NZ TRANSPORT AGENCY
WAKA KOTAHI

Roads of national significance

16 20

Western Ring Route – Waterview Connection

Traffic Modelling Report

Beca

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NZ Transport Agency

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Executive Summary

In 2009 the NZ Transport Agency confirmed its intention that the 'Waterview Connection Project' would be lodged with the Environmental Protection Authority as a Project of National Significance. The Project includes works previously investigated and developed as two separate projects: being the SH16 Causeway Project and the SH20 Waterview Connection. The key elements of the Waterview Connection Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunnelled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a pedestrian / cycle way throughout the surface road elements of the Waterview Connection Project corridor.

This report details the future year traffic modelling that has been undertaken in both the project assignment model and the operational traffic model developed for the assessment of the Waterview Connection Project. These models form part of a hierarchy of models used for the project, comprising the Auckland Regional Council's multi-modal strategic demand model, a detailed project assignment model, and localised operational models for the more detailed consideration of design and operational issues.

This report is a technical reference describing the inputs and outputs of the traffic modelling undertaken. The detailed assessment of effects on the transport system is based on these modelling results but is reported separately.

This report provides an overview of the modelling process and extensive model outputs. Key outcomes of the modelling include the following forecasts (the interpretation and explanation of these results is contained in the Technical Report G.18: *Assessment of Transport Effects*):

- With the project in place, traffic on SH16 (Westgate to Newton Road) is forecast to increase by up to 26% in 2026 compared to the situation if the Waterview Connection is not completed;
- In 2026, the SH20 extension section (Maioro Street to Great North Road) of the Waterview Connection is forecast to carry around 83,000 vehicles per day;
- The vehicle kilometres travelled (VKT) on local and arterial roads is forecast to decrease by 2% across the Greater Auckland Region and up to 6% in the study area with the completion of the project. There is a predicted corresponding increase in VKT on the motorways (up to 6% across the Greater Auckland Region and up to 32% in the study area) as a result of the completion of the Waterview Connection (compared to a no project scenario);

- Similarly the amount of heavy vehicle traffic on local and arterial roads is expected to decrease by 5-8%;

- There is a projected decrease in flow on many of the arterial roads around the project. Travel times on district and regional arterial roads are either lower or largely unchanged as a result of completing the Waterview Connection; and

- With the extra traffic attracted to the Waterview Connection, there are some localised movements or locations with a predicted increase in delay, however; in general, travel conditions on SH16 are expected to be improved over current conditions, even with the significant increase in traffic that the scheme is forecast to accommodate.

1. Introduction

1.1 Background

In 2009 the NZ Transport Agency confirmed its intention that the 'Waterview Connection Project' would be lodged with the Environmental Protection Authority as a Proposal of National Significance. The Project includes works previously investigated and developed as two separate projects: being the SH16 Causeway Project and the SH20 Waterview Connection. The key elements of the Waterview Connection Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunnelled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a pedestrian / cycle way throughout the surface road elements of the Waterview Connection Project corridor.

Beca Infrastructure Ltd, (Beca), has been commissioned by NZTA to undertake transport modelling to assess the effects of the completion of the Waterview Connection Project.

By completing the alternative strategic route to the Central Motorway Junction (CMJ), the Southern motorway and the Auckland Harbour Bridge, the Waterview Connection is expected to provide significant relief to both the city arterials and parts of the wider network.

1.2 Report Purpose

Beca has been working on behalf of NZTA to undertake traffic modelling to forecast the effect of the completion of the Waterview Connection both during construction and operation, and to inform other aspects of the assessment of environmental effects being undertaken such as air quality and noise.

The purpose of this report is to detail the findings of the forecast year traffic modelling that has been undertaken to assess the effects of this project. This report also details the assumptions and inputs to the traffic modelling that has been undertaken at a regional, project assignment and operational level.

1.3 Project Description

The Project includes key works proposed by the NZTA to progress completion of the Waterview Connection. This project includes works on both SH16 and SH20. **Figure 1.1** shows the location of the proposed work.

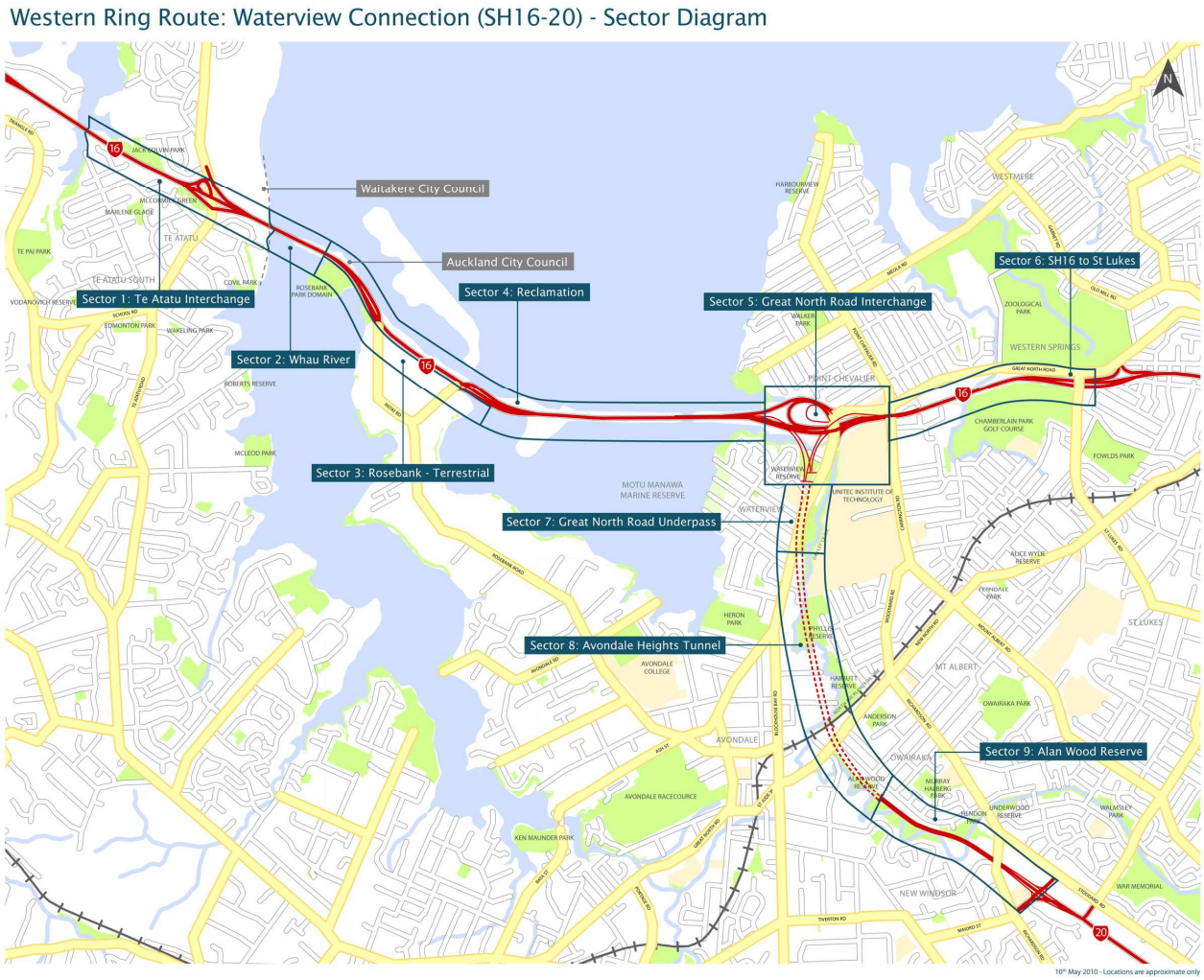

Figure 1.1 – Location of the Project

In summary, the project works includes the following:

- Improving the resilience of the WRR (by raising the causeway on SH16 between Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise);
- Providing increased capacity on the SH16 corridor (between St Lukes and eventually to Westgate Interchanges); and
- Providing a new section of SH20 between the Great North Road and Maioro Street Interchanges.

On SH20 the Project will extend SH20 from its current termination at the Maioro Street Interchange, and connect it with SH16 at Waterview and Point Chevalier (at the Great North Road Interchange). The new section of SH20 is approximately 5.5km in length and passes through or beneath the suburbs of Owairaka, Avondale and Point Chevalier. Further details of the project can be found in **Chapter 3 of this report**.

1.4 Other Reports

The main transport assessment is documented in the Technical Report G.18: *Assessment of Transport Effects*.

There are a number of technical reports which support the full transport assessment which has been undertaken for this project. These are as follows:

- Traffic Model Scoping Report, May 2009;
- Project Assignment Traffic Model Validation Report, February 2010;
- Technical Report G.26: *Operational Traffic Model Validation Report*, July 2010;
- Technical Report G.25: *Traffic Modelling Report*, July 2010; and
- Technical Report G.16: *Assessment of Temporary Traffic Effects*, July 2010.

This report forms the **Technical Report G.25: *Traffic Modelling Report*, July 2010**. It is intended as a technical model reference report, with the interpretation and analysis being included in the Technical Report G.18: *Assessment of Transport Effects*.

1.5 Report Structure

The remainder of this report is structured as follows:

- Chapter 2: Discusses the structure of the modelling system used to undertake the assessments;
- Chapter 3: Contains the project description;
- Chapter 4: Details the assumptions used in the modelling;
- Chapter 5: Details the demands used and processes for disaggregation and application of factors;
- Chapter 6: Contains an assessment of the wider network results;
- Chapter 7: Contains an assessment of the operational traffic assessments;
- Chapter 8: Details the results of the sensitivity analysis undertaken; and

- Chapter 9: Contains the conclusions of this report.

2. Model Structure

This chapter summarises the structure of the traffic models used for the assessment of environmental effects of the project. The development and validation of each of these models is described in more detail in separate validation reports as follows:

- Strategic Demand Model – Auckland Transport Models Project (ATM2) ART3 Model Testing and Validation Report, August 2008[1];
- Project Assignment Model – Project Assignment Traffic Model Validation Report, February 2010; and
- Operational Model – Technical Report G.26: *Operational Model Validation Report*, July 2010.

2.1 Model Structure

The WRR project follows the hierarchical modelling structure used successfully on other major projects across the Auckland region since the early 1990's such as SH1-SH20 link in Manukau, SH20 Manukau Harbour Crossing and SH18 Hobsonville Deviation. This involves the following three components:

- A strategic **Demand** model that relates land use (such as population and employment), to person travel patterns at a strategic, region-wide level;
- A **Project Assignment** model, which is similar in area to the demand model, but has a more refined network in the project area. This model loads the vehicle trip patterns predicted by the demand model onto the road network to test various options and investigate the traffic effects at a more detailed level; and
- An **Operational** model, which uses micro-simulation to look at specific intersections and connections in even greater detail.

It is the **project assignment** and **operational** models which are the subject of this traffic modelling report. Details are also included with respect to the assumptions used in the strategic **demand** model. The hierarchy of models is required as it is not practical to develop a system in a single model to cover both the strategic demand issues across the whole region and the detailed local operational effects. This hierarchical system has been used successfully on most major projects in the Auckland region (and elsewhere) and is a common modelling approach.

[1] Please contact the Auckland Regional Council (ARC) for this report

Figure 2.1 details the model structure, and the **Demand**, **Project Assignment** and **Operational** models components are described following.

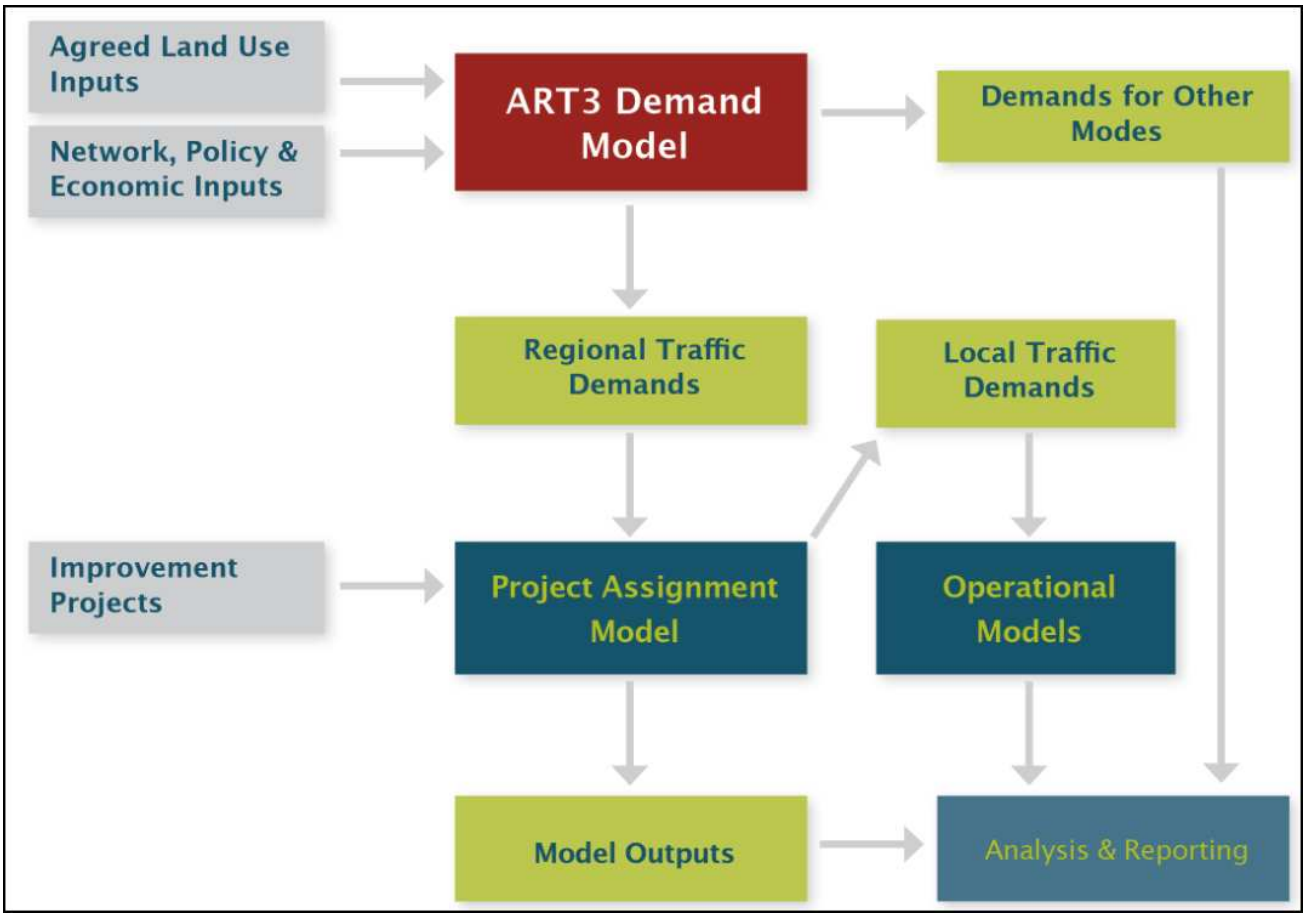

Figure 2.1 – Model Structure

2.2 ART3 Demand Model

The ART3 model is a 4-step multi-modal model. This model has recently been developed based on extensive data collected in 2006 (the 'ART3' model). It has a base year of 2006 which was developed using Census data, and a full model validation exercise was undertaken. The ART3 model produces demands for five periods of the day, and separate assignment models exist for the morning and evening peak and weekday inter-peak periods.

The model itself comprises of the following key modules:

- **Trip Generation**. This is where the number of person-trips are estimated as a function of the land use data (population, employment, school roll etc);

- **Mode Choice**. This is where the choice of preferred travel mode is determined, based on the relative costs of the various modes. The ART3 modes for mode choice are car (driver and passengers combined) and

passenger transport. Trips by car are converted into vehicle trips later in the model. The model also estimates the number of active mode trips, such as walking and cycling, although these are not fully modelled through to link flows;

- **Trip Distribution**. This is where the trips produced in each zone (generally by the households), are matched to a preferred destination. This distribution is predicted as a function of the relative attractiveness of each destination zone and the travel costs to reach each destination;

- **Time of Day**. This is where the proportion of daily trip making occurring in each period is calculated. These proportions change in response to changes in travel costs to represent peak spreading; and

- **Trip Assignment**. This is where the resulting travel demands, in the form of origin to destination trip tables, are loaded to the road and public transport networks. For the road assignment an iterative process is used to firstly identify the lowest-cost route between each origin and destination, followed by an estimation of the speeds and delays on each route associated with the predicted traffic flows on the route.

The ART3 model is operated by the ARC and is implemented in the EMME software, which is a well-used and proven platform for this kind of analysis.

It is therefore the ART3 model that predicts the overall regional traffic patterns, based on the inputs and forecasts of population and employment growth, together with the assumed level of road and public transport infrastructure. This model also predicts how trip making will change in response to a major project, such as the WRR. Details of the inputs and results of the future year modelling are reported separately.

2.3 Project Assignment Model

The project assignment model is similar to the assignment module in the ART3 model, but represents the road network in the immediate study area in significantly greater detail. It is only an 'assignment' model in that it takes the traffic demands from the ART3 model and 'assigns' them to the road network. Land use data is not used directly in this part of the model, and it only includes vehicle traffic (not passenger transport trips).

The project assignment model covers the same wider area as the ART3 model, namely the greater Auckland Region. However, it covers the area around the Waterview Connection and SH16 in greater detail than the ART3 model. As with the ART3 model, the project assignment model is validated to a 2006 base year. The model validation report for the project assignment model can be found in the separate model validation report[2]. Later chapters in this report contain details of the forecast year demands and networks.

[2] Project Assignment Traffic Model Validation Report, February 2010

2.4 Operational Model

Operational models are used to assess localised issues in more detail than is possible in the project assignment model. They are primarily to investigate specific design issues such as length of intersection turn lanes, likely length of queues and performance of motorway merge and weave areas. The operational model developed to assess the Waterview Connection project is a simulation model developed in the S-Paramics software covering SH20 between the Maioro Street interchange and SH16 as well as the length of SH16 between the Newton Road interchange and the Westgate interchange. This model obtains travel demands, in the form of origin-destination trip tables, from the project assignment model. These trip tables are then loaded as flow rates into the simulation models, along with assumed flow profiles to represent the build-up and dissipation of peak traffic flows.

Again, the simulation model has been calibrated and validated to a 2006 base year, details of which are included in the separate validation report[3]. Later chapters in this report contain details of the forecast year demands and networks.

[3] Technical Report G.26: *Operational Model Validation Report*, July 2010

3. Project

This chapter describes the project that has been tested and reported in this document.

3.1 Project Description

Two scenarios have been developed for the assessment of effects, a 'Do-Minimum' and an 'Option'. The Do-Minimum does not contain the Waterview Connection, with the Option including the Waterview Connection (the level of widening assumed on SH16 is dependant on the forecast year).

All other network assumptions remain the same between the two scenarios. Descriptions of the Waterview Connection are contained in the following sections.

3.2 SH20 Waterview Connection

In both 2016 and 2026, for the purposes of the transport modelling and assessment, the proposed SH20 extension is assumed to be a 6-lane motorway, with north facing ramps at the Maioro Street interchange (the south facing ramps and bridge are assumed to have been constructed before 2016), and joining to SH16 at the Great North Road interchange with east and west facing ramps.

Chapter 4 contains discussion of why the years 2016 and 2026 have been chosen for the analysis years.

3.3 SH16 Upgrade

Table 3.1 details the assumed widening on SH16 and in which forecast year this has been included. In the Option for 2016 and 2026, interchange upgrades are assumed at Lincoln Road and Te Atatu Road interchanges. Plan of the upgrades is shown in **Appendix A** and also can be seen in the Plan set F.2 Drawing No. 20.1.11-3-D-C-910-102.

Table 3.1 – SH16 Widening

Section	Number of Lanes			
	2006	2016/2026 Do Minimum	2016 Option	2026 Option
Westbound				
St Lukes to Great North Road	3	3	4	4
Through Great North Road Interchange	3	3	3	3
Great North Road to Rosebank	3	3	5	5
Rosebank to Patiki	3	3	4	4
Patiki to Te Atatu Road	3	3	4	4
Te Atatu Road to Lincoln Road	2	2	3	3
Lincoln Road to Royal Road	2	2	2	3
Royal Road to Westgate	2	2/3	3	3
Eastbound				
Westgate to Royal Road	2	2/3	3	3
Royal Road to Lincoln Road	2	2	2	3
Lincoln Road to Te Atatu Road	2	2	3	3
Te Atatu Road to Patiki	3	3	4	4
Patiki to Rosebank	3	3	4	4
Rosebank to Great North Road	3	3	4	4
Through Great North Road interchange	3	3	3	3
Great North Road to St Lukes	3	3	4	4

4. Model Inputs and Assumptions

This chapter describes the key inputs and assumptions made to create the future forecasts in the ART3 model, the project assignment model and the operational modelling.

4.1 Forecast Years

Two forecast years have been used, 2016 (to represent the opening year for the project) and 2026 (to represent 10 years post opening). These forecast years are consistent with the requirements of other environmental assessments such as noise and air quality.

4.2 Time Periods

Based on the ART3 demands, the project assignment model covers the following three time periods:

- AM Peak (07:00 to 09:00);
- Inter-peak (a 2-hour average of the 09:00 – 16:00 period)[4]; and
- PM Peak (16:00 to 18:00).

Three separate models for these time periods exist in the project assignment model. Factors are applied to each of the three peaks to create daily flows (see **Chapter 6**).

[4] The ART3 Inter-peak model covers average of the 09:00 – 15:00 period; however the average was within 1% in difference of the 09:00-16:00 period.

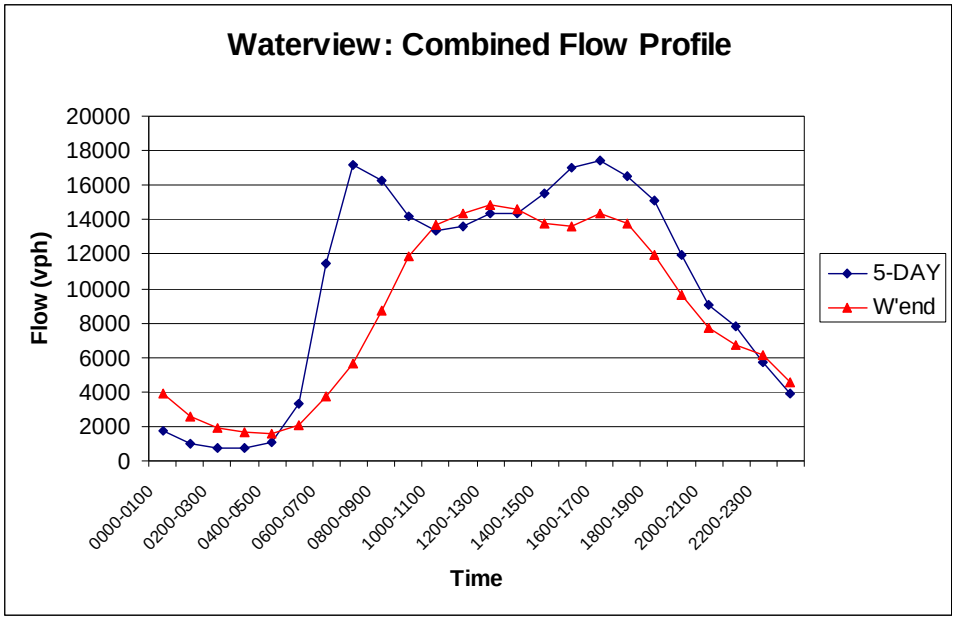

Figure 4.1 – Combined Flow Profile

The typical hourly flow profile of traffic in the study area is shown in **Figure 4.1**. The 5-day and weekend profiles are both averaged over a number of count sites, within the study area. The SH16 traffic flows are tidal in nature where higher proportion of traffic travels to the city in the AM peak while during the PM period majority of the traffic travels in the westbound direction.

