1.49876	261,262,284,438,439,440,442,599,603,
	Rail	Albert Park	21	7001	7501	9346	10	1.69750	108,110,112,113,114,118,119,120,295,
	Rail	Alberton	15	7002	7502	9352	10	1.70000	133,134,135,136,137,138,139,301,
	Bus	Aldgate	250	7003	7503	2190	10	1.49876	281,283,297,301,425,427,428,430,432,
	Rail	Ascot Park	15	7004	7504	9324	10	1.31875	182,200,201,208,336,339,346,348,349,
	Rail	Belair	7	7006	7506	9316	10	1.31875	185,187,320,321,324,
	Rail	Blackwood	155	7008	7508	9313	10	1.31875	188,189,322,323,324,325,441,437,603,

Figure C3 - Park and Ride Locations File

Table C2 - Park and Ride Location File Attributes and Description

Attribute Name	Attribute
Mode	Needs to be either: - Bus, Rail; or Tram
PnR Name	A text field describing each Park and Ride location
PnR Cap	The number of parking spaces available at each Park and Ride location.
PnR Node	The Park and Ride node – within the range 7000 – 7499.
PnR gate	The Park and Ride gate node – the Park and Ride node number plus 500 (7500 – 7999) e.g. if the PnR node = 7001 then the PnR Gate will be 7501.
Stop Node	The Public transport service stop node services by the Park and Ride.
Penalty	This attribute is used to adjust the Park and Ride access times as the number of parked vehicle approaches or exceeds the number of spaces available.
PnR Veh Occ	Average vehicle occupancy for each vehicle accessing the Park and Ride. *Note: This attribute is not used and that average vehicle occupancy is defined by the Park and Ride Vehicle Occupancy File.*
Catchment	A list of traffic activity/analyst zones (TAZ) serviced by each Park and Ride.

C.3: Non-Transit Walk Links

It is important that every Public Transport stop node is effectively connected to each traffic activity zone. Previous versions of MASTEM relied on the Highway zone connectors to provide walk access to the Public Transport stop nodes, however the significant changes to the Highway zone connectors implemented in MASTEM V3.1, which are now often remote from Public Transport stops requires that a separate system of Public Transport non-transit

walk links are provided. Each of these walk links is identified by a Link Type of 15. As described in section 5.4.2 and seen in figure C4 below.

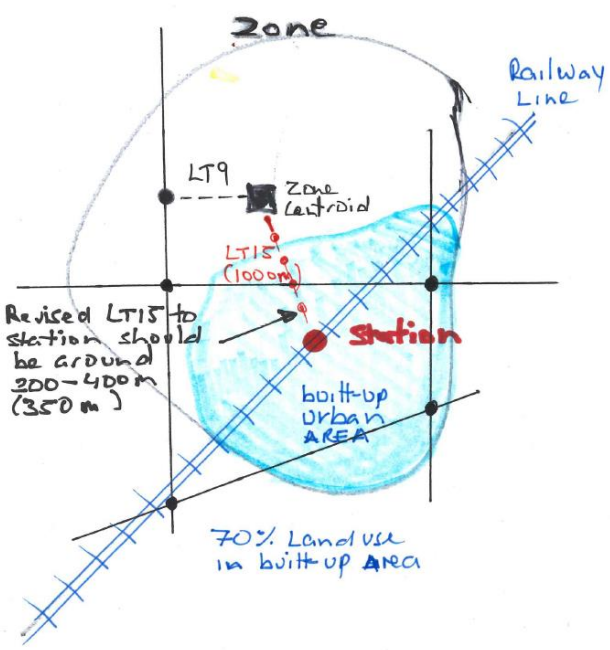


Figure C4 - Walk Link Distance for Built-Up Urban Area

C.4 PT Factors File/PT Interchange Priority Files

Changes to the Public Transport services may require the node lists in the following files to be updated:

- The stopping nodes lists in the wait factors section of the Factors File for each user class – as highlighted in Figure C5.1 below.

```
WAITFACTOR=2.2,  N=1000-3565,3567-3875,3878-6999                                  ; Bus Stops
WAITFACTOR=1.8,  N=3566, 3876, 3877                                               ; O-Bahn Stations
WAITFACTOR=1.8,  N=9004-9020,9027-9041,9044-9049,9052-9056,9067-9151,9158-9180,9182-9299  ; Tram Stops / BRT Stops - Non CBD
WAITFACTOR=1.3,  N=9001-9003,9021-9026,9042,9043,9050-9051,9057-9066,9152-9157,9181       ; Tram Stops / BRT Stops - CBD
WAITFACTOR=1.0,  N=9301,9304,9306                                                 ; Train Stations - CBD
WAITFACTOR=2.0,  N=9366,9367,9369                                                 ; Train Stations - Gawler Line inner Stations
WAITFACTOR=1.8,  N=9302,9305,9307-9344,9350-9365,9368,9370-9999                   ; Train Stations - All others
```

Figure C5.1 - Snapshot of PT Factors File - Wait Factors

- The interchange nodes defined in the Interchange Priority File as describe in Section 5.4.7 (as show in figure C5.2 – Interchange Priority “YYYY” snapshot below).

NODE_ID	XWC_TYPE
9301	3
9023	3
9025	3
9026	3
9379	3
3566	3
5068	2
9337	3
9353	3

Figure C5.2 - Snapshot of an Interchange Priority File

Appendix D – Highway Input Files Updating

D.1: Highway Junction Files

The junction model within MASTEM should closely emulate SCATS performance, although this will be limited to some extent by the limitations of the CUBE junction modelling. The junction model should also be robust under a range of possible scenarios / time periods in order to minimise the effort required to effectively develop this critical component of the model. The Highway Junction Files for each time period for each scenario run follow standard Cube practice however some attributes need to be carefully and consistently defined as noted below:

Time Period Variation:

To the extent possible, attribute values should be the same for all time periods, and should be chosen such that intersection performance is acceptable across all time periods. Separate time period files should only be used when banned movements or lane use changes throughout the day.

Signal Operation:

In general all signalised intersections / junctions should be coded using the Adaptive Signal, Geometric (HCM) option.

Lane Geometry:

The lane geometry should match the existing / proposed layouts.

Phases:

Signal phasing should match either the existing arrangement or – for proposed new signals – the preferred arrangement for four way intersections which provides greatest flexibility is to adopt leading and trailing right turn movements as shown in Figure D1.1.

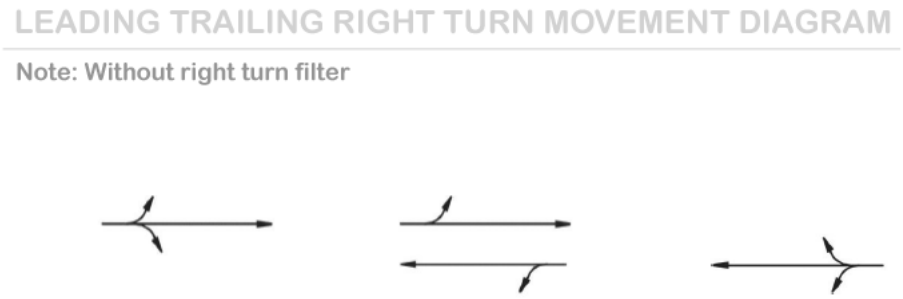


Figure D1.1 - Leading Trailing Right Turn Movement Diagram

For T junctions, the three phase signal operation is the preferred design of signals for input into the future year MASTEM Model as shown in Figure D1.2.

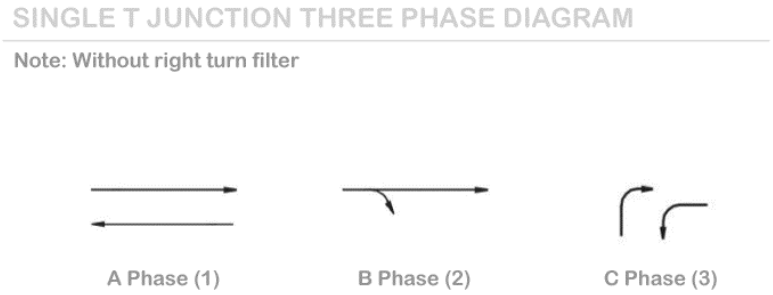


Figure D1.2 - Single T Junction Three Phase Diagram

For all new locations all right turns should be controlled (no right turn filters).

Cycle times should be 120 seconds for all time periods unless the intersection operates with longer cycle times across all time periods. Phase times for existing signalised intersections should be based on operational data, and the range between the minimum and maximum phase times should cover the likely range for all time periods.

D.2 Turn Penalty Files

Turn penalty files may be used to ban movements or to add delay to specific movements.

