ROAD DELAY SOLUTIONS

Shepherds Bay
Meadowbank

Traffic Model Output

Years 2010 2016 and 2026

Prepared in association with...

Varga Traffic Planning Pty Ltd

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ABSTRACT

Road Delay Solutions has been engaged by Robertson + Marks Architects to undertake strategic, computer based road network modelling of the Shepherds Bay Urban Renewal Project, Meadowbank.

The purpose of this document is to catalogue and provide the future projected mid block link volumes and intersection vehicle movement flows at key intersections, surrounding the Shepherds Bay Development, Meadowbank, in the horizon years 2016 and 2026.

The projected volumes are to be incorporated into operational computer based modelling, to be undertaken by Varga Traffic Planning, to substantiate the recommended geometric configurations and intersection control modes, associated with local and regional development growth.

THE DEVELOPMENT FOOTPRINT

The planned Shepherds Bay Development, Meadowbank, is defined by the the DoT's TPDC as a part portion of Zone 485, within the Ryde LGA, as shown in *Figure 1*.

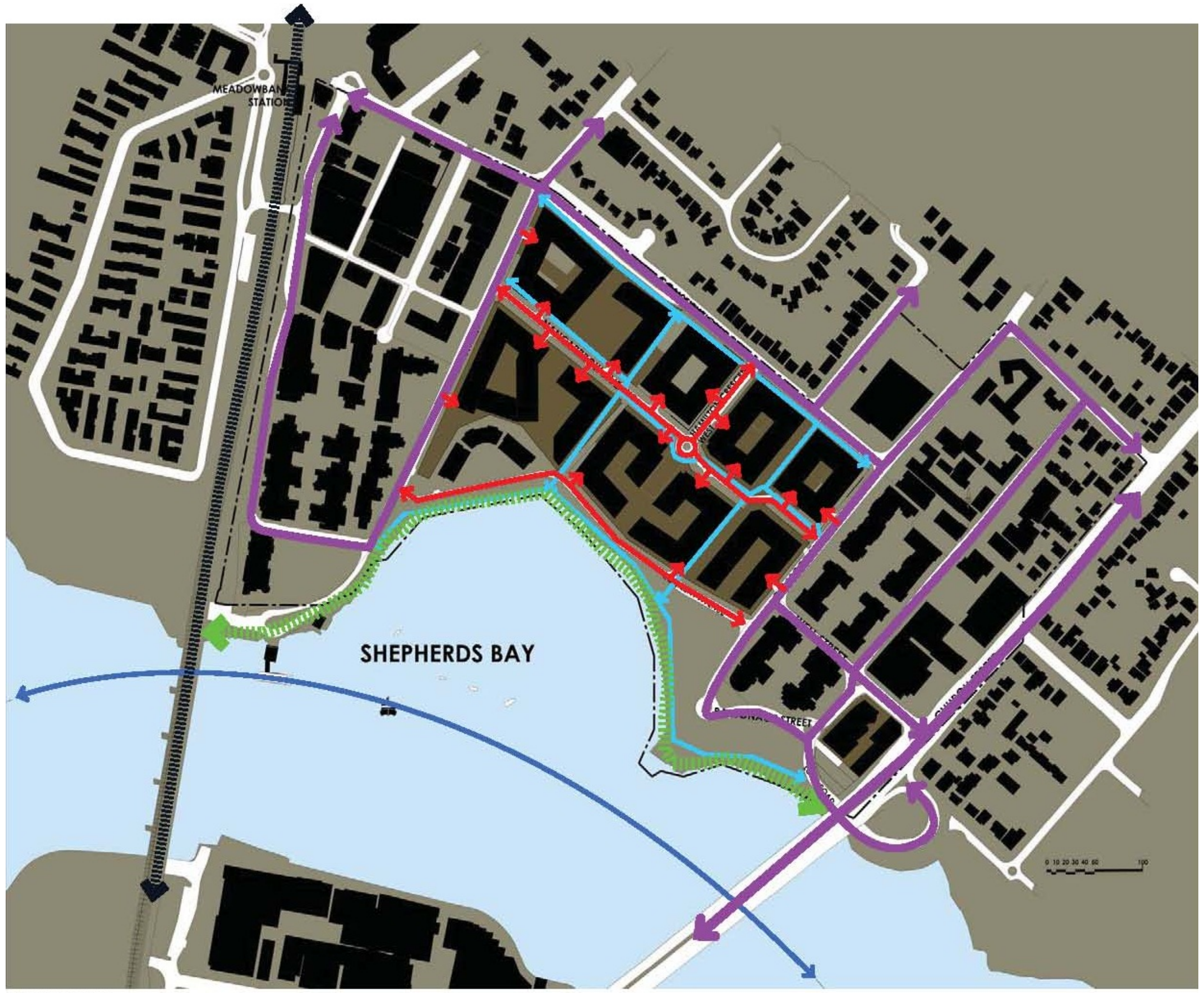
The proposed development comprises 3000 residential units, which are intended to replace 72,207m² of industrial floor area, of which 42,751m² or 59.2%, is currently occupied.

While the theoretical generation rate will not be significantly higher with the tranformation of the industrial lands to residential, trip distribution and flow patterns will be impacted. Currently traffic generally accesses the Shepherds Bay precinct in the morning and departs in the evening. With the planned development, this condition will reverse with traffic generally leaving the precinct in the morning and returning in the evening. This is reflected in the strategic modelling.

The proposed development footprint is presented in *Figure 2*.

Figure 1: TPDC Zone Boundaries (Shepherds Bay - Part Zone 485)

Figure 2: Proposed Shepherds Bay Development Footprint



Access Plan:

Source: ROBERTSON + MARKS Architects, 2010

1 PLANNING POLICIES AND GUIDELINES

This section contains a review of the strategic and statutory planning documents that will shape the Shepherds Bay Development. These include the Sydney Metropolitan Strategy and subregional planning documents, as well as the current local planning strategies, environmental planning instruments and guidelines, the *Local Environmental Plan* and relevant development control plans.

The focus here will be on the policies, strategic directions and development provisions that have direct implications for the development and will influence land use, transport services and facilities in the future. This information will be used as the basis for the development of the precinct plan and successful integration of land use and transport planning.

PLANNING PROVISIONS - SEPP NO. 59

CENTRAL WESTERN SYDNEY ECONOMIC AND EMPLOYMENT AREAS

State Environmental Planning Policy No.59 (SEPP 59) presents guiding principles for sustaining efficient transport with future developments and the requirements to be met in the preparation of a long-term transport plan. The aims of the policy include…

- *"promote economic development and the creation of employment in Western Sydney by providing for the development of major warehousing, industrial, high technology, research or ancillary facilities with good access to the existing and proposed road freight network, including the M4 motorway and the Westlink M7".*
- *"provide for the optimal environmental and planning outcomes for the land to which the policy applies by helping to achieve the goals set out in Action for Air, to contain the per capita growth in VKT (vehicle kilometres travelled) by achieving higher than normal public transport usage."*

The policy states that in developing Precinct plans, attention must be given to the following relevant issues that expand on the foregoing general provisions…

"A transport plan should be prepared that addresses the following…

i) roads, transit ways, and provision for walking and cycling, both within the Precinct and off site linkages,

ii) freight transport provisions, including initiatives for integrating freight handling within the precinct, and maximising opportunities for synergies between industries with regard to materials handling,

iii) the relationship between the staging of development and the provision of transport infrastructure,

iv) ways, including the design and layout of the proposal, in which the mode split to public transport, cycling and walking is to be increased above levels typical of areas surrounding the development. It is expected as a minimum that the proposal demonstrates that…

iv) the mode split of "cars as driver" for the journey to work can be reduced by at least 10% (eg from 75% down to 65%) compared to existing surrounding areas, and

- *the total VKT (vehicle kilometres travelled) to be generated by the proposed development should be reduced by at least 5% below that which would be generated by a 'conventional' approach to development, and*

v) funding proposals for the development of transport infrastructure."

DRAFT SEPP 66 – INTEGRATION OF LAND USE AND TRANSPORT

This policy provides guiding provisions that aim to ensure the urban structure, building forms, land use locations, development design, subdivision and street layouts help achieve the following planning objectives…

- Improving accessibility to housing, employment and services by walking, bicycling and public transport,
- Improving the choice of transport and reducing the dependancy on private vehicle usage,
- Moderating growth in the demand for travel and the distances travelled, especially by car,
- Supporting the efficient and viable operation of public transport services, and
- Providing for the efficient movement of freight.

METROPOLITAN PLANNING STRATEGIES

EMPLOYMENT LANDS FOR SYDNEY ACTION PLAN, 2007

The strategic framework in *'City of Cities Metropolitan Strategy, a Plan for Sydney's Future'*, dictates transport systems and urban structures with equitable access to jobs, services and leisure.

It also identifies the priority outcomes and presents the key policies and actions to achieve them. The regional strategy bridges the gap between local area needs and opportunities and the broader goals of the City of Cities strategy.

The purpose of the Employment Lands Action Plan is to create more job oportunities and stimulate economic growth, providing a cleaner environment, an improved transport network, safe community neighbourhoods and affordable housing. Further, it aims to reduce the growth of private vehicle use and curb urban sprawl.

2 THE STRATEGIC NETANAL MODEL

The Netanal model utilises defined travel demand between zonal pairs, represented as assimilated traffic movements, throughout the Sydney Metropolitan Area. The program incrementally assigns vehicular traffic onto a, computer based, road network developing link demand forecasts on each modelled section of road.

ROUTE SELECTION

Route selection between zonal pairs is determined on the basis of the shortest travel time or cost, considering the inherent route delays incurred along possible link(s). Parameters such as link capacity, speed and distance are coded into the model, by the user, from which the program determines the relative vehicular delays on each route, selecting, after undertaking a prescribed number of iterations, the route with the shortest travel time. Costs and travel time are relative within the Netanal model. Time penalties are applied to turn movements, stops and delays, etc… which in turn have a corresponding cost.

In the most general form, this 'cost' represents a combination of factors that drivers take into account when choosing routes through the road network; the most important of these factors are time and distance. Also where tolls are charged for the use of a specific section of road, these costs are included in the driver's route choice and are based on a driver's willingness to pay the toll.

The process that Netanal uses to determine the 'cost' of travel on competing paths, is based on travel time only. The toll value on a specific link is included indirectly by converting the monetary toll value to time (in minutes) based on the driver's perceived value of time. This 'time value of the toll' is applied as a 'penalty' to the link and is known as the Toll Diversion Penalty (TDP).

The premise on which the future year modelling has been based, specifically the route selection process, is the current value of time. Toll values, toll diversion penalties and socio economic decision making defaults, have not been increased with CPI or standard of living projections.

INCREMENTAL ASSIGNMENT

In order to reflect the impact of congestion on route selection, Netanal assigns the traffic from the trip table as a series of equal increments. This process is outlined below:

- The process commences by identifying the routes with the shortest travel times, for each origin-destination pair, with no traffic using the roads (ie based on sign-posted speed limits, green lights, etc). Known colloquially as increment 0 (zero), the link and intersection delays, accumulated over the modelled 0ne hour, are tabulated for later reference.
- The first incremental run of the model imposes the time delays recorded during Increment 0 and adds the delays to the travel time of each link. During the increment, routes yielding the lowest travel time between zonal pairs are chosen. Again the resultant delays on each link, inclusive of intersection, are recorded by the program.
- Each subsequent increment performs ongoing route selection based on recorded delay and the resultant link travel times. As delays stabilise, so too does the route selection within the model, until the optimum number of increments are run.
- At the completion of the incremental runs, the optimum routes and vehicle demands, on each link, are reported.

Incremental convergence is employed to determine the projective stability and optimum number of increments. The process of incremental convergence involves the running of sensitivity models reflecting a differing number of increments, with the projected volumes on a select number of key links, reported. Once the differential change between the projected volumes, on each reported link, minimises, the model is considered stable and the resultant number of increments are utilised in the project model runs.

For this project, 20 increments were found to provide stability in link demand.

ASSIGNMENT CALCULATIONS

Netanal calculates travel time on the basis of the capacity related, geometric and operational characteristics of roads and intersections defining the road network. The following are specifically incorporated in the calculations for the mid-block section of each link…

Speed-flow relationships. As traffic volume increases, speeds on roads decrease and the relationships within Netanal take this into account. The speed is based on the ratio of the traffic flow to the nominated road capacity. Netanal assumes free flow conditions on links up to a set value of degree of saturation (DS). This value is set to equal 90%. When traffic flows on a particular link exceeds the DS set value, the speed drops according to a speed flow relationship, to the power of four.

- **Transit lanes.** The proportion of traffic using the transit and non-transit lanes on a section of road is based on RTA surveys of Epping Road, Military Road and Victoria Road. This survey reported that the transit lanes operated to a maximum of 50% of the adjacent trafficable lane. Illegal use was reported as 25% while the DS of the adjacent lane was below 0.75.

With an increase above 0.75 in the adjacent lane, a proportionate increase in the illegal use of the transit lane results. Netanal applies this principle on all transit lanes, within the model.

The program assumes a 40% maximum usage of T3 transit lanes while the DS of the adjacent lane remains below 0.75. The program assumes the illegal usage of a T3 lane is the same as that of a T2.

Bus lanes, and bus stops can be included as part of the network. Netanal can report on travel time changes on these routes.

- **On-street parking**.
- **Speed limits**.
- **LATM devices** (eg speed humps, raised thresholds, road narrowings, etc...).

Pedestrian crossings.

Toll plazas A delay of seven seconds per vehicle is applied at toll plazas that have manual payment collection. This delay is reduced as some manual collection is retained and the proportion of electronic tolling increases. Electonic tolling invokes no toll plaza delay.

Toll fees Tolls are collected in dollars but have the effect of making a route less attractive. Therefore the toll has to be converted to a time value that can be attributed to the relevant link in Netanal to reflect additional travel time in the route selection process. This conversion factor is the TDP, and is expressed in minutes per dollar.

Those network characteristics which may vary across a 24hr time of day operation, such as transit lanes, bus lanes, parking restrictions, toll fees, turn prohibitions, etc,,, are included in the network definition and further impact on the assignment route selection.

Intersection delay, calculated within the model, employs the *Austroad's* and *AARB* established formulae for the control of intersections operating as Give Way or Stop Sign, roundabout or traffic signals. For the latter the benefits of Sydney's coordinated signal control system, SCATS, on improved traffic flow is incorporated. A turn penalty is added to the travel time to represent the delay that is associated with pedestrian conflict with left turns and opposing traffic for right turns.

Netanal specifically calculates both road mid-block and intersection performance. The model is therefore able to calculate queues when traffic demand exceeds capacity and incorporate the queuing delay in the calculation of travel time for each route.

If the travel time remains lower on a particular route with queues, Netanal will continue to assign traffic to that route until such time as the queue results in a time delay that makes an alternative route more attractive.

INTERSECTION TURNING MOVEMENT VOLUMES

Netanal is capable of projecting the hourly intersection turn movement demands at each node *(intersection)* within the strategic model. These specific outputs have been employed in this project to provide Varga Traffic Planning with the critical projected turn movements, within the Meadowbank precinct, to enable the operational micro analysis at key intersections.

Inherently, the predictive nature of strategic modelling and the location of zone generators is one of the primary factors impacting on the volume of traffic reported at each intersection. Zones harbour vehicle generation based on land use within a precinct boundary, generally representing several hectares. Zones are often located within the model based upon, but not limited to…

- Their context within the precinct in relation to the primary direction of traffic flow to and from the zone,
- Generally, central within a zone boundary *(subject to finer disaggregation as land use dictates)*,
- Representation of a major vehicle generator within the precinct, such as school, large apartment block, shopping centre, car park, significant commercial operation, recreational grounds, etc… , and
- To allow the even distributiuon of traffic onto the arterial road network while limiting the intrusion of through traffic within local communities, unless identified from field observations.