The operational model has two, four-hour long time periods, as follows:

- AM Peak (06:00 to 10:00); and
- PM Peak (15:45 – 18:45).

4.3 ART3 Assumptions

The following sub-sections detail the specific ART3 inputs and assumptions that have been used in terms of networks, land use and policy. The assumptions related to future projects were agreed with NZTA specifically for this project, however, the other inputs and assumptions were based on adopting those developed by the ARC for the purpose of modelling for the update to the Auckland Regional Transport Strategy (RLTS).

4.3.1 Do -Minimum Networks

The Do-Minimum scenario represents the minimum investment needed in the study corridor to maintain operations and hence represents the 'no project' case. It is however assumed to include new projects and upgrades outside the study corridor, and these assumptions are common to the 'no project' and 'project' scenarios.

The following **Table 4.1** details the roading, rail and bus network assumptions in the ART3 model for the Do-Minimum scenario for 2016 and 2026. The '✓' indicates the modelled years(s) in which the scheme was included.

Table 4.1 – ART3 Model Assumptions (Do-minimum)

Project	2016	2026
Roading Projects		
Regional Arterial Road plan (RARP)	✓	✓
SH1 Wainui Interchange	✓	✓
SH1 Alpurt	✓	✓
Central Motorway Junction Stage 2	✓	✓
SH18 Greenhithe	✓	✓
SH18 Hobsonville	✓	✓
SH1 Esmonde Interchange	✓	✓
SH1 Onewa Interchange	✓	✓
SH1 Victoria Park Tunnel	✓	✓
SH1 Newmarket Viaduct	✓	✓
SH1 Highbrook Interchange	✓	✓
SH1 Papakura Interchange	✓	✓
SH20 Mt Roskill	✓	✓
SH20 Maukau Harbour Crossing	✓	✓
SH20 – SH1 Manukau	✓	✓
SH20A	✓	✓
SH1 Widening (various)	✓	✓
AMETI stage 1	✓	✓
PENLINK	✓	✓
Tiverton/Wolverton	✓	✓
South West to East Tamaki Stage 1	✓	✓
Redoubt Road	✓	✓
Glenfield Road		✓
Massey North		✓
SH16 Grafton Gulley Stage 3		✓

AMETI Stage 2		✓
South West to East Tamaki Stage 2		✓
SH20 B		✓
Mill Road Corridor Stage 1		✓
Pukekohe Eastern Corridor		✓
Rail Projects		
Electrification	✓	✓
Onehunga Branch	✓	✓
Manukau Spur	✓	✓
CBD Rail Loop		✓
Bus Projects		
Central Transit Corridor	✓	✓
Northern Busway	✓	✓
Bus Lanes (various)	✓	✓
Northern Busway extension to Silverdale		✓

In addition to the above, the ART3 model assumes increases in rail and bus services in line with the Auckland Regional Transport Authorities (ARTA) Passenger Transport Network Plan (PTNP). The growth in rail, bus and also ferry services can be seen in the assumed changes in service-km as shown in **Table 4.2**.

Table 4.2 – ART3 Public Transport Services Improvements

Period	Mode	2006 Service km	Growth to 2016	Growth to 2026
AM	Bus	25,304	36%	56%
	Rail	1,049	120%	378%
	Ferry	552	94%	133%
IP	Bus	16,543	85%	111%
	Rail	803	113%	236%
	Ferry	231	187%	244%
PM	Bus	27,120	27%	44%

	Rail	1,128	108%	345%
	Ferry	593	73%	108%

Table 4.2 shows very substantial increases in services across all modes, and especially in the inter-peak periods. The bus services show the lowest proportional increase, but due to the higher current quantity of bus services they have the largest actual increase.

The ferry network/services are assumed to grow in accordance with the PTNP to 2016, with a further 20% increase in services by 2026. Ferry-km, which are a reflection of the services and frequencies provided, are modelled to grow by over 100% in the peaks and more than 240% in the off peaks.

The ART3 model also assumes that integrated ticketing and integrated fares are in place in 2016 and 2026. No increases in public transport fares were included (in real terms), and no specific allowance for differential increases in willingness to pay.

4.3.2 Option Networks

The following was assumed for the Option networks:

- 2016 – Do Minimum plus the Waterview Connection (with widening assumed on SH16 between St Lukes to Lincoln interchanges); and
- 2026 – Do Minimum plus the Waterview Connection (with widening assumed on SH16 between the St Lukes interchange and Westgate).

4.3.3 Land use

Table 4.3 displays the population and employment assumed in the ART3 model. The zone-by-zone forecasts are those used in the modelling undertaken by the ARC for the Regional Land Transport Strategy (RLTS), dated 15/09/2009.

Table 4.3 – Population and Employment Assumed in the ART3 model

	2006	2016	2026
Population	1,347,377	1,580,525	1,796,111
Employment	520,251	625,684	729,840

Table 4.3 shows that between 2006 and 2016 there will be an increase in population of 17% with a further 14% increase between 2016 and 2026 (giving a total increase of 33% between 2006 and 2026). In terms of employment, there is a projected 20% increase in jobs between 2006 and 2016, with a further increase of 17% between 2016 and 2026 (a total of 40% between 2006 and 2026).

4.3.4 Fuel price

The ART3 model contains assumptions relating to fuel price. Fuel price in this case means the pump price for fuel. The following pump prices have been included (all in $2006):

- 2006 – $1.55 per litre;
- 2016 – $2.38 per litre; and
- 2026 – $2.75 per litre.

These values were as adopted by the RLTS and were applied to the vehicle costs. As per the RLTS, these fuel prices were applied to the 2006 average consumption of 10 litres per 100km.

4.3.5 Travel Demand Management

The ART3 model does not explicitly respond to changes to non-price Travel Demand Management (TDM)-type measures, and instead the RLTS modelling asserts behaviour change in the models. Table 4.3 details the ART3 model assumptions relating to travel demand management (TDM). The values represent the percent of a particular modelled trip purpose that is assumed to change from private to public or active mode travel e.g. Workplace travel plan is targeted towards Home Based Work trips, Community travel plans targeted at Home Based Shopping and Home Based Other trips, with School/Tertiary travel plans being targeted towards Home Based Education trips.

Table 4.4 – Traffic Demand Management Assumed in the ART3 model

TDM initiative	2006	2016	2026
Non Price TDM initiative: Workplace travel plans to non-RGS[5] areas	0%	1.25%	2.5%
Non Price TDM initiative: Workplace travel plans to RGS areas including the CBD	0%	15%	15%
Non Price TDM initiative: School and Tertiary travel plans	0%	5%	9%
Non Price TDM initiative: Community travel plans	0%	3%	6%
Work at home	17%	20%	23%

4.4 Project Assignment Model Assumptions

4.4.1 Do-Minimum Networks

Although the project assignment model uses broadly the same network assumptions as the ART3 model, it also assumes some additional local small scale projects. **Table 4.5** details the network assumptions in the project assignment Do-Minimum model. Those projects highlighted are additional to those included in the ART3 model assumptions.

Table 4.5 – Project Assignment Model Network Assumptions

Project	2016	2026
Regional Arterial Road plan (RARP)	✓	✓
SH1 Alpurt	✓	✓
Central Motorway Junction Stage 2	✓	✓
SH18 Greenhithe Deviation	✓	✓
Central Transit Corridor	✓	✓
SH1 Esmonde Interchange	✓	✓

[5] RGS zones are areas defined in the model to have high-density, mixed land use.

SH1 East Tamaki Interchange	✓	✓
SH1 Papakura Interchange improvements	✓	✓
Northern Busway Stage 1	✓	✓
SH1 Onewa	✓	✓
SH1 to SH20 Manukau	✓	✓
SH1 Newmarket Viaduct	✓	✓
SH1 Victoria Park Tunnel	✓	✓
SH1 Widening (Ellerslie to Greenlane, Northcote to Sunnynook)	✓	✓
SH1 Redoubt Road	✓	✓
SH20A	✓	✓
AMETI Stage 1	✓	✓
AMETI Stage 2		✓
Northern Busway Stage 2	✓	✓
SH1 Wainui interchange	✓	✓
PENLINK	✓	✓
South-West to East Tamaki Stage 1	✓	✓
South-West to East Tamaki Stage 2		✓
SH16 Brigham Creek Extension	✓	✓
SH18 Hobsonville Deviation	✓	✓
SH18 Upper Harbour Bridge Duplication	✓	✓
SH20 Mt Roskill 4-laning	✓	
SH20 Mt Roskill 6-laning		✓
SH20 Manukau Harbour Crossing	✓	✓
SH20 Maioro Street Half Diamond Interchange	✓	✓
Universal Drive extension	✓	✓
Central Park Drive Extension	✓	✓
Massey North/NORSGA internal network	✓	✓
New Lynn Transit Orientated Design Improvements	✓	✓
Tiverton/Wolverton Stage 1	✓	✓
Tiverton/Wolverton Stage 2	✓	✓
SH16 3rd Westbound Lane through Great North Road interchange	✓	✓

Mill Road Corridor Stage 1		✓
Glenfield Road		✓
SH16 Grafton Gully Stage 3		✓
SH1 Widening (Hill Road to Hingia)		✓
SH20B Widening		✓
Pukekohe Eastern Corridor		✓
Ramp Signalling (SH1, SH16, SH18 and SH20)	✓	✓

4.4.2 Option Networks

The following was assumed for the Option networks:

- 2016 – Do Minimum plus SH20 Waterview Connection, SH16 Widening (St Lukes to Lincoln) and interchange upgrades at Te Atatu Road and Lincoln Road; and
- 2026 – Do Minimum plus SH20 Waterview Connection, SH16 Widening (St Lukes to Westgate) and interchange upgrades at Te Atatu Road and Lincoln Road.

4.5 Operational Model Assumptions

As the function of the operational model is to assess the operation of the project, a do-minimum model has not been developed for future years.

4.5.1 Option Networks

Table 4.6 details the network assumptions in operational Option model.

Table 4.6 – Network Assumptions in Operational Option Model

Project	2016	2026
SH16 3rd Westbound Lane through Great North Road interchange	✓	✓
Ramp Signalling (SH16)	✓	✓
Westbound Great North Road Interchange priority lanes	✓	✓
SH20 Maioro Street Interchange	✓	✓

SH20 Waterview Connection	✓	✓
SH16 Widening St Lukes to Lincoln	✓	✓
Te Atatu interchange upgrade	✓	✓
Lincoln Road Interchange Upgrade	✓	✓
Sh16 Widening Lincoln to Westgate		✓

It should be noted that the configuration for the Te Atatu and Lincoln interchanges included in the Operational model is slightly different to that in the project assignment model, due to advancements in the design of the interchanges which have taken place between the developments of the two models (the project assignment model uses designs from September 2009, the operational model includes ones from April 2010). However, it is not considered that this will materially affect the results in the project assignment model.

5. Demands

This chapter discusses the demands originating from the ART3 model, and how they are used in the project assignment and operational models.

5.1 ART3 Demands

The forecast year vehicle demands for the project model area were obtained from the ART3 model for the do-minimum and the option and using the inputs and assumptions described earlier. Based on the ART3 demands, the project assignment model covers the following three time periods:

- AM Peak (07:00 to 09:00);
- Inter-peak (a 2-hour average of the 09:00 – 15:00 period); and
- PM Peak (16:00 to 18:00).

Matrices were received by period for the following purposes:

- Home Based Work trips;
- Home Based Education trips;
- Home Based Shopping trips;
- Home Based Other trips;
- Non-Home Based Other trips;
- Employers Business trips; and
- Medium/Heavy Commercial Vehicle trips.

Table 5.1 displays the ART3 trip totals by purpose as received from the ARC for 2006, with Tables 5.2 and 5.3 displaying the same for 2016 and 2026 respectively.

Table 5.1 – 2006 ART3 Total Vehicle Demand Totals (per 2-hour period)

Purpose	Total Trips		
	AM	IP	PM
Home Based Work	176,513	44,830	167,359
Home Based Education	34,797	14,430	12,368
Home Based Shopping	17,853	64,396	41,838
Home Based Other	116,398	143,387	148,330
Non-Home Based Other	52,483	126,356	71,878
Employers Business	67,690	41,271	67,297
Medium/Heavy Commercial Vehicles	23,059	25,141	18,870
Total	488,793	459,811	527,940

Table 5.2 – 2016 ART3 Total Vehicle Demand Totals (per 2-hour period)

Purpose	Total Trips					
	AM		IP		PM	
	Do-Minimum	Option	Do-Minimum	Option	Do-Minimum	Option
Home Based Work	194,122	194,554	49,400	49,351	183,858	183,994
Home Based Education	31,333	31,459	12,809	12,794	11,053	11,048
Home Based Shopping	21,766	21,827	78,000	78,017	49,920	49,962
Home Based Other	139,951	140,218	171,457	171,436	177,201	177,211
Non-Home Based Other	59,132	59,285	140,288	140,359	80,217	80,284
Employers Business	72,339	72,706	44,696	44,661	72,139	72,165
Medium/Heavy Commercial Vehicles	35,222	35,222	38,423	38,423	28,783	28,783
Total	553,865	555,271	535,073	535,041	603,171	603,447

Table 5.3 – 2026 ART3 Total Vehicle Demand Totals (per 2-hour period)

Purpose	Total Trips					
	AM		IP		PM	
	Do-Minimum	Option	Do-Minimum	Option	Do-Minimum	Option
Home Based Work	201,938	202,554	52,233	52,206	192,380	192,715
Home Based Education	34,177	34,314	13,906	13,899	12,046	12,047
Home Based Shopping	23,413	23,487	83,311	83,352	53,633	53,731
Home Based Other	157,174	157,458	192,027	192,028	198,585	198,685
Non-Home Based Other	63,757	63,911	149,956	150,016	86,347	86,445
Employers Business	75,194	75,626	46,783	46,760	74,552	74,662
Medium/Heavy Commercial Vehicles	52,784	52,785	57,589	57,589	43,187	43,187
Total	608,437	610,135	595,805	595,850	660,730	661,472

From **Tables 5.1 – 5.3** the following can be determined:

- Between 2006 and 2016 (Do-Minimum) there is a growth in vehicle trips of 13% in the AM peak, 16% in the inter-peak, and 14% in the PM peak;
- Overall traffic growth between 2006 and 2026 is 24% which compares to population growth of 33% and employment growth of 40%, implying a significant switch to other modes;
- Between 2016 (Do-Minimum) and 2026 (Do-Minimum), there is a further growth of 10% in the AM and PM peaks, and 11% in the inter-peak;
- Between 2006 and 2016, in all three peaks, there is a decrease in Home Based Education trips of 10 – 11%, but there is growth in all other trips;
- There is growth in all trip purposes between 2016 and 2026;
- The growth in medium/heavy commercial vehicles is over 50% in all peaks, between 2006 and 2016 and between 2016 and 2026 (this is further discussed in **Section 5.5**);
- Between the Do-Minimum and the option, in both 2016 and 2026, there is only a very small difference in total trips (less than 1%). This is because these totals are at a regional level, and the project does not add many trips at a regional level, but does alter patterns at the local level (this is discussed further in **Section 6.9**); and

- The number of HCVs remains the same between the Do-Minimum and the Option. This is because in the ART3 model, HCV trips are not linked directly to generalised costs and hence do not change between schemes.

- The predicted change between the do-minimum and option scenarios include the effects of changes in distribution (destination choice), mode choice and time of travel (peak spreading). Whilst it is not feasible to isolate the effects of these elements individually, the change in mode can be seen by the small increase in private vehicle demands. Peak spreading can be seen in the change in proportion of total vehicle demands, in the peak periods. For example, in the do-minimum scenario the total vehicle demands in the AM peak is 2.12% higher than the inter-peak whilst in the option scenario this difference increases to 2.40%.

5.2 Project Assignment Model Demands

The future year project assignment model demands were taken from the ART3 model for the Do-minimum and the Option, for the three time periods discussed in **Section 5.1**.

5.2.1 Disaggregation

The disaggregation process used to convert the ART3 model zones to the project assignment model zones is documented in the validation report[6].

Disaggregation factors were developed for the 2006 model to convert the ART3 demand into the project model zoning system. It was necessary to revise some of these factors for the future year models to reflect greater growth in some sub-zones than others. Candidate zones for the revision of the factors were selected where there was significant growth forecast and where the split to sub zones in 2006 was very uneven.[7] For the candidate zones, the potential growth in the parent zones was manually allocated to the sub-zones, by looking at aerial photos and considering the likely growth area and then the factors were re-calculated.

Appendix B details the future year zones which have different disaggregation factors to the 2006 model.

5.2.2 Application of Matrix Estimation Factors

Following the development of the base year model, a set of matrix estimation factors were derived to calibrate the model to existing conditions. These factors were then applied to the future year model.

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[6] Project Assignment Traffic Model Validation Report, February 2010

[7] The actual factor was 0.1 different to the equal share factor, for any zone in the parent ART3 zone AND where the growth in trips was greater than 40%. For example: Zone 242 has 2 sub-zones, meaning equal share factor will be 0.50. One of the zones has a disaggregation factor of 0.73 and the other has 0.27 in 2006. This was selected because the disaggregation factor was more than 0.1 from the equal share factor and because the growth factor of 1.5 exceeded 1.4.

A number of differing methodologies for applying these factors were evaluated based around 'additive' and 'multiplicative' methodologies. The following were analysed:

- 100% additive (where the absolute change in trip numbers in 2006 are applied to the future year);
- 100% multiplicative (where the ratio of the 2006 changes are applied); and
- 70:30 (where a weighted average of additive (70%) and multiplicative (30%) is used.

The effect of each of these methodologies was compared to the raw ART3 matrices to assess their effect. The results of these comparisons are presented at a sector level in **Appendix C**.

The comparison showed little overall difference in the methods, so the 70:30 methodology was adopted. It was applied using the following formula:

$$T^1{}_F = (T_F * \frac{F06}{P06}) * 0.3 + (T_F + F06 - P06) * 0.7$$

Where:

T^1_F = Final Future Year Trips

T_F = Raw ART3 Future Year Trips

F06 = Final 2006 Matrix

P06 = Prior 2006 Matrix (raw ART3)

5.2.3 HCV assumptions

As shown in **Section 5.1** the growth in HCVs forecast by ART3 is higher than the forecast employment growth. HCV growth is forecast to be over 129% between 2006 and 2026, with employment growth only forecast to be 40%. The growth in HCVs is shown in **Table 5.4**.

Table 5.4 – ART3 HCV Growth

	2006 – 2016	2016 – 2026	2006 – 2026
AM Peak	53%	50%	129%
Inter-Peak	53%	50%	129%
PM Peak	53%	50%	129%

This level of growth was considered to be too high, and possibly due to double counting of growth related directly to employment and additive growth factor related to Gross Domestic Product (GDP) growth. Following

discussions with the peer reviewers the future growth was taken as 45% of that forecast by ART3. This value was chosen to be slightly greater than the employment growth of 40% between 2006 and 2026.

The 45% was chosen to include 40% employment related growth, but only a small additional growth due to GDP related growth. This approach reduced the potential double-counting of growth and brought the proportion of HCV traffic back to expected levels.

5.2.4 Resulting Growth

As a result of applying the matrix estimation factors and also the adjustment made to the HCVs, the trip totals used in the modelling, for the light and heavy vehicle trips are shown in **Table 5.5** (2016 and 2026 Do-Minimum shown). The induced traffic effects are discussed later in **Section 6.9**.

Table 5.5 – Resultant Trip Totals (2-hour total trips)

	2006		2016		2026	
	Lights	HCVs	Lights	HCVs	Lights	HCVs
AM Peak	483,737	24,552	537,255	28,692	575,437	36,598
Inter-Peak	453,106	27,118	518,844	31,309	562,110	39,937
PM Peak	540,444	20,411	606,259	23,468	650,620	29,952

Overall it can be seen from **Table 5.5** that there is between 11% and 15% growth between 2006 and 2016, with a further 8% – 9% occurring between 2016 and 2026. Due to the application of matrix estimation and HCV factors this is slightly lower than the growth shown in the raw ART3 matrices.

5.3 Operational Model Demands

The future year operational model demands were taken from the Project Assignment model for the Option, for the three time periods discussed in **Section 5.1**.

5.3.1 Disaggregation

The disaggregation process used to convert the project assignment model zones to the operational model zones is documented in **Chapter 4** of the operational model validation report[8]. The same methodology outlined in that report was applied to the future year Project Assignment model matrices.

5.3.2 Application of Matrix Estimation Factors

Following the development of the base year model, a set of factors were derived, which were then applied to the future year model. These factors are essentially factors applied to improve the local calibration of the model, and were derived from the adjustments made in converting the prior matrices to the final validated base matrices. The methodology chosen to apply these factors was 100% additive (where the absolute change in trip numbers in 2006 are applied to the future year). The resultant formula to apply these changes was as follows:

$$T^{1}{}_{\mathrm{F}} = T_F + (F06 - P06)$$

Where:

$T^{1}{}_{F}$ = Final Future Year Trips

T_F = Project Assignment Model Future Year Trips

[8] Operational Traffic Model Validation Report, May 2010

F06 = Final Operational model 2006 Matrix

P06 = Prior Operational 2006 Matrix (from Project Assignment Model)

5.3.3 HCV assumptions

As with the 2006 operational model, the split between light and heavy vehicles is that resulting from the project assignment model.

5.3.4 High Occupancy Vehicle Assumptions

Since 2006, high occupancy vehicle (HOV) lanes have been constructed at Te Atatu Road, Lincoln Road and Great North Road (westbound only) interchanges. These lanes are also included as part of the proposed Waterview Connection project. In order to assess the operational impact of these at the interchanges in was necessary to include a representation of HOV lanes within the future year operational model.