Appendix E - MASTEM User Benefit Calculation Tool

E.1 MASTEM User Benefit Calculation Tool

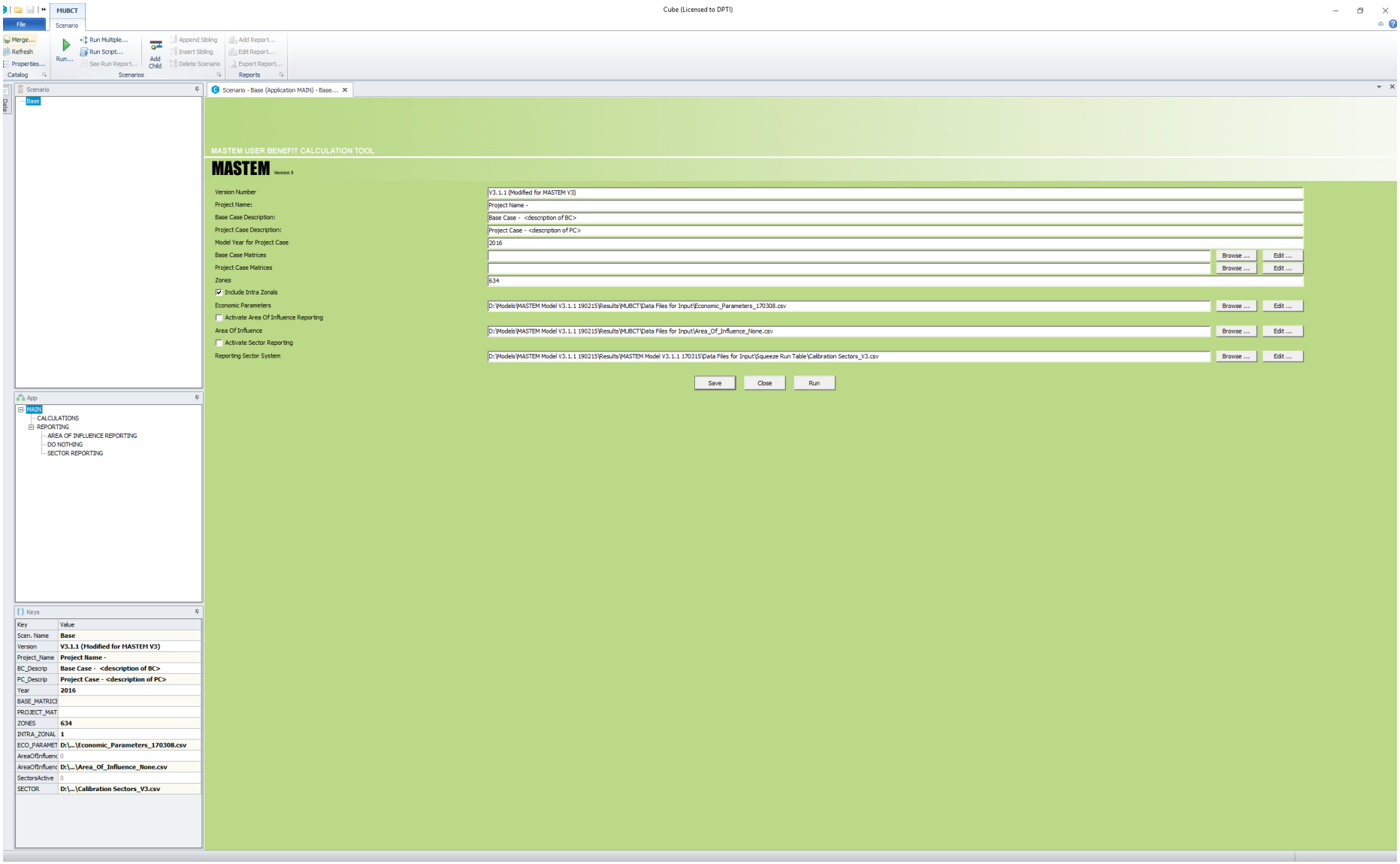


Figure E.1 - MUBCT - Main Input Page

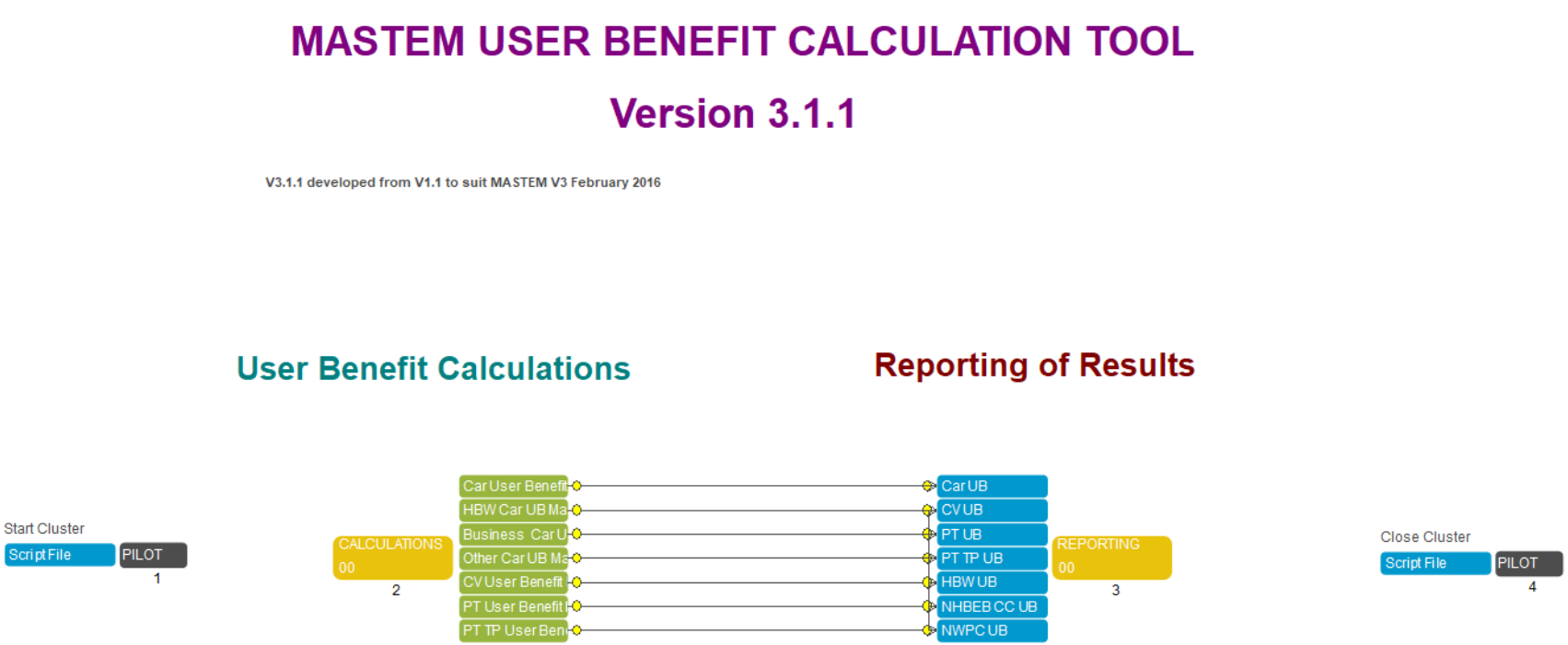
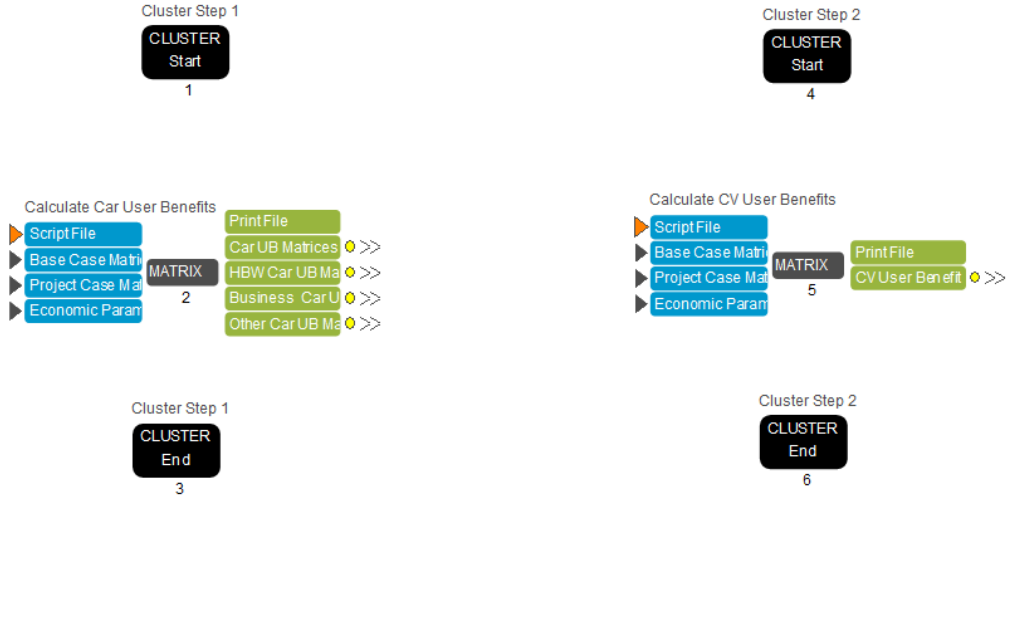


Figure E.2 - MUBCT - Main Application Page



EUB - Existing User-Benefit
IUB - Induced User-Benefit
CAR - Car Vehicle Demand
CAR_PER - Car Person Demand
CV - Commercial Vehicle
PT - Public Transport
AE - Access / Egress