In some instances, the zone location may propagate errors at some intersections, in close proximity to the vehicle generation. A zone may be located so as to avoid the unwanted diversion or 'rat run' of vehicles within a local precinct attempting to access the arterial road network.

Significant effort is placed on locating the zones within the model to effectively assign vehicles onto the road network. Zone disaggregation or 'splitting' allows a finer distribution of traffic but requires an iterative adjustment process which inadvertently increases the project duration, resources and costs, quite often is beyond the scope of a project.

The zone locations selected within the Meadowbank precinct have been allocated in accordance with the access and car parking provisions identified from preliminary architectural drawings of the proposed development. Manual correction may be required to some turn movement outputs from the strategic model when assessing the operational performance of an intersection, in close proximity to a zone.

CURRENT YEAR TRIP MATRIX

The geographic region modelled is represented by a trip matrix (trip table), that details the individual travel demands between origin and destination pairs. Each distinct area representing a trip origin or end is called a *'Zone'*. The Sydney Netanal model contains some 960 zones, following disaggregation. These elements define areas of homogenous land use (eg. residential, industrial, retail, education, airports, hospitals) enclosed and linked by physical features such as major roads, railways and rivers. The trip table specifies the number of car trips travelling from each zone to every other zone in the modelled area.

The boundaries of these zones for the Sydney Metropolitan Area were defined in 1996, by the NSW Department of Transport's TPDC, and have been generic across all traffic and transport modelling activities undertaken in Sydney. New boundaries were defined by TPDC 2006, and an equivalency table, prepared by the DoP, is employed to rationalise the current projected land use and trip distribution patterns.

The assignment process, described above, essentially determines the anticipated route selection made by motorists between the 'origin' and 'destination' zone during a designated time period. The total number of trips between all the zonal pairs produces the projected traffic volumes reported by the model. Netanal models the road network assignment over a 1hr period.

The base year 2010 trip matrix was originally developed by TPDC in October 2009. Disagregation of the generation and distribution of trip demand between zonal pairs has been undertaken by Road Delay Solutions to the 1hour morning and evening peak travel trip tables to accurately reflect and assimilate the operation of the Sydney Metropolitan road network.

The assumptions adopted, and transposed into the year 2010 trip matrices, are presented in *Table 3*.

3 MODEL CALIBRATION

This section provides a concise framework for the verification, validation and calibration of the base year 2010 traffic model, assimilating the current study area road network and it's operational conditions.

DATA COLLATION

Intersection traffic count data has been utilised in the calibration procedure to align the projected model volumes with the current traffic flow and distribution, within the study area.

Field data, specifically intersection turn movements, were collected, at select intersection sites, as presented in *Figure 4.*

A detailed audit and catalogue of the study area road network, and surrounds, has been undertaken ensuring the accuracy of the network platform onto which the developed morning and evening peak trip matrices have been assigned.

Generally, the network characteristics catalogued were…

- Road hierarchy,
- Road alignment,
- Number of lanes by peak period,
- Transit corridors,
- Regulated link speeds,
- Intersection control modes, and
- Toll collection locations on motorways.

All major infrastructure projects, to the future model date, have been employed in the future year modelled road networks.

Figure 3: Principle Road Infrastructure Projects to Year 2036

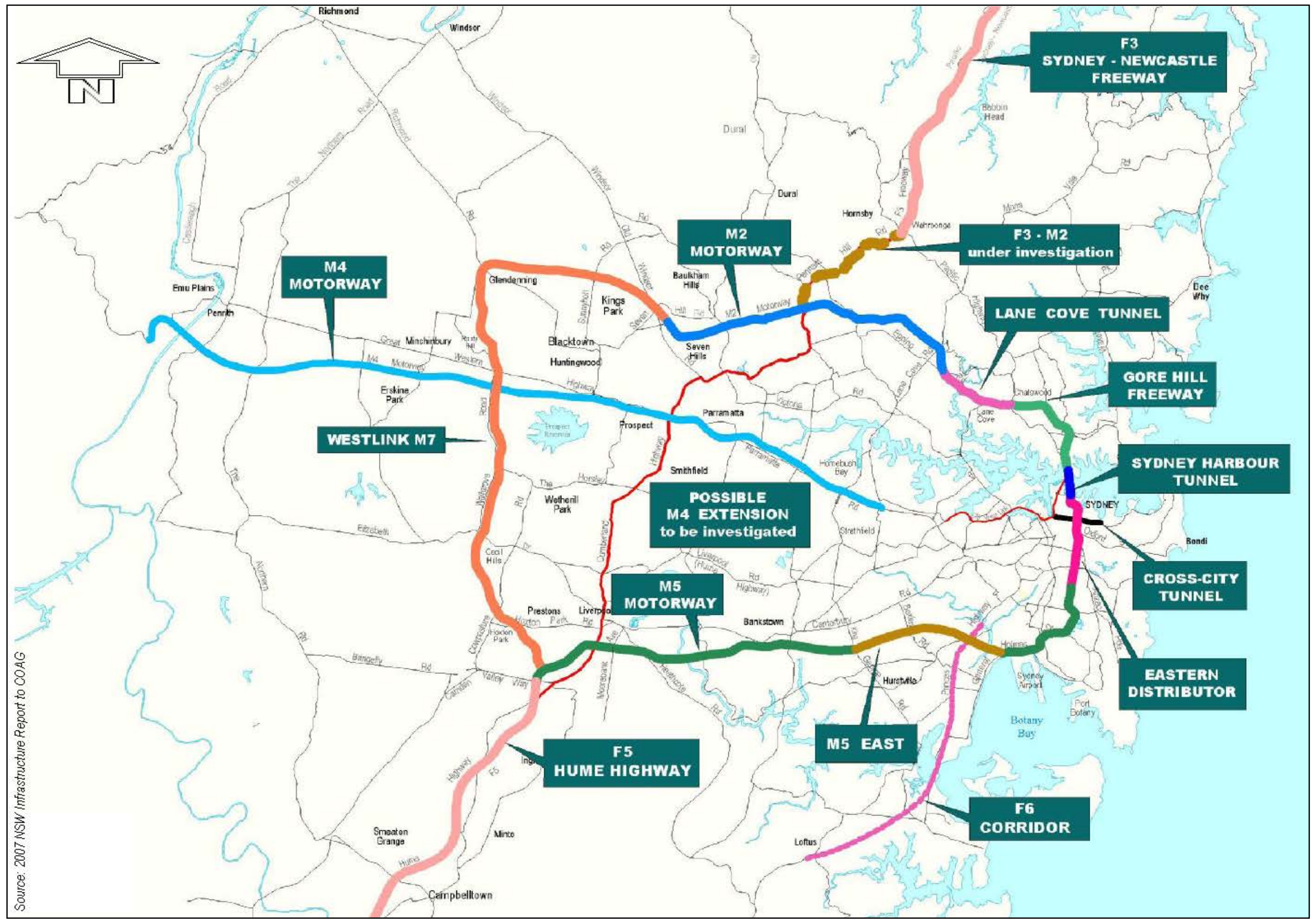
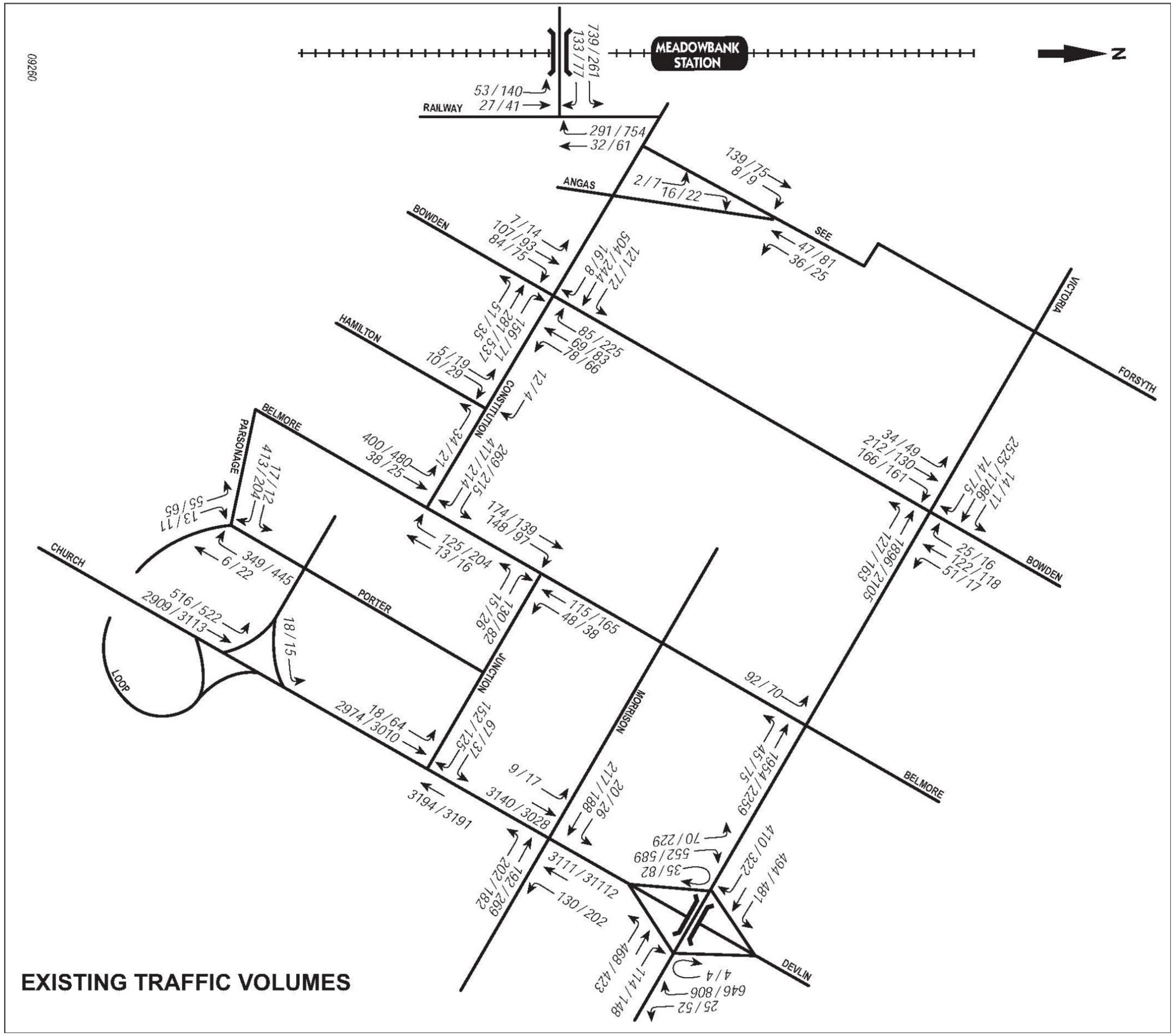


Figure 4: Existing Traffic Volumes



Sourtce: Varga Traffic Planning, 2010

VERIFICATION

Verification is the process of determining if the computer code, that implements the modelling logic, produces the desired output for a given set of input data and/or parameters.

A model is considered successful if the outputs are consistent, in terms of both magnitude and direction, with results from the direct application of the logic on which the code within the Netanal software is based.

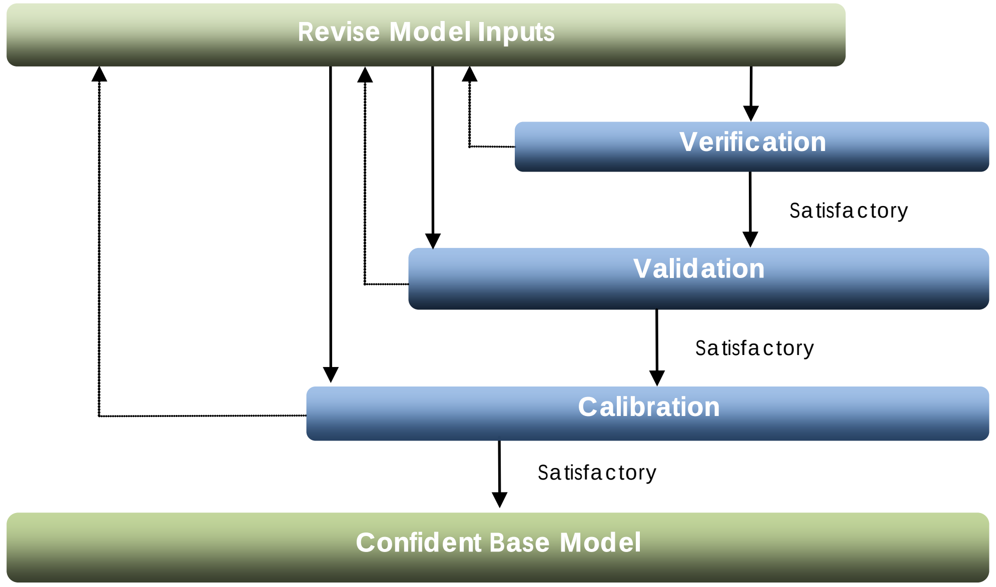
The Netanal software package produces traffic forecasts generally based upon travel time rather than distance or gravity principles. Netanal determines the invoked link and intersection delays, during a model assignment run, to effectively produce travel times between origin and destination.

Based on these times, route selection within the model is influenced by the determined travel times on each modelled or alternate route. Preferred travel routes will be those yielding the lowest travel times, with a direct correlation to the vehicle operating costs.

The Netanal model has been verified by the RTA, with reference found in *Part 2* of the '*Economic Analysis Manual'*[1].

[1] *'Economic Assessment Manual'* Roads and Traffic Authority, N.S.W., 1999 – Revised May 2006.

Figure 5: The Correctness Procedure



VALIDATION

The term applied to the fundamental method of assessing the effectiveness of the calibration procedure and its underlying principles in achieving an acceptable level of calibration.

To assess the model calibration, a formula known as the 'GEH Statistic'[2] has beenemployed to rationalise the differential between the modelled and actual counted traffic volumes, on selected links.

Links with low volumes and a higher differential between the modelled and counted volumes, while possibly exhibiting a high percentage of inaccuracy, are considered less critical than links accommodating higher volumes. The GEH Statistic balances the relative priority of each link based on the counted volume, during the model calibration process. The GEH statistic is computed by the Netanal program, as depicted in *Figure 8*.

[2] The GEH Statistic named after Geoffrey E. Havers, who invented it in the 1970s while working as a transport planner in London, England. In a mathematical form it is similar to a chi-squared test, but is not considered a true statistical test. Rather, it is an empirical formula that proves useful for a variety of traffic analysis purposes.

Figure 6: The GEH Statistic

$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

where… E = Predicted model volume V = Actual field counted volume

A range of GEH targets have been realistically set to achieve the prescribed LoA, noted in the following section, '*Calibration*'. The targets highlight the percentage and degree of difference between modelled volumes and the collected field data.

Figure 7, below, describes the components of the GEH Statistic and the targets employed in the calibration of the base year models.

Figure 7: Typical GEH Targets

A target 60% of the modelled volumes in the calibration summary should have a GEH of 5 or less

68 of the 89 count locations report a GEH of 5 or less

The 68 modelled volumes, with a GEH of 5 or less, equate to 76% of the total 89 count locations

	Counts	%
GEH <= 5 Target = > 60	68	76
GEH <= 7 Target = > 80	78	88
GEH <= 10 Target = > 95	86	97
GEH <= 12 Target = 100	89	100
GEH > 12 Target = 0	0	0
Total Counts		89

CALIBRATION

Defined as the process of model parameter and input manipulation to achieve a prescribed differential between actual local traffic volumes and those modelled.