In 2008/09 work was undertaken by Beca, TDG and Aurecon to assess the impact of priority (or HOV) lanes on SH16. This work adopted a process from that developed for the Eastern Transport Corridor Study (ETC) modelling, whereby classified count and vehicle occupancy survey data from circa 2001 was used to determine typical proportions of vehicle types in the total traffic streams. This methodology was applied to the operational assessment of the Waterview Connection, to allow the operation of the HOV lanes at the Te Atatu and Lincoln Road interchanges.

The basis for the occupancy disaggregation was data from occupancy surveys carried out for the ARC (2001) on ART model screenlines and from extra surveys undertaken for the ETC study. The occupancies at each site were considered by direction and time period, and from this it was determined that there was little difference in occupancy by direction and time period and insufficient data to make any conclusions about the difference in vehicle occupancy by geographical location.

As discussed, the operational model receives its demands form the project assignment model, split into two user classes, light and heavy vehicles. As with the previous modelling work, the split into vehicle occupancy was only undertaken for light vehicles. It was assumed that, as at present, the HOV lanes would be available to those light vehicles with 2 or more occupants, and therefore the light vehicle matrix was split according to the proportions shown in **Table 5.6**.

Table 5.6 – Car/LCV Occupants

	1 Occupant	2+ Occupants
AM Peak	83.0%	17%
PM Peak	78.0%	22%

It should be noted that these occupancies were validated against occupancy data collected on SH16 in 2005 as part of the 'Northwestern Motorway Traffic Demand management Survey' project undertaken by Beca on behalf of NZTA.

5.3.5 Resulting Growth

As a result of applying the matrix estimation factors , the trip totals were used in the operational modelling, for the light and heavy vehicle trips are shown in **Table 5.7** (2016 and 2026 option shown).

Table 5.7 – Resultant Trip Totals (4-hour total trips)

	2006		2016		2026	
	Lights	HCVs	Lights	HCVs	Lights	HCVs
AM Peak	79,891	3,684	104,962	6,559	110,803	9,761
PM Peak	88193	3,778	117,205	7,119	124,502	9,355

Overall it can be seen from **Table 5.7** that there is between 33% and 35% growth between 2006 and 2016, with a further 7% – 8% occurring between 2016 and 2026. The growth in the Greater Auckland Region (**Table 5.5**) is shown to be 11% – 15% between 2006 and 2016, with a further 8% – 9% occurring between 2016 and 2026. This shows that the growth in the study area for the project is forecast to be higher than that of the Greater Auckland Region.

It should be noted that the operational model covers a different area to the other models, meaning growth rates cannot be directly compared.

6. Wider Network Results

This chapter describes the effect of the project on the wider Auckland region, as well as the local network effects. It is based on comparisons of the Do-minimum and Option scenarios (as described in **Chapter 4**).

The following abbreviations are used in this section of the report for the scenarios assessed:

- DM = Do minimum; and
- OPT = Option.

This chapter concentrates on the effect of traffic flows on both the wider state highway network and also the local road network. This chapter also reports on the effect of the scheme on the vehicle kilometres travelled, and also the effect of induced traffic.

Daily flows have been calculated from the project assignment model by factoring the AM, inter and PM peak 2-hour flows and combining them to derive the daily flows. This calculation is done by applying the following factors:

- AM Peak = 1.25;
- Inter-peak = 4.99; and
- PM Peak = 1.25.

Due to the higher factor in the inter-peak, changes in flows at this time have a greater influence on the changes at a daily level. These factors were derived from a detailed analysis of the 2006 counts across the network. Details on this analysis can be found in **Appendix D.** These factors have been found to be fairly stable over the last 10 years, so the same expansion factors were adopted for the future years.

6.1 Network Wide Effects

Figure 6.1 shows the changes in daily traffic between the Do minimum and Option in 2026 across the Auckland Region. These changes are discussed in greater detail in the following sections. Positive (red) show where the traffic is predicted to increase compared to the Do-Minimum, with negative (light green) indicating where traffic is expected to decrease.

Figure 6.1 – Predicted Changes in Daily Flow between Do Minimum and Option 2026

6.2 Effects on SH16

Table 6.1 details the effects of the project on SH16 at a daily level.

Table 6.1 – Daily Traffic Flows on SH16 (2 directional)

Location	Scenario						
	2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Newton Road to St Lukes Road	126,900	135,100	148,400	13,300 (10%)	137,900	156,000	18,100 (13%)
St Lukes to Great North Road	116,700	113,700	138,800	25,100 (22%)	117,000	147,700	30,700 (26%)
Great North Road to Rosebank	104,000	105,300	120,200	14,900 (14%)	115,500	133,000	17,500 (15%)
Rosebank to Patiki	88,400	89,000	101,500	12,500 (14%)	97,600	113,200	15,600 (16%)
Patiki to Te Atatu Toad	105,400	106,200	118,600	12,400 (12%)	116,500	132,200	15,700 (13%)
Te Atatu Road to Lincoln Road	76,600	82,600	93,500	10,900 (13%)	91,300	109,700	18,400 (20%)
Lincoln Road to Royal Road	61,100	75,500	77,400	1,900 (3%)	86,200	96,100	9,900 (11%)
Royal Road to Westgate	42,800	54,600	55,900	1,300 (2%)	69,000	75,300	6,300 (9%)

The following can be observed from **Table 6.1**:

- There is an increase in flows on all sections of SH16 (apart from St Lukes to Great North Road) between 2006 and 2016 due to growth in the corridor, and between 2016 and 2026. This growth is minor on the eastern sections of SH16, but is observed to be substantial (over 20%) on the western sections of SH16. The minor reduction in traffic flows, in the section of SH16 between St Lukes and Great North Road, is indicated in the model to be greatly due to the changes in the road network including completion of Manukau Harbour Bridge, Tiverton/Wolverton widening and the extension of SH20 Mt Roskill. For

example, traffic on SH16 from the west which previously continued to SH1 at the Central Motorway Junction (CMJ), divert down Great North Road or Carrington Road to use SH20. Additionally, the model showed traffic from the New Lynn area previously travelled via Great North Road, SH16 and CMJ to the east/Auckland City. In the future the model predicts that this traffic is likely to be attracted to alternative routes, such as Tiverton Road, Wolverton Street and New Windsor Road. This traffic diversion effect hence is likely to reduce a small percentage of traffic volumes along SH16, between the Waterview and St Lukes interchanges. Other factors that may contribute to this reduction include changes in demand patterns due to effects such as assumed increases in rail and bus services, increased fuel price, increase in parking costs in the CBD, and travel demand management initiatives.

- As may be expected, a further increase in flow can be observed when SH16 is widened as part of the option (up to 22% between St Lukes and Great North road interchanges). In 2016, the greatest increase is seen in the sections to the east of Lincoln Road of SH16, as the western end has not been widened. In 2026, there is a large increase in traffic seen along the whole length of SH16 as the whole motorway is widened, thereby attracting more traffic (up to 20% in the section between Te Atatu and Lincoln Road Interchanges); and

- The extension of the project to the Westgate interchange in 2026 further increases the volume of traffic on SH16. This is due to more traffic being attracted to SH16, as a result of the widening being completed between Henderson Creek and Westgate; and

    - It should be noted that the differences in flows may not necessarily be due to rerouting alone, but also due to distribution and mode shift effects as a result of changes in the ART3 model between the do-minimum and the option runs (the only difference between the two scenarios is the introduction of the project).

Tables 6.2 and **6.3** detail the 2-hour peak flows (AM and PM peaks) by direction along the sections of SH16.

Table 6.2 – AM Peak flows on SH16 (2 hour)

Location	Dir	Scenario						
		2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Newton to St Lukes	EB	11,600	12,000	11,900	-100 (1%)	11,900	11,900	0 (0%)
	WB	5,200	6,400	7,000	600 (9%)	6,700	7,600	900 (13%)
St Lukes Road to Great North Road	EB	10,500	10,100	12,900	2,800 (28%)	10,100	13,000	2,900 (29%)
	WB	5,300	5,300	6,500	1,200 (23%)	5,600	7,000	1,400 (25%)
Great North Road to Rosebank	EB	10,200	10,200	12,500	2,300 (23%)	10,500	13,000	2,500 (24%)
	WB	5,100	5,600	6,400	800	6,200	6,900	700

Location	Dir	Scenario						
		2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
					(14%)			(11%)
Rosebank To Patiki	EB	9,200	9,100	11,200	2,100 (23%)	9,300	11,900	2,600 (28%)
	WB	3,800	4,000	4,600	600 (15%)	4,500	5,100	600 (13%)
Patiki to Te Atatu	EB	10,900	10,900	12,900	2,000 (18%)	11,100	13,800	2,700 (24%)
	WB	4,500	4,600	5,200	600 (13%)	5,200	5,800	600 (12%)
Te Atatu Road to Lincoln Road	EB	6,500	6,900	8,600	1,700 (25%)	6,800	9,900	3,100 (46%)
	WB	3,600	4,000	4,800	800 (20%)	4,500	5,700	1,200 (27%)
Lincoln Road to Royal Road	EB	6,000	6,400	6,600	200 (3%)	6,900	8,600	1,700 (25%)
	WB	2,600	4,100	4,300	200 (5%)	4,700	5,300	600 (13%)
Royal Road to Westgate	EB	3,400	3,700	4,100	400 (11%)	4,900	6,100	1,200 (24%)
	WB	2,000	3,600	3,600	0 (0%)	4,200	4,600	400 (10%)

Table 6.3 – PM Peak flows on SH16 (2-hour)

Location	Dir	Scenario						
		2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Newton to St Lukes	EB	6,400	7,400	8,300	900 (12%)	7,700	9,100	1,400 (18%)
	WB	11,300	13,600	14,000	400 (3%)	13,400	13,900	500 (4%)
St Lukes Road to Great North Road	EB	6,100	5,800	7,500	1,700 (29%)	6,100	8,300	2,200 (36%)
	WB	10,800	11,100	13,100	2,000 (18%)	11,100	13,200	2,100 (19%)
Great North Road to Rosebank	EB	6,100	6,200	6,800	600 (10%)	6,800	7,500	700 (10%)
	WB	9,500	9,200	12,100	2,900 (32%)	9,400	12,800	3,400 (36%)
Rosebank To Patiki	EB	4,600	4,600	5,200	600 (13%)	5,100	5,800	700 (10%)
	WB	8,800	8,400	11,100	2,700 (32%)	8,500	11,800	3,300 (39%)
Patiki to Te Atatu	EB	5,300	5,200	5,900	700 (13%)	5,800	6,500	700 (14%)
	WB	10,500	10,300	13,000	2,700 (26%)	10,500	13,800	3,300 (39%)
Te Atatu Road to Lincoln Road	EB	4,500	5,500	6,200	700 (13%)	6,100	7,000	900 (15%)
	WB	7,600	7,400	9,300	1,900 (26%)	7,300	10,400	3,100 (42%)
Lincoln Road to Royal Road	EB	3,600	5,200	5,200	0 (0%)	5,900	6,100	200 (3%)
	WB	6,700	7,100	7,500	400 (6%)	7,200	9,000	1,800 (25%)
Royal Road to Westgate	EB	2,700	4,200	4,100	-100 (-2%)	5,000	5,300	300 (6%)
	WB	4,600	5,100	5,400	300 (6%)	5,600	6,700	1,100 (20%)

Tables 6.2 – 6.3 show the following:

- As was seen in **Table 6-1**, there is an increase in traffic observed on SH16 in the 10 year period between 2006 and 2016, with a further increase in the ten years to 2026;

- The completion of the Waterview Connection project further increases the flow on the motorway;

- It is apparent that SH16 has a 'peak direction bias' that is eastbound (city bound) in the AM peak, and westbound in the PM peak, but this bias reduces over time with higher growth in the non-peak direction; and

- In both the AM and PM peaks, the non-peak direction experiences a small increase in flow due to the project.

6.3 Impacts on the Wider State Highway Network

Table 6.4 shows the daily flow on selected key state highway links around Auckland.

Table 6.4 – Daily Flows on Key State Highway Links

Location	Scenario						
	2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
SH1 Auckland Harbour Bridge	184,100	191,600	191,800	200 (0%)	193,400	194,000	600 (0%)
SH18 Upper Harbour Bridge	26,500	57,100	58,000	900 (2%)	66,800	68,000	1,200 (2%)
SH20 Mt Roskill Extension	-	49,400	84,300	34,900 (71%)	51,400	98,800	47,400 (92%)
SH20 Manukau Harbour Crossing	-	126,100	133,100	7,000 (6%)	133,100	141,800	8,700 (7%)
SH1 Greenlane East to Market Road	180,500	186,600	183,400	-3,200 (-2%)	188,900	184,400	-4,500 (-2%)
SH1 CMJ (south of SH16)	159,600	194,000	182,100	-11,900 (-6%)	201,300	186,100	-15,200 (-8%)

The following can be determined from **Table 6.4**:

- Between 2006 and 2016, there is a growth on the key State Highway Links. The large increase in growth between 2006 and 2016 on the SH18 Upper Harbour Bridge is due to the completion of the SH18 improvement projects (Greenhithe, Hobsonville and Upper Harbour Bridge), in the intervening years;

- Between 2016 and 2026, 1% growth is forecast on Auckland Harbour Bridge and SH1, with a further 17% growth being forecast for SH18;

- In 2026, the increase in flow on SH18 Upper Harbour Bridge is around 1,000 vehicles per day with the project in place, whereas on SH16 (Royal to Westgate) is around 6,000 vehicles per day. This suggests that the project is not increasing trips to/from the North Shore much compared with growth on SH16;

- With the project in place in both 2016 and 2026 a decrease (albeit small) in flows on SH1 is forecast. This a result of vehicles choosing to use the completed WRR rather than SH1;

- With the Waterview Connection is in place, there is an increase (6% – 7%) in flow expected on SH20 Manukau Harbour Crossing. This is because the widening on SH16 and the SH20 Waterview Connection means that the WRR is complete, which provides an alternative to SH1 to get to the North and West and attracts traffic from the local road network. The increase on flow on SH20 Mt Roskill is 71% in 2016 and 92% in 2026; and

- As previously discussed, it should be noted that the differences in flows may not necessarily be due to rerouting alone, but also due to distribution and mode shift effects as a result of changes in the ART3 model between the do-minimum and the option runs (the only difference between the two scenarios is the introduction of the project).

6.3.1 Impacts on SH1 (Central Motorway Junction)

One of the objectives of the WRR is to relieve congestion that currently occurs on SH1 and to provide an alternative rute north across the Auckland Isthmus. The provision of the Waterview Connection is expected to result in traffic diverting from SH1 and CMJ to the WRR.

The modelling has indicated that there will be a shift in longer distance trips from Sh1 to SH20 (WRR), consistent with the objectives of the WRR.

The analysis indicates that in 2026 there is a net reduction in the daily flow through CMJ in 2026 with the Waterview Connection in place. CMJ is defined here as all traffic passing through the central junction between the Symonds Street southbound on-ramp and the Symonds Street northbound off-ramp. This reduction is 11,500 vehicles per day (vpd) (7%). This net reduction is a result of 28,500 vpd diverting out of CMJ, but these have been replaced by 17,000 vpd of new local trips who take advantage of the reduced congestion. Of the 28,500 vpd who divert out of CMJ, 94% divert to the Waterview Connection (SH20), with the other 6% diverting to other routes.

The diversion of 28,500 vpd who divert out of CMJ will improve the traffic flow through CMJ. Travel Demand Management (TDM) techniques, such as ramp signalling, could then be used to minimise the predicted inducement of local trips, thereby sustaining the network benefits.

6.4 Impacts on District and Arterial Roads

Table 6.5 shows the changes in daily flow on a number of arterial routes, and **Figure 6.2** shows the location of these flows.

Figure 6.2 Location of Reported Daily Flows

Table 6.5 – Predicted Daily Flows on Arterial Routes

Location	Scenarios						
	2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Manukau Road (south of Greenlane)	31,400	30,900	28,900	-2,000 (-6%)	30,900	28,500	-2,400 (-8%)
Gilies Avenue	16,200	17,900	12,100	-5,800 (-32%)	20,100	10,700	-9,400 (-47%)
Mt Eden Road	22,300	22,100	19,900	-2,200 (-10%)	21,700	19,000	-2,700 (-12%)
New North Road	29,800	28,600	29,600	1,000 (3%)	28,200	29,200	1,000 (4%)
Dominion Road	16,900	21,600	16,900	-4,700 (-22%)	21,600	16,800	-4,800 (-22%)
Sandringham Road	14,700	15,600	13,200	-2,400 (-15%)	15,400	12,900	-2,500 (-16%)
Tiverton/Wolverton	17,800	27,300	23,700	-3,600 (-13%)	28,400	24,300	-4,100 (-14%)
Mt Albert Road	18,600	16,600	14,300	-2,300 (-14%)	16,400	13,000	-3,400 (-21%)
Carrington Road	28,100	30,800	23,000	-7,800 (-25%)	32,400	23,000	-9,400 (-29%)
Great North Road (West of New Lynn)	37,000	35,800	33,100	-2,700 (-8%)	37,800	34,700	-3,100 (-8%)
Great North Road (north of Blockhouse Bay Road)	48,200	46,700	42,700	-4,000 (-9%)	46,300	42,200	-4,100 (-9%)
Rosebank Road	25,000	25,700	25,800	100 (0%)	27,200	27,400	200 (1%)
Blockhouse Bay Road	13,600	15,100	10,300	-4,800 (-32%)	15,200	10,300	-4,900 (-32%)
St Lukes Road	30,600	34,400	27,700	-6,700 (-19%)	34,600	26,500	-8,100 (-23%)
Te Atatu Road	42,800	43,300	46,200	2,900 (7%)	44,100	48,400	4,300 (10%)
Lincoln Road	44,800	44,400	44,200	-200 (0%)	48,800	49,900	1,100 (2%)

The average reduction across these radial routes is over 12% in 2016 and 14% in 2026 when the project is in place.

Table 6.6 shows the peak period flows for the roads in **Table 6.5** with and without the project for 2026. These show substantial reductions in peak-period flows, which may reduce congestion and other traffic impacts on these roads. Also, **Tables 6.5** and **6.6** show that increases are however predicated on certain arterial routes, as a result of vehicles now accessing the WRR via SH16.

Table 6.6 – Peak Flows on Selected Arterial Routes in 2026 (Two-way, 2 hours)

Location	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
Manukau Road	4,600	4,100	-500 (-11%)	4,000	3,700	-300 (-8%)	4,100	3,900	-200 (-5%)
Gilies Avenue	2,500	1,600	-900 (-36%)	2,700	1,400	-1,300 (-48%)	2,800	1,400	-1,400 (-50%)
Mt Eden Road	3,100	2,500	-600 (-19%)	2,700	2,400	-300 (-11%)	3,500	3,100	-400 (-11%)
New North Road	4,500	4,600	100 (2%)	3,500	3,700	200 (6%)	4,100	4,000	-100 (-2%)
Dominion Road	3,000	2,200	-800 (-27%)	2,700	2,200	-500 (-19%)	3,500	2,500	-1,000 (-29%)
Sandringham Road	2,400	1,800	-600 (-25%)	2,000	1,600	-400 (-20%)	1,900	2,100	200 (11%)
Tiverton/Wolverton	3,800	3,300	-500 (-13%)	3,400	2,900	-500 (-15%)	5,400	4,600	-800 (-15%)
Mt Albert Road	2,800	2,300	-500 (-18%)	2,000	1,600	-400 (-20%)	2,300	1,700	-600 (-26%)
Carrington Road	4,400	3,400	-1,000 (-23%)	4,200	2,900	-1,300 (-31%)	4,700	3,400	-1,300 (-28%)
Great North Road (West of New Lynn)	5,700	5,400	-300 (-5%)	4,600	4,300	-300 (-7%)	6,200	5,200	-1,000 (-16%)
Great North Road (north of Blockhouse Bay Road)	6,900	6,400	-500 (-7%)	5,600	4,900	-700 (-13%)	7,800	7,800	0 (0%)
Rosebank Road	3,800	3,900	100 (3%)	3,600	3,600	0 (0%)	3,600	3,700	100 (3%)
Blockhouse Bay Road	2,000	1,400	-600 (-30%)	2,000	1,300	-700 (-35%)	2,200	1,700	-500 (-23%)

Location	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
St Lukes Road	4,900	3,600	-1,300 (-27%)	4,400	3,400	-1,000 (-23%)	5,200	4,000	-1,200 (-23%)
Te Atatu Road	5,700	6,500	800 (14%)	5,700	6,200	500 (9%)	6,800	7,500	700 (10%)
Lincoln Road	5,800	6,100	300 (5%)	6,500	6,500	0 (0%)	7,300	7,900	600 (8%)

Both Lincoln Road and Te Atatu Road are four-lane arterial roads but much of the current congestion on these roads is due to the SH16 interchanges. As the modelling has assumed that the Te Atatu and Lincoln Road Interchanges would be upgraded as part of the SH16 widening project, those interchanges would be better able to accommodate the increase in traffic created by the Waterview Connection, than the current configurations. It should also be noted that these roads will be operating at or close to their capacity in 2026, and that the predicted increases in traffic would add marginally to the congestion. It is noted that Waitakere City Council is investigating improvements to these two corridors. These options include improving access to buses and high occupancy vehicle lanes.

6.5 Users of the SH20 Waterview Connection

In 2016 (proposed year of opening), the SH20 Waterview Connection is forecast to attract 70,000 vehicles per day (vpd), and by 2026, this number is expect to rise to 83,000 vpd. **Table 6.7** details the daily users of the ramps and mainline in 2016 and 2026, with **Table 6.8** showing the number of users in the 2-hour peak periods.. **Figures 6.3 – 6.6** show the direction of the users of the SH20 Waterview Connection for the daily traffic and also the three modelled periods in 2026.