Figure E.3 - Calculation Application Page

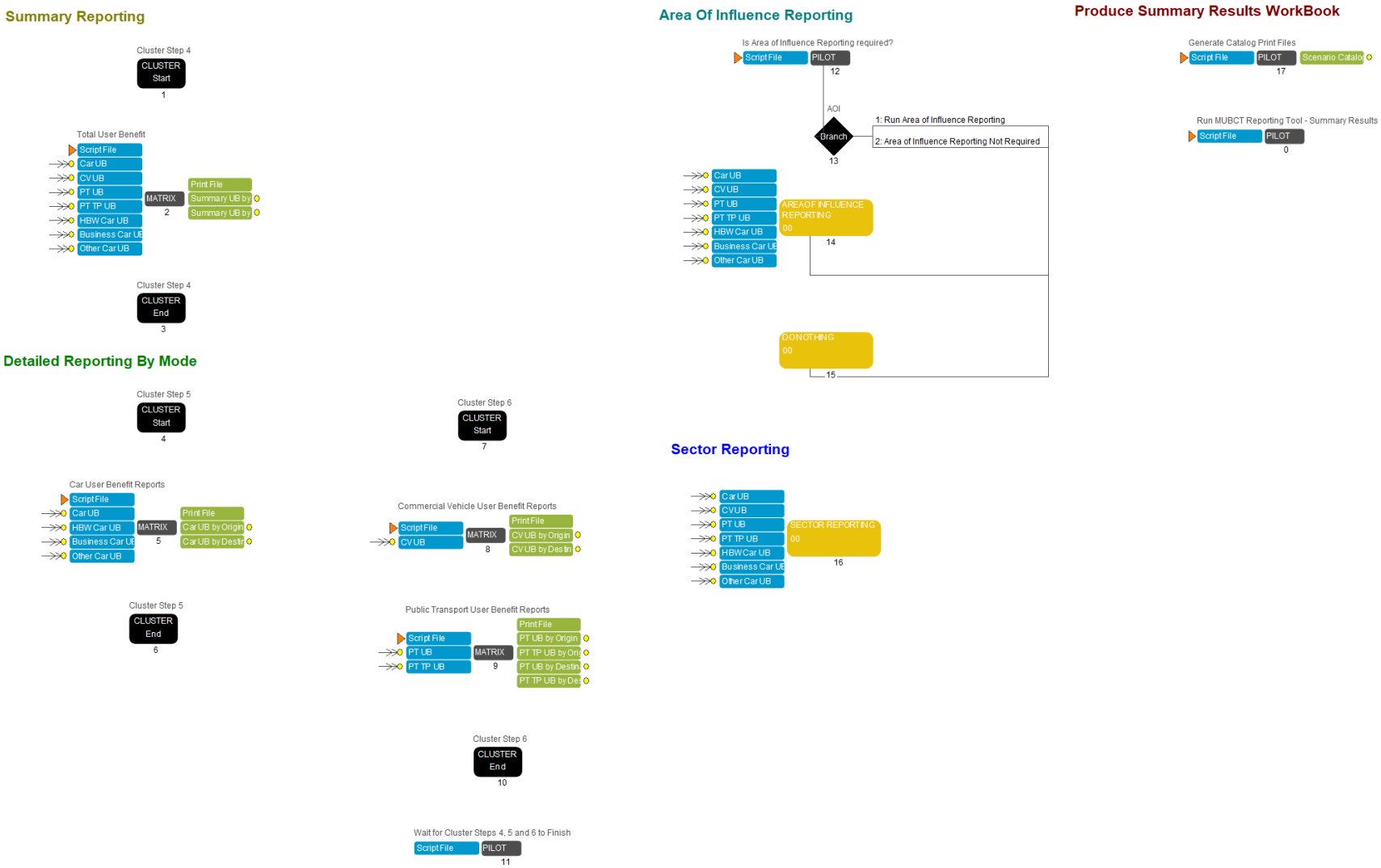


Figure E.4 - Main Reporting Page

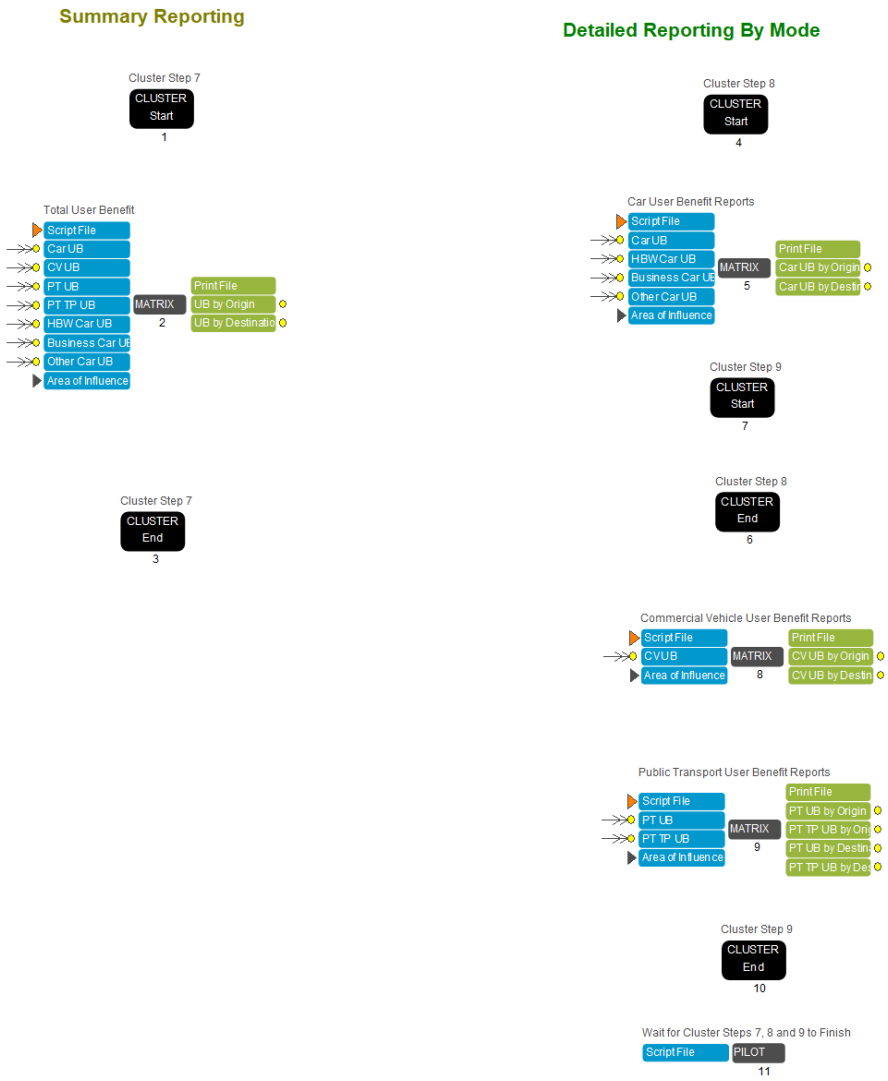


Figure E.5 - Area of Influence Reporting Application Page

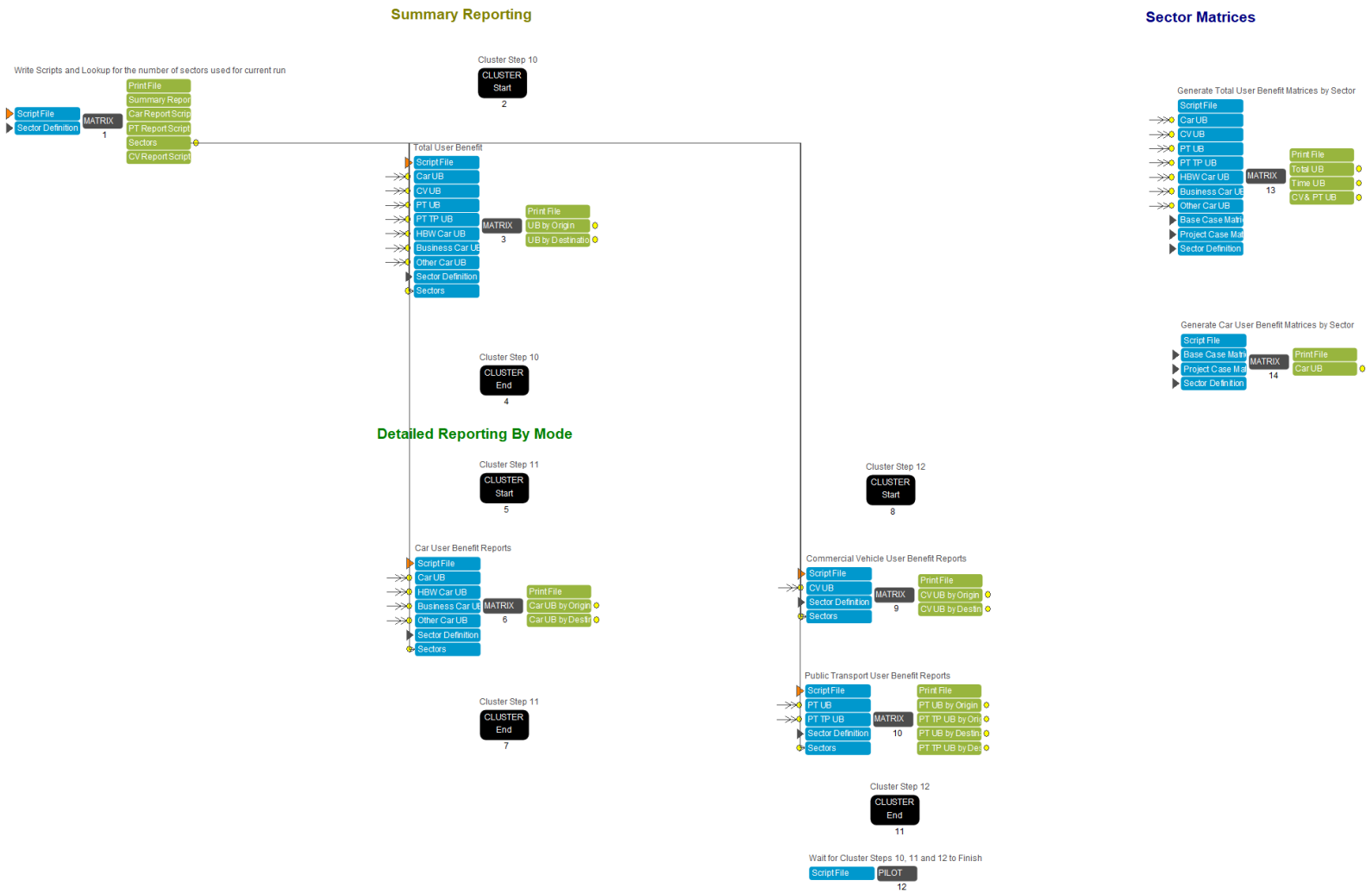


Figure E.6 - Sector Reporting Application Page

E.2 Origin-Destination User Benefit Tool (ODUBT)

Origin-Destination User Benefit Tool (ODUBT)

Technical Report

For: Department of Planning, Transport and Infrastrcutrue

Government of South Australia

Department of Planning, Transport and Infrastructure

3rd August 2015

Project Name:	ODUBT
Project Number:	3005444
Report for:	Department of Planning, Transport and Infrastructure

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
1	03/08/15	J Parrott	P. Tisato	J Parrott

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SMEC COMPANY DETAILS

SMEC AUSTRALIA
Level 4, 19 Grenfell Street, Adelaide, SA 5000

Tel: **08 8225 9800**

Fax: **08 8225 9850**

Email: **James.Parrott@smec.com**

www.smec.com

TABLE OF CONTENTS

1 INTRODUCTION

This is the Technical Report for version 2.0 of the DPTI[1] Origin-Destination User Benefit Tool (ODUBT). Version 1.0 of the tool and its associated report were developed by SKM. Version 2.0 has been produced by SMEC for DPTI.

ODUBT is a tool for calculating the user-benefits associated urban transport infrastructure projects on an origin-destination basis. The methodology is recommended by Infrastructure Australia as best practice for the assessment of large urban transport initiatives.

For a given transport initiative, the ODUBT specifically calculates user benefits on a disaggregated basis for each origin-destination pair. It then aggregates across all origin-destination pairs to give the total user-benefit for the initiative. ODUBT uses as its primary input results from DPTI's strategic travel demand model MASTEM.

ODUBT standard results are currently produced by:

- Mode of travel (private car home-based work trip, private car non-work trip, commercial/business car, commercial vehicles (CV, i.e. truck) and public transport
- Time period AM peak, PM peak and Off-Peak (OP) time periods
- For the Adelaide metropolitan area as a whole (as modelled by MASTEM), and on an Area of Influence basis (optional).

The tool was developed in the CUBE Voyager and Microsoft Excel software platforms. User-benefit calculations are not required after every run of MASTEM, thus the ODUBT was developed as a separate post-processing tool that forms part of the MASTEM suite. The tool resides in the MASTEM 'Results' folder along with the summary statistics reporting. To provide consistency with the summary statistics reporting, the results from the ODUBT were developed with a similar style including a catalogue key report, specific to the ODUBT catalogue key.

This current version of ODUBT operates using the following software:

- MASTEM V2.3.0 (21/08/10) which includes the Summary Statistics 2 update;
- CUBE Voyager 6.1.0 (SP1) and Microsoft Excel 2010.

All parameter values have been provided by DPTI.

The rest of this technical report documents:

- the formula and parameters used for user benefit calculations (Section 2);
- the reporting provided by the tool (Section 3);
- how the ODUBT operates (Section 4); and

[1] Department of Planning, Transport and Infrastructure

2 USER BENEFIT CALCULATIONS

This section outlines how user benefit is calculated in ODUBT. The formulas follow standard transport cost-benefit analysis (CBA) methodology as outlined in the *National Guidelines for Transport System Management.*[2]

2.1 User Benefit Formula

The following formulas[3] outline how user benefit is calculated in the ODUBT.

Notation:

- origin zone i and destination zone j
- modes - m = 1, 2, 3, ….
- base case - BC
- project case - PC
- generalised cost - GC
- demand/trip – T

The user benefit (UB) for O-D pair ij and mode m is:

$$UB_{ij}^{m} = A_{ij}^{m} + B_{ij}^{m} \quad (1)$$

where

$$A_{ij}^{m} = (GC_{ij}^{m,BC} - GC_{ij}^{m,PC})T_{ij}^{m,BC} \quad (2)$$

and

$$B_{ij}^{m} = 0.5(GC_{ij}^{m,BC} - GC_{ij}^{m,PC})(T_{ij}^{m,PC} - T_{ij}^{m,BC}) \quad (3)$$

where

A_{ij}^{m} is the user benefit to existing users of mode m, and

B_{ij}^{m} is the user benefit to users who switch to mode m from other modes, and is calculated using the conventional method in CBA called the 'rule of half'.

The user benefit across all modes for O-D pair ij is then:

$$UB_{ij} = \sum_{m} UB_{ij}^{m}$$

The user benefit for a given mode, m across all O-D pairs is:

$$UB^{m} = \sum_{ij} UB_{ij}^{m}$$

[2] Transport and Infrastructure Council (2015) *National Guidelines for Transport System Management* (http://www.transportinfrastructurecouncil.gov.au/publications/files/National_Guidelines_Volume_4.pdf)

[3] Provided by DPTI.

The total user benefit for the initiative can be calculated by summing across either all O-D pairs or all modes:

$$UB = \sum_{ij} UB_{ij} = \sum_{m} UB^{m}$$

ODUBT currently calculates user benefits on the basis of 'perceived' user costs. A separate 'resource correction', to adjust for difference between perceived and resource costs, is currently calculated outside ODUBT using aggregate outputs from the MASTEM model. In due course, the resource correction calculations could also be undertaken within ODUBT.