Calibration is, fundamentally, the transparent production of output, controlled by the value of input parameters on the basis of available field data. The success or failure of the calibration process, is determined by the accurate and logical evaluation of the collected and available field data employed in the selected input parameters.

From the collected intersection counts, all turn movements have been calibrated, individually, to ensure the integrity of the trip distribution and volume flows within the study area and surrounds.

The calibration report of traffic flows, on key routes, was used as output for the base Year 2010.

The trip matrices, currently employed in the base Netanal models, were originally developed by TPDC, based upon the Year 2006 Census Data published as LGA Community Profiles by the Australian Bureau of Statistics.

The zonal information, contained within the matrices, has been disaggregated in accordance with data collated during studies conducted by Sims Varley Traffic Systems Pty Ltd and Road Delay Solutions Pty Ltd, generally yielding a mean absolute screen line calibration LoA of some 15-20%.

The traffic volume calibration process for this project has adopted a standard deviation of 15% of the absolute mean, constituting an accepted LoA within the study area, while a deviation of 25% defines the LoA through the greater Metropolitan.

It should be noted that the Netanal program is in fact a demand model, which reflects the total volume of traffic on a link, including queued traffic at the end of the modelled one-hour time period. This is in contrast to the counted volume, collected in the field data, which only records those vehicles passing a given point during the same period. Therefore, it is safe to assume, that a count location will report a lower traffic volume than those reported in the Netanal model, significant vehicle queues exist at the site.

CALIBRATION SYNOPSIS

Table 1: Morning Peak Calibration Report

Calibration Summary for Model 10AM39
Network = 2010 Trip Table = 10AM39
2010 AM Peak BASE SYDNEY MODEL
Observed Counts versus Modelled Volumes

Note.... If a record contains a '*' it is possible that the count flow data used is low due to being a SCATS count or oversaturated queueing is present. SCATS counts will be up to 10% low under normal flow conditions & up to 40% low where oversaturation occurs. All counts for a 1 hour peak period will be low where queues occur due to oversaturation. The count flow data at these locations represents the actual capacity and not the demand whereas the modelled flows are the demand.
Note.... If a record contains a '?' the calibration is suspect.
Note.... If a record contains a '!' the calibration is unacceptable.

Location..........		Node	Node	Count	Model	Diff	Diff%	GEH
VICTORIA EB E FORSYTH		1034	4118	2613	2233	-380	-15	8
VICTORIA WB E FORSYTH	!	4118	1034	1955	1637	-318	-16	8
BOWDEN NB N VICTORIA		4118	3684	226	196	-30	-13	2
BOWDEN SB N VICTORIA		3684	4118	198	175	-23	-12	2
VICTORIA EB E BOWDEN		4118	7779	2742	2355	-387	-14	8
VICTORIA WB E BOWDEN	!	7779	4118	2023	1699	-324	-16	8
VICTORIA WB E BELMORE		4131	4132	1999	1748	-251	-13	6
DEVLIN NB ONLOAD		4131	4164	608	535	-73	-12	3
DEVLIN SB OFFLOAD		4164	4130	675	575	-100	-15	4
CHURCH SB ONLOAD	!	4130	4129	878	694	-184	-21	7
CHURCH NB OFFLOAD	!	4129	4131	657	549	-108	-16	4
MORRISON EB W CHURCH	?	1026	4128	237	195	-42	-18	3
MORRISON EB E CHURCH		4128	4139	347	310	-37	-11	2
CHURCH SB N MORRISON	!	4129	4128	3241	2713	-528	-16	10
MORRISON WBE CHURCH		4139	4128	394	355	-39	-10	2
JUNCTION EB E BELMORE	?	4120	1027	196	160	-36	-18	3
JUNCTION WB E BELMORE	?	1027	4120	145	103	-42	-29	4
EB W CHURCH		1027	4127	219	216	-3	-1	0
JUNCTION WB W CHURCH		4127	1027	18	17	-1	-6	0
CHURCH NB S JUNCTION		4122	4127	2992	2676	-316	-11	6
CHURCH SB S JUNCTION	!	4127	4122	3346	2839	-507	-15	9
LOOP LT ONTO CHURCH	?	4125	4124	419	353	-66	-16	3
LOOP LT FROM CHURCH	?	4124	4125	68	26	-42	-62	6
BELMORE NB S CONSTITUT		1028	4121	438	375	-63	-14	3
BELMORE SB S CONSTITUT	?	4121	1028	430	340	-90	-21	5
BELMORE NB N CONSTITUT		4119	4120	322	286	-36	-11	2
BELMORE SB N CONSTITUT	?	4120	4119	138	115	-23	-17	2
BELMORE NB S MORRISON		4120	1026	304	287	-17	-6	1
BELMORE SB S MORRISON		1026	4120	163	173	10	6	1
MORRISON WB W CHURCH	?	4128	1026	201	168	-33	-16	2
SEE SB N ANGAS	?	1032	1036	83	99	16	19	2
SEE NB S ANGAS		4116	1036	147	149	2	1	0
RAIL O'BRIDGE EB	!	4112	4113	872	674	-198	-23	7
RAIL O'BRIDGE WB	?	4113	4112	344	276	-68	-20	4
CONSTITUTION EB E SEE		4116	4117	641	683	42	7	2
CONSTITUTION WB E SEE		4117	4116	373	334	-39	-10	2
BOWDEN NB S CONSTITUTI		1029	4117	198	224	26	13	2
BOWDEN SB S CONSTITUTI	?	4117	1029	136	273	137	101	10
BOWDEN NB S VICTORIA		1037	4118	412	394	-18	-4	1
BOWDEN SB S VICTORIA		4118	1037	323	315	-8	-2	0
CONSTITUTION EB E BOWD		4117	1031	666	614	-52	-8	2
CONSTITUTION WB E BOWD		1031	4117	488	476	-12	-2	1
HAMILTON NB S CONSTITU		1030	1031	15	14	-1	-7	0
HAMILTON SB S CONSTITU	?	1031	1030	46	17	-29	-63	5
CONSTITUTION EB E HAMI		1031	4119	686	624	-62	-9	2
CONSTITUTION WB E HAMI		4119	1031	559	488	-71	-13	3

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	34	74
GEH <= 7 Target = > 80%	39	85
GEH <= 10 Target = > 95%	46	100
GEH <= 12 Target = 100%	46	100
GEH > 12 Target = 0%	0	0
Total Counts	46	

Mean, Mean Absolute Difference (MAD) & 10% MAD Analysis - Model 10AM39

Date = 07-29-2010. Time = 23:44:10

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD 10% Count Variability Analysis is calculated and the results given below. The 10% MAD count variation endeavours to cater for the known 20% variation in daily traffic volumes, errors and discrepancies in SCATS and other count methods.

Observed Count Range	Mean %	MAD ABS %	MAD +10% %	Counts
0001 to 0500	8.64	14.07	4.07	29
0501 to 1000	12.91	14.26	4.26	9
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	20.74	14.39	4.39	2
2001 to 2500	16.02	16.02	6.02	1
2501 to 3000	12.97	12.97	2.97	3
3001 to 3500	15.71	15.71	5.71	2
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	12.94	14.31	4.31	46
Total of Counts 0501 to Maximum Range	14.06	14.37	4.37	17

Table 2: Evening Peak Calibration Report

Calibration Summary for Model 10PM39
Network = 2010 Trip Table = 10PM39
2010 PM Peak BASE SYDNEY MODEL
Observed Counts versus Modelled Volumes

Note.... If a record contains a '*' it is possible that the count flow data used is low due to being a SCATS count or oversaturated queueing is present. SCATS counts will be up to 10% low under normal flow conditions & up to 40% low where oversaturation occurs. All counts for a 1 hour peak period will be low where queues occur due to oversaturation. The count flow data at these locations represents the actual capacity and not the demand whereas the modelled flows are the demand.
Note.... If a record contains a '?' the calibration is suspect.
Note.... If a record contains a '!' the calibration is unacceptable.

Location..........	Flag	Node	Node	Count	Model	Diff	Diff%	GEH
VICTORIA EB E FORSYTH	!	1034	4118	1878	1591	-287	-15	7
VICTORIA WB E FORSYTH		4118	1034	2170	1921	-249	-11	6
BOWDEN NB N VICTORIA		4118	3684	147	128	-19	-13	2
BOWDEN SB N VICTORIA		3684	4118	151	144	-7	-5	1
VICTORIA EB E BOWDEN		4118	7779	1964	1706	-258	-13	6
VICTORIA WB E BOWDEN		7779	4118	2268	2018	-250	-11	5
VICTORIA WB E BELMORE		4131	4132	2334	2025	-309	-13	7
DEVLIN NB ONLOAD		4131	4164	629	553	-76	-12	3
DEVLIN SB OFFLOAD	!	4164	4130	862	723	-139	-16	5
CHURCH SB ONLOAD	!	4130	4129	745	624	-121	-16	5
CHURCH NB OFFLOAD	!	4129	4131	900	760	-140	-16	5
MORRISON EB W CHURCH	?	1026	4128	214	111	-103	-48	8
MORRISON EB E CHURCH		4128	4139	214	198	-16	-7	1
CHURCH SB N MORRISON	!	4129	4128	3314	2695	-619	-19	11
MORRISON WB E CHURCH		4139	4128	451	428	-23	-5	1
JUNCTION EB E BELMORE		4120	1027	135	115	-20	-15	2
JUNCTION WB E BELMORE		1027	4120	108	123	15	14	1
JUNCTION EB W CHURCH	?	1027	4127	162	204	42	26	3
JUNCTION WB W CHURCH		4127	1027	64	63	-1	-2	0
CHURCH NB S JUNCTION		4122	4127	3074	2825	-249	-8	5
CHURCH SB S JUNCTION	!	4127	4122	3316	2784	-532	-16	10
LOOP LT ONTO CHURCH		4125	4124	226	222	-4	-2	0
LOOP LT FROM CHURCH	?	4124	4125	76	88	12	16	1
BELMORE NB S CONSTITUT		1028	4121	505	476	-29	-6	1
BELMORE SB S CONSTITUT	?	4121	1028	230	270	40	17	3
BELMORE NB N CONSTITUT		4119	4120	236	203	-33	-14	2
BELMORE SB N CONSTITUT		4120	4119	220	194	-26	-12	2
BELMORE NB S MORRISON		4120	1026	221	210	-11	-5	1
BELMORE SB S MORRISON		1026	4120	203	193	-10	-5	1
MORRISON WB W CHURCH		4128	1026	286	264	-22	-8	1
SEE SB N ANGAS	?	1032	1036	106	127	21	20	2
SEE NB S ANGAS		4116	1036	84	73	-11	-13	1
RAIL O'BRIDGE EB		4112	4113	338	290	-48	-14	3
RAIL O'BRIDGE WB	!	4113	4112	894	675	-219	-24	8
CONSTITUTION EB E SEE	?	4116	4117	324	376	52	16	3
CONSTITUTION WB E SEE		4117	4116	776	706	-70	-9	3
BOWDEN NB S CONSTITUTI	?	1029	4117	182	276	94	52	6
BOWDEN SB S CONSTITUTI	?	4117	1029	126	226	100	79	8
BOWDEN NB S VICTORIA		1037	4118	340	388	48	14	3
BOWDEN SB S VICTORIA		4118	1037	356	386	30	8	2
CONSTITUTION EB E BOWD		4117	1031	385	412	27	7	1
CONSTITUTION WB E BOWD		1031	4117	643	612	-31	-5	1
HAMILTON NB S CONSTITU	?	1030	1031	48	18	-30	-63	5
HAMILTON SB S CONSTITU	?	1031	1030	25	15	-10	-40	2
CONSTITUTION EB E HAMI		1031	4119	429	425	-4	-1	0
CONSTITUTION WB E HAMI		4119	1031	705	622	-83	-12	3

Summary of GEH Calibration Validation

	Counts	%
GEH <= 5 Target = > 60%	36	78
GEH <= 7 Target = > 80%	41	89
GEH <= 10 Target = > 95%	45	98
GEH <= 12 Target = 100%	46	100
GEH > 12 Target = 0%	0	0
Total Counts	46	

Mean, Mean Absolute Difference (MAD) & +/- 10% MAD Analysis - Model 10PM39
Date = 07-29-2010. Time = 23:45:17

Note.... A Mean, a Mean Absolute Difference (MAD) & a MAD +/- 10% Count Variability Analysis is calculated and the results given below. The 10% MAD count variation endeavours to cater for the known 20% variation in daily traffic volumes, errors and discrepancies in SCATS and other count methods.

Observed Count Range	Mean %	MAD ABS %	MAD +-10% %	Counts
0001 to 0500	-1.36	14.44	4.44	29
0501 to 1000	13.64	13.64	3.64	9
1001 to 1500	0.00	0.00	0.00	0
1501 to 2000	20.90	14.19	4.19	2
2001 to 2500	11.93	11.93	1.93	3
2501 to 3000	0.00	0.00	0.00	0
3001 to 3500	14.43	14.43	4.43	3
3501 to 4000	0.00	0.00	0.00	0
4001 to 5000	0.00	0.00	0.00	0
5001 to Maximum	0.00	0.00	0.00	0
Total of Counts 0001 to Maximum Range	10.82	13.73	3.73	46
Total of Counts 0501 to Maximum Range	13.57	13.57	3.57	17

4 FUTURE CONDITIONS

FUTURE YEAR 2036 TRIP MATRIX

The future Year trip tables, produced by BTS in October 2009, have been developed from a 4 step travel model based on forecast population, employment and the transport network. These trip tables form the basis for the Netanal future year trip demands and are applied to the 2001 TDC zone system, through the employment of an equivalency table, also prepared by the TDC.

Generally, the Netanal distribution for the future year trip tables of the Sydney Metropolitan Region has been retained from the BTS trip matrices. However, irregularities have been found between the land use assumptions within the BTS matrices and available data, making it necessary to disaggregate the course zone structure to better reflect the furture year demand generations associated with the Shepherds Bay Development.

For the Ryde LGA, the variations to the BTS trip matrices are presented in *Table 4*.

It should be noted that the zone locations within Shepherd's Bay Precinct have been selected to coincide with areas of homogenous land use and planned residential parking provisions, broadly based on the intended residential, employment, retail and commercial activities.

Non JTW trips are added to the matrices to allow for service providers such as vehicle mechanics, education journey to school, smash repairers, etc... It was found, post modelling, that the southern leg of Bowden Street, in the vicinity of Nancarrow Avenue, contained significant service operations generating some 100 to 150vph, even following the proposed removal of the Northbank Business Park, which is currently located on the proposed development site. With the exclusion of some minor on street parking in Bowden Street, south of Constitution Road, residential parking is currently accessed from Bay Drive, to the west of Bowden Street, adjacent to the railway line. The retained vehicle trips, generated from the southern catchment of Bowden Street, have been included in the modelled zone located on Bowden Street, between Victoria Road and Constitution Road. This action results in lower than anticipated vehicle movements to and from the southern leg of Bowden Street at the Constitution Road intersection. Consideration of these additional movements, which should occur at the Constitution Road intersection with Bowden Street, were found to have only a minor impact on the future operational performance of the intersection.

