NZ MUGS Research: Transport Predictions compared with Actual Observations (Predicted vs Actual)

Preliminary Investigation Findings

PREPARED FOR NZ Modelling User Group | April 2023

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Stantec

Revision schedule

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1 Research Overview

1.1 Background and Key Objectives

The Predicted Versus Actual research project is a desktop exercise to review transport modelled predictions of project outcomes against observed data records post-project opening.

There are two objectives of this research; to determine the feasibility of carrying out an assessment of this nature and to examine the outcomes from the selected projects to determine any trends, findings, outcomes which are of value to the Transport Planning / Modelling Industry.

1.2 Preliminary Research Stage

This is research report covers an initial preliminary stage. A smaller number of projects have been identified where observed data is somewhat readily available. The aim of reviewing this sub-set of projects is to determine whether a more significant research undertaking may be worthwhile and/or the general feasibility of the broad method used in the project reviews.

This research has deliberately been broad to catch a range of types of models.
While not a detailed post implementation review, it seeks to offer an ability to review the effectiveness of past work and enable lessons learnt to improve the future work. These reviews have been done at a high level and conducted in a manner in which either strong outcomes can be identified and/or lessons can be learnt to improve future performance, not to apportion blame.

This preliminary research phase has been carried out by Stantec for the NZ Modelling User Group (MUGs).

1.3 Predictions Assessed

The following predictions have been assessed:

- Halswell Junction Road Roundabout Metering: Travel time predictions
- Mackays to Peka Peka: Traffic volumes and travel time predictions
- Hutt Road Sustainable Transport: PT patronage, journey time and cyclist volumes predictions
- Te Ara Kahikatea – Whakatu Arterial: Traffic volumes
- Transmission Gully: Adjacent Road network traffic volumes and travel time predictions
- Waterview Tunnel: Traffic volumes predictions
- Christchurch Southern Motorway Stage 2: Traffic volume predictions
- Basin Bridge: Do min accuracy

Should there be future work it is suggested that projects that make predictions relating to public transport patronage and travel times (both vehicle and public transport) are evaluated, along with the adjacent road network. Further review of active mode predictions may also prove valuable given the increased focus on active modes under current transport policy and growing inclusion within-in transport models.

2 Research Methodology

2.1 Broad Approach

This work was a desktop exercise which found documented and specific modelled values for volumes or travel times which was then compared to a reported actual value. Sources were typically evidence for the projects the modelling work was about, with actual values coming from a range of sources such as TMS, Bluetooth monitoring or a survey for informing more modelling work.

2.2 Traffic Growth Assumptions

With predictions for future states being limited to a few future years, it is rare that predictions are available for a year where data is precisely available. While predictions for all 'future' states are reported, when interpolating the predictions, linear growth was assumed between the two bounding years.

When a major project opened, it was desired to avoid using traffic data from the year it opened where possible. However, this was not always possible and there were times where a full years data was not used. This is shown in Figure 2-1.

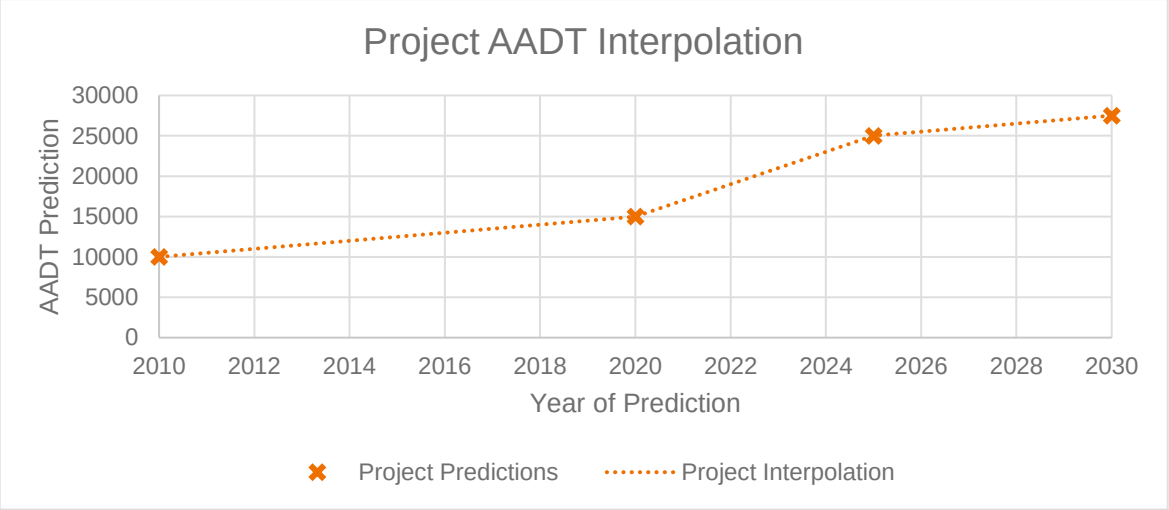

Figure 2-1: Linear interpolation used for estimating predictions

When a project opened after a predicted year where the project was expected to be open, it was assumed that the overall transport demand remained the same and a linear interpolation was still valid.

If predictions are only available in the future, they have been noted.