2.2 Mode Notation

The following notation is used for the four modes modelled:

- **PV CAR**: private car – private, non-business travel by car
- **COMM CAR**: commercial car – non-private business travel by car
- **CV**: truck, referred to here (as per MASTEM) as 'commercial vehicle'
- **PT**: public transport (bus, train and tram)

2.3 Generalised Cost

Each mode has its own generalised cost equation which takes into account all cost elements incurred by the user. The equations are listed below:

$$GC_{PV\ CAR} = (VoT_{PV\ CAR}/60) \times Time_{CAR} + (VOC_{PV\ CAR}) * Distance_{CAR} + P \times I_P$$

$$GC_{COM\ CAR} = (VoT_{COMM\ CAR}/60) \times Time_{CAR} + (VOC_{COM\ CAR}) * Distance_{CAR} + P \times I_P$$

$$GC_{CV} = (VoT_{CV}/60) \times Time_{CV} + (VOC_{CV}) * Distance_{CV}$$

$$GC_{PT} = F \times I_F + (VoT_{PT}/60) \times (T_{AE} \times W_{AE} + T_{PKR} \times W_{PKR} + T_W \times W_W + T_{I\ BUS} \times W_{I\ BUS} + T_{I\ TRAM} \times W_{I\ TRAM} + T_{I\ TRAIN} \times W_{I\ TRAIN} + TT_P \times W_P + TT_{AT} \times W_{AT} + TT_{WT} \times W_{WT})$$

where for any trip between an origin-destination (O-D) pair:

$VoT_{PV\ CAR}$ is the value of time in dollars per person-hour for private car trips

$VoT_{COMM\ CAR}$ is the value of time in dollars per person-hour for commercial car trips

VoT_{CV} is the value of time in dollars per vehicle-hour for CV trips

VoT_{PT} is the value of time in dollars per person-hour for PT trips

$VOC_{PV\ CAR}$ is the vehicle operating cost in dollars per vehicle-kilometre for private car trips

$VOC_{COMM\ CAR}$ is the vehicle operating cost in dollars per vehicle-kilometre for commercial car trips – at this point in time, the same value is used as for $VOC_{PV\ CAR}$

VOC_{CV} is the vehicle operating cost in dollars per vehicle-kilometre for CV trips

$\mathbf{Time_{CAR}}$ is the highway skim for average car travel time

$\mathbf{Time_{CV}}$ is the highway skim for average CV travel time

$\mathbf{Distance_{CAR}}$ is the highway skim for average car travel distance

$\mathbf{Distance_{CV}}$ is the highway skim for average CV travel distance

P is the weighted average parking charge that car vehicles pay per trip

$\mathbf{I_P}$ is the indexation factor for parking charges

F is the weighted average fare that public transport passengers pay per trip

$\mathbf{I_F}$ is the indexation factor for Public Transport Fares

$\mathbf{T_{AE}}$ is the time cost for walk access/egress

$\mathbf{W_{AE}}$ is the weighting for walk access/egress

$\mathbf{T_{PKR}}$ is the time cost for park/kiss and ride

$\mathbf{W_{PKR}}$ is the weighting for park/kiss and ride

$\mathbf{T_W}$ is the waiting time for the initial boarding

$\mathbf{W_W}$ is the weighting on the waiting time for the initial boarding

$\mathbf{T_{I\ BUS}}$ is the time cost for bus in vehicle travel time

$\mathbf{W_{I\ BUS}}$ is the weighting for bus in vehicle travel time

$\mathbf{T_{I\ TRAM}}$ is the time cost for tram in vehicle travel time

$\mathbf{W_{I\ TRAM}}$ is the weighting for tram in vehicle travel time

$\mathbf{T_{I\ TRAIN}}$ is the time cost for train in vehicle travel time

$\mathbf{W_{I\ TRAIN}}$ is the weighting for train in vehicle travel time

$\mathbf{TT_P}$ is the total transfer penalty

$\mathbf{W_P}$ is the weighting for time costs for transfers

$\mathbf{TT_{AT}}$ is the total access/walk time for service transfers

$\mathbf{W_{AT}}$ is the weighting for access/walk times for transfers

$\mathbf{TT_{WT}}$ is the total time waiting for service transfers

$\mathbf{W_{WT}}$ is the weighting for wait times for transfers

Notes:

1) Generalised cost is calculated for each O-D pair, resulting in an O-D matrix of generalised cost (referred to as 'skims').
2) Time is calculated in minutes.
3) **PV CAR** represents both home-based work (HBW) and Non-Work car trips. **COMM CAR** combines non-home based employer's business (NHBEB) car trips and commercial car trips. HBW and NHBEB are trip purpose codes from the MASTEM model.

4) The **GC_{PT}** formula is the application of the formula in the ATC (2006)[4] within the scope of the MASTEM model. The variations in application here are as follows:
   a) Park/kiss and ride costs are shown separately from other access/egress costs
   b) In-vehicle time costs are shown for each of the three public transport modes (bus, train and tram) because a trip can consist of several boardings of different public transport modes
   c) **I_P** and **I_F** allow the dollar values built into the MASTEM model to be indexed up to current value
   d) **TT_P** is equivalent to N_T * T_P in Transport and Infrastructure Council (2015). TT_P is the way MASTEM reports.
   e) **TT_{AT}** is equivalent to N_T * T_{AT} in Transport and Infrastructure Council (2015). TT_{AT} is the way MASTEM reports.
   f) **TT_{WT}** is equivalent to N_T * T_{WT} in Transport and Infrastructure Council (2015). TT_{WT} is the way MASTEM reports.

[4] Australian Transport Council (2006), *National Guidelines for Transport System Management*. Vol.4, p.45. Can be referenced via the weblink in footnote 2 – at the website, go to > About > Reference Documents

2.4 Parameter Values

User benefits are calculated using parameter values supplied by DPTI. The values at June 2015 are listed in Table 1.

Table 1 Parameter Values

	Parameter	Value	Unit
$VOT_{PV\ CAR}$	CAR_VoT	15.40	$'s_per_person_per_hour
$VOT_{COMM\ CAR}$	Comm_CAR_VoT	46.70	$'s_per_person_per_hour
VOT_{CV}	CV_VoT (1)	47.90	$'s_per_vehicle_per_hour
VOC_{CAR}	CAR_VOC	0.27	$'s_per_vehicle_per_kilometre
VOT_{CV}	CV_VOC	0.72	$'s_per_vehicle_per_kilometre
VOT_{PT}	PT_VoT	15.40	$'s_per_person_per_hour
P	Car_Parking_Charge	(2),(3)	$'s per trip
F	PT_Fare	(2),(4)	$'s per trip
I_P	Car_parking_charge_indexation_factor	1.0	
I_F	PT_fare_indexation_factor	1.16	
W_{AE}	Walk_Access_Time_Weighting	1.4	Multiplier of time
W_{PKR}	Park_and_Ride_Access_Time_Weighting	1	Multiplier of time
W_W	Wait_Time_Initial_Boarding_Weighting	1.4	Multiplier of time
W_{IBUS}	Bus_In-Vehicle_Time_Weighting	1	Multiplier of time
W_{ITRAIN}	Train_In-Vehicle_Time_Weighting	1	Multiplier of time
W_{ITRAM}	Tram_In-Vehicle_Time_Weighting	1	Multiplier of time
W_P	Transfer_Penalty_Weighting	1.4	Minutes
W_{AT}	Walk_Transfer_Time_Weighting	1	Multiplier of time
W_{WT}	Wait_Time_Transfer_Boarding_Weighting	1.2	Multiplier of time
	Car_Annualisation_Factor	328	Multiplier of traffic volume
	CV_Annualisation_Factor	286	Multiplier of traffic volume
	PT_Annualisation_Factor	280	Multiplier of patronage

Notes:

(1) Varies with the mix of heavy trucks. Hence needs to be specified for each project assessment. The figure reported here represents traffic mix on South Road at Mile End (between Henley Beach Road and Sir Donald Bradman Drive).

(2) Parking (P) and fare (F) costs are built into the MASTEM model.[5]

(3) Calculated in MASTEM on an O-D basis and by trip type. Values in MASTEM range from $5.55 to $9.05 for work based trips i.e. all day parking and range from $0.90 to $2.05 for non-work trips i.e. short term parking. These numbers are in 2006 dollars. DPTI does not have a parking cost index series, and is not aware of one in ABS series. The motoring cost sub-group of the ABS CPI series (6401, Table 11) shows a small decline in real terms (relative to general inflation [ABS, CPI series, 6401.0, Adelaide, All Groups] from 2006 to 2015. In the absence of better information, the indexation factor $\mathbf{I_p}$ was kept at 1.0.

[5] See 2014 DPTI report #83244222 *MASTEM Travel Demand Model – Methodology and Assumptions.*

(4) Calculated in MASTEM on a trip purpose basis using the Adelaide Metro fare structure and fare levels. In MASTEM the fare data is in 2006 dollars, and are then indexed up in real terms to 2015 dollars via the indexation factor I_F. I_F was calculated based on real fare indexation by combining the fare data with general inflation data (ABC, CPI series, 6401.0, Adelaide, All Groups).

Sources:

VoT and VOC: Austroads (2012) Guide to Project Evaluation, Part 4 – values supplied by DPTI

PT weightings: Australian Transport Council (2006), National Guidelines for Transport System Management, Vol 4, appendix A (see footnote 4 for weblink).

Annualisation factors: supplied by DPTI

Car Parking Charge indexation factor: supplied by DPTI, see note 3 above

PT Fare indexation factors: Supplied by DPTI, based on internal DPTI data, see note 4 above.

3 REPORTING

The outputs from ODUBT relate to the four dimensions of calculations undertaken in the tool. They are:

1) **Mode** – Private Car Person, Commercial Car Person, Commercial Vehicle and Public Transport Passenger[6]
2) **Cost Component** – *Car and CV*: Time and Distance
   Public Transport: Fare, Walk Access/Egress and Transfer, Park and Ride Access/Egress, Bus/Train/Tram In-Vehicle Time, Initial and Transfer Wait Times and Transfer Penalties
3) **Time Period** - AM, OP and PM
4) **User Type** – Existing and Induced[7]

The calculations are performed and available at the O-D level; however it is not practical to report the results at this level (320x320[8] matrices). Thus outputs are produced at several geographical levels. They are as follows:

- whole of Adelaide metropolitan area as modelled by MASTEM;
- at the origin zone level;
- at the destination zone level; and
- by area of influence (AOI).

The purpose of the AOI option is to remove the influence of traffic effects in parts of the transport network where one would expect the project to have little impact. This removes the potential influence of any MASTEM 'model noise' in those locations. All travel demand models contain 'model noise', and this is a practical method for limiting its influence in user benefit calculations.

The AOI option works by zeroing out results for all O-D pairs where both the origin zone and destination zone are not included within the specified AOI zone list. If one or both of the origin zone and destination zone are included in the AOI zone list, the result for the OD pair is still included in the user benefit results.

Table 2, Table 3, Table 4 and Table 5 below detail the outputs (denoted by an X). All outputs generated are at the origin and destination level respectively. For consistency and efficiency, results produced at the origin and destination level are also generated for the sector and area of influence reporting as well.

[6] Due to the coarse nature of the Walk and Cycle networks within MASTEM, both non-motorised modes are not included in the calculations.

[7] 'Existing' refers to the level of use in the base case, and 'induced' refers to the change in use between the base case and project case. The project case has both existing and induced use.

[8] Although MASTEM V2.3 does not have 320 zones, the highest zone number is 320. For reporting purposes, it is easier to include non-active zones so that the results are consecutive from zone 1 through to zone 320. Non-Active zones are greyed out in the report to denote they are inactive.

Table 2 Summary Reporting by Mode, Time Period and User Type

Mode	AM			PM			OP			DAILY		
	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total
Car			X			X			X			
CV			X			X			X			
PT			X			X			X			
Total	X	X	X	X	X	X	X	X	X	X	X	X

Note: 'Car' applies for both PV CAR and COMM CAR.