MODE SHARE

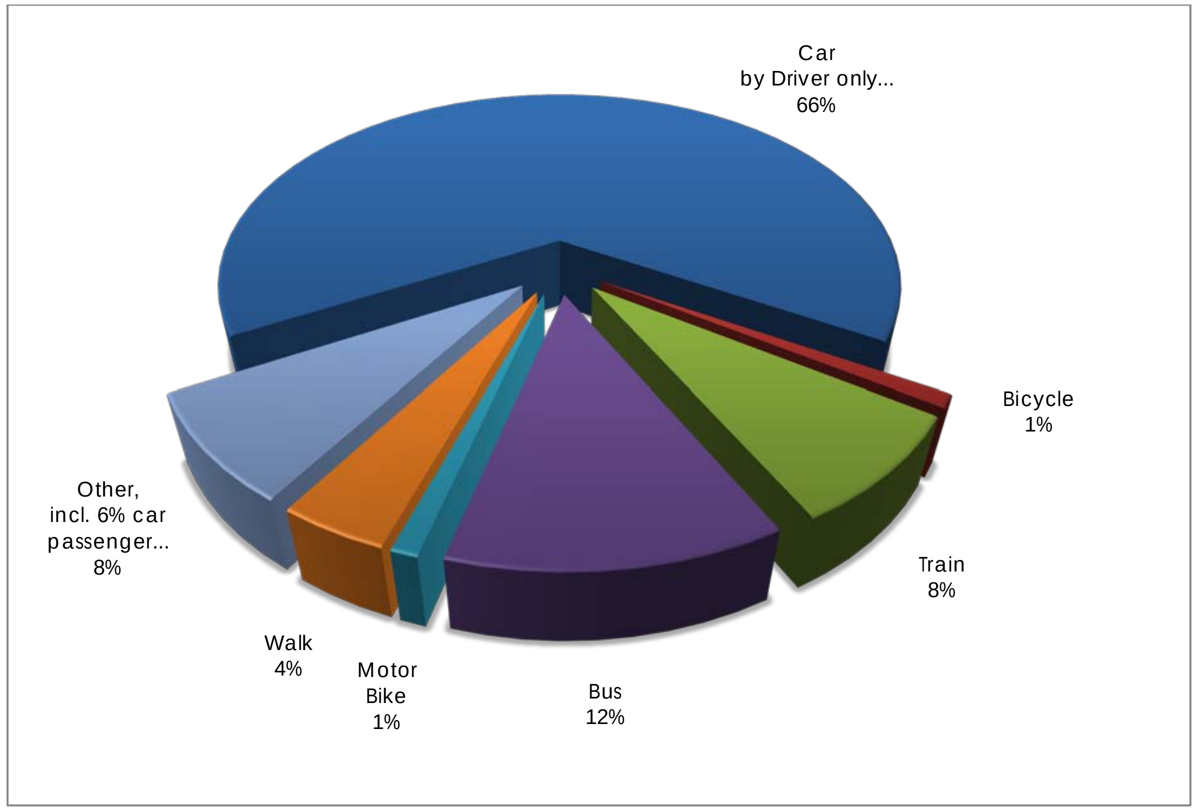
The 2006 census data indicates that the overall mode split for the Ryde LGA is 66% car driver, in the context of a single mode journey. This is, however, an area wide average and must not be taken to apply equally to all local precincts.

Figure 8 presents a comparison of transport modes for JTW trips within the Ryde LGA, as adopted in the trip matrices.

The high percentage of car drivers and passangers, within the Ryde LGA, is likely a result of one or a combination of any or all the following reasons...

- → *Inability or perception that public transport fails to meet community needs,*
- → *Lack of direct public transport services to employment centres,*
- → *Inadequate frequency of public transport,*
- → *Inadequate inter regional services,*
- → *Congestion on major roads accommodating bus services,*
- → *Poor modal interchange,*
- → *The peception that private vehicle travel is more convenient,*
- → *Access by motor vehicles to regional employment centres, is comparatively more convenient, and/or*
- → *A significantly high proportion of self employed and/or tradesmen are car dependent for business.*

Figure 8: Ryde LGA JTW Mode Share – Journey by Single Mode



 # Source: 2006 ABS Census data – 'Basic Community Profile- Ryde

The future traffic generation rates for the Ryde LGA, and more specifically, the Shepherds Bay Development, have been factored to reflect a 10% modal shift away from private motor vehicle usage, in juxtaposition with the close proximity to Meadowbank Railway Station, the significant bus corridor along Church Street, Ferry provisions on Parramatta River, improved pedestrian amenity, revitalised urban cohesion between transport modes and increased focus on the differing community priorities.

Given that the 10% indicative mode shift is of a whole (100%), a percentage correction must be applied to achieve the modal reduction associated with only 66% of JTW trips made by private motor vehicle. The percentage of modal shift can be calculated by applying the following formula...

$$* Applied\ Modal\ Shift = \frac{10(\%\ Modal\ Shift)\ x\ 66(\%\ Journey\ by\ Car)}{100}$$

**Therefore the Applied Modal Shift for the Ryde LGA = 6.6%*

Table 3: Modelled Land Use Projections and Vehicle Generation Table

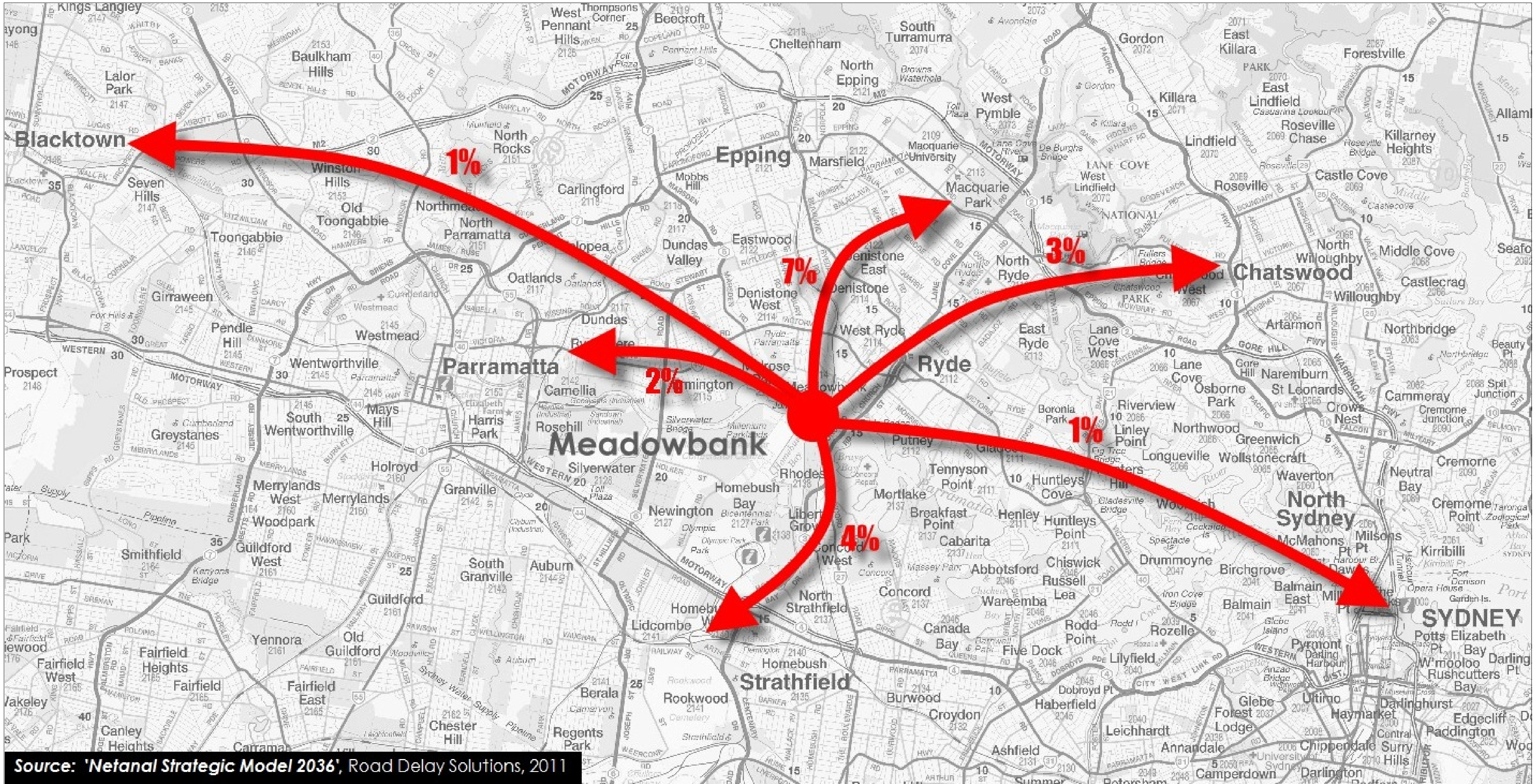
2010					2016		2026		HOUSEHOLDS				EMPLOYEES				2016 AM		2016 PM		2026 AM		2026 PM	
Zone	Zone Identity	LGA	HHD	EMP	HHD	EMP	HHD	EMP	*Peak Vehicle Trips/HHD	10% Mode Shift Due to Transport Initiatives	Trips from Zone Morning Peak	Trips from Zone Evening Peak	Vehicle Trips per Employee	10% Mode Shift Due to Transport Initiatives	Trips from Zone Morning Peak	Trips from Zone Evening Peak	Trips from Zone Morning Peak	Trips to Zone Morning Peak	Trips from Zone Evening Peak	Trips to Zone Evening Peak	Trips from Zone Morning Peak	Trips to Zone Morning Peak	Trips from Zone Evening Peak	Trips to Zone Evening Peak
476	Marsfield	Ryde	4,868	1,895	4,930	1,741	5,061	1,557	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,736	1,617	1,617	2,736	2,786	1,532	1,532	2,786
477	East Ryde	Ryde	2,084	6,848	2,137	7,100	2,250	7,991	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,814	4,261	4,261	1,814	1,961	4,775	4,775	1,961
478	South Ryde	Ryde	2,276	678	2,325	623	2,429	565	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,271	652	652	1,271	1,319	633	633	1,319
479	North Ryde	Ryde	3,388	1,253	3,434	1,160	3,530	1,078	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,900	1,097	1,097	1,900	1,942	1,063	1,063	1,942
480	Eastwood	Ryde	3,509	2,118	3,541	2,005	3,609	1,902	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,040	1,585	1,585	2,040	2,065	1,536	1,536	2,065
481	Denistone	Ryde	2,878	1,941	2,899	1,794	2,942	1,626	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,685	1,383	1,383	1,685	1,691	1,295	1,295	1,691
482	Eastwood West	Ryde	1,540	1,948	1,625	1,804	1,806	1,667	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,024	1,223	1,223	1,024	1,104	1,170	1,170	1,104
483	Denistone West	Ryde	2,185	1,161	2,233	1,073	2,334	992	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,267	892	892	1,267	1,312	860	860	1,312
484	Meadowbank	Ryde	3,201	764	3,377	697	3,748	633	0.65	0.066	0.80	0.20	0.66	0.066	0.15	0.85	1,820	804	804	1,820	1,879	787	787	1,879
#485 638	Shepherds Bay	Ryde		171	1,200		1,200		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	278	70	70	278	260	65	65	260
#485 639	Shepherds Bay	Ryde		38	1,200		1,200		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	278	70	70	278	260	65	65	260
#485 652	Shepherds Bay	Ryde	342		342		342		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	79	20	20	79	74	19	19	74
#485 657	Shepherds Bay	Ryde			450		450		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	104	26	26	104	98	24	24	98
#485 658	Shepherds Bay	Ryde			150		150		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	35	9	9	35	33	8	8	33
#485 640	Railway Road Infill	Ryde			293		293		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	68	17	17	68	63	16	16	63
#485 641	Curch Street Infill	Ryde			1,052		1,052		0.29	0.066	0.80	0.20	0.66	0.066	0.15	0.85	244	61	61	244	228	57	57	228
485	Ryde	Ryde	5,231	6,921	1,810	6,378	3,622	6,210	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,573	3,813	3,813	1,573	2,498	3,955	3,955	2,498
486	Tennyson	Ryde	4,010	3,504	4,064	3,228	4,179	2,967	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	2,433	2,339	2,339	2,433	2,467	2,208	2,208	2,467
487	Gladesville	Ryde	1,853	2,791	1,886	2,527	1,954	2,245	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	1,231	1,663	1,663	1,231	1,239	1,514	1,514	1,239
784	Macquarie Park North	Ryde	2,523	28,110	2,561	30,131	2,641	33,161	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	4,315	17,236	17,236	4,315	4,656	18,946	18,946	4,656
785	Macquarie Park	Ryde	77	5,234	126	5,363	228	5,841	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	596	3,025	3,025	596	697	3,306	3,306	697
853	Macquarie University	Ryde	445	2,747	473	4,880	532	9,059	0.65	0.000	0.80	0.20	0.66	0.000	0.15	0.85	246	61	61	246	1,174	5,151	5,151	1,174

Denotes Proposed Shepherds Bay Development Zone

** 0.65 Trips per HHD is non density specific*

0.29 Trip per HHD is high density

Figure 9: Meadowbank AM Peak JTW Trip Distribution *(Netanal Zone 485, BTS Zone 2517)*



Source: 'Netanal Strategic Model 2036', Road Delay Solutions, 2011

MEADOWBANK
AM PEAK CROSS SECTION
JTW TRIP DISTRIBUTION
2036

Blacktown CBD	1%
Chatswood	3%
Homebush	4%
Macquarie Park	7%
Parramatta CBD	2%
Sydney CBD	1%