Table 6.7 – Daily Users of SH20 Waterview Connection

Location	Direction	2016	2026
SH20 Waterview Connection mainline	N/B	36,000	41,700
	S/B	33,900	40,600
East Facing Ramps	To city	19,100	21,800
	From SH16	16,300	19,300
West Facing Ramps	To West	18,900	19,900
	From SH16	17,600	21,300

Table 6.8 – Peak Period (2 hour) Users of SH20 Waterview Connection

Location	Dir	2016			2026		
		AM	IP	PM	AM	IP	PM
SH20 Waterview Connection mainline	N/B	4,700	4,600	5800	5,000	5,400	6,900
	S/B	5,500	4,500	3,800	6,500	5,500	4,100
East Facing Ramps	To city	2,700	2,500	2,500	2,800	2,900	3,000
	From SH16	1,800	2,400	1,800	2,200	2,800	2,000
West Facing Ramps	To West	2,000	2,000	3,300	2,200	2,500	3,800
	From SH16	3,600	2,100	2,000	4,400	2,600	2,200

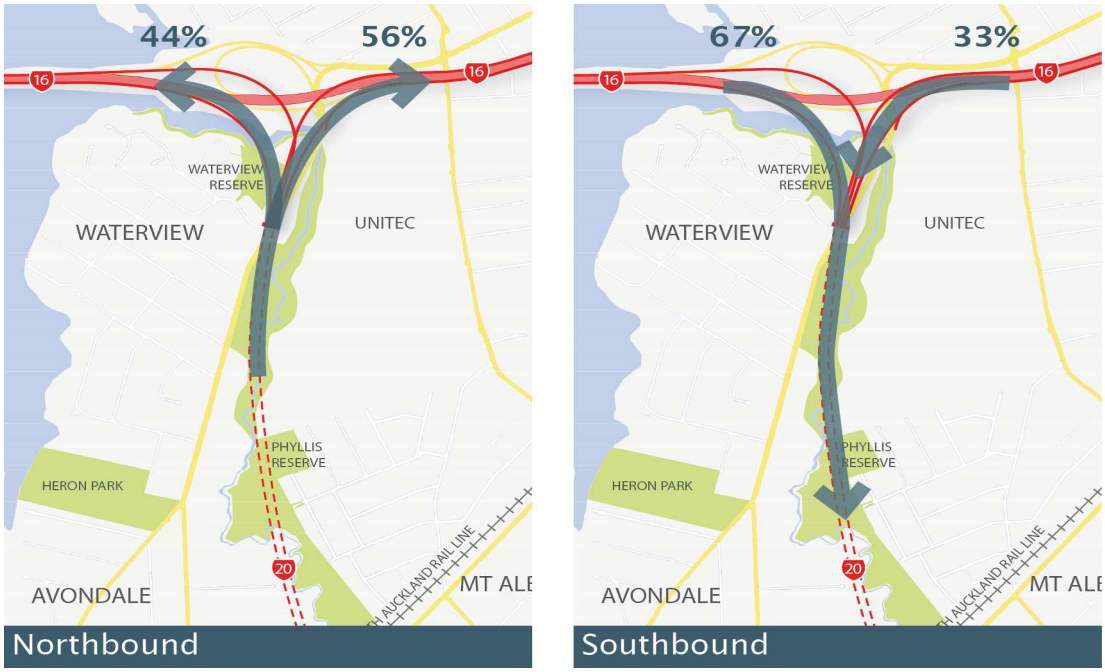

Figure 6.3 – 2026 AM Peak traffic distributions on the SH20 Extension

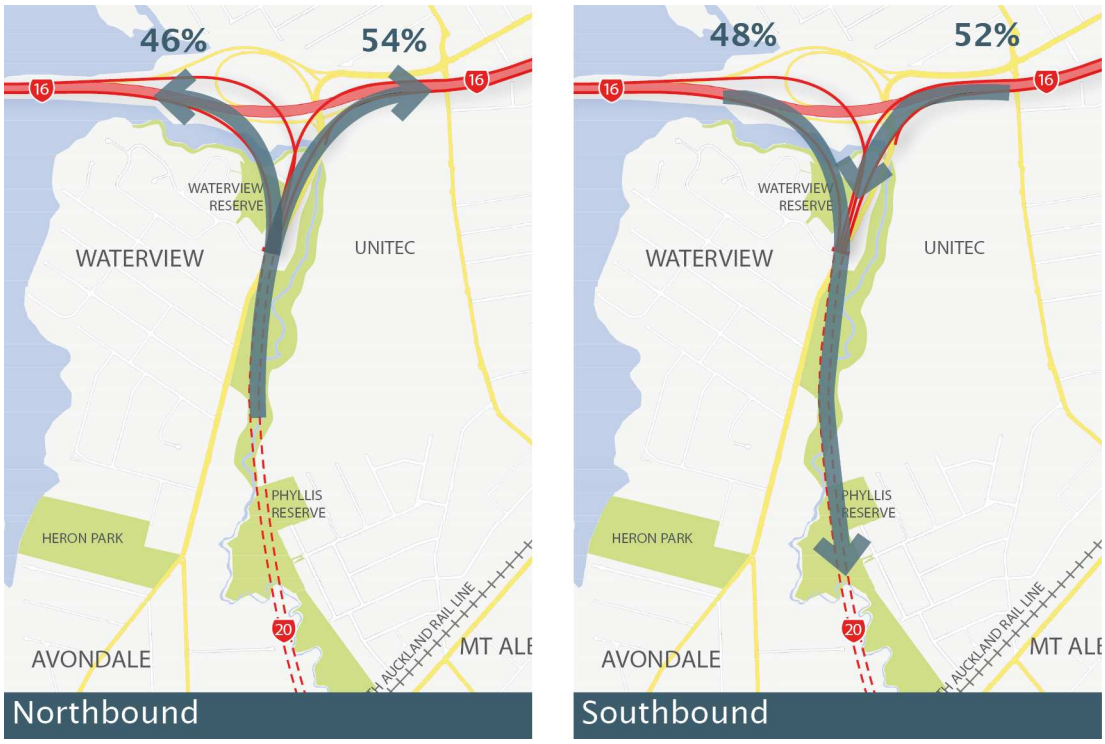

Figure 6.4 – 2026 Inter-Peak traffic distributions on the SH20 Extension

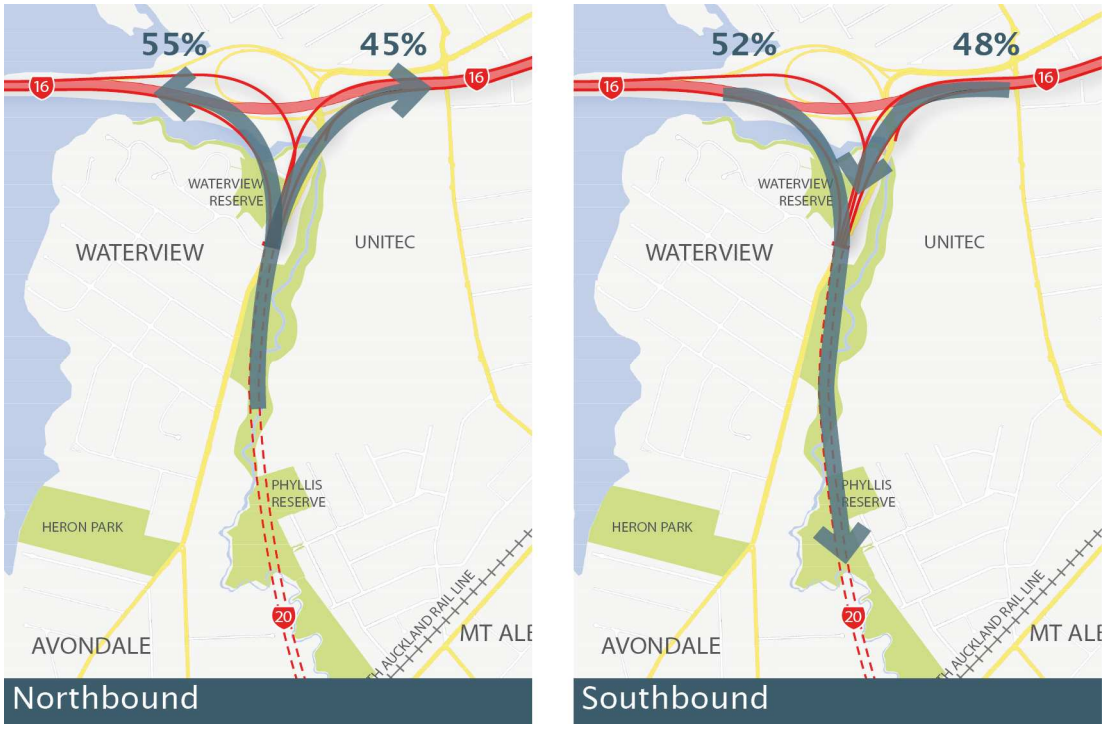

Figure 6.5 – 2026 PM Peak traffic distributions on the SH20 Extension

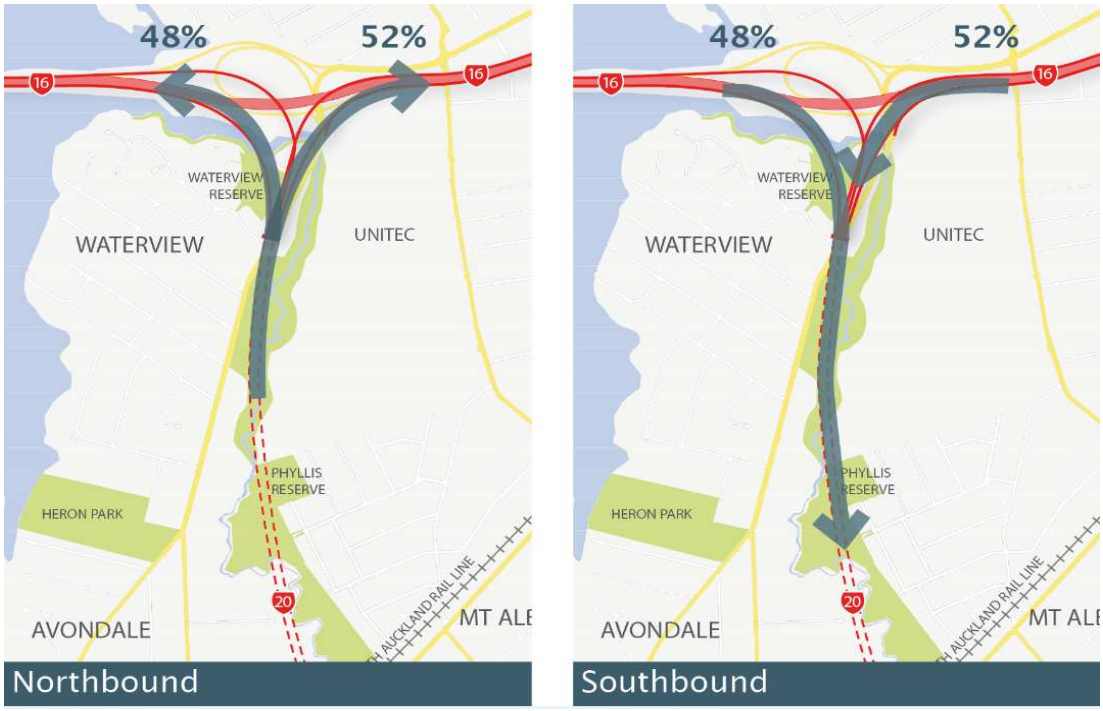

Figure 6.6 – 2026 Daily traffic distributions on the SH20 Extension

From **Figures 6.3 – 6.6**, the following can be observed:

- At a daily level, the slightly higher movement of traffic using the SH20 section of the Waterview Connection is those going to/from the city (although this is only 4% higher than movements to the west);
- Other than in the southbound direction in the AM peak, there is a fairly even split between east and west users of the SH20 section of the Waterview Connection;
- In the AM peak there are more southbound users of the SH20 section of the Waterview Connection are from the west, having used SH16 in the peak direction;
- In the PM peak, the dominant movement of users is to/from the west, which may be expected as this is primary role of the WRR; and
- The AM southbound (67%/33%) and PM northbound (55%/45%) splits are not more similar due to due a different mix of traffic (journey purposes) in the AM and PM peaks. For example, the AM peaks users are mainly commuters and education traffic, with the PM peak being a wider variety of trips, such as commuters, leisure and personal trips. Education trips are expected have been completed before the PM peak period commences.

Further analysis was undertaken to understand where traffic using the facility come from in the wider network. The origins and destinations of vehicles using the Waterview Connection at a daily level are shown in terms of

sector-sector movements in **Table 6.9**, using the following sectors (shown in **Figure 6.6**), % shown is based on the table total (82,400 vehicles)

- **Sector One –** North Shore
- **Sector Two** – West Waitakere
- **Sector Three** – Central Waitakere
- **Sector Four –** Titirangi
- **Sector Five** – Avondale
- **Sector Six** – Auckland CBD
- **Sector Seven –** Herne Bay/Mt Eden
- **Sector Eight** – Hillsborough/Mt Roskill
- **Sector Nine** – Eastern Suburbs
- **Sector Ten –** South Auckland

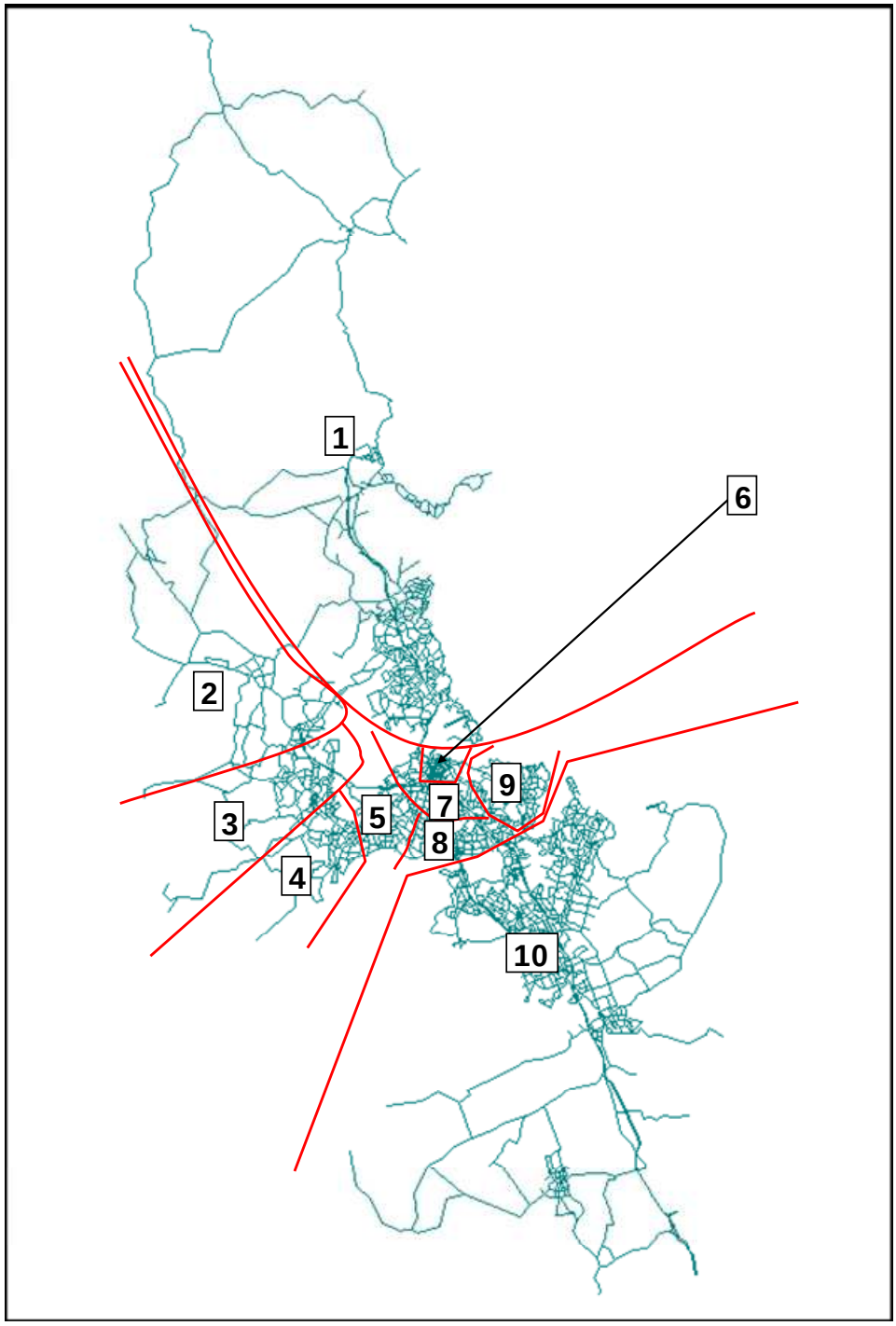

Figure 6.6 – Sector System

Table 6.9 – Daily Users of the SH20 Waterview Connection Extension in 2026

		Destination										
Origin		North Shore	West Waitakere	Central Waitakere	Titirangi	Avondale	Auckland CBD	Herne Bay/Mt Eden	Hillsborough /Mt Roskill	Eastern Suburbs	South Auckland	Total
	North Shore	0 (0%)	0 (0%)	0 (0%)	0 (0%)	300 (0%)	0 (0%)	0 (0%)	1,600 (2%)	0 (0%)	7,200 (9%)	9,200 (11%)
	West Waitakere	0 (0%)	0 (0%)	0 (0%)	0 (0%)	300 (0%)	0 (0%)	0 (0%)	1,600 (2%)	300 (0%)	3,600 (4%)	5,800 (7%)
	Central Waitakere	0 (0%)	0 (0%)	0 (0%)	0 (0%)	400 (0%)	0 (0%)	0 (0%)	3,300 (4%)	600 (1%)	6,500 (8%)	11,000 (13%)
	Titirangi	200 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	300 (0%)	300 (0%)	0 (0%)	100 (0%)	0 (0%)	1,000 (1%)
	Avondale	500 (1%)	300 (0%)	500 (1%)	0 (0%)	500 (1%)	1,400 (2%)	1,000 (1%)	1,200 (1%)	300 (0%)	1,600 (2%)	7,300 (9%)
	Auckland CBD	0 (0%)	0 (0%)	0 (0%)	0 (0%)	900 (1%)	0 (0%)	0 (0%)	2,600 (3%)	0 (0%)	3,800 (5%)	7,300 (9%)
	Herne Bay/Mt Eden	0 (0%)	0 (0%)	0 (0%)	0 (0%)	700 (1%)	0 (0%)	0 (0%)	1,400 (2%)	0 (0%)	1,900 (2%)	4,000 (5%)
	Hillsborough/Mt Roskill	1,400 (2%)	1,700 (2%)	3,400 (4%)	100 (0%)	1,400 (2%)	2,500 (3%)	1,400 (2%)	0 (0%)	100 (0%)	0 (0%)	12,000 (15%)
	Eastern Suburbs	0 (0%)	200 (0%)	300 (0%)	0 (0%)	200 (0%)	0 (0%)	0 (0%)	100 (0%)	0 (0%)	100 (0%)	900 (1%)
	South Auckland	7,300 (9%)	3,600 (4%)	5,400 (7%)	100 (0%)	1,500 (2%)	3,900 (5%)	2,200 (3%)	0 (0%)	0 (0%)	0 (0%)	24,100 (29%)
	Total	9,400 (11%)	5,700 (7%)	9,700 (12%)	300 (0%)	6,300 (8%)	8,100 (10%)	5,000 (6%)	11,800 (14%)	1,400 (2%)	24,700 (30%)	82,400

When interpreting this data, care should be taken when estimating the proportion of users associated with each sector. Because each movement involves an origin and a destination, the sector totals will involve double-counting. This double-counting is avoided by considering the total origins and destinations (165,000). On this basis, the following can be noted from **Table 6.9**:

- 11% to/from the North Shore;
- 30% to/from Manukau and the south (including the airport);
- 9% to/from Auckland CBD;
- 20% to/from Waitakere; and
- 30% Auckland City including the study area but excluding the CBD.

Of additional note is that while the immediate study area would receive significant benefits from reduced traffic flows on local roads, less than 9% of traffic using the project would be associated with the immediate study area itself (the Avondale sector).

6.6 Impacts on Travel Times

The introduction of the project has an impact on travel times across the network. The effect on travel times between a number of origins and destinations were calculated. The origins and destinations used are shown in **Figure 6.7**.

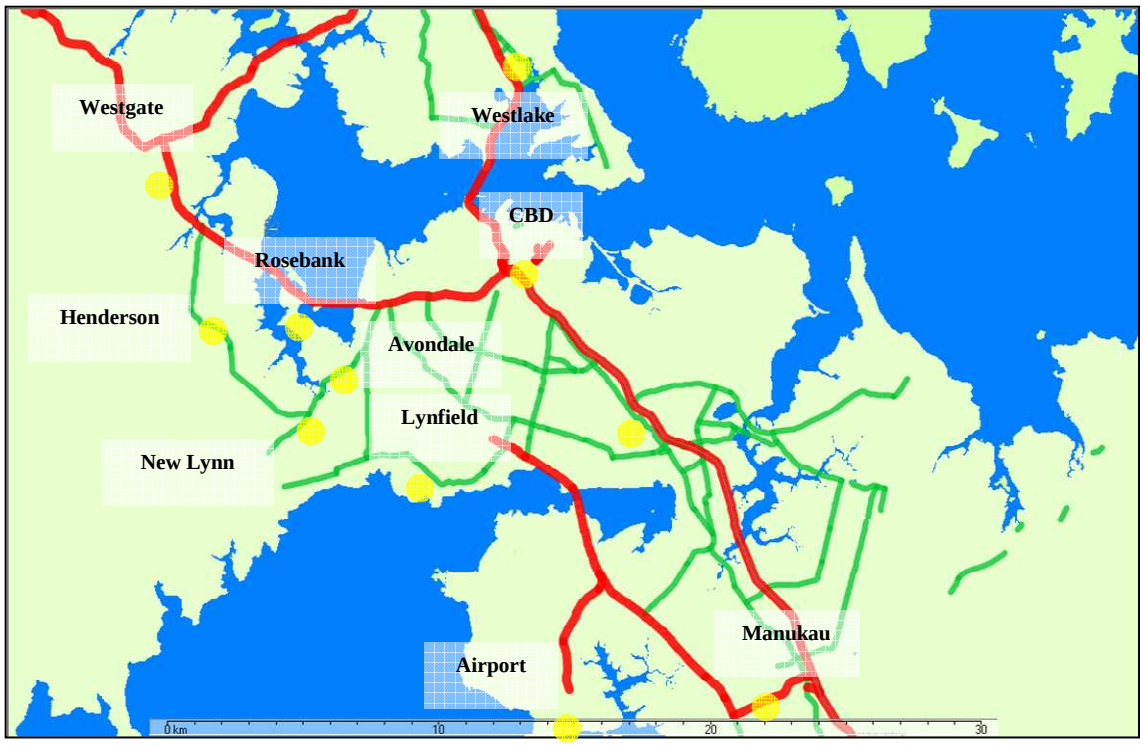

Figure 6.7 Origin-Destination Travel Time Locations

Table 6.10 details the change in average travel time between the selected origin and destinations when the project is in place, as compared to the Do Minimum. The actual travel times for both the Do Minimum and the Option can be found in **Appendix E.** Decreases in travel times are highlighted.

It should be noted that these are changes for the average 2-hour modelled periods, and may differ from those in the height of the peak.