Table 3 Car Person Reporting by Cost Component, Time Period and User Type

Cost Component	AM			PM			OP			DAILY		
	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total
Time	X	X		X	X		X	X		X	X	X
Distance	X	X		X	X		X	X		X	X	X
Parking Charges	X	X		X	X		X	X		X	X	X
Total										X	X	X

Table 4 Commercial Vehicle Reporting by Cost Component, Time Period and User Type

Cost Component	AM			PM			OP			DAILY		
	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total
Time	X	X		X	X		X	X		X	X	X
Distance	X	X		X	X		X	X		X	X	X
Total										X	X	X

Table 5 Public Transport Reporting by Cost Component, Time Period and User Type

Cost Component	AM			PM			OP			DAILY		
	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total	Existing	Induced	Total
Fare	X	X		X	X		X	X		X	X	X
Walk Access/Egress	X	X		X	X		X	X		X	X	X
PandR Access/ Egress	X	X		X	X		X	X		X	X	X
Initial Wait Time	X	X		X	X		X	X		X	X	X
Bus IVT	X	X		X	X		X	X		X	X	X
Train IVT	X	X		X	X		X	X		X	X	X
Tram IVT	X	X		X	X		X	X		X	X	X
Transfer Penalty	X	X		X	X		X	X		X	X	X
Transfer Walk	X	X		X	X		X	X		X	X	X
Transfer Wait	X	X		X	X		X	X		X	X	X
Total										X	X	X

4 HOW ODUBT OPERATES

4.1 Methodology

MASTEM V2.3 provides results by car (person/vehicle), public transport, bicycle, walk and commercial vehicle. Results for walk and bicycle are not included in the ODUBT at this point in time.

Calculations are performed by mode (private car person/ commercial car person/ commercial vehicle [truck]/ public transport passenger) by time period (AM, PM and Off-Peak) by origin-destination zone (~320x320) with all results converted to dollar values.

The MASTEM model is a series of mathematical equations and parameter values used to model travel demand in Adelaide. The equations are estimated using Adelaide data. 'Cube Voyager' is a software package specifically designed to develop and run strategic transport models, and has been used to develop and run MASTEM.

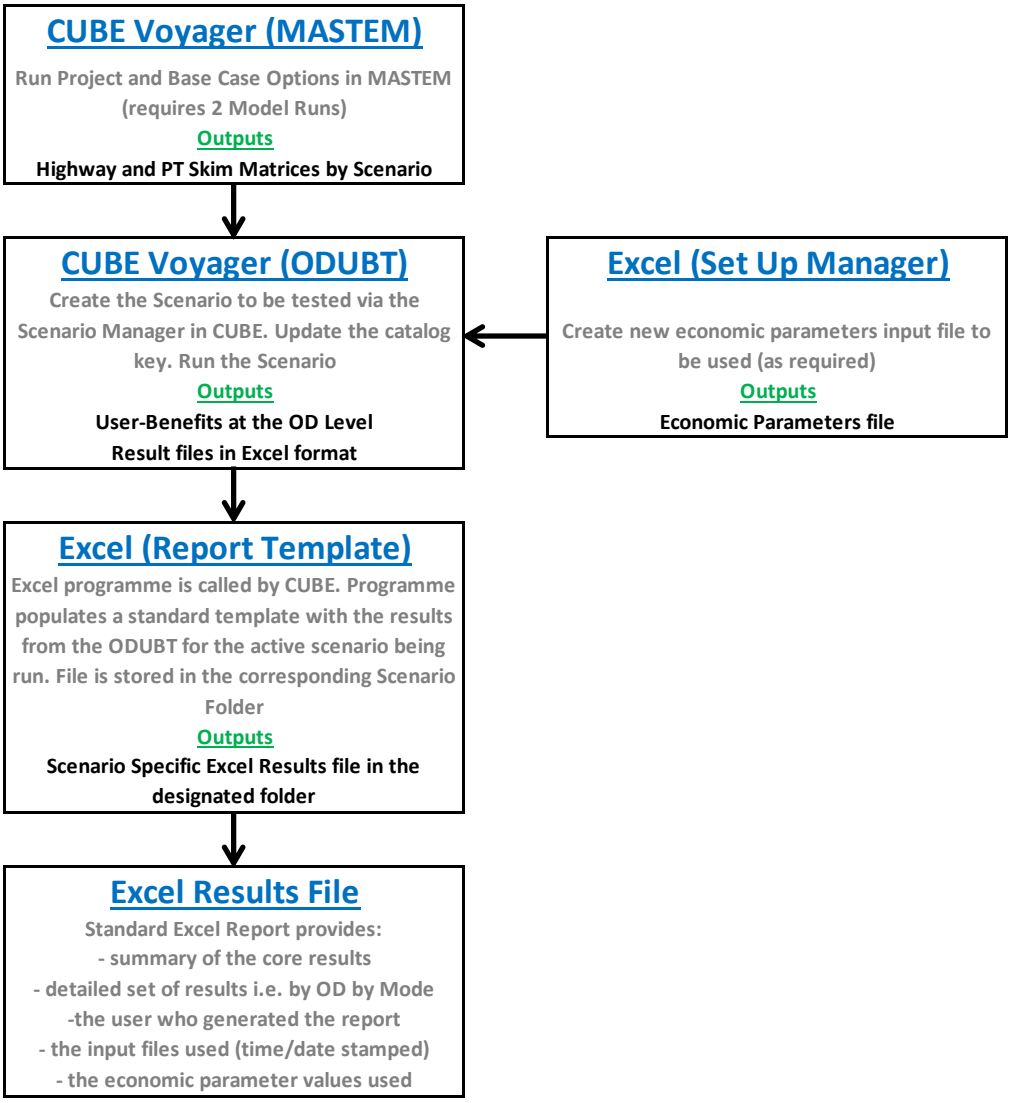
MASTEM has developed using Cube Voyager, and, to provide consistency between the ODUBT and MASTEM, the ODUBT has also been developed in CUBE Voyager. All matrix calculations are undertaken using the CUBE Voyager software and summary results are then provided in Microsoft Excel to ensure end users are able to access results without requiring specialised software.

The steps to create a report that details the total User-Benefit for a given set of MASTEM base and project case runs are as follows:

1. MASTEM is run twice (1 base case and 1 project case run).
2. Parameter value input files are updated as required.
3. (Optional) – Area of Influence input files are created or updated as required.
4. A new scenario is set up using the ODUBT in CUBE with all input files linked correctly in the catalogue key. A 'scenario' is a specific pair of base and project case runs from MASTEM.
5. ODUBT is run for the given scenario.
6. The excel report sheet is automatically created and closed during the CUBE run.
7. The excel report sheet is located in the respective scenarios output folder i.e. for scenario TEST it is located in: *C:\MASTEM Model\Results\ODUBT\Base\TEST*.

A flow diagram of the overall process is provided in Figure 1.

Figure 1 Flow Diagram of ODUBT



4.2 Input Files and Catalogue Key

MASTEM V2.3 has been modified so that one file is required each from a base case and project case model run respectively. The default location of the files is as follows:

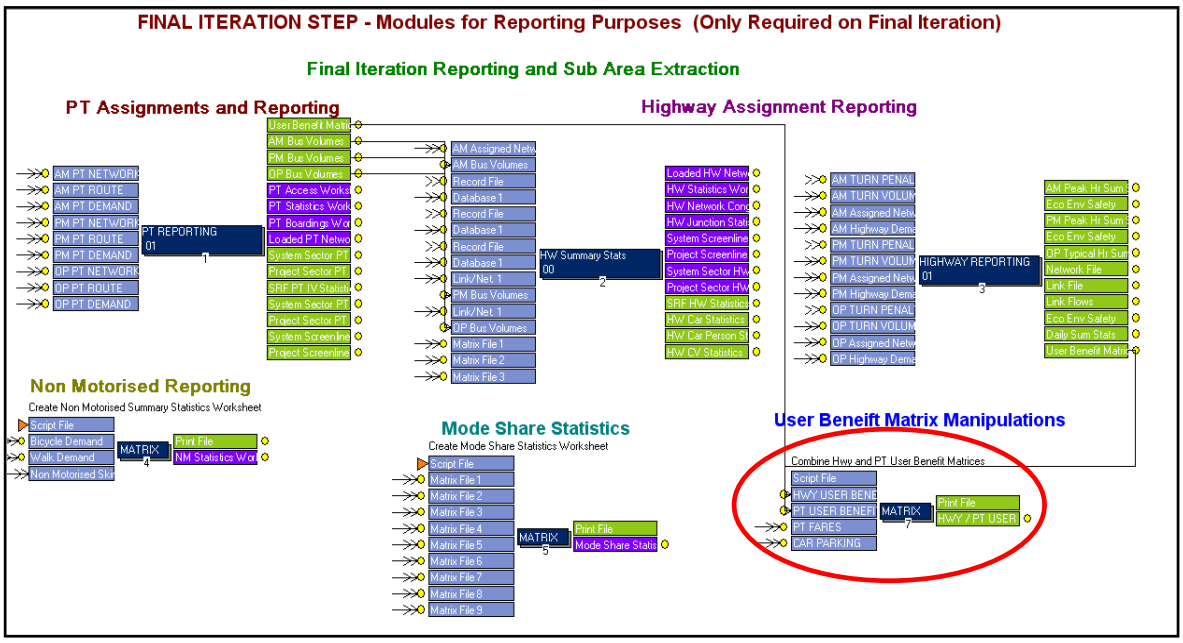
{SCENARIO_DIR}\HWY_PT_USER_BENEFIT_{SCENARIO_SHORTNAME}.MAT

An example of the file path that would be generated for a 2006 Scenario F run is:

C:\MASTEM Model\Base\S_2006\ScenarioF\HWY_PT_USER_BENEFIT_ScenarioF.MAT

This file is automatically created each time MASTEM is run. See Figure 2 for a screenshot of where it is located within MASTEM V2.3. The base case and project case MASTEM V2.3 output files need to be linked in the ODUBT catalogue key as a base case or project case run respectively.

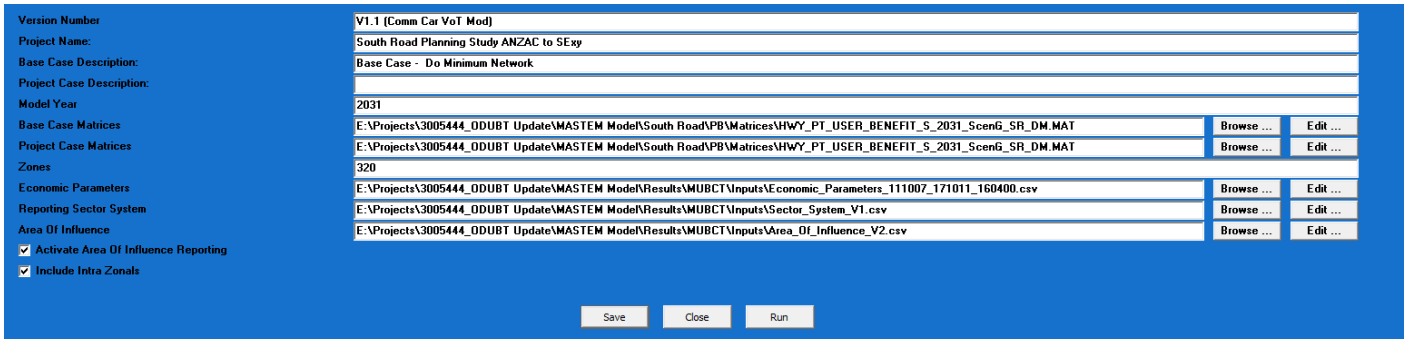
Figure 2 Location of MASTEM V2.3 output file for base and project case model runs



Aside from the MASTEM matrices files, there are three further input files that are used in the ODUBT. The three files required are the parameter values and the area of influence. In each case the ODUBT default files need to be reviewed by the user for each project application[9].