Not to Scale

APPENDIX A – 2010 CALIBRATED BASE PLOTS

Figure A1: 2010 Calibrated AM Peak Traffic Model Projections

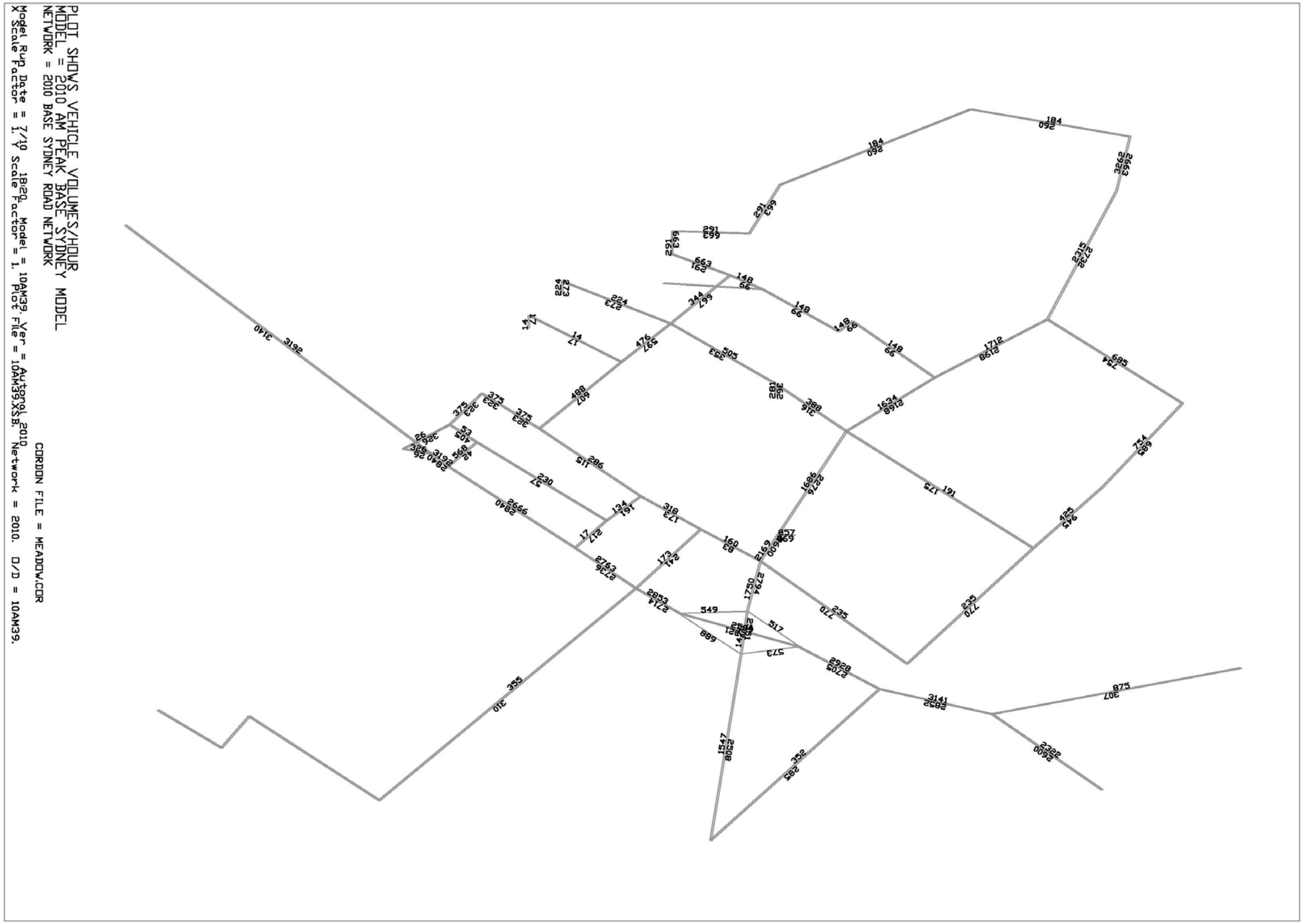


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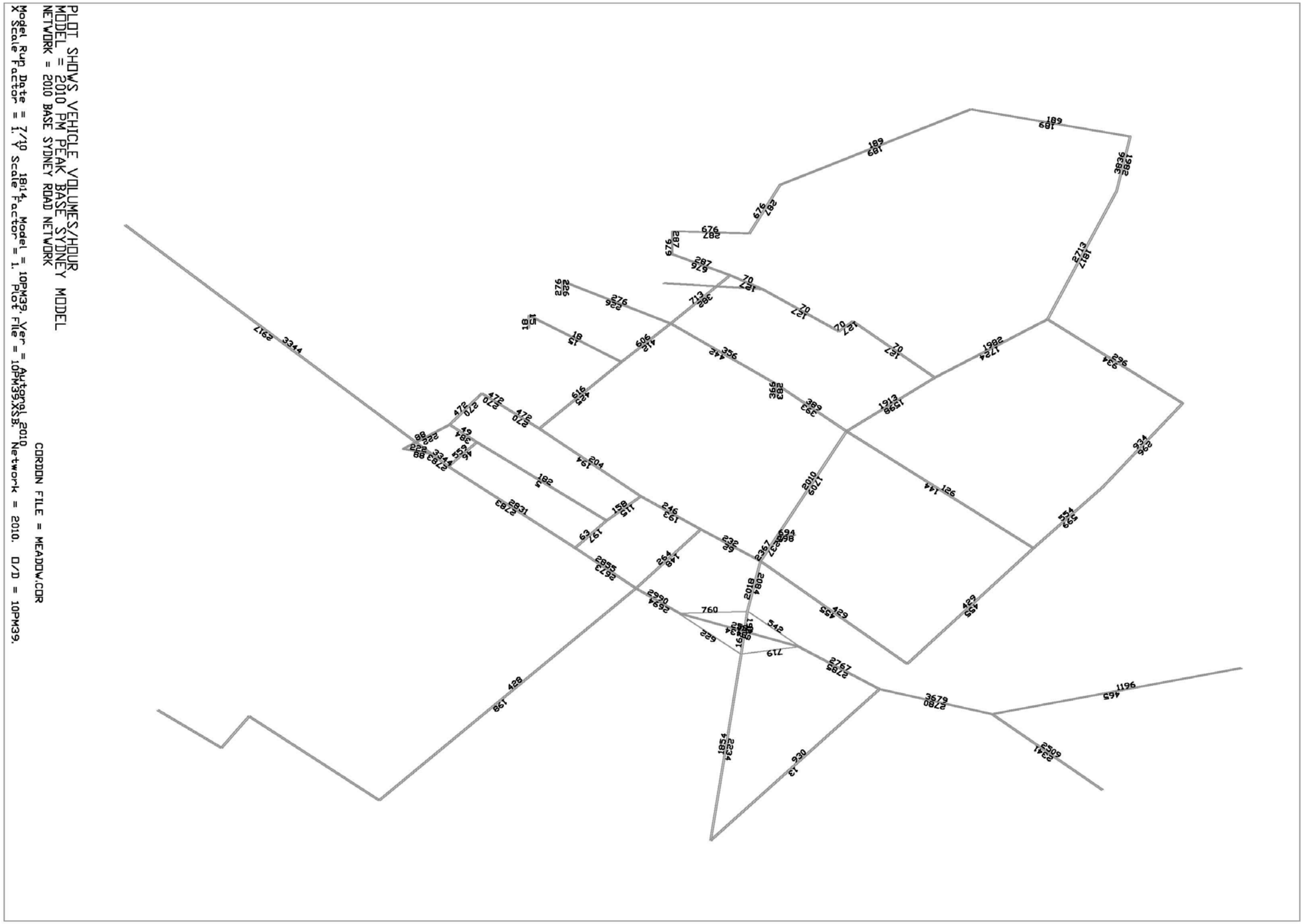
Figure A2: 2010 Calibrated PM Peak Traffic Model Projections



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APPENDIX B – 2016 BASE PLOTS INCORPORATING RESIDENTIAL INFILL

Figure B1: 2016 AM Peak Base Traffic Model Projections

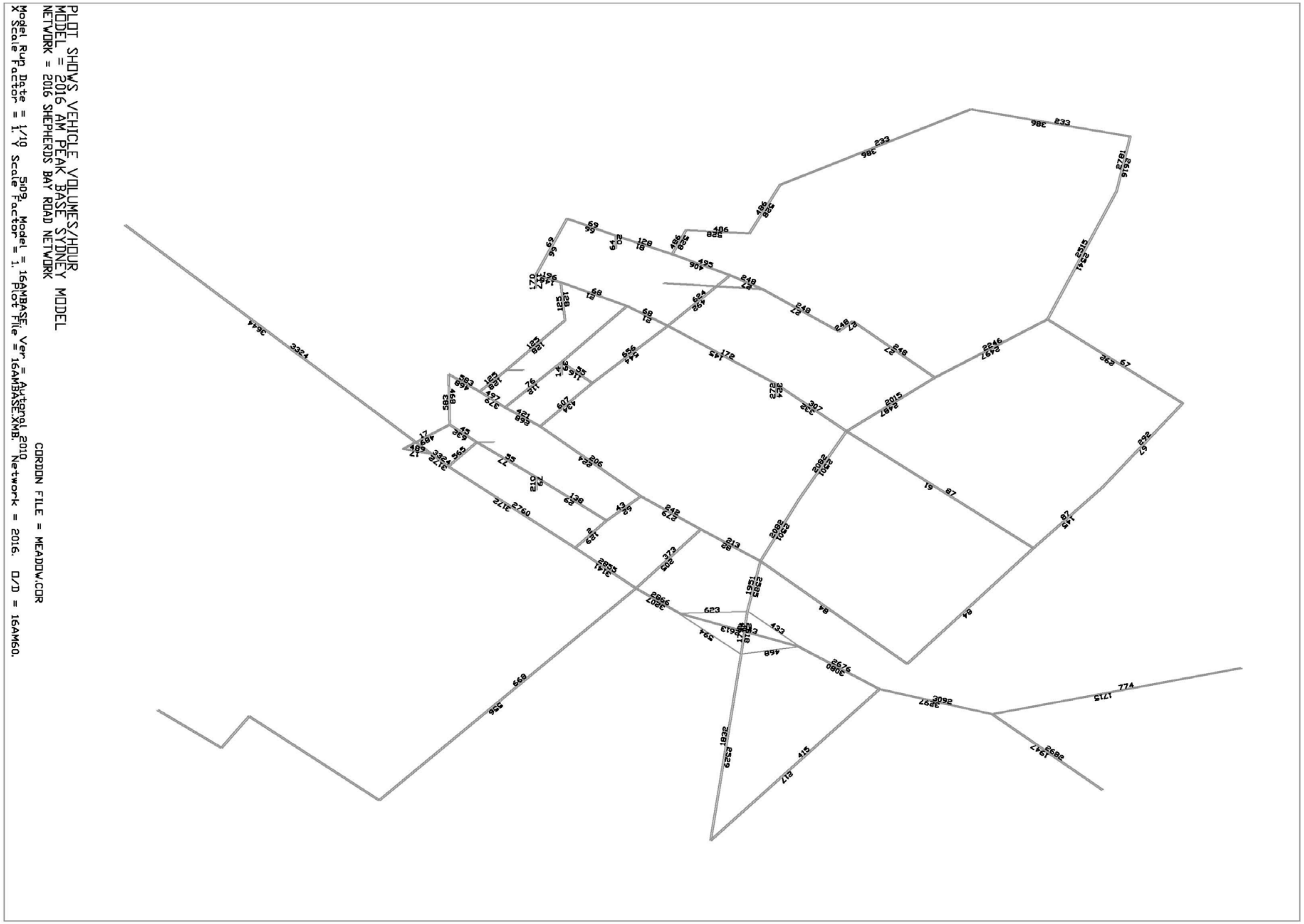

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Figure B2: 2016 PM Peak Base Traffic Model Projection

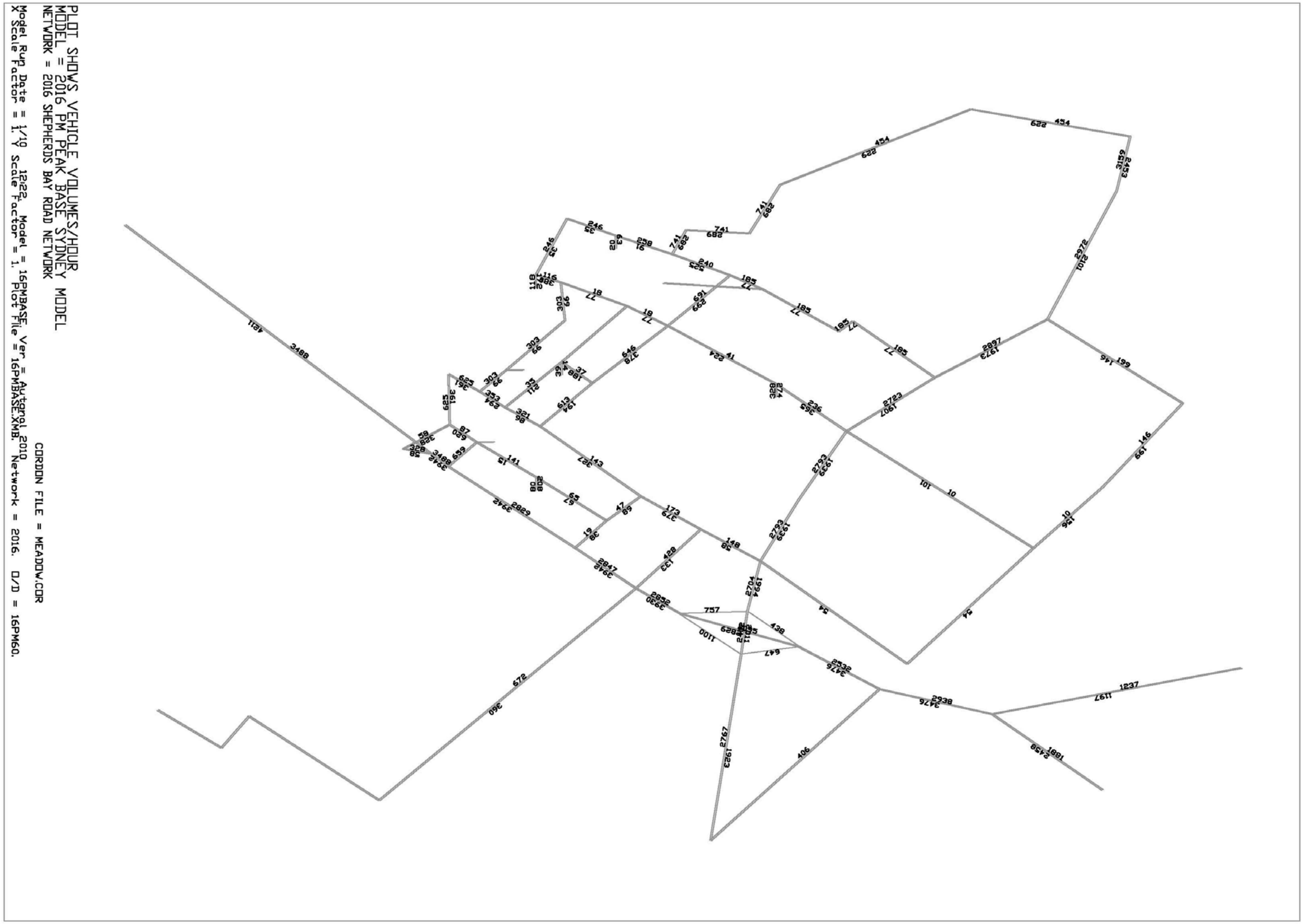

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Figure B3: 2016 AM Peak Base Case Turn Projections