Table 6.10 – Change in 2026 AM Peak Origin-Destination Travel Times compared to the Do Minimum (minutes)

		Destination										
		Westlake	Auckland CBD	Penrose	Manukau	Airport	Westgate	Henderson	New Lynn	Avondale College	Rosebank	Lynfield
Origin	Westlake	0.0	-1.1	-2.1	-2.4	-2.4	0.2	0.3	-0.8	-0.8	-0.7	-4.5
	Auckland CBD	0.1	0.0	-1.0	-1.2	-1.2	0.2	0.6	0.0	0.0	0.0	-3.4
	Penrose	-0.3	-0.3	0.0	-0.1	-0.1	0.0	0.3	-0.3	-0.3	-0.2	0.1
	Manukau	-0.8	-0.8	-0.4	0.0	0.0	-5.3	-4.9	0.8	-0.5	-5.4	0.2
	Airport	-0.7	-0.8	-0.4	0.0	0.0	-5.4	-5.0	0.8	-0.4	-5.6	0.2
	Westgate	-0.4	-1.8	-2.7	-6.2	-5.4	0.0	0.2	-1.9	-1.9	-3.1	-6.5
	Henderson	-0.4	0.3	-0.6	-4.2	-3.3	0.2	0.0	-0.4	0.2	-1.0	-3.4
	New Lynn	-0.6	-0.4	-1.3	0.4	0.4	-0.4	0.3	0.0	-0.2	-0.8	-0.6
	Avondale College	0.0	0.2	-0.7	0.6	0.5	-0.4	0.0	0.0	0.0	-0.6	-0.4
	Rosebank	1.6	1.3	0.4	-3.1	-2.3	0.2	0.6	1.1	1.2	0.0	-3.7
	Lynfield	-3.8	-1.2	-0.6	1.8	1.7	-6.3	-6.0	0.0	-1.2	-6.5	0.0

Table 6.10 shows the following:

- AM peak Travel times between most origin/destination pairs decrease when the project is in place and the WRR is complete;
- The largest decreases in travel time can be seen from Westgate to the south, and destinations along the WRR such as Henderson and Avondale;
- Decreases in travel time can be seen in trips from the airport and Manukau – especially to Rosebank, Westgate and Westlake;
- People travelling from Westlake to and from the airport experience a reduction in travel time as they can use the completed SH20;
- There are a number of increases in travel time observed – this is due to increases in delay on SH16 or SH20 rather than delays on the Waterview Connection itself; and

- As previously discussed, it should be noted that the differences in travel times may not necessarily be due to rerouting alone, but also due to distribution and mode shift effects as a result of changes in the ART3 model between the do-minimum and the option runs (the only difference between the two scenarios is the introduction of the project).

It can be seen that the increases are relatively minor, especially when compared to the larger savings to most other movements. When weighted by the traffic flows, the net result is a significant overall reduction in travel time.

Similarly, **Table 6.11** details the change in average travel time in the PM peak 2026. The actual travel times can be found in **Appendix G**.

Table 6.11 - Change in 2026 PM Peak Origin-Destination Travel Times compared to the Do Minimum (minutes)

		Destination										
		Westlake	Auckland CBD	Penrose	Manukau	Airport	Westgate	Henderson	New Lynn	Avondale College	Rosebank	Lynfield
Origin	Westlake	0.0	0.1	-0.1	-0.3	-0.4	-0.8	-0.9	0.1	0.5	0.3	-1.9
	Auckland CBD	0.3	0.0	-0.3	-0.5	-0.6	-6.5	-4.3	0.1	0.4	0.2	-1.5
	Penrose	-1.4	-1.0	0.0	-0.3	-0.3	-8.4	-6.2	-1.1	-1.5	-1.7	-0.5
	Manukau	-2.1	-1.8	-0.5	0.0	-0.1	-13.5	-11.3	0.8	-0.6	-6.8	1.3
	Airport	-1.9	-1.6	-0.3	0.0	0.0	-12.6	-10.4	0.8	-0.7	-5.9	1.3
	Westgate	0.1	0.1	-0.1	-5.3	-4.3	0.0	-0.1	-0.2	-0.1	0.0	-3.8
	Henderson	1.3	1.0	0.9	-4.3	-3.3	0.8	0.0	1.3	0.9	1.0	-2.8
	New Lynn	0.0	-0.3	-0.4	-1.2	-1.2	-6.9	-1.4	0.0	0.0	0.7	-0.9
	Avondale College	0.2	-0.1	-0.2	-1.4	-1.4	-5.9	-3.7	-0.1	0.0	0.8	-1.1
	Rosebank	0.3	0.1	-0.1	-5.3	-4.2	-6.7	-4.5	-0.3	-0.1	0.0	-3.8
	Lynfield	-5.2	-4.9	-0.8	-0.1	-0.2	-12.9	-10.7	-0.7	-0.9	-6.2	0.0

Table 6.11 shows the same trend as in the AM peak, but with the savings to some movements now as high as 13 minutes.

The origin-destination savings do not directly indicate the changes in speeds on specific routes, only the average of all routes used. The predicted travel time along a number of specified routes was calculated for the Do Minimum and when the project is in place. The routes that were chosen were as follows, and are shown in **Figure 6.8**:

- SH16 (Royal Road to St Lukes);
- Rosebank Road (Rosebank Road/Patiki Road roundabout to Blockhouse Bay Road);
- Tiverton/Wolverton;
- Great North Road/New North Road (Clark Street to St Lukes Road);
- Great North Road;
- Carrington Road;
- Dominion Road;
- Te Atatu Road (Great North Road to SH16); and
- Lincoln Road (Swanson Road to SH16).

Figure 6.8 – Travel Time Routes

Table 6.12 details the total travel times along these routes for the AM and PM peaks for the Do Minimum and Option options in 2026. Graphs showing the travel times along each route can be found in **Appendix F**.

Table 6.12 – 2026 Total Travel Times along Selected Routes

Route	Dir	Length (km)	Travel Times (minutes)					
			DM AM	OPT AM	Change	DM PM	OPT PM	Change
SH16 (Royal Road to St Lukes)	E/B	11.5	12.1	9.3	-2.8 (-23%)	7.3	7.2	-0.1 (-1%)
	W/B	11.0	6.9	6.9	0 (0%)	16.5	8.3	-8.2 (-50%)
Rosebank Road	E/B	4.1	7.3	8.4	1.1 (15%)	9.3	9.0	-0.3 (-3%)
	W/B	4.1	10.3	9.6	-0.7 (-7%)	8.2	8.8	0.6 (7%)
Tiverton/Wolverton	E/B	3.5	8.5	7.4	-1.1 (-13%)	6.2	6.1	-0.1 (-2%)
	W/B	3.5	6.1	6.2	0.1 (2%)	6.9	6.1	-0.8 (-12%)
Great North Road/New North Road	N/B	6.1	13.9	13.2	-0.7 (-5%)	13.5	12.3	-1.2 (-9%)
	S/B	6.1	12.9	12.1	-0.8 (-6%)	13.8	12.3	-1.5 (-11%)
Great North Road	N/B	3.4	5.7	5.6	-0.1 (-2%)	5.7	5.5	-0.2 (-4%)
	S/B	3.4	5.9	5.6	-0.3 (-5%)	6.8	6.1	-0.7 (-10%)
Carrington Road	N/B	5.0	7.8	7.2	-0.6 (-8%)	7.6	7.1	-0.5 (-7%)
	S/B	5.0	8.3	7.0	-1.3 (-16%)	7.2	7.0	-0.2 (-3%)
Dominion Road	N/B	4.4	9.0	8.2	-0.8 (-9%)	8.6	8.3	-0.3 (-3%)
	S/B	4.4	8.0	7.8	-0.2 (-3%)	8.9	8.5	-0.4 (-4%)
Te Atatu Road	N/B	3.3	6.6	7.4	0.8 (12%)	6.6	6.5	-0.1 (-2%)
	S/B	3.3	5.5	6.1	0.6 (11%)	6.4	7.7	1.3 (20%)
Lincoln Road	N/B	2.9	7.7	8.0	0.3 (4%)	7.8	6.5	-1.3 (-17%)
	S/B	2.9	5.9	5.8	-0.1 (-2%)	6.3	7.7	1.4 (22%)

Table 6.12 shows that travel times along the district and regional arterials are either lower or largely unchanged, in particular:-

- Peak direction travel times along SH16 are much improved with the project in place. Eastbound in the AM peak is 23% (3 minutes) faster, with the PM peak becoming over 8 minutes (50%) faster;
- Travel times along the Tiverton/Wolverton corridor are up to 13% faster when the project is in place – this is because a large amount of traffic is diverted from this corridor to the Waterview Connection when it is in place;

- Great North Road/New North Road are up to 9% faster;
- Travel Times along Great North Road are up to 8 minutes faster when the Waterview Connection is in place – this is due to a reduction in traffic on Great North Road and the roads accessing Great North Road when the tunnel is in place;
- Carrington Road is up to 9% faster;
- Dominion Road has improved travel times by more than 9% faster when the Waterview Connection is in place – again, this may be due to the traffic diverting from Dominion Road to use the completed WRR; and
- Travel times along Te Atatu and Lincoln Road are increased in the peak direction due to extra traffic accessing the completed Western Ring Route; and
- As previously discussed, it should be noted that the differences in travel times may not necessarily be due to rerouting alone, but also due to distribution and mode shift effects as a result of changes in the ART3 model between the do-minimum and the option runs (the only difference between the two scenarios is the introduction of the project).

6.7 Impact on HCVs

An indicative assessment was undertaken to assess the potential effect of the routes taken by HCVs when the Waterview Connection is completed.

The assessment showed that when the Waterview Connection is in place, reductions in the number of HCVs are observed on the regional/arterial roads, these are demonstrated in **Table 6.13**, which shows the change in HCVs on those roads highlighted in **Figure 6.2**.

Table 6.13 – Predicted Daily HCV Flows on Radial Routes

Location	Scenarios						
	2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Manukau Road (south of Greenlane)	1,850	1,740	1,310	-430 (-25%)	2,140	1,600	-540 (-25%)
Gilies Avenue	360	450	380	-70 (-16%)	530	500	-30 (-6%)
Mt Eden Road	860	1,190	1,020	-170 (-14%)	1,520	1,280	-240 (-16%)
New North Road	930	530	560	30 (6%)	660	710	50 (8%)

Location	Scenarios						
	2006	2016 DM	2016 OPT	Change	2026 DM	2026 OPT	Change
Dominion Road	610	1,070	710	-360 (-34%)	1,210	920	-290 -13%)
Sandringham Road	600	720	480	-240 (-33%)	940	600	-340 (-36%)
Tiverton/Wolverton	1,110	1,860	1,590	-270 (-15%)	2,290	2,000	-290 (-13%)
Mt Albert Road	570	490	300	-190 (-39%)	530	310	-220 (-42%)
Carrington Road	730	1,110	480	-630 (-57%)	1,410	540	-870 (-62%)
Great North Road (West of New Lynn)	2,020	1,960	1,720	-240 (-12%)	2,440	2,150	-290 (-12%)
Great North Road (north of Blockhouse Bay Road)	1,690	2,510	2,360	-150 (-6%)	3,030	2,800	-230 (-8%)
Rosebank Road	2,450	2,620	2,510	-110 (-4%)	3,320	3,220	-100 (-3%)
Blockhouse Bay Road	410	580	400	-180 (-31%)	710	530	-180 (-25%)
St Lukes Road	1,090	1,730	1,270	-460 (-27%)	2,200	1,530	-670 (-30%)
Te Atatu Road	3,110	3,970	4,230	260 (7%)	4,940	5,270	330 (7%)
Lincoln Road	2,810	2,820	2,740	-80 (-3%)	4,000	3,950	-50 (-1%)

From **Table 6.13** it can be determined that across a number of arterial roads, there is a reduction in the volume of HCVs using these road when the Waterview Connection is in place. There is an average decrease across these roads of 19% in 2016 and 18% in 2026.

There is a small increase in HCV flow observed on Te Atatu Road and New North Road. This is matched by the increase it total overall daily flow on these links, as demonstrated in **Table 6.5**.

The overall decrease in flows on arterial toads is also demonstrated in an assessment of the vehicle kilometres travelled (VKT), both across the Auckland region and the study area, in **Tables 6.14** and **6.15** (defined as the refined area of model coding, as discussed in **Chapter 3** of the Project Assignment Model Validation Report, which is broadly the Waitakere City area plus the western area of the Auckland Isthmus).

Table 6.14 – HCV VKT by Road Type (2026) – Auckland Region

	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
All Roads	334,500	336,000	1,500 (0%)	365,800	367,500	1,700 (0%)	273,300	274,400	1,100 (0%)
Local	30,900	30,100	-800 (-3%)	32,000	31,400	-600 (-2%)	25,100	24,600	-500 (-2%)
Arterial	112,400	110,100	-2,300 (-2%)	121,200	118,300	-2,900 (-2%)	92,600	90,800	-1,800 (-2%)
Motorway	159,500	164,000	4,500 (3%)	177,700	183,000	5,300 (3%)	129,000	132,500	3,500 (3%)
Rural	31,900	31,900	0 (0%)	34,800	34,900	100 (0%)	26,600	26,600	0 (0%)

Table 6.15 – HCV VKT by Road Type (2026) – Study Area

	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
All Roads	68,200	71,500	3,300 (5%)	74,400	77,900	3,500 (5%)	55,600	58,100	2,500 (4%)
Local	7,000	6,600	-400 (-6%)	7,200	6,800	-400 (-6%)	5,700	5,400	-300 (-5%)
Arterial	25,200	23,400	-1,800 (-7%)	27,300	25,200	-2,100 (-8%)	20,600	19,200	-1,400 (-7%)
Motorway	30,500	36,100	5,600 (18%)	34,000	40,000	6,000 (18%)	24,700	28,900	4,200 (17%)
Rural	5,500	5,500	0 (0%)	5,900	5,900	0 (0%)	4,600	4,500	-100 (-2%)

Tables 6.14 and **6.15** demonstrate that across the greater Auckland region the change in HCV VKT is very small. However, in the study area, this change is more noticeable, with a marked decrease in trucks on the local and arterial roads, and a significant increase on the motorways.

6.8 Impacts on Total Vehicle Kilometres Travelled

Table 6.16 shows the daily vehicle kilometres travelled (VKT) by varying road type in 2026. These VKT statistics are aggregated across the whole network but reported by different road types.

Table 6.16 – VKT by Road Type (2026)

	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
All Roads	5,595,000	5,682,000	87,000 (2%)	5,057,000	5,107,000	49,000 (1%)	6,136,000	6,204,000	68,000 (1%)
Local	1,224,000	1,215,000	-9,000 (-1%)	1,110,000	1,100,000	-10,000 (-1%)	1,355,000	1,343,000	-12,000 (-1%)
Arterial	1,696,000	1,670,000	-25,000 (-1%)	1,441,000	1,408,000	-33,000 (-2%)	1,809,000	1,777,000	-32,000 (-2%)
Motorway	1,944,000	2,062,000	118,000 (6%)	1,845,000	1,936,000	91,000 (5%)	2,094,000	2,205,000	111,000 (5%)
Rural	732,000	735,000	3,000 (0.4%)	662,000	663,000	1,000 (0.2%)	877,000	879,000	2,000 (0.2%)

From **Table 6.16** it can be seen that when the project is in place, there is an increase in VKT across the Auckland region in all three peak periods. This is partially due to the expected traffic induced by the completion of the WRR, but also because some vehicles are attracted to the longer, faster motorway route. This is supported by the fact the increase in average trip length across the whole model, as shown in **Table 6.17**.

Table 6.17 – Average Trip Length across the Auckland Region (2026)

Time Period	2026		
	DM	OPT	Change
AM	9.18 km	9.26 km	0.08 km (1%)
IP	8.43 km	8.48 km	0.05 km (1%)
PM	9.05 km	9.12 km	0.07 km (1%)

Table 6.16 also indicates that with the introduction of the project the travel on motorways increases, but there is a consequential decrease in travel on local and arterial roads.

The increase on motorways and decrease on other roads is due to construction of a new length of motorway, and due to the completion of the WRR. The completion of the WRR means that vehicles can travel from the

Manukau and airport areas to West Auckland on motorways whereas before the Waterview Connection is built, vehicles must travel on arterial and local roads or on SH1, through CMJ to SH16.

Table 6.18 displays the changes in VKT in the study area. For the purposes of **Table 6.18**, the study area is defined as the refined area of model coding, as discussed in **Chapter 3** of the Project Assignment Model Validation Report, which is broadly the Waitakere City area plus the western area of the Auckland Isthmus..

Table 6.18 – Study Area VKT by Road Type (2026)

	AM			IP			PM		
	DM	OPT	Change	DM	OPT	Change	DM	OPT	Change
All Roads	1,082,700	1,173,900	91,200 (8%)	946,600	1,016,400	69,800 (7%)	1,182,900	1,264,200	81,300 (7%)
Local	165,300	157,100	-8,200 (-5%)	140,700	134,700	-6,000 (-4%)	185,500	175,500	-10,000 (-5%)
Arterial	448,200	425,800	-22,400 (-5%)	385,500	361,600	-23,900 (-6%)	479,600	457,400	-22,200 (-5%)
Motorway	385,600	507,300	121,700 (32%)	349,400	449,100	99,700 (29%)	423,400	536,000	112,600 (27%)
Rural	83,500	83,600	100 (0%)	70,900	70,900	0 (0%)	94,400	95,300	900 (1%)

Table 6.18 displays the same trends as **Table 6.16** that is when the Waterview Connection is in place the travel on motorways is seen to increase, with traffic on local and arterial roads reducing as a consequence. The greatest impact in the study area is seen on the motorways, with VKT increasing by between 27% and 32%.

6.9 Induced Traffic

The construction of the Waterview Connection reduces travel times and congestion across much of the network, which is expected to induce some additional travel onto the road network. These induced trips include newly created trips, as well as trips that change destinations, change travel modes or change their time of travel. The models estimate that some 6,000 vpd of the 82,400vpd using the Waterview Connection are due to induced traffic.

The ART3 model does not generate purely 'new' trips. The 6,000 induced trips come from redistribution of trips (i.e. traffic changing trip destinations that require use of this corridor), modal-shift (from PT to cars, from walking/cycling to cars etc), and from time-shifting (i.e. trips that were made in the inter peak may be taken in the AM peak as a result of the project and vice versa). The ART3 model retains the total number of person-trips when different transport options are tested, but the amount of car trips changes. These additional car trips are not included as 'new' trips, because they will just be person trips changing the place, time, mode or route of their trip. It is estimated that about 93% of the trips on the SH20 Waterview Connection are due to re-routing, and 7% are due to 'induced' trips (redistributed, mode change, time change).

Table 6.19 displays the change in trip totals between the Do-Minimum and the Option in 2016, with **Table 6.20** showing the same for 2026.

Table 6.19 – 2016 Trip Totals (2-hour total trips)

	2016 Lights			2016 HCVs		
	DM	Opt	Change	DM	Opt	Change
AM Peak	537,255	538,518	1,263 (0.2%)	28,692	28,692	0 (0.0%)
Inter-Peak	518,844	518,777	-67 (0.0%)	31,309	31,309	0 (0.0%)
PM Peak	606,259	606,365	106 (0.0%)	23,468	23,468	0 (0.0%)

Table 6.20 – 2026 Trip Totals (2-hour total trips)

	2026 Lights			2026 HCVs		
	DM	Opt	Change	DM	Opt	Change
AM Peak	575,437	576,830	1,393 (0.2%)	36,598	36,598	0 (0.0%)
Inter-Peak	562,110	562,107	-3 (0.0%)	39,937	39,937	0 (0.0%)
PM Peak	650,620	651,164	544 (0.1%)	29,952	29,952	0 (0.0%)

Tables 6.19 and **6.20** shows that:

- As in Section 5.1, the number of HCVs remains the same between the Do-Minimum and the Option; and
- As also reported in Section 5.1, at a regional level, the option does not change the total number of trips by more than 0.5% in either 2016 or 2026, and as may be expected, has the least impact on the inter-peak trips.

7. Operational Results

This Chapter discusses the results of the operational modelling that has been undertaken, and also provides analysis on the stability of the model.

7.1 Background

Whilst the AM and PM operational models can provide more detailed assessment, it is noted that they are still only a 'simulation' of the potential operation of the road network during these peak periods. The aim of 'simulation' modelling is therefore to identify any potentially significant issues associated with the road network operation in a generic set of network operating conditions for the different assessment scenarios in order that design modification or any further mitigation can be identified. Whilst the models give consideration to the influence of factors, such as driver behaviour and other operational and design factors, there will inevitably be fluctuations in the day-to-day operation of the road network, as well as across different times of year, depending on the specific road operating conditions at that time. In this regard, manual capacity calculations have been undertaken to assess the effects of the design specification for the roads and to support the operational model assumptions, where necessary.

It is noted that the geographic extent of operational model can make it more difficult to assess and optimise and coordinate each intersection across the full scope of the model network. Consequently, whilst some optimisation of signalised intersections has generally been incorporated in the future year operational models, further improvements in network performance may be able to be achieved at certain locations with further refinement to the optimisation and coordination of adjacent intersections. In addition, the modelling of ramp signals at motorway on ramps has been replicated using a slow vehicle speed over a short section of the on ramp. Whilst this can replicate the effects of the ramp signals it does not adjust to traffic demand on the on ramp and therefore cannot fully replicate the complex operation of the ramp signal systems. These points have been discussed in relation to a number of locations, as identified in the following paragraphs.

7.2 Travel Time Results

The operational modelling has focused on the effect of the project on travel times, rather than on changes in flow. The assessments consider both the 2016 and 2026 future year operating conditions with the Project (the 'Option' scenarios), as well as the baseline 2006 conditions. Comparison of the wider operation of the network without the Project (the 'do minimum' scenarios) in the future years has been provided earlier in **Chapter 6**.

In relation to the average travel times, the routes extracted from the operational model, shown on **Figure 7.1** include routes along SH16 and SH20, as well as locations, where connections are provided between State highways, or between the State highway and arterial road network.