The catalogue key can be viewed in Figure 3 and a description of each of the keys is provided in Table 6.

Figure 3 Catalogue Key



[9] Updates to the parameter values are made as directed by DPTI (Peter Tisato).

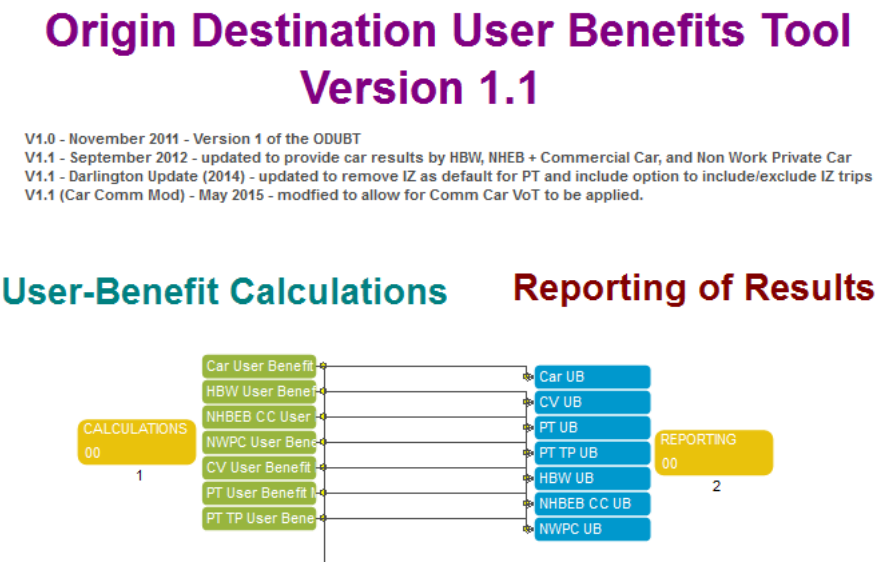
Table 6 Description of Catalogue Keys

Catalogue Key	Description
Version Number	Version number of the ODUBT
Project Name	The name of the project being run
Base Case Description	Description of the base case
Project Case Description	Description of the project case
Model Year	Demand Year for project run
Base Case Matrices	MASTEM output matrices file for base case run (.MAT)
Project Case Matrices	MASTEM output matrices file for project case run (.MAT)
Zones	Highest MASTEM zone number.
Parameter Values	File that contains all parameter values to calculate the user-benefit e.g. VoT
Reporting Sector System	Sector system provides results for an aggregated set of MASTEM zones (under development)
Area of Influence	Provides the option to remove results from specific zone(s). Applies to all O-D pairs for the given zone(s)
Activate Area of Influence Reporting	Switch to deactivate the Area of Influence reporting if it is not required.

4.3 Structure of Tool

The model structure for the ODUBT is broken into two steps/ CUBE Applications. These are shown in Figure 4. The first step performs the user-benefit calculations, the second generates the reports including running the Excel reporting tool.

Figure 4 Main Interface



4.4 Location of ODUBT Folders/Files within the MASTEM Suite

The ODUBT is stored within the MASTEM suite in the following location:
C:\MASTEM Model\Results\ODUBT

A list of the sub-folders and a description of the types of files stored in each is provided in Table 7. The catalogue key to open the ODUBT is: **C:\MASTEM Model\Results\ODUBT\ODUBT.cat**

Table 7 ODUBT Sub-Folders

Folder	Contents
... \ODUBT\Base	All scenario specific output folders and their respective output files.
... \ODUBT\Inputs	Input files: Parameter values, Area of Influence system.
... \ODUBT\Outputs	No files.
... \ODUBT\Outputs\Arrays	Working arrays of results
... \ODUBT\Outputs\Matrices	Working matrices generated when running ODUBT.
... \ODUBT\Outputs\Misc	Lookup files used.
... \ODUBT\Outputs\Print Files	Working print files generated when running ODUBT
... \ODUBT\Results	Results generator and results template - Excel files.
... \ODUBT\Scripts	All CUBE scripts used in ODUBT.

4.5 Output Files

Table 8 below lists the files that are output from ODUBT when the tool is run.

Table 8 Reporting Module Set Up Files

File Name	Description
Default Catalogue Key	Print file that contains the catalogue key information for the current scenario run in ODUBT.
Catalogue Key Autorun	File required to automatically run the extraction process when RUN_EXPORT.xls is opened. This file is automatically created and deleted during a scenario run of the ODUBT.
Template	File that contains the template for displaying the results exported from the ODUBT.
Scenario Default Catalogue Key	Default file name for the catalogue key that will be saved in the scenario specific folder.
Default Report File Name	Default name that the Excel report will use, combined with the scenario name to create the Excel report filename.
Summary Origin/Destination	Default filename for the summary results file.
Car Origin/Destination	Default filename for the car results file.
CV Origin/Destination	Default filename for the CV results file.
PT Origin/Destination	Default filename for the PT results file.
PT TP Origin/Destination	Default filename for the results file by PT Time Period.
AOI Summary Origin/Destination	Default filename for the area of influence summary results file.
AOI Car Origin/Destination	Default filename for the area of influence car results file.
AOI CV Origin/Destination	Default filename for the area of influence CV results file.
AOI PT Origin/Destination	Default filename for the area of influence PT results file.
AOI PT TP Origin/Destination	Default filename for the area of influence results file by PT Time Period.
Sector Summary Origin/Destination	Default filename for the sector based summary results file.
Sector Car Origin/Destination	Default filename for the sector based car results file.
Sector CV Origin/Destination	Default filename for the sector based CV results file.
Sector PT Origin/Destination	Default filename for the sector based PT results file.
Sector PT TP Origin/Destination	Default filename for the results file by sector by PT Time Period.

The following tables describe the output matrices from the user benefit calculations that are input into excel for reporting. Each of these sets of matrices is output for both origin and destination.

Table 9 describes the matrices that are output for overall summary reporting. Then Table 10, Table 11 and Table 12 describe the matrices that are output to report the user benefit by mode.

Finally Table 13 describes the matrices that are output in order to report the PT user benefit by time period. Car and CV benefits are already reported by time period in their respective files but due to the number of parameters require for PT reporting the PT reporting was split into 2 files.

Table 9 Matrices for summary reporting

Matrix Name	Description
Zone	MASTEM origin/destination zone
Total UB	Total User Benefit
Existing UB	Portion of user benefit from existing users
Induced UB	Portion of user benefit from induced demand
Total Existing AM UB	Total existing user benefit in the AM Peak period
Total Existing PM UB	Total existing user benefit in the PM Peak period
Total Existing OP UB	Total existing user benefit in the Off Peak period
Total Induced AM UB	Total induced user benefit in the AM Peak period
Total Induced PM UB	Total induced user benefit in the PM Peak period
Total Induced OP UB	Total induced user benefit in the Off Peak period
Total AM UB	Total user benefit in the AM Peak period
Total PM UB	Total user benefit in the PM Peak period
Total OP UB	Total user benefit in the Off Peak period
Car UB AM	Total user benefit for mode car in the AM Peak period
Car UB PM	Total user benefit for mode car in the PM Peak period
Car UB OP	Total user benefit for mode car in the Off Peak period
CV UB AM	Total user benefit for mode commercial vehicle in AM Peak period
CV UB PM	Total user benefit for mode commercial vehicle in the PM Peak period
CV UB OP	Total user benefit for mode commercial vehicle in the Off Peak period
PT UB AM	Total user benefit for mode public transport in the AM Peak period
PT UB PM	Total user benefit for mode public transport in the PM Peak period
PT UB OP	Total user benefit for mode public transport in the Off Peak period

Table 10 Matrices for reporting by mode car

Matrix Name	Description
Zone	MASTEM origin/destination zone
Total UB	Total User Benefit
Time UB	Time costs for the user benefit
Distance UB	Distance costs for the user benefit
Parking UB	Parking costs for the user benefit

Matrix Name	Description
Existing UB	Portion of user benefit from existing users
Induced UB	Portion of user benefit from induced demand
Existing Time UB	Time costs for existing users
Existing Distance UB	Distance costs for existing users
Existing Parking UB	Parking costs for existing users
Induced Time UB	Time costs for induced users
Induced Distance UB	Distance costs for induced users
Induced Parking UB	Parking costs for induced users
Existing Time UB AM	Time costs for existing users in the AM Peak period
Existing Time UB PM	Time costs for existing users in the PM Peak period
Existing Time UB OP	Time costs for existing users in the Off Peak period
Existing Distance UB AM	Distance costs for existing users in the AM Peak period
Existing Distance UB PM	Distance costs for existing users in the PM Peak period
Existing Distance UB OP	Distance costs for existing users in the Off Peak period
Existing Parking UB AM	Parking costs for existing users in the AM Peak period
Existing Parking UB PM	Parking costs for existing users in the PM Peak period
Existing Parking UB OP	Parking costs for existing users in the Off Peak period
Induced Time UB AM	Time costs for induced users in the AM Peak period
Induced Time UB PM	Time costs for induced users in the PM Peak period
Induced Time UB OP	Time costs for induced users in the Off Peak period
Induced Distance UB AM	Distance costs for induced users in the AM Peak period
Induced Distance UB PM	Distance costs for induced users in the PM Peak period
Induced Distance UB OP	Distance costs for induced users in the Off Peak period
Induced Parking UB AM	Parking costs for induced users in the AM Peak period
Induced Parking UB PM	Parking costs for induced users in the PM Peak period
Induced Parking UB OP	Parking costs for induced users in the Off Peak period

Table 11 Matrices for reporting by mode CV

Matrix Name	Description
Zone	MASTEM origin/destination zone
Total UB	Total User Benefit
Time UB	Time costs for the user benefit
Distance UB	Distance costs for the user benefit
Existing UB	Portion of user benefit from existing users
Induced UB	Portion of user benefit from induced demand
Existing Time UB	Time costs for existing users
Existing Distance UB	Distance costs for existing users
Induced Time UB	Time costs for induced users
Induced Distance UB	Distance costs for induced users
Existing Time UB AM	Time costs for existing users in the AM Peak period
Existing Time UB PM	Time costs for existing users in the PM Peak period
Existing Time UB OP	Time costs for existing users in the Off Peak period
Existing Distance UB AM	Distance costs for existing users in the AM Peak period
Existing Distance UB PM	Distance costs for existing users in the PM Peak period
Existing Distance UB OP	Distance costs for existing users in the Off Peak period
Induced Time UB AM	Time costs for induced users in the AM Peak period
Induced Time UB PM	Time costs for induced users in the PM Peak period
Induced Time UB OP	Time costs for induced users in the Off Peak period
Induced Distance UB AM	Distance costs for induced users in the AM Peak period
Induced Distance UB PM	Distance costs for induced users in the PM Peak period
Induced Distance UB OP	Distance costs for induced users in the Off Peak period

Table 12 Matrices for reporting by mode PT

Matrix Name	Description
Zone	MASTEM origin/destination zone
Total UB	Total User Benefit
Existing UB	Portion of user benefit from existing users
Induced UB	Portion of user benefit from induced demand
Fare UB	Fare costs for the user benefit
Walk Access/Egress UB	Walk access/egress time costs for the user benefit
Park/Kiss and Ride Access/Egress UB	Park/kiss and ride access/egress time costs for user benefit
Initial Wait Time UB	Initial wait time costs for the user benefit