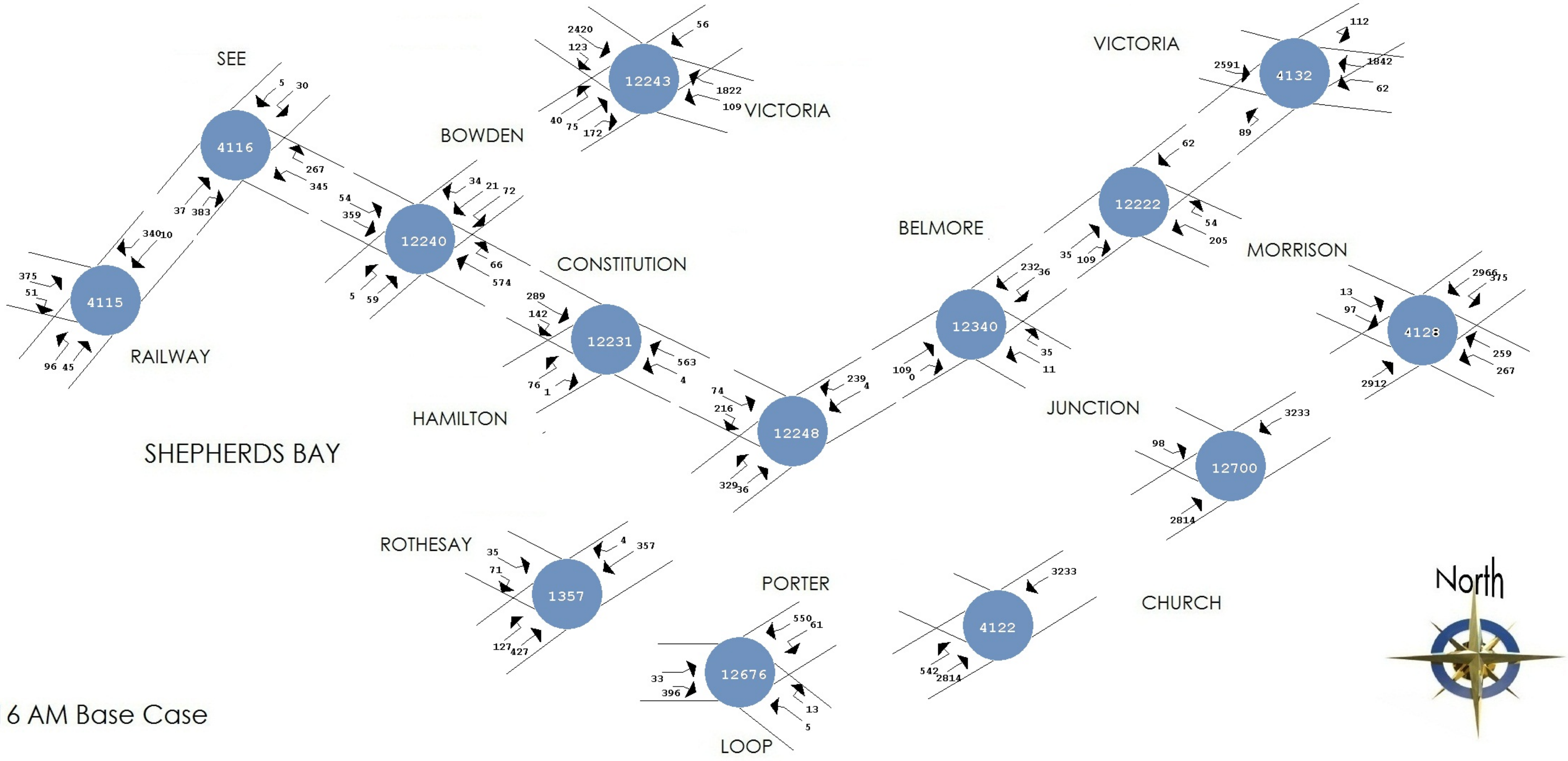
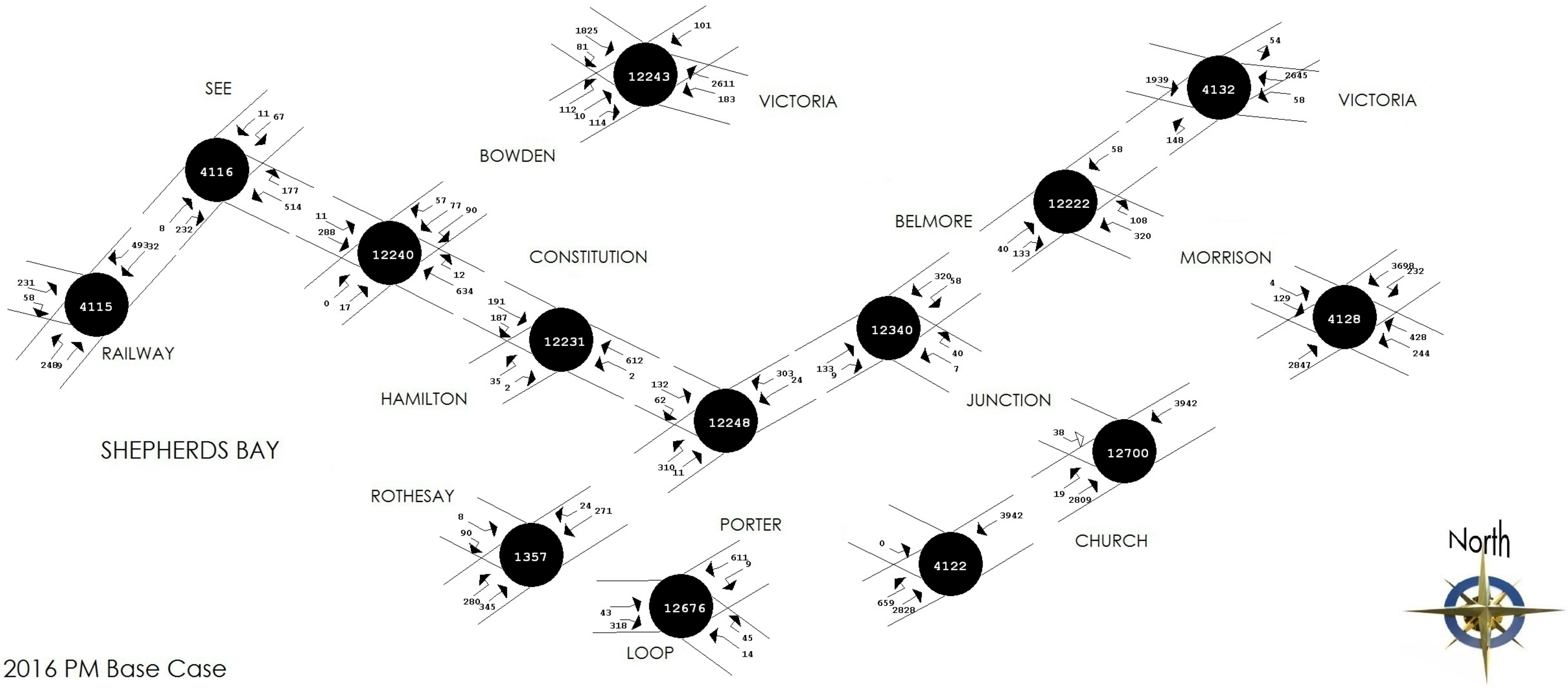


Figure B4: 2016 PM Peak Base Case Turn Projections



APPENDIX C – 2016 SHEPHERDS BAY DEVELOPMENT PLOTS

Figure C1: 2016 AM Peak Development Traffic Model Projections

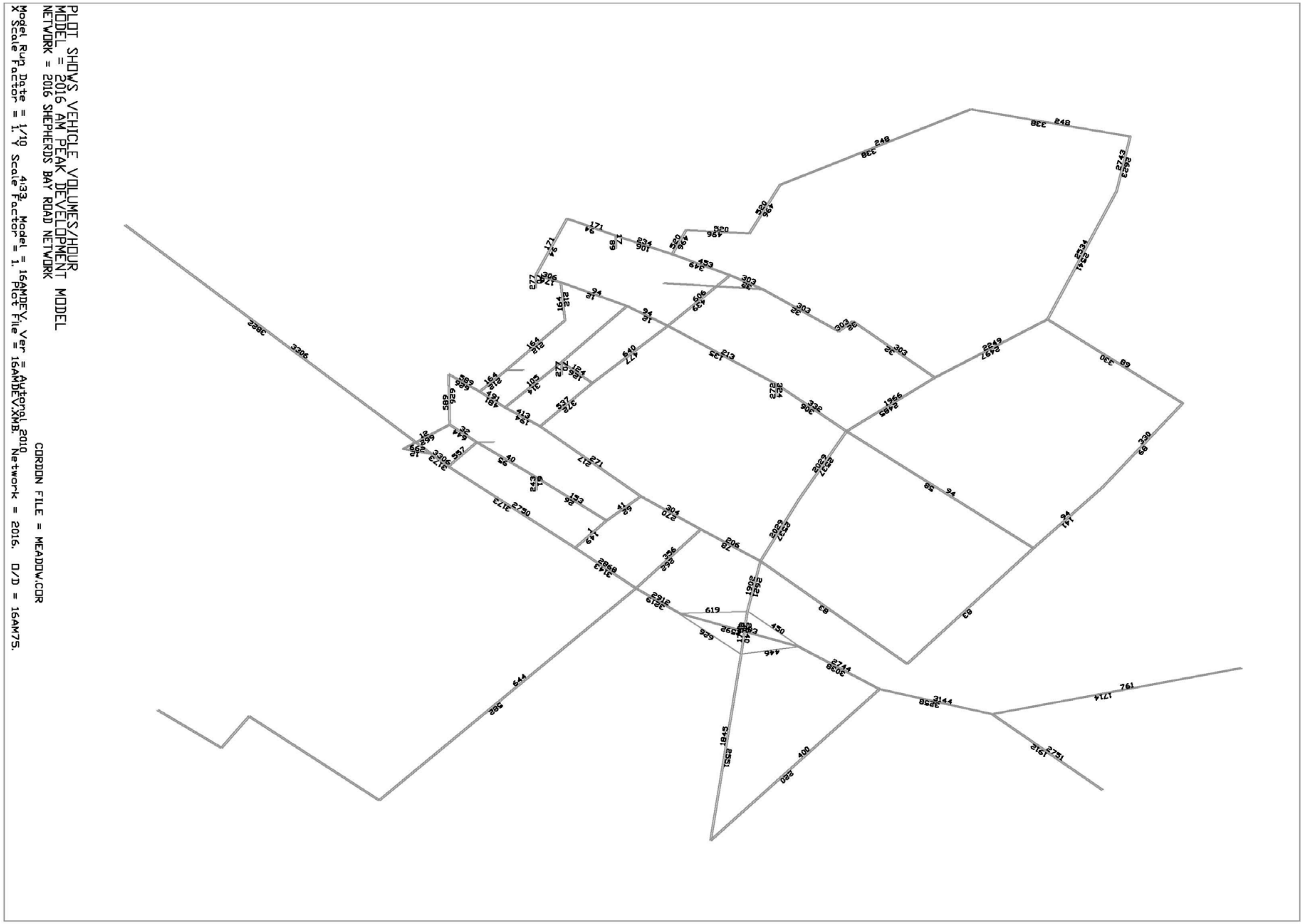


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Figure C2: 2016 PM Peak Development Traffic Model Projections

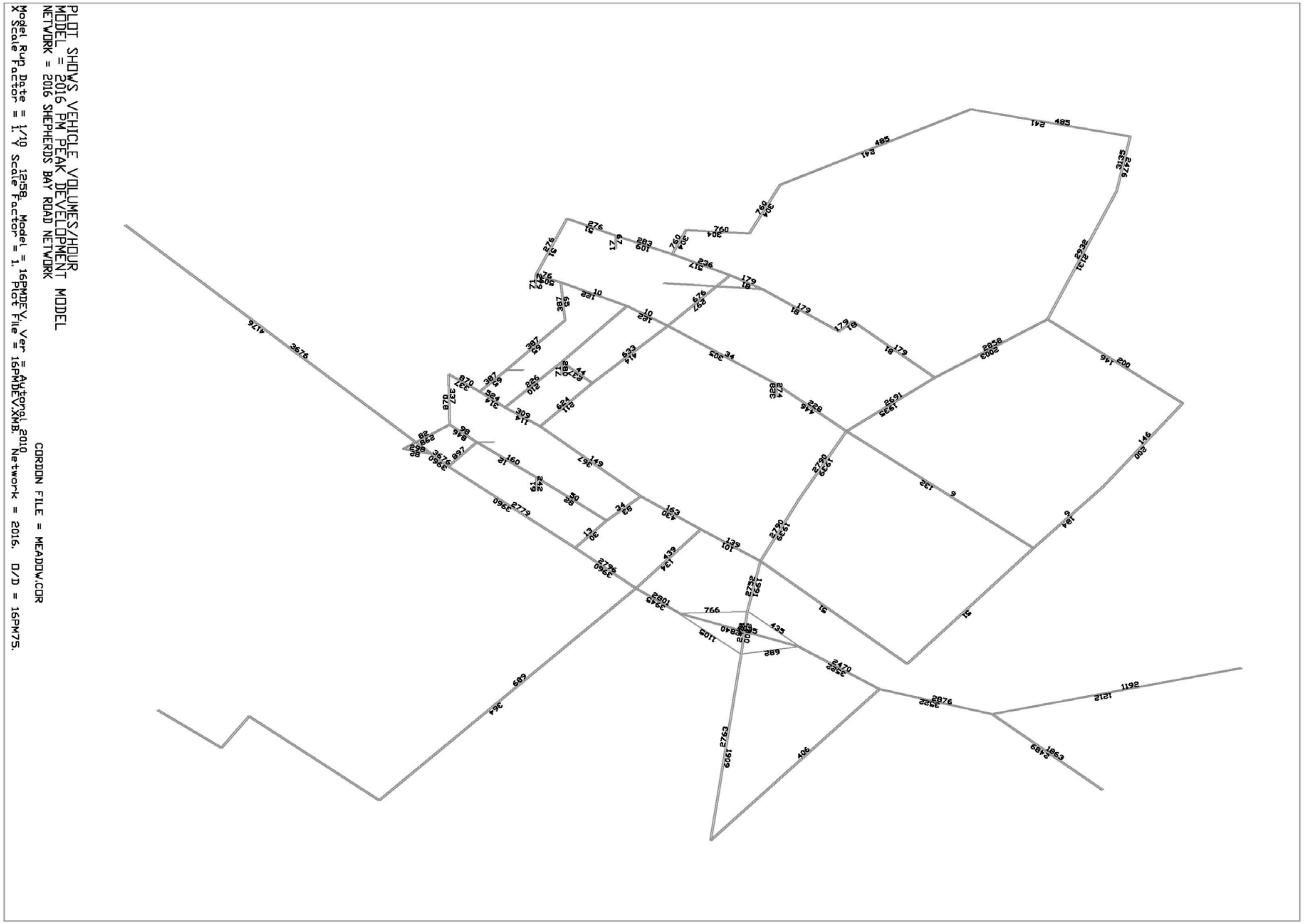

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Figure C3: 2016 AM Peak Development Case Turn Projections