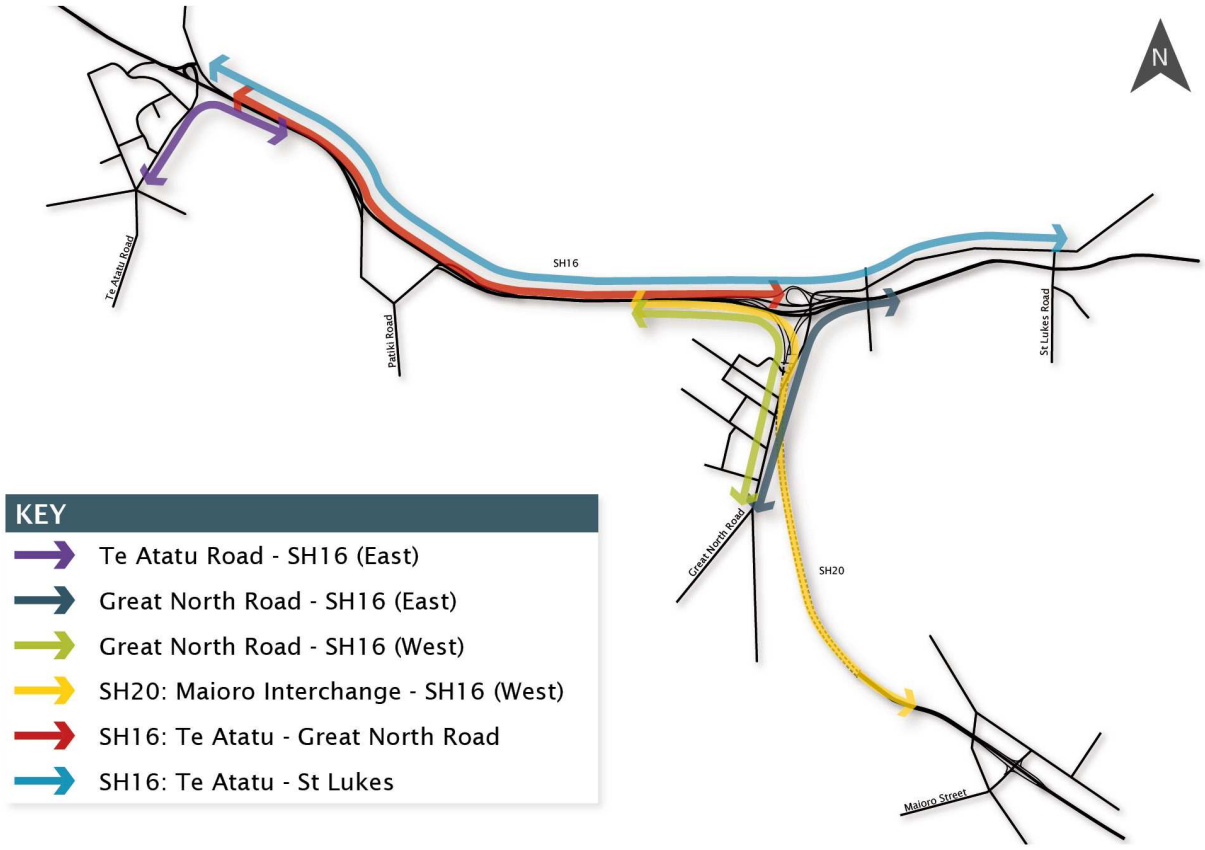

Figure 7.1: Operational Model Travel Time Routes

7.2.1 AM Peak Period

Table 7.1 provides a summary of the predicted average travel times (minutes), comparing the 2006 operational model outputs with the predicted 2016 OPT and 2026 OPT future year operation for the AM peak period.

Table 7.1: Summary of Average Travel Times – AM Peak Period

Route	Direction	2006	2016 OPT – With Project		2026 OPT – With Project	
		Average Travel Time (mins)	Average Travel Time (mins)	Change 2006 to 2016 OPT (mins)	Average Travel Time (mins)	Change 2016 OPT to 2026 OPT (mins)
Te Atatu Rd – SH16 (East)	N/B	6.7	7.0	0.3	6.8	-0.2
	S/B	2.5	3.5	1.0	4.5	1.0
Great North Rd – SH16 (East)	N/B	11.9	7.1	-4.8	8.5	1.4
	S/B	2.9	2.9	0.0	2.8	-0.1
Great North Rd – SH16 (West)	N/B	7.1	4.4	-2.7	5.2	0.8
	S/B	5.3	4.6	-0.7	4.4	-0.2
SH20: Maioro Interchange – SH16 (West)	N/B	n/a	4.8	n/a	5.2	0.4
	S/B	n/a	4.4	n/a	4.8	0.4
SH16: Te Atatu – Great North Road	E/B	6.8	4.0	-2.8	4.8	0.8
	W/B	3.5	3.7	0.2	3.7	0.0
SH16: Te Atatu – St Lukes	E/B	11.8	6.1	-5.7	7.1	1.0
	W/B	5.3	5.6	0.3	5.6	0.0

The main points from **Table 7.1** are identified as:

- Northbound traffic on Te Atatu Road to SH16 eastbound is on average identified as experiencing a broadly similar travel time to the 2006 baseline in both the 2016 and 2026 OPT scenarios. However, vehicles travelling in the opposite (southbound) direction from SH16 to Te Atatu Road are anticipated to experience increased delays. This is considered to be primarily due to increased delay on Te Atatu Road, where traffic flows are predicted to increase, due to the extra capacity provided on SH16, as identified in **Table 6.5** and **Table 6.6**.

- On Great North Road, northbound traffic heading to either SH16 (East) or SH16 (West) is on average anticipated to experience improvement in travel time with the Project in both 2016 OPT and 2026 OPT scenarios, compared with the 2006 baseline. This is anticipated to be related to the predicted reductions in traffic flow on Great North Road and extra capacity provided on SH16, discussed in **Section 6.4**. In the equivalent southbound direction, there are only marginal changes in the travel times anticipated.

- Along SH20 between the Maioro Street Interchange and SH16 (West), only marginal changes in the northbound and southbound travel times occur between the 2016 OPT and 2026 OPT scenarios. The

average travel time along this route of approximately 5 minutes, which equates to an average vehicle speed of approximately 70kph on this route.

- On SH16, there is anticipated to be noticeable improvements in the eastbound peak direction travel time in the 2016 OPT scenario, when compared with the 2006 baseline. Between the 2016 OPT and 2026 OPT scenarios, there is anticipated to be an increase in the eastbound travel times on SH16, although travel times are still anticipated to be improved when compared with the 2006 baseline. In this regard, eastbound travel times equate to average vehicle speeds of around 40kph, 70kph and 65 kph in the 2006, 2016 OPT and 2026 OPT scenarios respectively. It is noted that this should be considered in the context of the increases of approximately 25% (2,000-2,500 vehicles in the two hour peak), in eastbound traffic on SH16 between St Lukes and Te Atatu Interchanges. In the westbound direction, travel times are predicted to remain broadly similar in each scenario with average vehicle speeds equating to approximately 80-90kph.

The key observations in relation to the operational model during the AM peak period in the 2016 OPT and the 2026 OPT scenarios are provided below. Each set of observations is referenced to **Figure 7.2** and **Figure 7.3** in relation to the 2016 OPT and 2026 OPT observations respectively. The observations from the 2016 OPT scenario, in the AM peak period model, are as follows:

1. On the northbound approach from Te Atatu South, the observed queuing extends to the south of the Edmonton Road roundabout over a period between approximately 0700 and 0900. It is considered that this queuing occurs, in part, as a result of the observed vehicle weaving in the model related to the lane changing approaching the intersection. In comparison to the model observations, it is considered that in reality drivers are actually likely to make more informed decisions at an earlier stage and as a consequence there would be improved lane utilisation. Given the increases in traffic flow predicted on this section of Te Atatu Road, combined with these observation and no capacity improvements along the corridor south of the interchange, it is considered that a broadly similar operational performance along Te Atatu Road to the 2006 baseline would be observed.

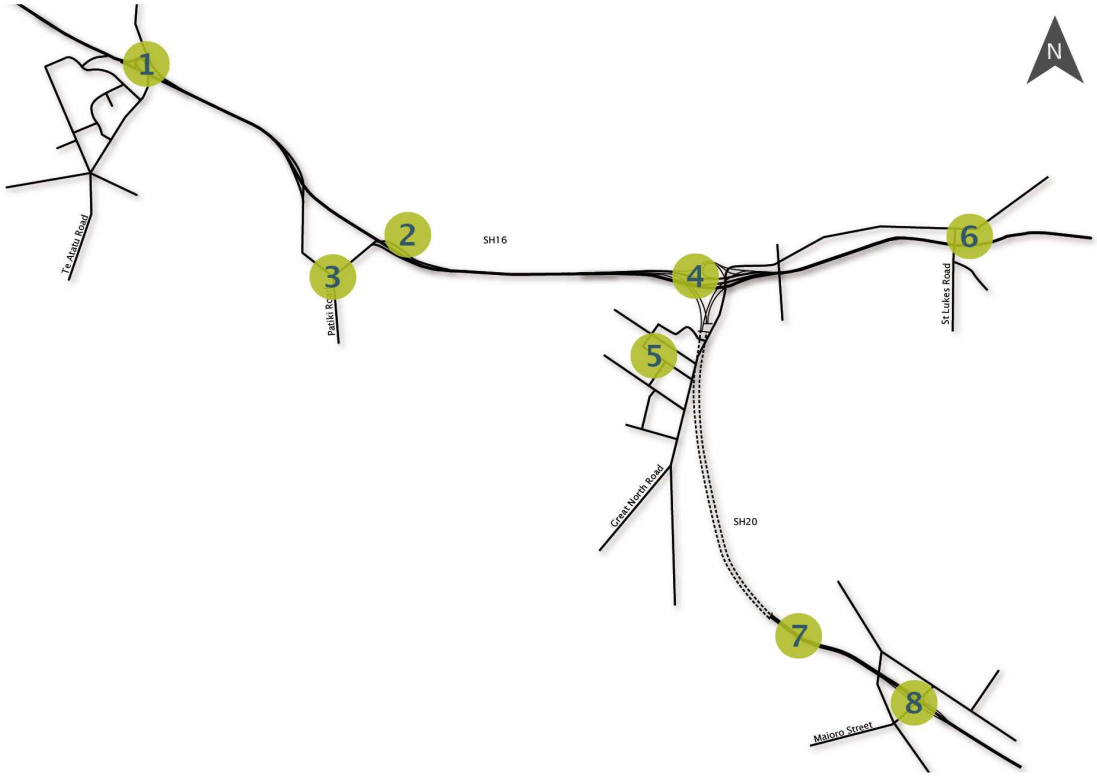

Figure 7.2: 2016 OPT AM Peak Period Observations

On the southbound approach from Te Atatu Peninsula, queuing is observed to extend back along Te Atatu Road beyond the Gloria Avenue roundabout for a period from around 0800 through to the end of the peak period. This is considered to be related to the operation of the signals at the eastbound on ramp for southbound traffic and the priority lane for northbound traffic, as well as the coordination with the ramp signals on this eastbound on ramp. Due to the method of modelling the ramp signals in the operational model, it is not possible to optimise the operation of the ramp signal on the eastbound on ramp to the vehicle demand or coordinate its operation with the adjacent signals associated with the northbound priority lane. Whilst refinements to the optimisation and coordination of these signals could reduce the observed queuing, management plans for accommodating this possibility should be developed by the Auckland Motorway Alliance (AMA).

2. Eastbound on SH16, the model observations indicate weaving of vehicles and a slight reduction in vehicle speeds, which initially occur over a short section just east of the Rosebank eastbound on ramp around 0800 due to lane changing /selection approaching the Great North Road Interchange. However, this is observed to dissipate by around 0900 and traffic is observed to operate satisfactorily through to the end of the peak period.

3. In general, the on ramps and off ramps at Patiki and Rosebank are observed to operate well during the AM peak period. However, it is noted that the model observations indicate queues occurring back from the Patiki Road / Rosebank Road roundabout onto the Rosebank Road westbound off ramp, as well as onto the SH16 westbound mainline for a period of around 90 minutes from 0800. However, this observed queuing

is considered to be a result of some limitations in the operational model to effectively model the operation of the Patiki Road / Rosebank Road roundabout. Separate assessments, using the SIDRA detailed intersection analysis package, have been undertaken to review the potential queuing. These more detailed assessments have indicated that, based on the demand traffic flows at this roundabout extracted from the project assignment model, the queuing on the Rosebank Road approach would not extend to the Rosebank westbound off ramp. As such, the extent of queuing observed in the operational model is not anticipated to occur. The SIDRA analysis undertaken is discussed in further details in later sections of this chapter.

4. At the Great North Road Interchange, both the eastbound on ramps to SH16 from SH20 and Great North Road are generally observed to operate satisfactorily. The eastbound on ramp from Great North Road is observed to extend back around the on ramp for a short period before 0900. It is considered that refinement of the operation of the ramp signals by changing the signal timings could reduce the observed queuing at this on ramp.

5. Observations of the queuing and vehicles speeds on Great North Road indicate that the overall operation for northbound vehicles would be improved compared with observed operations in 2006, with a reduction in the duration of queuing and improvements in vehicle speeds and travel times.

6. To the east of the St Lukes / Western Springs Interchange weaving is predicted to occur as eastbound vehicles lane change approaching Newton Road and the SH1 Interchange, which causes slow moving queue of traffic back along SH16 to the west of the St Lukes Interchange. This is observed to occur over a period of around 90 minutes across the peak period. However, toward the end of the peak period, this weaving and slow moving traffic has dissipated, similarly to the 2006 scenario.

   It is also noted that the model observations indicate queuing on the Western Springs eastbound off ramp extending back onto the eastbound mainline on SH16 for a period of around 30 minutes at the height of the AM peak period, due to the demand for the right turn onto Great North Road at the end of the ramp. On St Lukes Road approaching the Great North Road intersection, queuing is predicted to build from around 0800 through to 0930, but dissipates by the end of the peak period. Whilst further optimisation and coordination of the traffic signals on St Lukes Road and Great North Road may reduce the observed queues back to the SH16 eastbound mainline and on St Lukes Road, management plans for accommodating this possibility should be developed.

7. SH20 is observed to operate satisfactorily throughout the AM peak period around the Great North Road Interchange and through the tunnel, as indicated by the travel times along the route presented above. On the southbound approach to Maioro Street Interchange, reduced vehicle speeds are observed for HCVs and other larger vehicles exiting the tunnel as the gradient increases. These vehicles are generally observed to move to the nearside lane and as a result the observations do not indicate that queuing occurs back though the tunnel.

8. At the Maioro Street Interchange, the ramps are observed to operate satisfactorily throughout the peak periods and the SH20 mainline operates satisfactorily through the interchange. It is observed that there high traffic flows from Maioro Street (West) and Richardson Road (South) proceeding across the interchange bridge to turn south onto the southbound on ramp. Whilst refinement to the optimisation and coordination of the Maioro Street / Richardson Road signals may reduce the observed queuing and the adverse effects on the operation of the interchange, management plans for accommodating this possibility

should be developed.

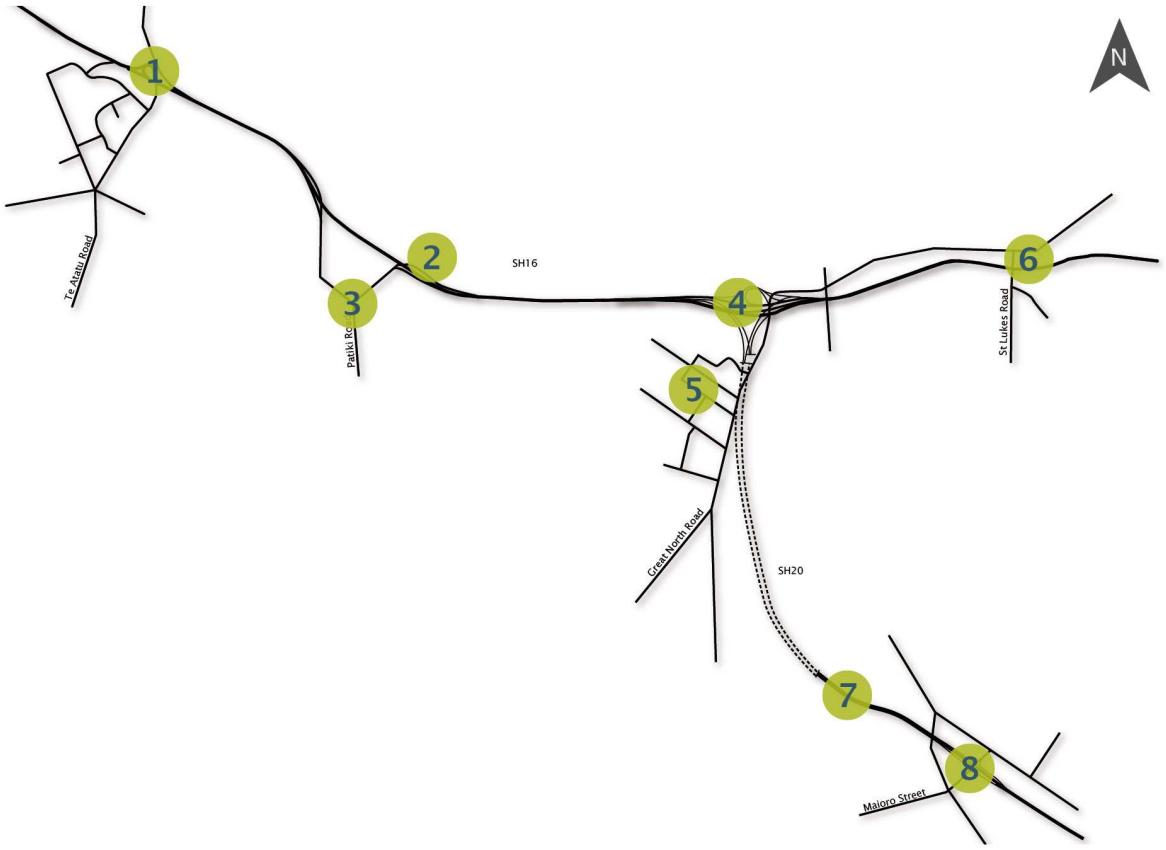

Figure 7.3: 2026 OPT AM Peak Period Observations

The observations from the 2026 OPT scenario, in the AM peak period model, are as follows:

1. The observations on Te Atatu Road approaching the interchange are similar to those in the 2016 OPT scenario, although due to variations in traffic flow demands and the optimisation/coordination of the signals different patterns are observed.

   On the southbound approach from Te Atatu Peninsula, queuing is observed to extend back along Te Atatu Road beyond the Gloria Avenue roundabout for a period of between 45 and 60 minutes during the height of the AM peak period. The reasons for this are considered to the similar to those discussed previously and relate to the operation of the signals at the eastbound priority lane on ramp as well as the coordination with the ramp signals on this on ramp.

   On the northbound approach from Te Atatu South, the observed queuing extends to the south of the Edmonton Road roundabout over a period between approximately 0700 and 0930. It is again considered that this queuing occurs, in part, as a result of the observed lane changing approaching the intersection.

Nevertheless, the observed queuing in 2026 is broadly similar to the operational performance along Te Atatu Road in 2006, even accounting for the predicted increases in traffic flows.

2. Similarly to the 2016 OPT scenario, eastbound vehicles on SH16 are observed to weave and there is a reduction in vehicle speeds, which initially occur over a short section just east of the Rosebank eastbound on ramp around 0800. This is observed to be related to vehicles changing lanes in advance of the off ramps at the Great North Road Interchange, but occurs well in advance of these off ramps. Between 0800 and 0900, this weaving continues to occur over a similar length but moves further west to around the Rosebank eastbound on ramp. In reality, it is anticipated that this weaving of eastbound vehicles would occur over a longer section between the Rosebank on ramp and Great North Road off ramp.

3. In general, as in the 2016 OPT scenario, the on ramps and off ramps at Patiki and Rosebank are observed to operate well during the AM peak period. However, the model observations indicate queues occurring back from the Patiki Road / Rosebank Road roundabout onto the Rosebank Road westbound off ramp, as well as onto the SH16 westbound mainline for a period of around 30-45 minutes. More detailed SIDRA analyses have again been undertaken which indicate the queuing on the Rosebank Road approach would not extend back to the Rosebank westbound off ramp. The extent of queuing observed in the operational model is therefore not anticipated to occur. Again, more detail o the SIDRA analysis is discussed later in this report.

4. At Great North Road Interchange, the queue on the eastbound on ramp from Great North Road is observed to extend back around the on ramp for a period of around 30 minutes at the height of peak period. At the SH20 eastbound on ramp, queues are observed to extend back to around the crest of the ramp at times during the height of the peak period.

5. Observations of the queuing and vehicles speeds on Great North Road indicate that the overall operation for northbound vehicles would be similar to the observed operations in 2006, with some reduction in the duration of queuing and improvements in vehicle speeds and travel times.

6. As in the 2016 OPT scenario, to the east of the St Lukes / Western Springs Interchange, weaving is predicted to occur as eastbound vehicles change lanes approaching Newton Road and the SH1 Interchange. In the 2026 OPT scenario this is observed to result in a slow moving queue of traffic back along SH16 to the west of the St Lukes Interchange, which occurs over a period of around 90 minutes across the peak period. However, toward the end of the peak period, this weaving and slow moving traffic has dissipated. This is considered to demonstrate a similar level of observed operation for eastbound traffic on SH16 to the observations of the 2006 baseline scenario.

   It is also noted that the model observations indicate queuing on the Western Springs eastbound off ramp extending back onto the eastbound mainline on SH16 for a period of around 60 minutes at the height of the AM peak period, due to the demand for the right turn onto Great North Road at the end of the ramp. On the westbound off ramp at St Lukes Interchange, queuing is predicted back to the mainline for a short period in the AM peak, due to the demand for right turns from the off ramp onto St Lukes Road. In both cases, whilst further optimisation and coordination of the traffic signals on St Lukes Road and Great North Road at and between these off ramps may reduce the observed queues back to the SH16 mainline, management plans for accommodating this possibility should be developed.

7. SH20 is observed to operate satisfactorily throughout the AM peak period around the Great North Road Interchange and through the tunnel, as indicated by the travel times along the route presented above. As in the 2016 OPT scenario, on the southbound approach to Maioro Street Interchange reduced vehicle speeds are observed for HCVs and other larger vehicles exiting the tunnel as the gradient increases, but observations do not indicate that queuing occurs back though the tunnel.

8. Similar observations to the 2016 OPT scenario occur at the Maioro Street Interchange, but the extent of the queuing on Maioro Street and Richardson Road is observed to increase. The ramps are generally observed to operate satisfactorily throughout the peak periods and the SH20 mainline operates satisfactorily through the interchange. It is observed that high traffic volumes from Maioro Street (West) and Richardson Road (South) proceeding across the interchange bridge to turn south onto the southbound on ramp. It is considered that the method used for the ramp signal operation in the model does not allow the ramp signal to be optimised to the variations in traffic demand during the peak period. As such, queuing back across the overbridge is observed to affect the northbound off ramp operation, resulting in queuing on the northbound off ramp back to the SH20 northbound mainline for around 30 minutes. Whilst refinement to the optimisation and coordination of the Maioro Street / Richardson Road signals, the interchange signals and at the southbound on ramp, the observed queuing may be reduced, management plans for accommodating this possibility should be developed.

PM Peak Period Models

Table 7.2 provides a summary of the predicted average travel times (minutes), comparing the 2006 operational model outputs with the predicted 2016 OPT and 2026 OPT future year operation for the PM peak period.