Matrix Name	Description
Bus In-Vehicle Time UB	Bus in vehicle time costs for the user benefit
Train In-Vehicle Time UB	Train in vehicle time costs for the user benefit
Tram In-Vehicle Time UB	Tram in vehicle time costs for the user benefit
Transfer Penalty UB	Transfer penalty costs for the user benefit
Transfer Walk Time UB	Transfer walk time costs for the user benefit
Transfer Wait Time UB	Transfer wait time costs for the user benefit
Existing Fare UB	Fare costs for existing users
Existing Walk Access/Egress UB	Walk access/egress time costs for existing users
Existing Park/Kiss and Ride Access/Egress UB	Park/kiss and ride access/egress time costs for existing users
Existing Initial Wait Time UB	Initial wait time costs for existing users
Existing Bus In-Vehicle Time UB	Bus in vehicle time costs for existing users
Existing Train In-Vehicle Time UB	Train in vehicle time costs for existing users
Existing Tram In-Vehicle Time UB	Tram in vehicle time costs for existing users
Existing Transfer Penalty UB	Transfer penalty costs for existing users
Existing Transfer Walk Time UB	Transfer walk time costs for existing users
Existing Transfer Wait Time UB	Transfer wait time costs for existing users
Induced Fare UB	Fare costs for induced users
Induced Walk Access/Egress UB	Walk access/egress time costs for induced users
Induced Park/Kiss and Ride Access/Egress UB	Park/kiss and ride access/egress time costs for induced users
Induced Initial Wait Time UB	Initial wait time costs for induced users
Induced Bus In-Vehicle Time UB	Bus in vehicle time costs for induced users
Induced Train In-Vehicle Time UB	Train in vehicle time costs for induced users
Induced Tram In-Vehicle Time UB	Tram in vehicle time costs for induced users
Induced Transfer Penalty UB	Transfer penalty costs for induced users
Induced Transfer Walk Time UB	Transfer walk time costs for induced users
Induced Transfer Wait Time UB	Transfer wait time costs for induced users

Table 13 Matrices for reporting by mode PT by time period

Matrix Name	Description
Zone	MASTEM origin/destination zone
Existing Fare UB AM	Fare costs for existing users in the AM Peak Period
Existing Walk Access/Egress UB AM	Walk access/egress time costs for existing users in the AM Peak Period
Existing Park/Kiss and Ride Access/Egress UB AM	Park/kiss and ride access/egress time costs for existing users in the AM Peak Period
Existing Initial Wait Time UB AM	Initial wait time costs for existing users in the AM Peak Period
Existing Bus In-Vehicle Time UB AM	Bus in vehicle time costs for existing users in the AM Peak Period
Existing Train In-Vehicle Time UB AM	Train in vehicle time costs for existing users in the AM Peak Period
Existing Tram In-Vehicle Time UB AM	Tram in vehicle time costs for existing users in the AM Peak Period
Existing Transfer Penalty UB AM	Transfer penalty costs for existing users in the AM Peak Period
Existing Transfer Walk Time UB AM	Transfer walk time costs for existing users in the AM Peak Period
Existing Transfer Wait Time UB AM	Transfer wait time costs for existing users in the AM Peak Period
Existing Fare UB PM	Fare costs for existing users in the PM Peak Period
Existing Walk Access/Egress UB PM	Walk access/egress time costs for existing users in the PM Peak Period
Existing Park/Kiss and Ride Access/Egress UB PM	Park/kiss and ride access/egress time costs for existing users in the PM Peak Period
Existing Initial Wait Time UB PM	Initial wait time costs for existing users in the PM Peak Period
Existing Bus In-Vehicle Time UB PM	Bus in vehicle time costs for existing users in the PM Peak Period
Existing Train In-Vehicle Time UB PM	Train in vehicle time costs for existing users in the PM Peak Period
Existing Tram In-Vehicle Time UB PM	Tram in vehicle time costs for existing users in the PM Peak
Existing Transfer Penalty UB PM	Transfer penalty costs for existing users in the PM Peak Period
Existing Transfer Walk Time UB PM	Transfer walk time costs for existing users in the PM Peak Period
Existing Transfer Wait Time UB PM	Transfer wait time costs for existing users in the PM Peak Period
Existing Fare UB OP	Fare costs for existing users in the Off Peak Period
Existing Walk Access/Egress UB OP	Walk access/egress time costs for existing users in the Off Peak
Existing Park/Kiss and Ride Access/Egress UB OP	Park/kiss and ride access/egress time costs for existing users in the Off Peak Period
Existing Initial Wait Time UB OP	Initial wait time costs for existing users in the Off Peak Period
Existing Bus In-Vehicle Time UB OP	Bus in vehicle time costs for existing users in the Off Peak Period
Existing Train In-Vehicle Time UB OP	Train in vehicle time costs for existing users in the Off Peak Period
Existing Tram In-Vehicle Time UB OP	Tram in vehicle time costs for existing users in the Off Peak Period

Matrix Name	Description
Existing Transfer Penalty UB OP	Transfer penalty costs for existing users in the Off Peak Period
Existing Transfer Walk Time UB OP	Transfer walk time costs for existing users in the Off Peak Period
Existing Transfer Wait Time UB OP	Transfer wait time costs for existing users in the Off Peak Period
Induced Fare UB AM	Fare costs for induced users in the AM Peak Period
Induced Walk Access/Egress UB AM	Walk access/egress time costs for induced users in the AM Peak Period
Induced Park/Kiss and Ride Access/Egress UB AM	Park/kiss and ride access/egress time costs for induced users in the AM Peak Period
Induced Initial Wait Time UB AM	Initial wait time costs for induced users in the AM Peak Period
Induced Bus In-Vehicle Time UB AM	Bus in vehicle time costs for induced users in the AM Peak Period
Induced Train In-Vehicle Time UB AM	Train in vehicle time costs for induced users in the AM Peak Period
Induced Tram In-Vehicle Time UB AM	Tram in vehicle time costs for induced users in the AM Peak Period
Induced Transfer Penalty UB AM	Transfer penalty costs for induced users in the AM Peak Period
Induced Transfer Walk Time UB AM	Transfer walk time costs for induced users in the AM Peak Period
Induced Transfer Wait Time UB AM	Transfer wait time costs for induced users in the AM Peak Period
Induced Fare UB PM	Fare costs for induced users in the PM Peak Period
Induced Walk Access/Egress UB PM	Walk access/egress time costs for induced users in the PM Peak Period
Induced Park/Kiss and Ride Access/Egress UB PM	Park/kiss and ride access/egress time costs for induced users in the PM Peak Period
Induced Initial Wait Time UB PM	Initial wait time costs for induced users in the PM Peak Period
Induced Bus In-Vehicle Time UB PM	Bus in vehicle time costs for induced users in the PM Peak Period
Induced Train In-Vehicle Time UB PM	Train in vehicle time costs for induced users in the PM Peak Period
Induced Tram In-Vehicle Time UB PM	Tram in vehicle time costs for induced users in the PM Peak Period
Induced Transfer Penalty UB PM	Transfer penalty costs for induced users in the PM Peak Period
Induced Transfer Walk Time UB PM	Transfer walk time costs for induced users in the PM Peak Period
Induced Transfer Wait Time UB PM	Transfer wait time costs for induced users in the PM Peak Period
Induced Fare UB OP	Fare costs for induced users in the Off Peak Period
Induced Walk Access/Egress UB OP	Walk access/egress time costs for induced users in the Off Peak Period
Induced Park/Kiss and Ride Access/Egress UB OP	Park/kiss and ride access/egress time costs for induced users in the Off Peak Period
Induced Initial Wait Time UB OP	Initial wait time costs for induced users in the Off Peak Period
Induced Bus In-Vehicle Time UB OP	Bus in vehicle time costs for induced users in the Off Peak Period

Matrix Name	Description
Induced Train In-Vehicle Time UB OP	Train in vehicle time costs for induced users in the Off Peak Period
Induced Tram In-Vehicle Time UB OP	Tram in vehicle time costs for induced users in the Off Peak Period
Induced Transfer Penalty UB OP	Transfer penalty costs for induced users in the Off Peak Period
Induced Transfer Walk Time UB OP	Transfer walk time costs for induced users in the Off Peak Period
Induced Transfer Wait Time UB OP	Transfer wait time costs for induced users in the Off Peak Period

APPENDIX A FURTHER DETAILS RELATED TO MASTEM

A.1 Derivation of Outputs from MASTEM V2.3.0

In order to run the ODUBT, MASTEM V2.3 must be run to generate the necessary demand and skim matrices to perform the user-benefit calculations. Although most of the required demand and skim matrices are used in the generalised cost equations, some additional outputs were required for the generalised cost equations used for the user-benefit calculations.

Three new modules were required to (a) calculate fare matrices, (b) calculate parking charge matrices and (c) to combine the highway and public transport matrices together so that only one file is required to be linked to the ODUBT per MASTEM scenario. The script updates required for this in MASTEM V2.3 are listed in Table 14.

Table 14 MASTEM V2.3 Script Updates

Process	Script File
New PT Fare matrices:	C:\MASTEM MODEL\MCMAT00A.S
New Car Parking Charge matrices	C:\MASTEM MODEL\MCMAT00H.S
PT Skimming:	C:\MASTEM MODEL\PTPTR01B.S C:\MASTEM MODEL\PTPTR01C.S C:\MASTEM MODEL\PTPTR01D.S C:\MASTEM MODEL\PTMAT01J.S
Highway Skimming:	C:\MASTEM MODEL\HRMAT01M.S
Combine Skims	C:\MASTEM MODEL\FIMAT00A.S

The locations of the ODUBT modules within MASTEM are shown in Figure 5 and Figure 6.