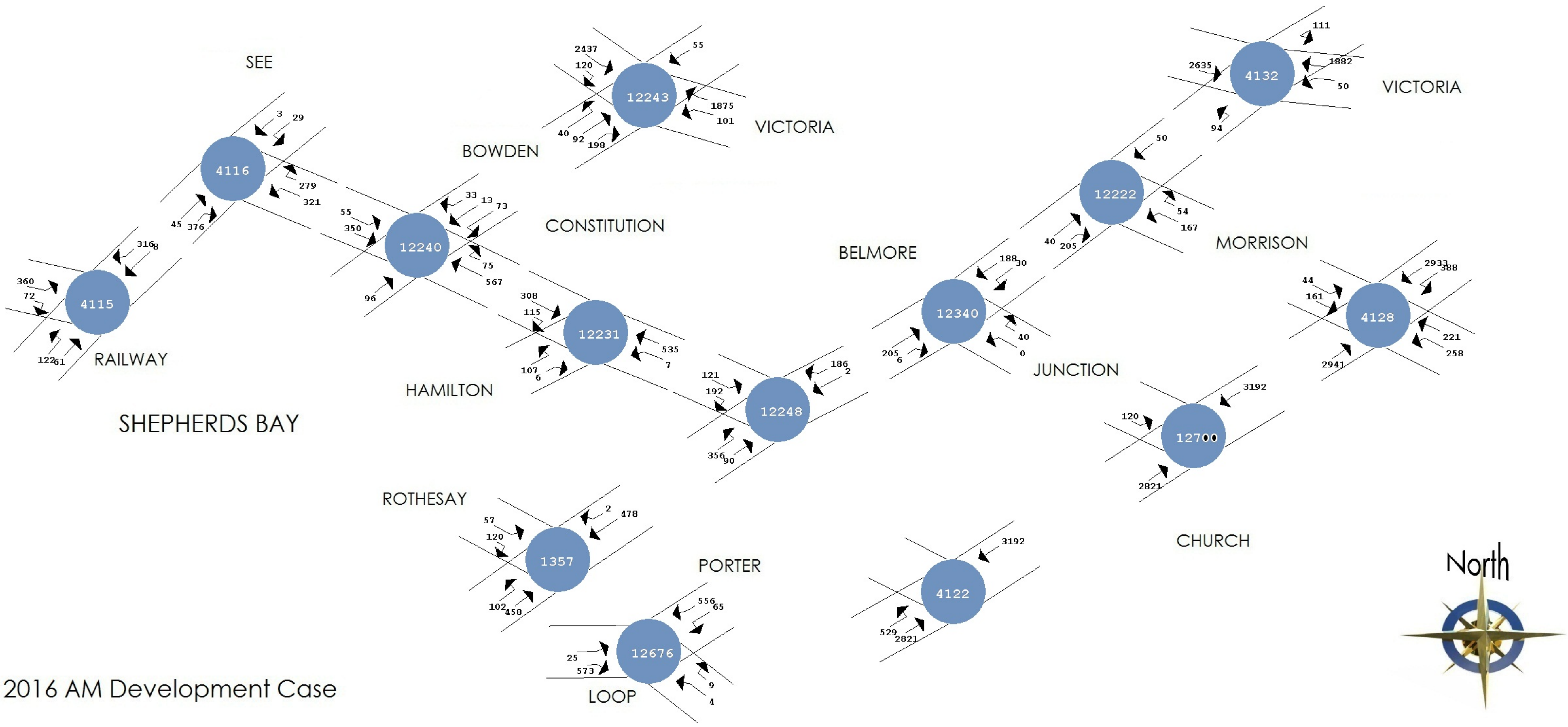
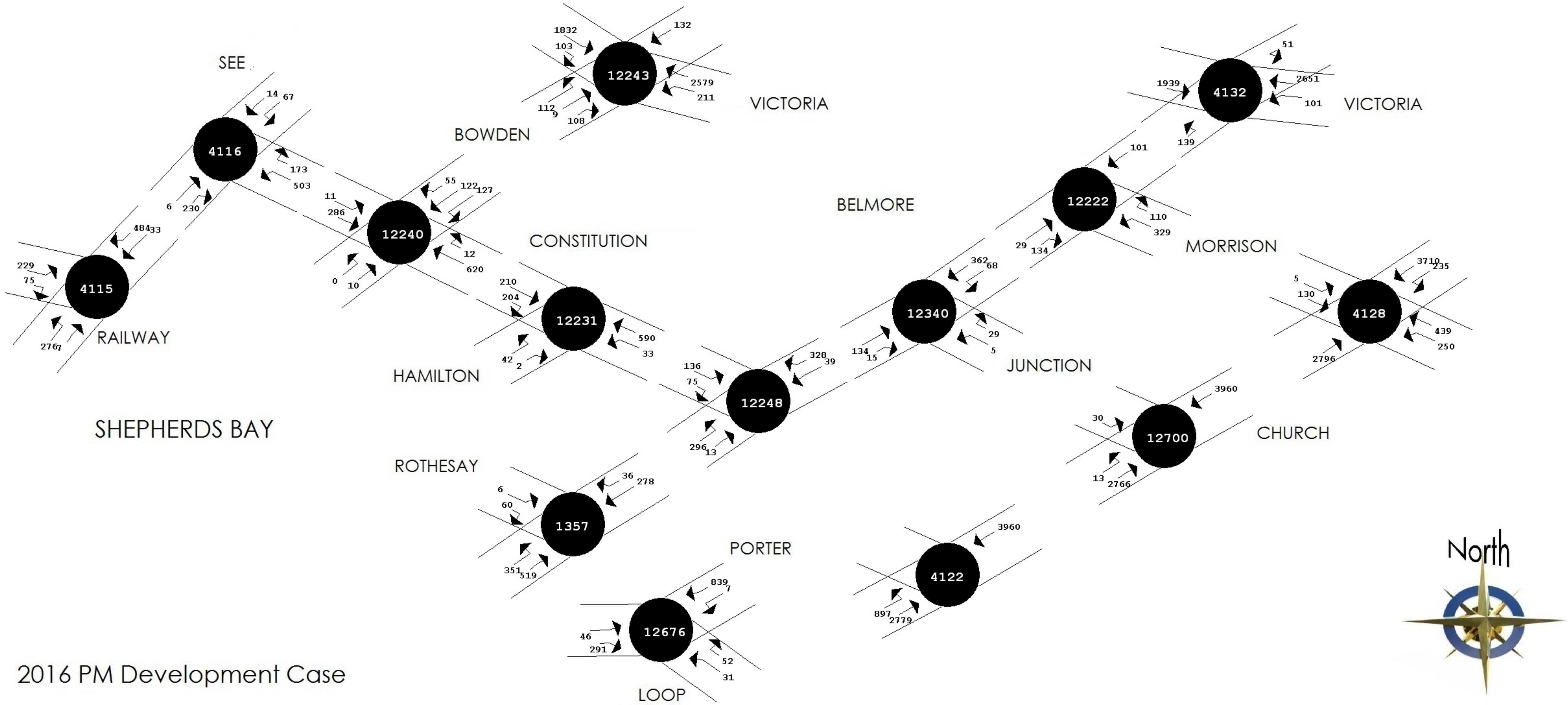


Figure C4: 2016 PM Peak Development Case Turn Projections



APPENDIX D – 2026 BASE PLOTS INCORPORATING RESIDENTIAL INFILL

Figure D1: 2026 AM Peak Base Traffic Model Projections

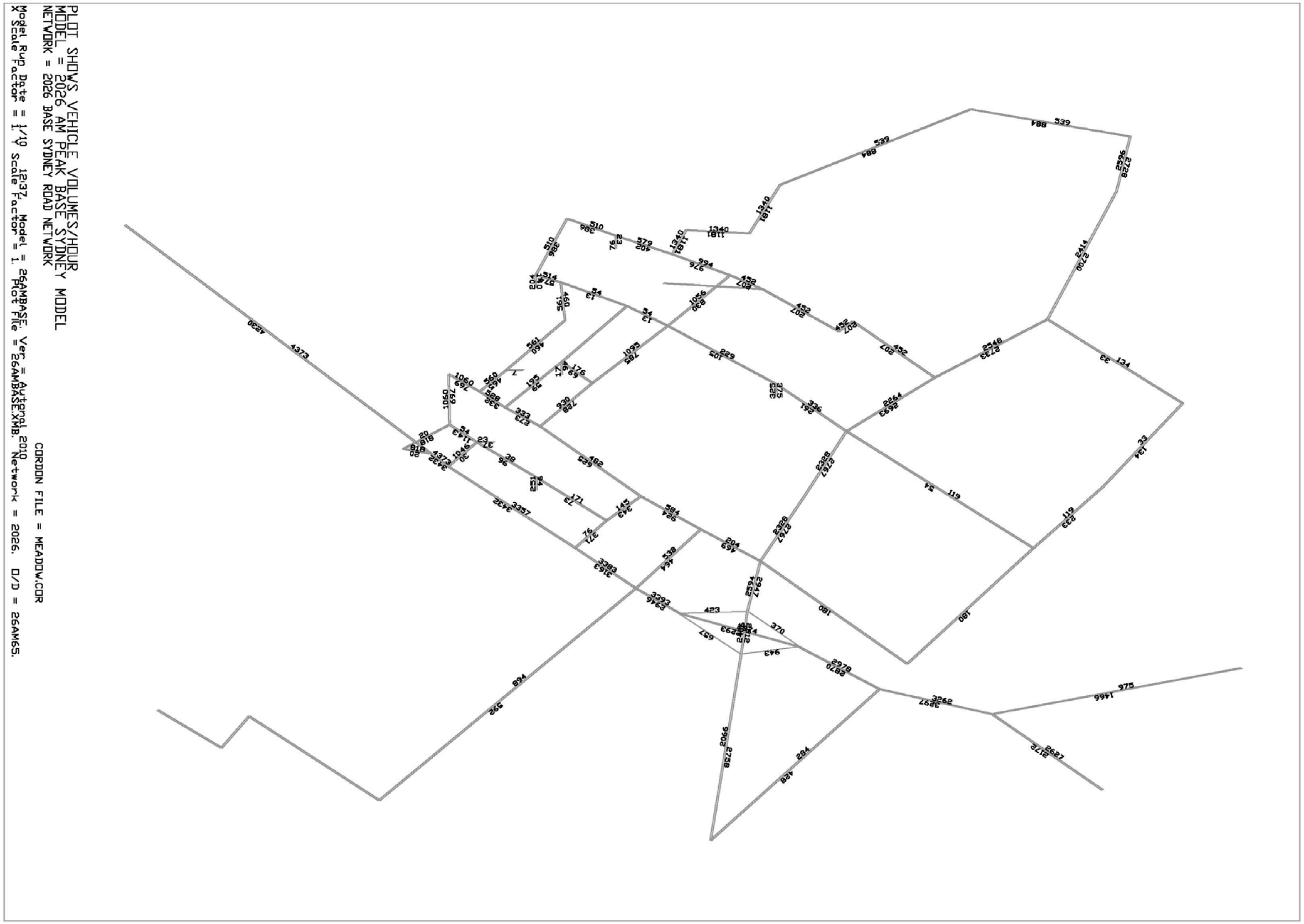


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Figure D2: 2026 PM Peak Base Traffic Model Projections

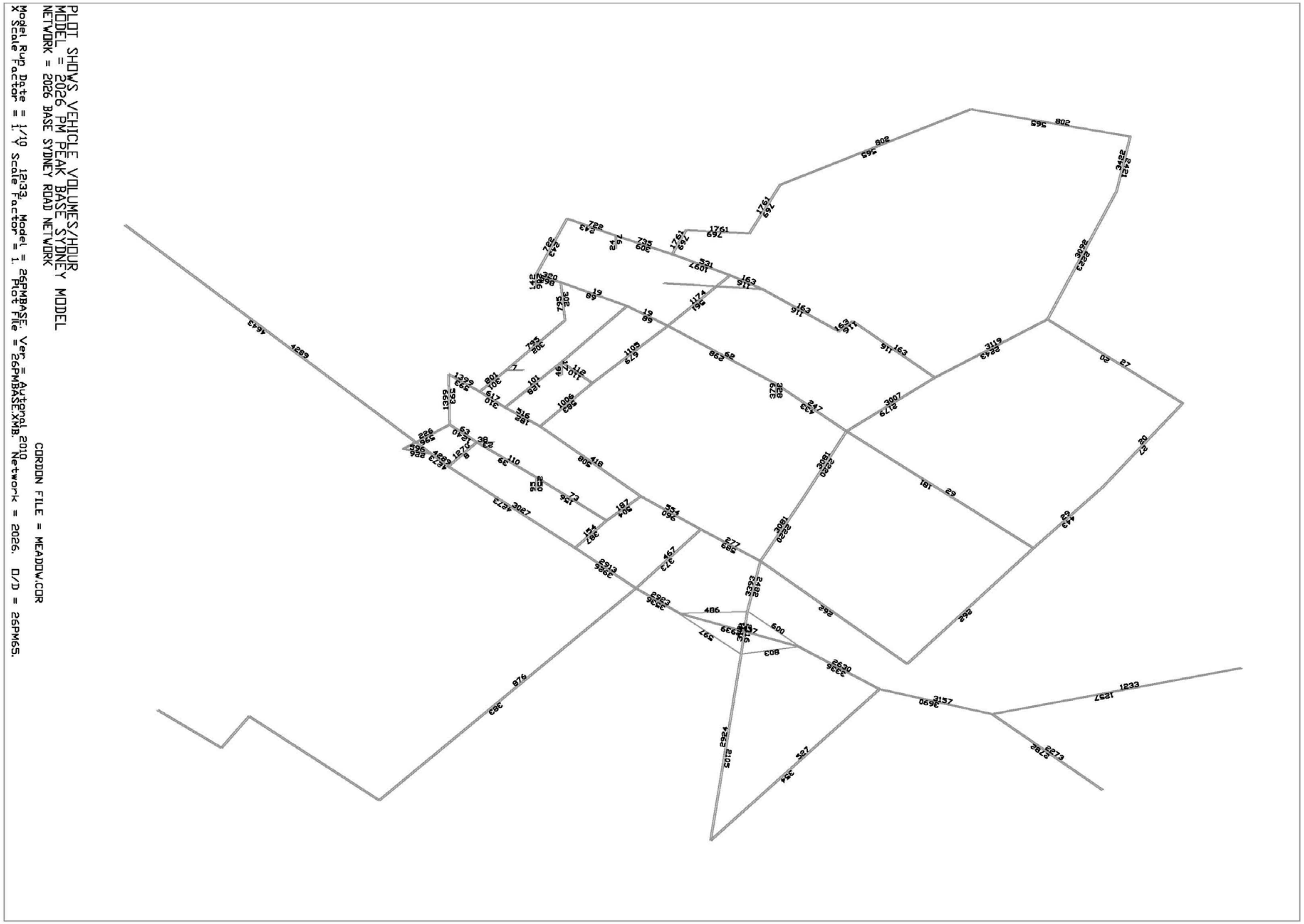

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Figure D3: 2026 AM Peak Base Case Turn Projections