Table 7.2: Summary of Average Travel Times – PM Peak Period

Route	Direction	2006	2016 OPT – With Project		2026 OPT – With Project	
		Average Travel Time (mins)	Average Travel Time (mins)	Change 2006 to 2016 OPT (mins)	Average Travel Time (mins)	Change 2016 OPT to 2026 OPT (mins)
Te Atatu Rd – SH16 (East)	N/B	3.5	10.3	6.8	9.4	-0.9
	S/B	3.3	4.6	1.3	4.5	-0.1
Great North Rd – SH16 (East)	N/B	4.9	4.4	-0.5	4.4	0.0
	S/B	3.4	4.2	0.8	4.1	-0.1
Great North Rd – SH16 (West)	N/B	4.1	3.6	-0.5	4.5	0.9
	S/B	5.0	4.2	-0.8	4.2	0.0
SH20: Maioro Interchange – SH16 (West)	N/B	n/a	4.1	n/a	5.6	1.5
	S/B	n/a	4.2	n/a	4.3	0.1
SH16: Te Atatu	E/B	3.5	3.4	-0.1	3.4	0.0

– Great North Road	W/B	7.7	6.2	-1.5	8.0	1.8
SH16: Te Atatu – St Lukes	E/B	5.3	5.1	-0.2	5.1	0.0
	W/B	10.2	9.1	-1.1	10.9	1.8

The main points from **Table 7.2** are identified as:

- Northbound traffic on Te Atatu Road to SH16 eastbound is on average identified as experiencing an increase in travel time between the 2006 baseline and both the 2016 OPT and 2026 OPT scenarios. Increases in travel time for southbound vehicles on Te Atatu Road are also predicted with the Project in both the 2106 OPT and 2026 OPT scenarios. This is considered to be due to the observed poor operation of this road corridor, in combination with the predicted increases in traffic flows associated with the Project identified in **Table 6.5** and **Table 6.6**. It is also expected that significant growth in the non-peak direction (i.e. from the west) associated with growth to the west, add conflicting movements at the interchange.

- On Great North Road, travel times northbound and southbound, to and from the SH16 eastbound on or off ramp respectively are predicted to improve in the future years with the Project. There is also predicted to be improved travel times northbound on Great North Road to SH16 westbound in the 2016 OPT scenario However, in the other scenarios, travel times to and from the SH16 westbound carriageway are affected by the observed queuing on SH16 westbound, as discussed below. Along SH20 between Maioro Street Interchange and SH16 (West), only a marginal increase in the southbound travel time occurs between the 2016 OPT and 2026 OPT scenarios, with average vehicle speeds remaining 75 to 80kph. However, in the northbound direction, an increase in travel time between the 2016 OPT and 2026 OPT scenarios is predicted, which is consistent with the observations below relating to the increases in queuing on SH16 westbound back to the SH20 on ramp. The increase in travel time equates to a reduction in the average vehicle speed from around 80 to 55kph along this travel time route.

- In the westbound (peak direction) on SH16 in the PM peak period, there is predicted only marginal changes in travels times between the 2006 baseline and the 2016 OPT scenarios, even with westbound traffic flows increasing by approximately 20-25% (or around 2,000-2,500 vehicles). Between the 2006 baseline and 2026 OPT scenario, travel times are predicted to increase by around 30-35% on SH16 westbound with the equivalent vehicle speeds reducing from around 50-55kph to approximately 40kph over these routes. However, it is again noted that whilst additional capacity is provided westbound with the Project, traffic flows between these scenarios are also predicted to increase by around 35% (see **Table 6.3**).

- In the eastbound direction, travel times are predicted to remain broadly similar in each scenario with average vehicle speeds equating to approximately 80-90kph. However, it is noted that compared to the 2006 baseline, the 2016 OPT and 2026 OPT scenarios are predicted to result in increases in 2 hour traffic flows of 10-15% and 20-25% respectively (see **Table 6.3**).

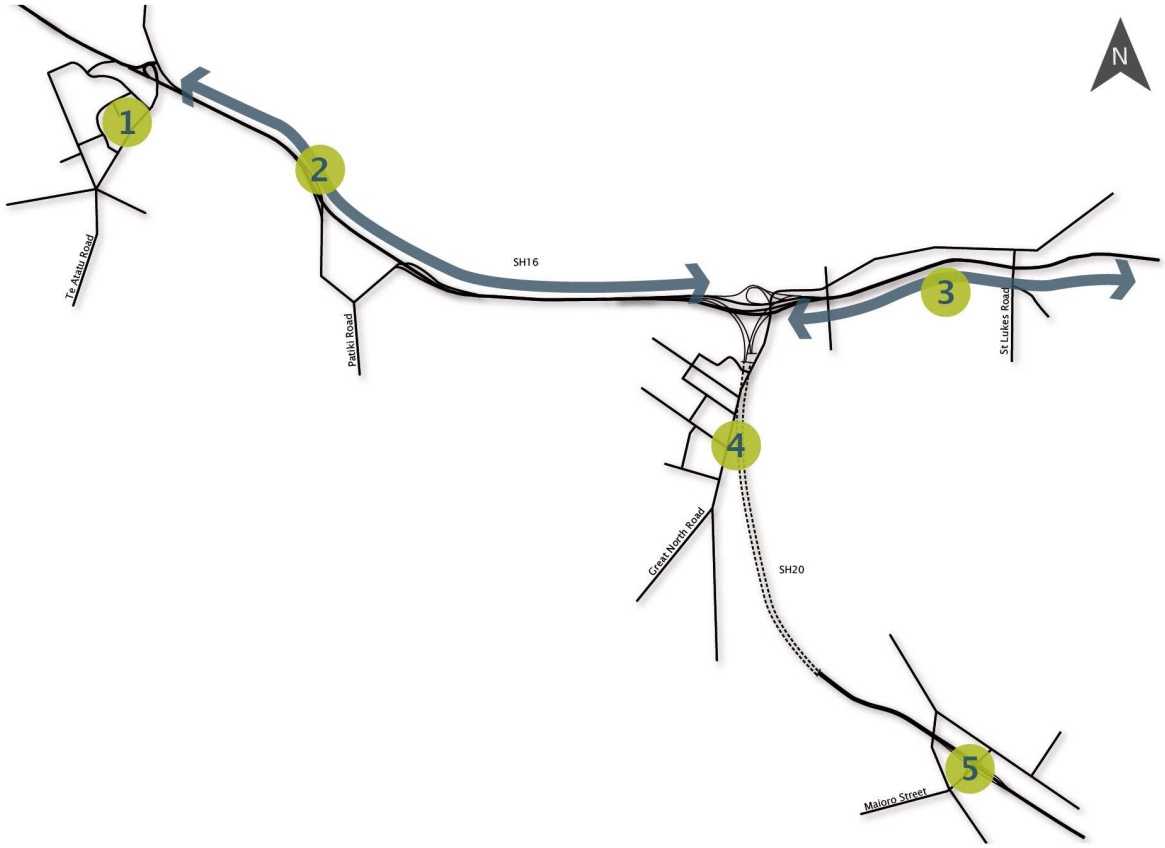

Figure 7.4: 2016 OPT PM Peak Period Observations

The key observations in relation to the operational model during the PM peak period in the 2016 OPT and the 2026 OPT scenarios are provided below. Each set of observations is referenced to **Figure 7.4** and **Figure 7.5** in relation to the 2016 OPT and 2026 OPT observations respectively.

The observations from the 2016 OPT scenario, in the PM peak period model, are as follows:

1. During the PM peak period, queues are observed to build on the Te Atatu Road northbound approach to the interchange. Queues are observed to extend south past the Edmonton Road roundabout for around two hours through the peak period until around 1830, when queuing begins to dissipate. As in the AM peak period, observations indicate that poor lane utilisation and weaving in the model, as vehicles arrive at the interchange, contributes to this situation. It is noted that the observations do not indicate any significant issues with the operation of the interchange intersections or ramps and there is no significant southbound queuing on Te Atatu Road (from Te Atatu Peninsula).

2. At around 1630, weaving and platooning of vehicles is observed to occur on a short section of SH16 westbound between Te Atatu Interchange and the Patiki westbound on ramp. As the peak period progresses, the queue is observed to build, such that by around 1800 to 1830 it extends back to around the Great North Road Interchange westbound on ramps. By the end of the model period, the queue

reduces, but is still observed to occur from the approach to the Te Atatu Interchange back to east of the Rosebank westbound off ramp.

It is noted that the queue is not observed to extend back onto either the SH20 or Great North Road westbound on ramps at any stage in the peak period. It is also observed that the ramps at Great North Road continue to operate satisfactorily throughout the peak period.

3. To the east of the Great North Road Interchange, weaving and queuing begins to occur around St Lukes / Western Springs Interchange around 1500. It is observed that the weaving occurs as vehicles move between lanes on this section from St Lukes approaching the Great North Road Interchange. As with the queuing to the west of Great North Road Interchange, this builds during the peak period, such that by around 1730 there is observed to be queuing on the SH16 mainline from the westbound off ramps at Great North Road through to the east of the St Lukes / Western Springs Interchange. This queuing begins to dissipate by the end of the peak period and at no stage is observed to have significant adverse effects on the operation of the St Lukes / Western Springs Interchange and ramps.

   Through the peak period, queues are observed to build on St Lukes Road northbound from the St Lukes Road / Great North Road intersection through the peak period. As was discussed with the AM peak observations, it is considered that further refinements to the optimisation and coordination of signals in this part of the St Lukes Road / Great North Road corridor could reduce these observed queues.

4. In general, traffic on both Great North Road and SH20 is observed to operate satisfactorily throughout the peak period. As in the AM peak period observations there is some platooning of slow moving traffic exiting the tunnel in the southbound direction. However, this is not observed to result in queuing back into the tunnel.

5. The Maioro Street Interchange is generally predicted to operate satisfactorily during the PM peak period in the 2016 OPT scenario, with no significant queuing observed on either the SH20 mainline through the interchange or the ramps. However, as the peak period progresses, queues build on the Stoddard Road / Sandringham Road and the Richardson Road (North and South) approaches. By the end of the peak period there is observed to be significant queuing on these approaches. However, it is noted that the operation of the signals through the interchange intersections have generally been coordinated for the State highway off ramps and through movements between the interchange and Maioro Street. As such, it is considered that with further refinement to the phasing, optimisation and coordination at the intersections around the Maioro Street interchange, the queuing on the surrounding arterial roads could be reduced, without compromising the operational performance of the State highway ramps.

In general, the pattern of the observations from the 2026 OPT scenario (annotated on **Figure 7.5**) is similar in character to the observations in the 2016 OPT scenario. However, as discussed following **Figure 7.4**, there are differences due to changes in peak period traffic demand:

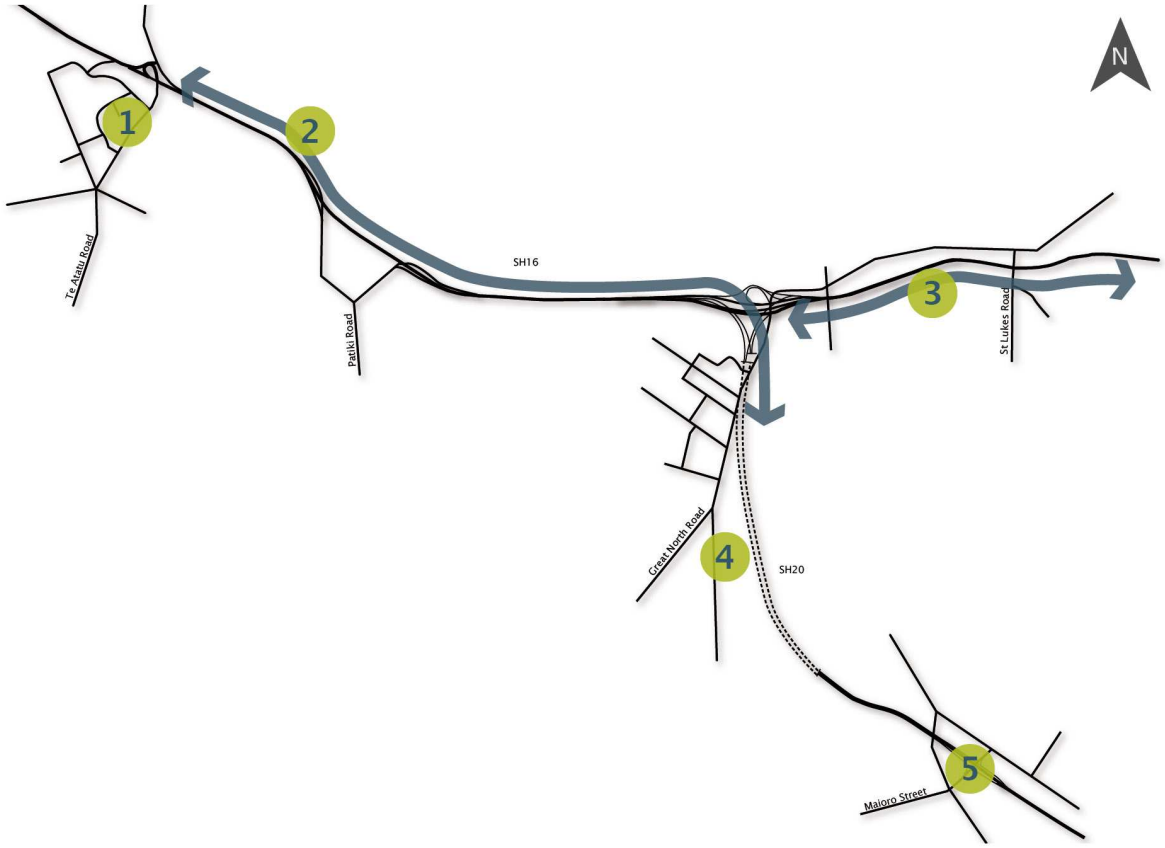

Figure 7.5: 2026 PM Peak Period Observations

1. Similar northbound queuing patterns are observed along Te Atatu Road toward the Te Atatu Interchange in the 2026 OPT to the 2016 OPT scenario, although the extent of queuing is not as significant. From around 1530, the northbound queue on Te Atatu Road builds and extends past the Edmonton Road roundabout. By around 1700, the queue has dissipated and there is observed to be only shorter sections of platooning and slow moving traffic on Te Atatu Road, such that by around 1800 there is minimal queuing northbound. It is also noted that the observations of queuing on the northbound approach to the Interchange are not dissimilar to the observations from the 2006 baseline scenarios.

   By comparison, whilst not observed in the 2016 OPT scenario, there is also predicted to be some queuing on the southbound approach to the interchange (from Te Atatu Peninsula) later in the peak period, which occasionally extends back to around Gloria Avenue. It is considered that the observed changes in the queuing patterns at the Te Atatu Interchange are probably associated with changes in the signal optimisation between the 2016 and 2026 OPT scenarios. In the 2026 OPT scenario queuing on the northbound approach is reduced with resulting increases in queuing on the southbound approach, which is observed to be affected by the optimisation and coordination of the signals on the eastbound priority lane on ramp.

   During the peak period, both the on and off ramps at Te Atatu Interchange are observed to operate satisfactorily, with short queues occasionally forming on the eastbound off ramp for right turn vehicles.

2. In the 2026 OPT scenario, weaving and platooning of vehicles is again observed to occur on a short section between the Te Atatu Interchange and Patiki westbound on ramp near the start of the peak period. This builds during the peak period to a more significant extent than observed in the 2016 OPT scenario, such that by around 1730 queues extend back onto the SH20 westbound on ramp at the Great North Road Interchange. As the peak period continues, the queuing is observed to extend further back along SH20 northbound into the Great North Road Underpass and around 1830 there is observed to be very slow moving traffic northbound through northern section of the tunnel. This is observed to continue, with the queue and slow moving remaining at a similar extent, until the end of the peak period. This is also reflected in the travel times along SH20 to SH16 westbound in the PM peak period, as discussed above.

   In these circumstances, it would be necessary for a tunnel management plan or strategy to be initiated to manage the northbound traffic flow on SH20 into and through the tunnel, in order that more significant stationary queues did not occur further south through the tunnel.

3. To the east of the Great North Road Interchange, similar patterns are observed in the 2026 OPT scenario to the 2016 OPT scenario, with weaving and platooning of westbound vehicles observed between the Great North Road Interchange and the St Lukes / Western Springs Interchange around 1500-1530, which begins to extend back to the east through the St Lukes / Western Springs Interchange as the peak period continues, but is observed to dissipate toward the end of the peak period. These observations are similar to those in the 2006 baseline scenario. As the travel times in **Table 7.2** show, there is predicted to be an increase in the travel times westbound on SH16 in the 2026 OPT scenario, however, this in the context of increases in the 2 hour traffic flows on SH16 westbound of approximately 35% compared with the 2006 baseline or 2026 DM scenarios.

   It is also observed in the 2026 OPT scenario, that with the increases in traffic demands on St Lukes Road and Great North Road (westbound), queuing occurs south along St Lukes Road for northbound traffic, east along Great North Road for westbound traffic approaching the Western Springs Interchange intersection and also on the westbound off ramp at St Lukes. As was discussed, it is considered that further refinement of the coordination and optimisation of signals through this corridor could reduce these observed queues.

4. Other than the queuing observed back from SH16 westbound along SH20 northbound, both SH20 and Great North Road are observed to operate satisfactorily. As was discussed previously, the predicted queuing back along SH16 westbound affects SH20 northbound through the tunnel and this was reflected in the travel times shown in **Table** .

5. In the 2026 OPT scenario, the predicted traffic flows on the arterial roads around the Maioro Street Interchange are lower than in the 2016 OPT scenario, due to wider changes in travel patterns identified in the project assignment model. In this regard, whilst queuing is observed on the Richardson Road and Stoddard Road approaches, as well as on the northbound off ramp, this is not observed to be significant and is less than the observed queuing in the 2016 OPT scenario.

7.3 Model Stability

The travel times discussed in **Section 7.1** are from an average of five simulation 'runs' of the model and averaged over the 2-hour period. Multiple runs of the model are required as these are stochastic simulations, meaning each run gives different results due to the random selection of vehicles and driver behaviours. Further analysis of these averages has been undertaken to show how the travel times vary between the five runs, and if the results can therefore be considered to be stable and the averages representative. Three forms of analysis have been undertaken:

- Analysis of the travel times for all five runs compared to the average;
- Analysis of the individual 15 minute data for each of the five runs, concentrating on the minimum, maximum and average results; and
- Analysis of the travel times for five runs compared to ten runs; and

Each of these is discussed in detail in the following sections.

7.3.1 Analysis of Five Runs

Table 7.3 displays the modelled average travel time along certain routes from the 2006 AM peak validated model, along with the average for five runs, with **Table 7.4** showing the same for the 2016 AM peak.

Table 7.3: Average Travel Time by model run 2006 AM Peak

Route	Dir	Average Travel Time					Average of runs 1-5
		Run 1	Run 2	Run 3	Run 4	Run 5	
Te Atatu Road	N/B	6.86	6.65	6.80	6.73	6.57	6.7
	S/B	2.44	2.47	2.44	2.47	2.48	2.5
Great North Road	N/B	11.11	12.30	12.37	12.09	11.70	11.9
	S/B	2.90	2.89	2.90	2.88	2.88	2.9
Great North Road to SH16 (west)	N/B	6.91	7.25	7.22	7.27	7.09	7.1
	S/B	5.14	5.28	5.53	5.26	5.21	5.3
SH20 Maioro Interchange to SH16	N/B	n/a	n/a	n/a	n/a	n/a	n/a
	S/B	n/a	n/a	n/a	n/a	n/a	n/a
SH20 Maioro Interchange to SH16 (west)	E/B	n/a	n/a	n/a	n/a	n/a	n/a
	W/B	n/a	n/a	n/a	n/a	n/a	n/a
SH20 to Te Atatu	E/B	n/a	n/a	n/a	n/a	n/a	n/a
	W/B	n/a	n/a	n/a	n/a	n/a	n/a

Table 7.4: Average Travel Time by model run 2016 AM Peak

Route	Dir	Average Travel Time					Average of runs 1-5
		Run 1	Run 2	Run 3	Run 4	Run 5	
Te Atatu Road	N/B	6.98	7.16	7.15	7.24	7.23	7.2
	S/B	3.37	3.37	3.43	3.42	3.40	3.4
Great North Road	N/B	5.72	5.54	5.92	5.45	5.64	5.7
	S/B	3.02	3.06	3.03	3.04	3.05	3.0
Great North Road to SH16 (west)	N/B	4.06	4.09	4.15	3.99	4.03	4.1
	S/B	4.44	4.44	4.47	4.50	4.42	4.5
SH20 Maioro Interchange to SH16	N/B	5.08	5.46	5.47	5.11	5.20	5.3
	S/B	5.24	5.31	5.27	5.19	5.24	5.3
SH20 Maioro Interchange to SH16 (west)	E/B	4.90	4.88	5.12	4.97	4.67	4.9
	W/B	4.49	4.53	4.52	4.43	4.47	4.5
SH20 to Te Atatu	E/B	7.93	8.02	8.11	8.04	7.87	8.0
	W/B	8.98	9.11	9.12	8.95	9.04	9.0

From **Table 7.3** and **Table 7.4** it can be determined that the model is stable between runs, as there is little variation between the runs in both 2006 and 2016. **Appendix G** contains graphical information showing this analysis for the average across the 2 hour period, and also by each 15 minute period. The 15 minute graphs show the there is little variation in the data for the runs in both 2006 and 2016.

7.3.2 Analysis of Five Runs vs. Ten Runs

In order to confirm that five model runs provided a representative result, the models were run for a further 5 simulations 'runs' to allow a comparison on results between a 5 and 10 run scenario. The results of this analysis are presented in **Table 7.5** for the 2016 PM peak.

Table 7.5: Travel Time Results Comparison 2016 PM Peak

Route	Dir	5 Runs			10 Runs		
		Min	Avg	Max	Min	Avg	Max
Te Atatu Road - SH16 (East)	N/B	9.98	10.26	10.44	9.96	10.28	10.53
	S/B	4.43	4.70	4.90	4.43	4.67	4.90

Great North Road - SH16 (East)	N/B	4.29	4.30	4.32	4.26	4.29	4.32
	S/B	4.20	4.27	4.32	4.19	4.26	4.32
NB - Great North Road - SH16 (West)	N/B	3.52	3.55	3.61	3.48	3.55	3.61
	S/B	4.13	4.15	4.19	4.13	4.17	4.24
SH20: Maioro Interchange - SH16 (West)	N/B	4.00	4.03	4.11	4.00	4.04	4.11
	S/B	4.18	4.21	4.22	4.18	4.21	4.26
EB - SH16: Te Atatu - Great North Road	E/B	3.37	3.37	3.38	3.37	3.37	3.38
	W/B	5.65	6.02	6.59	5.65	6.04	6.59
EB - SH16: Te Atatu - St Lukes	E/B	5.07	5.07	5.08	5.07	5.07	5.08
	W/B	8.59	8.95	9.55	8.59	8.95	9.55

The results in **Table 7.5** show little difference between the minimum, average and maximum travel times for either 5 or 10 runs of the model. The comparison in **Table 7.5** gives confidence that the 5 runs used for the analysis of the model runs in both this report and the transport assessment are robust enough for the reporting that has been undertaken.