Figure 5 Updates to Mode Choice Application to extract PT Fare Matrices

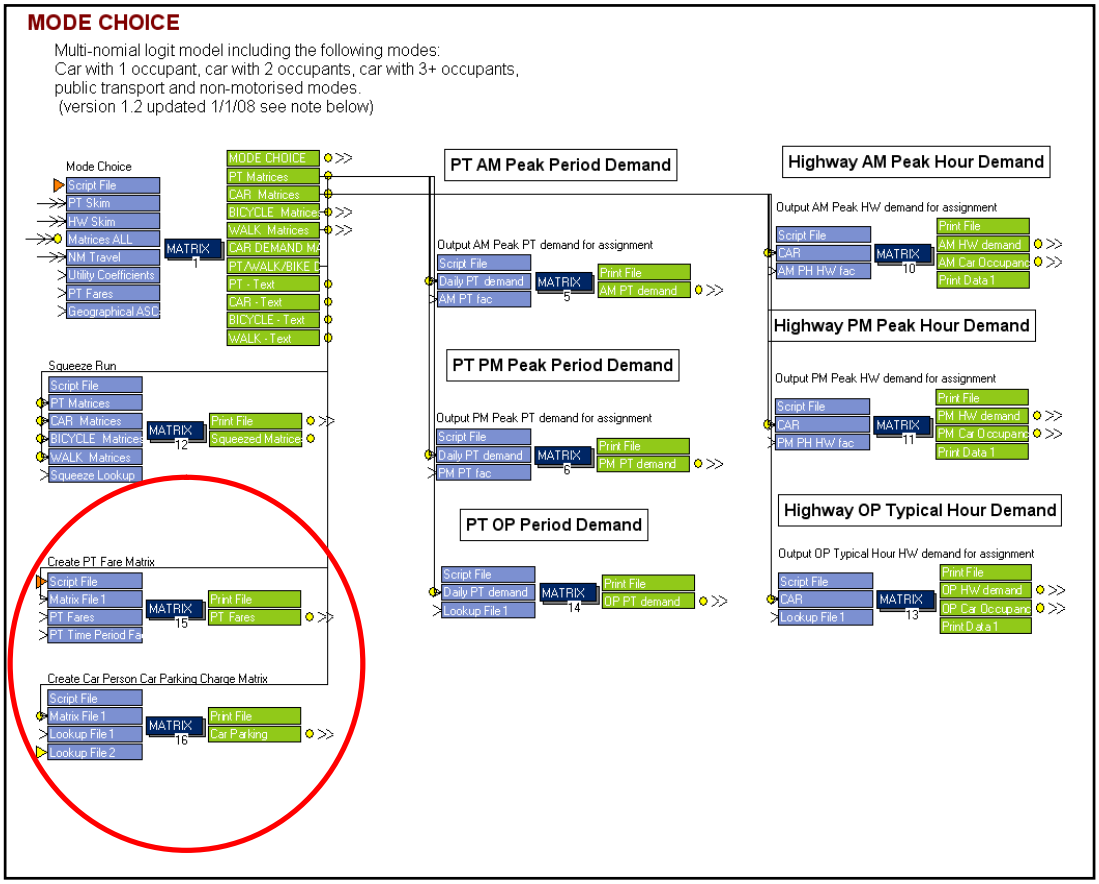
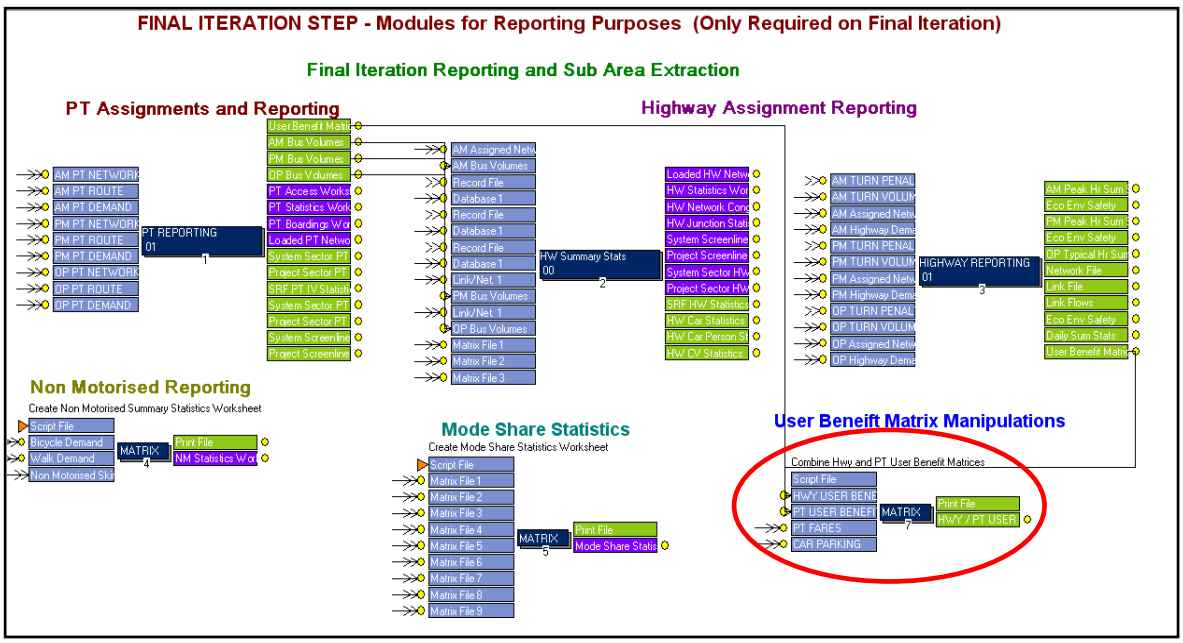


Figure 6 Updates to Final Iteration Application



In order to derive the PT fare matrices, the demand for PT services is calculated based on trip purpose (HBW, HBE, HBS, HBR, HBPB, HBO, NHBEB and NHBPB). A PT fare is then applied to the demand for each combination of trip purpose and car ownership (0, 1, 2, or 3+ cars). This is done for each time period AM Peak, PM Peak and Off Peak. The

average PT fare is then calculated as the total PT fares divided by the total PT demand for each time period.

To derive the parking charge matrices, the parking is divided up into parking for HBW, parking for other home based trip purposes, parking for NHBEB and parking for NHBPB. The parking matrices are then adjusted based on a percentage of car vehicle trips that do not pay for parking in the CBD. The demand for parking is calculated based on car vehicle trips and trip purpose, with the relevant parking charge then applied to each trip purpose. The average parking charge is then calculated as the total parking charges divided by the total parking demand for each time period.

To derive the PT mode access transfers the total trips and total PT boardings parameters are used. The total PT boardings is calculated as the sum of the average number of bus boardings, average number of train boardings and average number of tram boardings. It is assumed there are no transfers for intra-zonal trips, otherwise for each trip the number of transfers is the number of boardings less 1 to account for the initial boarding for the trip (unless the average number of boardings is less than 1, in which case it is assumed there are no transfers). When calculating the transfer wait time and transfer walk time, the actual times rather than perceived times are used.

A.2 MASTEM V3

The ODUBT currently operates in MASTEM V2.3 only. The production of an equivalent version of ODUBT for MASTEM V3 should simply require transfer to the MASTEM V3 platform. A thorough review will be needed to confirm updates required as MASTEM V3 performs some calculations in slightly different formats to V2.3 and this will need to be assessed carefully. The ODUBT will also need to be updated to be compatible with MASTEM V3 due to the additional time period being modelled in MASTEM V3.

Appendix F – MASTEM Audit Check List

Project Name:		
Model Developer:		
Date of Model Development:		
Model Verifier:		
Date of Review/Verification:		

Status	Issue Comment
1	**Major Issue** - requires immediate resolution
2	**Moderate Issue** - needs clarification prior to release of next milestone
3	**Minor issue** - to be addressed in next milestone
4	**Closed**

Item	Model Elements	Notes for the Modeller and Reviewer	Model Reviewer/Verifier's Comments	Screenshot	Review Status	DPTI's Response	Modeller's Response	Final Status
	Model Description							
1	**Genneral Model Parameters**							
1.1	MASTEM Version	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.2	CUBE Version	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.3	Operating System and its version	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.4	Scenario Description	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.5	Scenario Year	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.6	Catalog Directory	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.7	Scenario Directory	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.8	Scenario Fullname	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.9	Scenario Shortname	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.10	Model Zones	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
1.11	Number of CBD Zones	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.12	Number of External Zones	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.13	Scenario Year Demographics	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.14	Base Year Demographics	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.15	Scenario Year External Trip Ends	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.16	Base Year External Trip Ends	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.17	Minimum Number of Model Loops	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.18	Maximum Number of Model Loops	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.19	VOT for Mode Choice Model	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.20	VOC for Mode Choice Model	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						
1.21	Mode Choice Coefficients	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeller (along with reasons for change) and to be reviewed by the verifier						

Figure F.1 - MASTEM Audit Checklist - General Model Parameters

Item	Model Elements	Notes for the Modeller and Reviewer	Model Reviewer/Verifier's Comments	Screenshot	Review Status	DPTI's Response	Modeller's Response	Final Status
2	**Highway Inputs**							
2.1	Input Network	To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
2.2	Network Shape File	Needs to ensure that any modifications to the Network (Hwy ort PT) that the GIS shape file has been updated. To be checked against the Summary Results workboook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.3	DT and NT Junction File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.4	AM Junction File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.5	PM Junction File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.6	DT and NT Turn Penalty File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.7	AM Turn Penalty File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.8	PM Turn Penalty File	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
2.9	Time Factor for Highway Assignment	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer/verifier. In the case of no change, the modeler to report no review required						
2.10	Distance Factor for Cars in Highway Assignment	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer/verifier. In the case of no change, the modeler to report no review required						
2.11	Distance Factor for Trucks in Highway Assignment	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer/verifier. In the case of no change, the modeler to report no review required						
2.12	Car Parking Cost File	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
2.13	Vehicle or PCU Assignment	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required						
2.14	New Highway nodes	If any modification are made, the modeller is required to report on the changes along with the reason for change. Modeller and reviewer need to ensure that the new / modified node(s) have had all of the field attributes completed and coded correctly (see MASTEM Guidelines for details)						
2.15	New Highway links	If any modification are made, the modeller is required to report on the changes along with the reason for change. Modeller and reviewer need to ensure that the new / modified link(s) have had all of the field attributes completed and coded correctly (see MASTEM Guidelines for details)						
2.16	Modified / New Junction testing	If any modifications are made to the junctions, the modeler is required to the report on the changes along with the reasons for change and the independent reviewer / verifier to review. To be checked against the Highway Junction Performanance Application and reported by the modeler and to be reviewed by the independent reviewer / verifier. This needs to be done not just for the project but for the area of influence (see MASTEM Guideline for further details)						
2.17	Distance field	In the case of change, the distance field in the NET file needs to updated to match the assoicated GIS shape file (CUBE distance should not be used at any time).						

Figure F.2 - MASTEM Audit Checklist - Highway Inputs

Item	Model Elements	Notes for the Modeller and Reviewer	Model Reviewer/Verifier's Comments	Screenshot	Review Status	DPTI's Response	Modeller's Response	Final Status
3	**Public Transport Inputs**							
3.1	PTLine File – Line Name	To be reported by the modeler and to be reviewed by the independent reviewer / verifier. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT Lines file) and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.2	PTLine File – Longname	To be reported by the modeler and to be reviewed by the independent reviewer / verifier. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT Lines file) and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.3	PTLine File – Headways [1], [2], [3], [4], [5]	To be reported by the modeler and to be reviewed by the independent reviewer / verifier AM = 7-9 [1], DT 9-3 [2], PM 3-6 [3], NT 6-midnight [4], Daily 7-midnight [5]. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT Lines file) and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.4	PTLine File – USERNn	To be reported by the modeler and to be reviewed by the independent reviewer / verifier. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT Lines file) and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.5	PTLine File – USERAn	To be reported by the modeler and to be reviewed by the independent reviewer / verifier. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT Lines file) and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.6	PnR Locations	To be reported by the modeler and to be reviewed by the independent reviewer / verifier. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier						
3.7	Fare System	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.8	Factor File - WAITFACTOR	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.9	Factor File - RUNFACTOR	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.10	Factor File - XFERPEN	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.11	Factor File - IWAITCURVE	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.12	Factor File - XWAITCURVE	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.13	Factor File - BRDPEN	In the case of change, the change to be reported by the modeler along with the reason(s) for change and reviewed by the independent reviewer / verifier. In the case of no change, the modeler to report no review required. To be checked against the Summary Results workbook - sheet 3 Model Inputs (PT System, PT Factors User Class files) and reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.14	Modified network - check PT lines	To be reported by the modeler and to be reviewed by the independent reviewer / verifier.						
3.15	New PT Node	If any modification are made, the modeller is required to report on the changes along with the reason for change. Modeller and reviewer need to ensure that the new /modified PT node(s) have had all of the field attributes completed and coded correctly (see MASTEM Guidelines for details)						
3.16	New PT Link	If any modification are made, the modeller is required to report on the changes along with the reason for change. Modeller and reviewer need to ensure that the new / modified PT link(s) have had all of the field attributes completed and coded correctly (see MASTEM Guidelines for details)						

Figure F.3 - MASTEM Audit Checklist - Public Transport Inputs