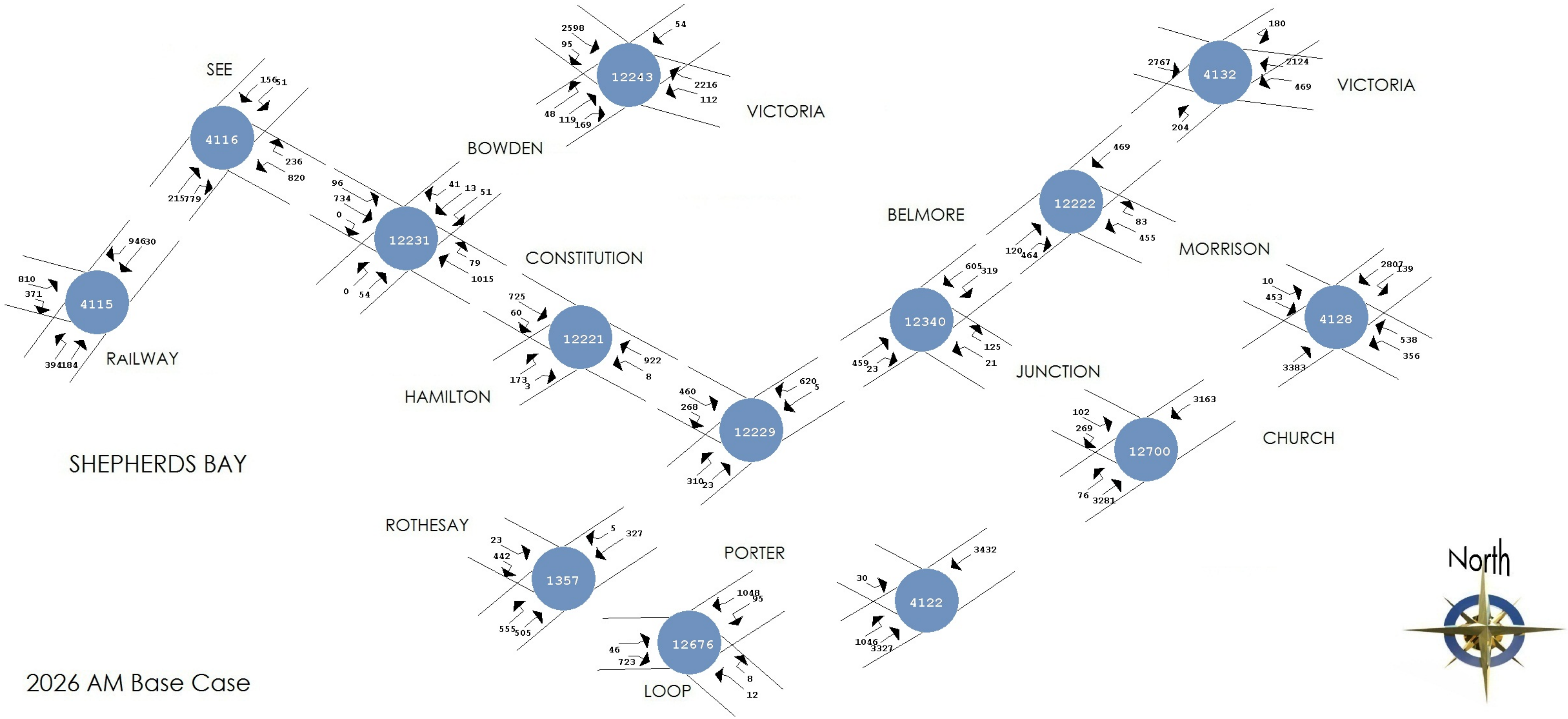
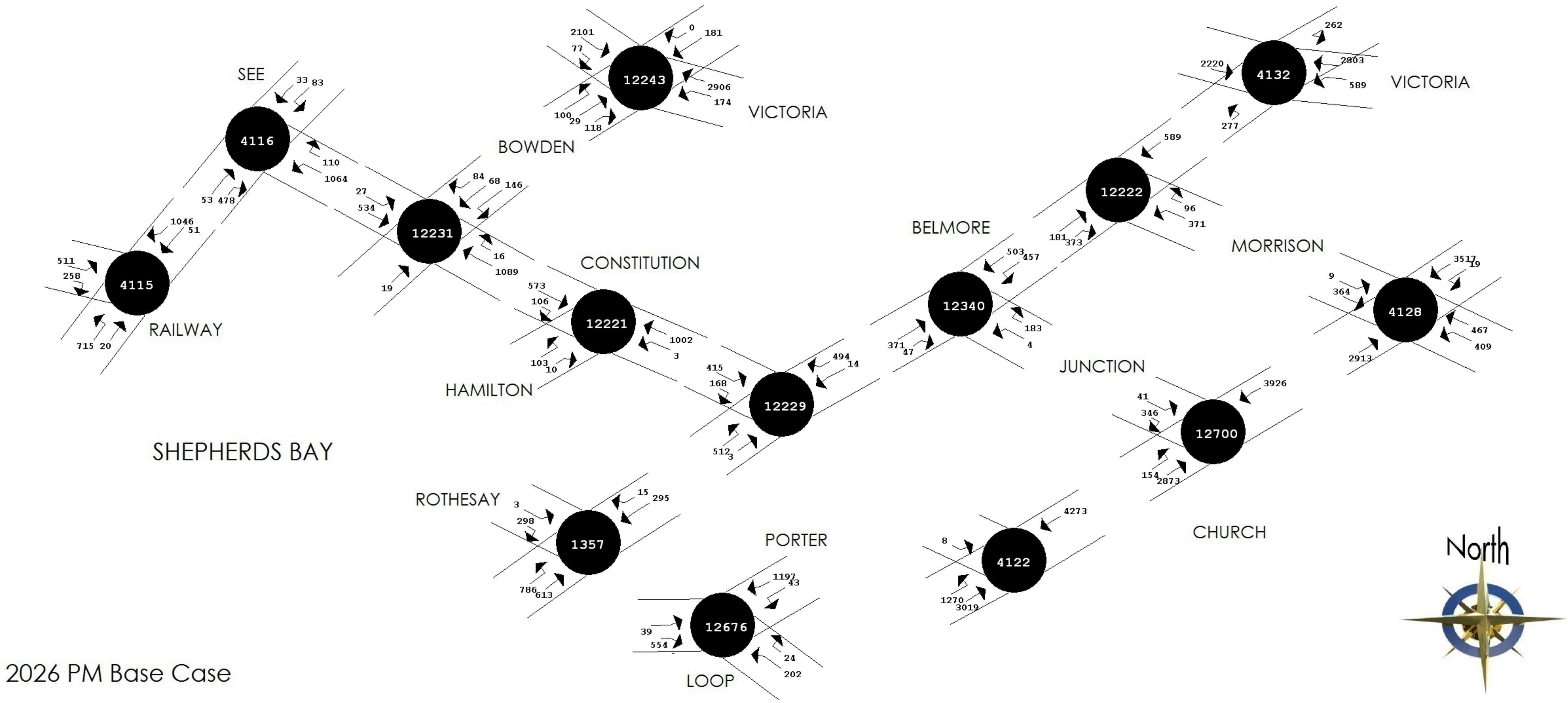


Figure D4: 2026 PM Peak Base Case Turn Projections



APPENDIX E – 2026 SHEPHERDS BAY DEVELOPMENT PLOTS

Figure E1: 2026 AM Peak Development Traffic Model Projections

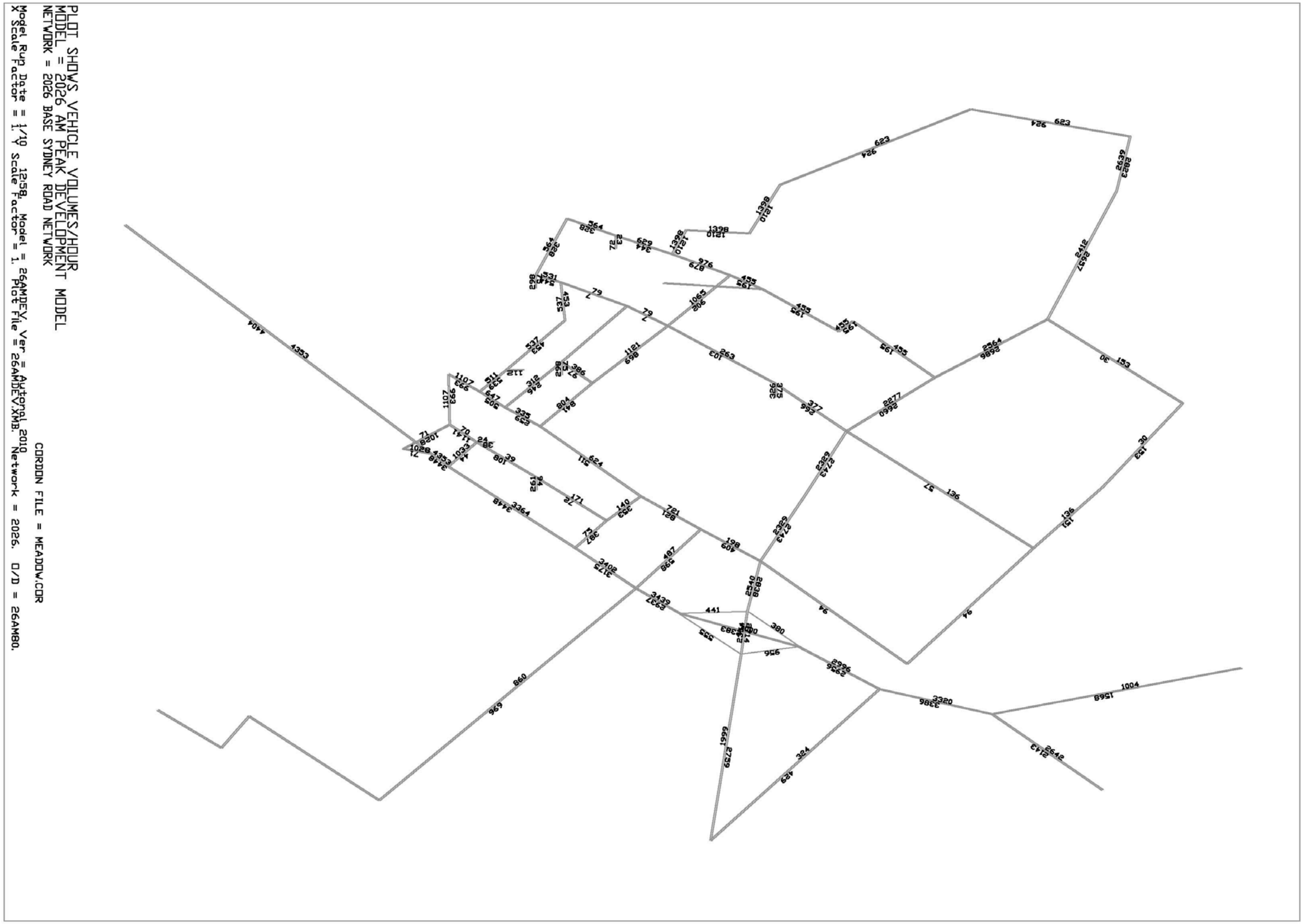


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Figure E2: 2026 PM Peak Development Traffic Model Projections

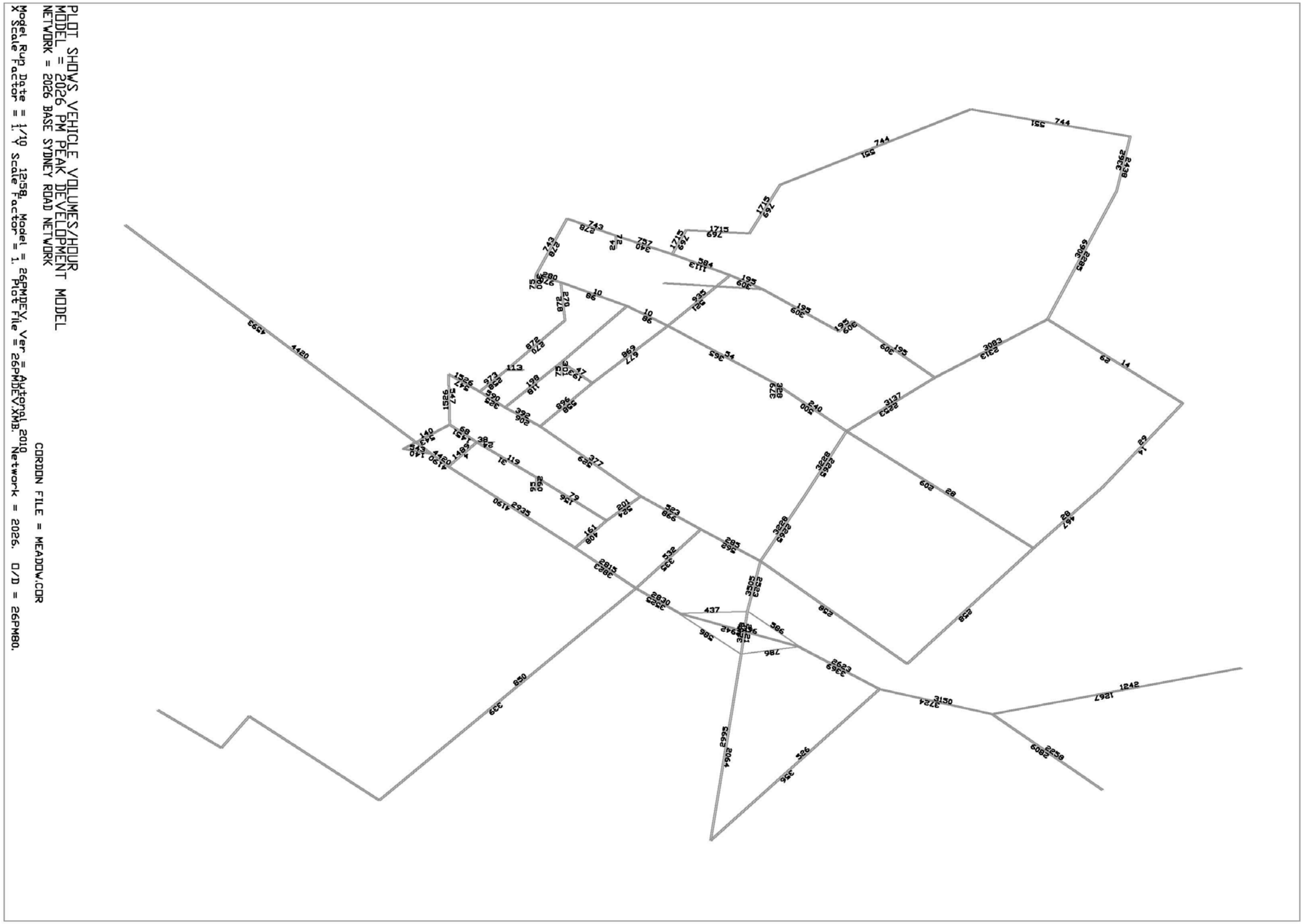

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Figure E3: 2026 AM Peak Development Case Turn Projections

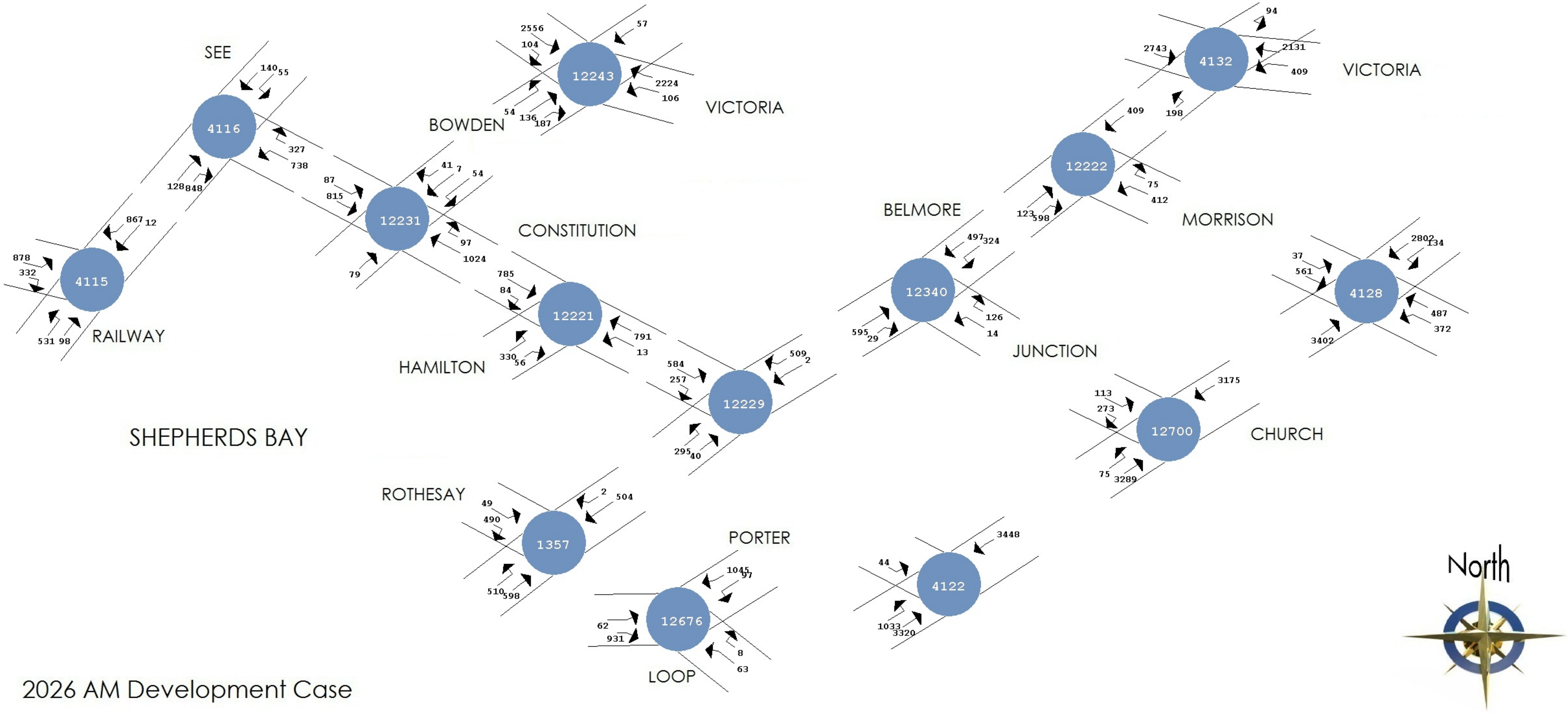

Figure E4: 2026 PM Peak Development Case Turn Projections