Appendix H contains data showing the variation in data across the 5 runs for each 15 minute period for the 2016 2 hour PM peak, and also data showing the minimum, maximum and average for the 5 runs and 10 runs, which confirm the points made above.

7.4 SIDRA Analysis

As discussed previously in this chapter, a separate analysis was undertaken in SIDRA of the performance of the roundabout at the intersection of Rosebank and Patiki Roads. This analysis was undertaken as observations from the operational model indicated that in the AM peak in both 2016 and 2026 queues may occur back from the Patiki/Rosebank Road roundabout onto the Rosebank Road westbound off ramp, as well as onto the SH16 westbound mainline for a period of around 30-45 minutes. Also, observations of the model showed the HCVs appeared to circulate the roundabout very slowly, which, given the size of the roundabout in question did not appear correct, and could be having an incorrect impact on the capacity and queueing.

A SIDRA model was developed for 2016 and 2026 for the AM peak (the peak in which the queuing was seen to occur).

Firstly the SIDRA model was run using turning flows directly from the project assignment model this showed the following:

- All approaches operated with a level of service C or below in 2016;

- In 2016, the 95% queue on the Rosebank Road northern approach to the roundabout stretched 172m, which would not go back as far as the SH16 off ramp;
- In 2016, the intersection as a whole, with the project assignment model flows, is expected to operate at a level of service B;
- The project assignment model showed that all approaches operated with a level of service C or below in 2026;
- In 2026, the 95% queue on the Rosebank Road northern approach to the roundabout stretched 167m, which would not go back as far as the SH16 off ramp; and
- In 2026, the intersection as a whole, with the project assignment model flows, is expected to operate at a level of service B.

The SIDRA model was then re-run using demand flows created more directly from traffic counts at this location, using the project assignment model only to get the predicted growth. This also confirmed satisfactory operation of the roundabout under the predicted flows.

Analysis of the operation model showed that local traffic on Patiki Road was all assigned to the local access road off the roundabout[9]. When more correctly allocated along Patiki Road, the model showed satisfactory performance, consistent with that in the SIDRA model.

In summary, while the operational model showed extensive queuing going back from the Rosebank/Patiki roundabout, this was found to be due to the local Patiki Road traffic being all loaded to a single point. When spread more realistically, this showed satisfactory performance, which was confirmed by the SIDRA.

[9] Note, when this loading pattern was also put in the SIDRA model, it also showed significant queuing on Rosebank Road. Although this is not a realistic scenario, it shows that SIDRA and the operational model show consistent results given the same input.

8. Sensitivity Analysis

Sensitivity analysis has been undertaken on some of the assumptions made in the ART3 model which effect the level of demands passed to the project model, particularly Travel Demand Management (TDM), road pricing and fuel prices (that is pump prices). Analysis has also been undertaken at the ART3 level regarding two major infrastructure projects which may occur in the Auckland region within the next thirty years, the additional Waitemata Harbour Crossing and the Auckland CBD Rail Loop.

This chapter contains the results of a high-level analysis of the assumptions made in the ART3 model.

8.1 ART3 demand Analysis

As discussed previously, the WRR model takes its demands from the regional ART3 model. There are a number of assumptions included in the ART3 model which may have an effect on the levels of demand forecast to use SH16 and the Waterview Connection in the future years. Analysis has been undertaken into the effect of two of these assumptions as follows:

- Traffic Demand Management (TDM); and
- Fuel Price (pump price).

The results of this analysis are presented in the following sections.

8.1.1 Travel Demand Management

TDM covers a wide range of measures, such as travel plans or an increase in home working.

The current preferred RLTS option in the ART3 model assumes a "medium level" of TDM is in place. To assess the impact of the assumptions made in the models, the ART3 model was run using the latest RLTS preferred option, with and without TDM to assess its impact on the WRR. Analysis was then undertaken both at a total regional level (matrix totals) and also at a sector level, using the ten sector system previously discussed in **Chapter 6**. **Table 8.1** displays the results of the regional analysis.

Table 8.1 – Regional Analysis of TDM

	RLTS Preferred Option no TDM	RLTS Preferred Option With TDM	Change
AM	665,200	610,900	-54,300 (-9%)
IP	644,200	596,200	-48,000 (-8%)
PM	719,500	662,000	-57,500 (-9%)
Daily	7,715,100	7,097,100	-618,000 (-9%)

Table 8.1 shows that at a regional level, the implementation of TDM reduced the overall number of trips in the Auckland region by 9%. As may be expected, the inter-peak experiences a lower level of reduction than the AM and PM peaks, due to TDM being focused on 'work' trips, education and community-based initiatives, which primarily occur in the AM and PM peaks.

Further analysis has been undertaken at the sector level (discussed in **Section 6.5**), this is shown in **Table 8.2**, concentrating on movements to and from Sectors 5, 7 and 8, Avondale, Herne Bay/Mt Eden and Hillsborough/Mt Roskill, (thought to be those most representative of the study area), with full sector to sector results shown in **Appendix I.**

Table 8.2 – Sector Analysis of TDM (total trips for Sectors 5, 7 and 8)

	RLTS Preferred Option no TDM	RLTS Preferred Option With TDM	Change
AM	249,700	225,500	-24,500 (-11%)
IP	235,900	215,100	20,800 (-10%)
PM	249,800	226,100	23,700 (-10%)
Daily	2,787,400	2,522,400	-265,000 (-10%)

Table 8.2 shows the following:

- The effects of TDM appear to be slightly greater in the study area than is observed in **Table 8.1** at the regional level;
- There is a 10% reduction in trips to/from the study area with TDM in place;

- Without TDM, the flow on SH20 may be 10% higher (91,000) per day in 2026), which would still mean that the 6-lane facility would operate within capacity although with more pressure on the feeder routes; and

- It is expected that due to its nature, TDM will have a greater effect on short trips, therefore the effect on the study area may be more influenced by trips internal to the study area than is reflected at the regional level which may take greater account of longer trips.

8.1.2 Fuel Price

The ART3 model contains assumptions relating to fuel price. Fuel price in this case means the pump price for fuel. The following pump prices have been included (all in $2006):

- 2006 - $1.55/litre;

- 2016 - $2.38/litre; and

- 2026 - $2.75/litre.

A sensitivity analysis was undertaken with the fuel price for 2026 being lowered to the 2006 price (that is $1.55/litre)

As with TDM, analysis was then undertaken at both the regional level (matrix totals) and the ten sector level.

Table 8.3 - Regional Analysis of Fuel Price

	Existing forecasts	No increase in fuel price	Change over existing forecasts
AM	608,400	622,200	13,800 (2%)
IP	596,000	617,900	22,000 (4%)
PM	660,700	719,500	58,800 (9%)
Daily	7,078,100	7,467,600	389,500 (6%)

Table 8.3 shows that at a regional level, the lower fuel price increases the overall number of trips in the Auckland region by 6% at a daily level. The PM peak experiences the greater increase in trips, this may be due to more trips occurring in the PM peak than in the other two peaks, and also the fact that more long distance trips occur in the PM peak.

Further analysis has been undertaken at the sector level (discussed in **Section 6.5**), this is shown in **Table 8.4**, concentrating on movements to and from Sectors 5, 7 and 8, Avondale, Herne Bay/Mt Eden and

Hillsborough/Mt Roskill, (thought to be those most representative of the study area), with full sector to sector results shown in **Appendix J.**

Table 8.4 – Sector Analysis of Fuel Price (total trips for Sectors 5, 7 and 8)

	Existing forecasts	No increase in fuel price	Change over existing forecasts
AM	223,300	230,000	6,700 (3%)
IP	215,000	224,400	9,400 (4%)
PM	224,900	249,800	24,900 (11%)
Daily	2,505,300	2,674,700	169,400 (7%)

Table 8.4 shows the following:

- The effects of fuel price appear to be similar in the study area to those observed in **Table 8.3** at the regional level;
- There is a 7% increase in trips to/from the study area with a lower fuel price – this would mean the SH20 Waterview Connection would be forecast to carry 88,000 vehicles per day –within its capacity; and
- It is expected that the impact of fuel price is seen to have a greater effect on long distance trips which may be trips travelling through the study area on the completed Waterview Connection rather than internal trips.

8.2 Regional Network Assumptions

Two major infrastructure schemes are planned for the Auckland Region which may have an effect on the Waterview Connection and SH16, these being the proposed additional Waitemata Harbour Crossing and the Auckland CBD rail loop. Although these projects are thought to be outside of the 2026 time line for the majority of analysis undertaken for the WRR project, it is considered important nevertheless to understand their impact. The ART3 model has been run both with and without the additional Waitemata Harbour Crossing and CBD rail loop (these tests have been undertaken independently from each other), for the year 2041. The results of these tests are presented in the following sections.

8.2.1 Additional Waitemata Harbour Crossing

In 2008, a joint project between Auckland City Council, the ARC, ARTA, North Shore City Council and NZTA identified a preferred option for an additional transport link across the Waitemata Harbour between Auckland CBD and the North Shore. The benefits of the project have been identified as[10]:

[10] Taken from www.nzta.govt.nz

- A connected and cohesive transport system to support economic growth in the region;
- More opportunities for walking, cycling and passenger transport;
- Improved access and more reliable travel times across the harbour linking the North Shore to Auckland CBD and beyond;
- Ease congestion on the Auckland Harbour Bridge; and
- Increased resilience of the state highway network.

The recommended option comprises four tunnels, two for road and two for rail, catering for separate north and southbound travel located to the east of the Auckland Harbour Bridge. CMJ would link to the northern motorway; while the suburban rail network could in future be extended northward form the Auckland central business district to the North Shore.

Although, as discussed previously, this project is thought to be outside of the 2026 time line of the main assessment contained in this report, it is important to understand the projects impact on the Waterview Connection. The ART3 model was run for the year 2041, with and without the additional Harbour Crossing (all other assumptions remained the same).

Table 8.5 shows the difference in flow for the AM peak period for a selection of links without and with the additional Harbour Crossing. Plots showing actual flows can be seen in **Appendix K**. In **Table 8.5**, AHC stands for Additional Harbour Crossing.

Table 8.5 – 2041 Peak period (2 hour) flows, with and without the Additional Harbour Crossing

Location	Dir	AM			Inter-peak			PM		
		No AHC	With AHC	Change	No AHC	With AHC	Change	No AHC	With AHC	Change
SH16 Rosebank Road to Great North Road	E/B	13,900	13,600	-300 (-2%)	11,900	11,900	0 (0%)	9,600	9,600	0 (0%)
	W/B	9,500	9,500	0 (0%)	10,700	10,600	-100 (-1%)	12,500	12,400	-100 (-1%)
SH16 Great North Road to St Lukes	E/B	12,800	12,200	-600 (-5%)	11,000	10,900	-100 (-1%)	8,000	8,200	200 (3%)
	W/B	7,300	7,800	500 (7%)	10,200	10,100	-100 (-1%)	11,400	11,300	-100 (-1%)
SH20 Waterview	N/B	6,200	6,100	-100 (-	6,200	6,100	-100 (-	6,000	6,000	0 (0%)

Connection				2%)			2%)			
	S/B	4,900	5,000	100 (2%)	6,000	6,000	0 (0%)	4,700	4,800	100 (2%)

Table 8.5 shows that the Additional Harbour Crossing is not expected to have a noticeable effect on the Waterview Connection, as the increase in flows as a result of the project is expected to be below 8% in all three peaks – for the majority of links in the above table it is expected to be an increase of 3% or less. In a number of cases shown in the above table there will actually be a reduction in flows on the Waterview Connection as a result of the Additional Harbour Crossing although these are expected to be minor (less than 5%).

This analysis does not mean that some traffic using the Auckland Harbour Bridge does not also use SH20, as shown in **Figure 8.1**.

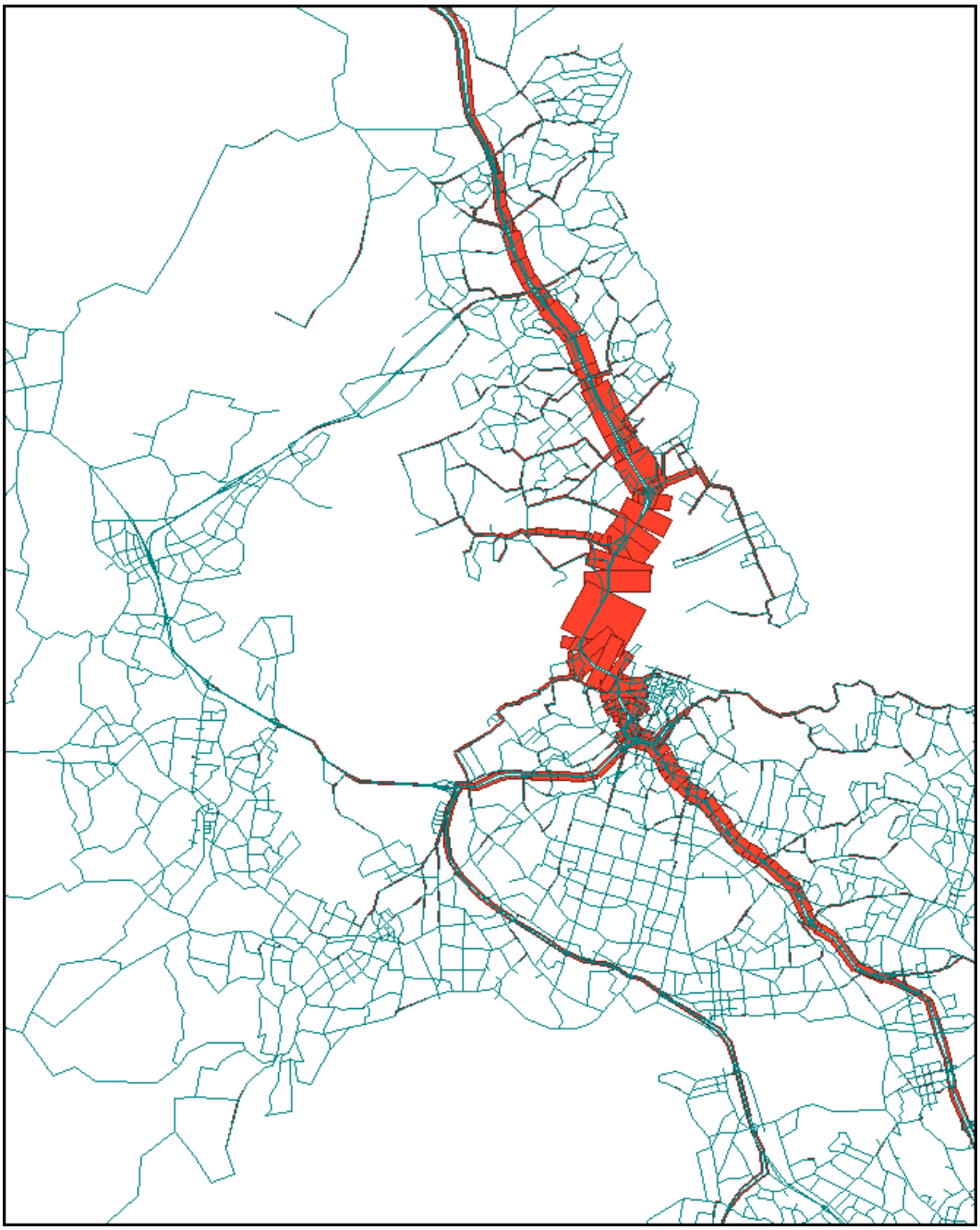

Figure 8.1 – 2026 AM Peak users of Auckland Harbour Bridge

Figure 8.1 shows that of the forecast 26,000 users of Auckland Harbour Bridge in the (2-hour) AM peak in 2026, 1,700 (7%) also use the SH20 extension section of the Waterview Connection. In the PM peak, there are forecast to be 24,000 users of the Harbour Bridge, of which 800 (3%) also use the SH20 extension section of the Waterview Connection. The vehicles using the Auckland Harbour Bridge and the SH20 extension section of the Waterview Connection use the east facing ramps of SH20.

It should be noted that this analysis is indicative only. There are still uncertainties surrounding the final form of the Additional Harbour Crossing and its connections both north and south of the Waitemata Harbour. This

comparison was conducted to ensure that the final design of the Waterview Connection (particularly the SH20 extension section) is not compromised by the exclusion of the Additional Harbour Crossing in the analysis of the Waterview Connection reported in earlier sections of this report and in the Technical Report G.18: *Assessment of Transport Effects*.

8.2.2 Auckland CBD Rail Loop

In 2009 a preferred route was identified for Auckland's proposed CBD Rail Loop tunnel. It is proposed that the tunnel will run between Mt Eden and the Britomart, taking in Khyber Pass Road, Symonds Street and Karagahape Road, with the opportunity for three train station locations at Symonds Street/Khyber Pass Road; Karangahape Road/Pitt Street and on Albert Street between Victoria and Wellesley Streets.

The benefits of the project have been identified as:[11]

- The CBD loop, made possible by the Government's decision to electrify Auckland's rail network, has the potential to be a transformational project for the region, providing significant economic, social and environmental benefits, as well as revitalising the CBD and giving Auckland a truly international feel;

- It will provide easy pedestrian access to all the CBD's commercial, tourist, residential and educational amenities;

- The proposed tunnel will allow more train movements, by unlocking the capacity constraint of the Britomart (developing Britomart into a through station);

- The CBD Loop Tunnel will unlock the potential of Auckland's rapid transit network, making the tunnel as important to the rail system as the CMJ is to the motorways; and

- The proposed tunnel is regarded is a key element in future transport infrastructure for Auckland by increasing capacity across the entire rail network, bringing the rail network into the heart of th city and stimulating economic development by reducing traffic congestion.

Although, as discussed previously, this project is thought to be outside of the 2026 time line of the main assessment contained in this report, it is important to understand the projects impact on the Waterview Connection. The ART3 model was run for the year 2041, with and without the CBD Rail Loop (all other assumptions remained the same).

The below table (**Table 8.6**) shows the difference in flow for the AM peak period for a selection of links without and with the CBD Rail Loop. Plots showing the actual flows can be seen in **Appendix L**.

[11] www.arta.co.nz

Table 8.6 – 2041 Peak period (2 hour) flows, with and without the CBD Rail Loop

Location	Dir	AM			Inter-peak			PM		
		No CBD Rail Loop	With CBD Rail Loop	Change	No CBD Rail Loop	With CBD Rail Loop	Change	No CBD Rail Loop	With CBD Rail Loop	Change
SH16 Rosebank Road to Great North Road	E/B	13,700	13,900	200 (1%)	12,000	11,900	-100 (-1%)	9,600	9,600	0 (0%)
	W/B	9,500	9,500	0 (0%)	10,900	10,700	-200 (-2%)	12,700	12,500	-200 (-2%)
SH16 Great North Road to St Lukes	E/B	12,500	12,800	300 (2%)	11,000	11,000	0 (0%)	8,100	8,000	-100 (-1%)
	W/B	7,300	7,300	0 (0%)	10,400	10,200	-200 (-2%)	11,400	11,400	0 (0%)
SH20 Waterview Connection	N/B	6,200	6,200	0 (0%)	6,100	6,200	100 (2%)	6,100	6,000	-100 (-2%)
	S/B	5,000	4,900	-100 (-2%)	6,100	6,000	-100 (-2%)	4,800	4,700	-100 (-2%)

It is expected that the addition of the CBD rail loop would, if anything, result in slight reductions in flow on the Waterview Connection as a result of a mode shift to public transport. **Table 8.6** shows that the CBD Rail Loop does not appear to have a noticeable effect on the traffic forecast on the Waterview Connection. In most cases, as may be expected, it is demonstrated that there will actually be a slight reduction in flows in all three peaks, although, again this is negligible.

It should be noted that this analysis is indicative only. There are still uncertainties surrounding the final form and connectivity of the CBD rail loop. This comparison was conducted to ensure that the final design of the Waterview Connection is not compromised by the exclusion of the CBD Rail Loop in the analysis of the Waterview Connection reported in earlier sections of this report and in the Technical Report G.18 *Assessment of Transport Effects*.

9. Summary

In 2009 the NZ Transport Agency confirmed its intention that the 'Waterview Connection Project' would be lodged with the Environmental Protection Authority as a Project of National Significance. The Project includes works previously investigated and developed as two separate projects: being the SH16 Causeway Project and the SH20 Waterview Connection. The key elements of the Waterview Connection Project are:

- Completing the Western Ring Route (which extends from Manukau to Albany via Waitakere);
- Improving resilience of the SH16 causeway between the Great North Road and Rosebank Interchanges to correct historic subsidence and "future proof" it against sea level rise;
- Providing increased capacity on the SH16 corridor (between the St Lukes and Te Atatu Interchanges);
- Providing a new section of SH20 (through a combination of surface and tunnelled road) between the Great North Road and Maioro Street Interchanges; and
- Providing a pedestrian / cycle way throughout the surface road elements of the Waterview Connection Project corridor.

This report details the future year traffic modelling that has been undertaken in both the project assignment model and the operational traffic model developed for the assessment of the Waterview Connection Project. These models form part of a hierarchy of models used for the project, comprising the Auckland Regional Council's multi-modal strategic demand model, a detailed project assignment model, and localised operational models for the more detailed consideration of design and operational issues.

This report is a technical reference describing the inputs and outputs of the traffic modelling undertaken. The detailed assessment of effects on the transport system is based on these modelling results but is reported separately.

This report provides an overview of the modelling process and extensive model outputs. Key outcomes of the modelling include the following forecasts (the interpretation and explanation of these results is contained in the Technical Report G.18: *Assessment of Transport Effects*.):

- With the project in place, traffic on SH16 (Westgate to Newton Road) is forecast to increase by up to 26% in 2026 compared to the situation if the Waterview Connection is not completed;
- In 2026, the SH20 extension section (Maioro Street to Great North Road) of the Waterview Connection is forecast to carry around 83,000 vehicles per day;
- The vehicle kilometres travelled (VKT) on local and arterial roads is forecast to decrease by 2% across the Greater Auckland Region and up to 6% in the study area with the completion of the project. There is a predicted corresponding increase in VKT on the motorways (up to 6% across the Greater Auckland Region

and up to 32% in the study area) as a result of the completion of the Waterview Connection (compared to a no project scenario);

- Similarly the amount of heavy vehicle traffic on local and arterial roads is expected to decrease by 5-8%;

- There is a projected decrease in flow on many of the arterial roads around the project. Travel times on district and regional arterial roads are either lower or largely unchanged as a result of completing the Waterview Connection; and

- With the extra traffic attracted to the Waterview Connection, there are some localised movements or locations with a predicted increase in delay, however, in general, travel conditions on SH16 are expected to be improved over current conditions, even with the significant increase in traffic that the scheme is forecast to accommodate.