2.3 Data Collected

When reviewing publications relating to the model and its predictions, the key information about the basis of prediction was collected, this included:

- Software platform
- Parent model if applicable
- Year of base model
- Supplementary data where applicable

It was noted that not all of these fields were relevant to all models, i.e. active mode predictions typically used spreadsheet based estimations.

The project also needed to make some predictions about the impact, this was interpreted to be quite wide and included things such as:

- Traffic volumes
- Travel times on identified routes
- Number of active users

Within this model, there were no specific public transport related projects which made specific and reportable predictions for inclusion and is a known weak point of this particular initial phase of research.

3 Model Summaries

3.1 Springs Road / Halswell Junction Road Roundabout Metering

3.1.1 Project Overview

The Springs Road Roundabout modelling work took an existing Paramics Microsimulation model of the study area and applied this model to evaluate the effectiveness of a roundabout signal meter at the Springs Road / Halswell Junction Road roundabout.

The project was located in southwest Christchurch as shown in Figure 3-1.

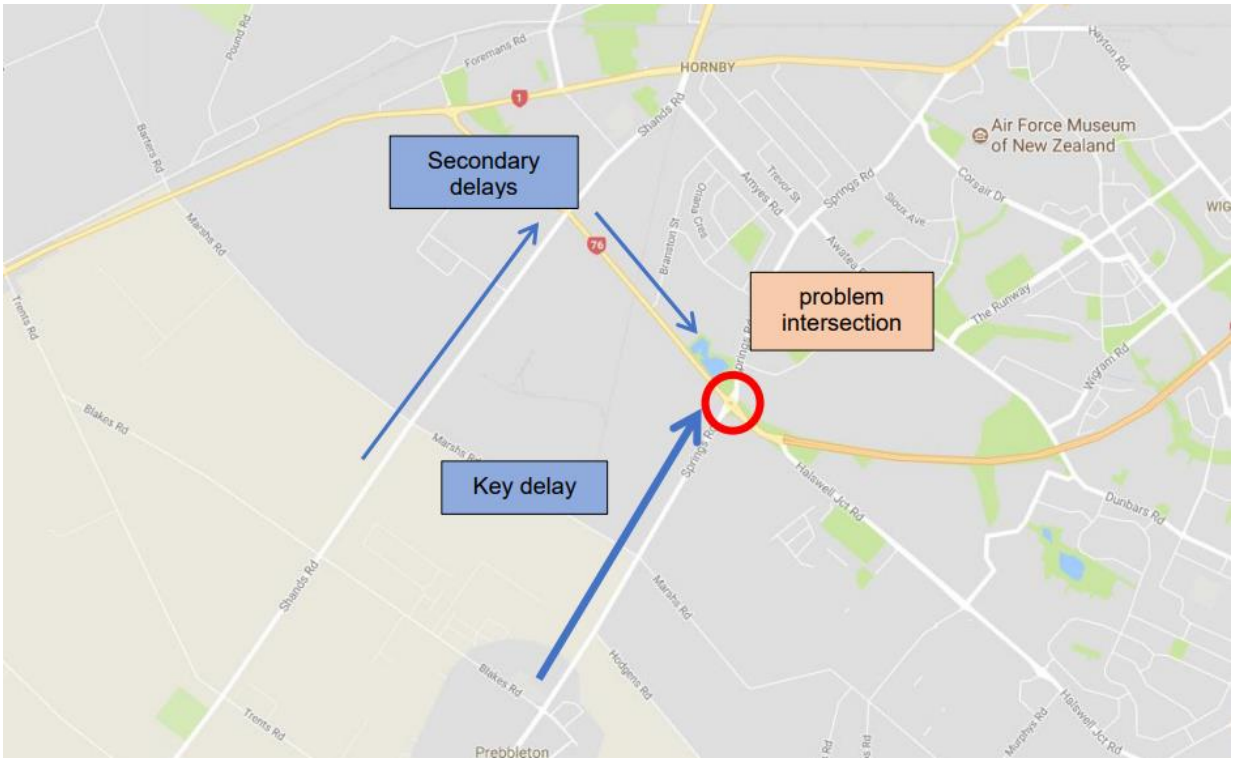

Figure 3-1: Roundabout modelling project area

Due to the imbalance in traffic flows, there were significant delays on some approaches to the roundabout, this also included an adjacent roundabout.

3.1.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in Table 3-1.

Table 3-1: Springs Road Roundabout Model Key Information

General	**Project Name**	**Halswell Junction Road Roundabout Metering**
	Project Type	Low cost low risk
	Project Physical Works Budget	$185,000

	Year Constructed	2017	
	Year of prediction compared to actual	2017	
	Outcome Sought by Model	Predict the value of travel time savings along Springs Junction Road following the installation of metering signals to prevent excessive delays caused by flow imbalance on a roundabout approach	
Model Inputs	Type of Model	Microsimulation	
	Project Specific Model	No – the model was adapted from an existing microsimulation model within the area	
	Software Used	Paramics	
	Traffic Matrix	Yes	Christchurch Transportation Model
	Traffic Counts	Yes	September 2016
	Travel Times	Yes	Bluetooth from CTOC system PT Service times
Key Outputs	Volumes Critical	No	The focus of this work was about reducing delays
	Travel Times Critical	Yes	As this was about reducing travel times

3.1.3 Predicted vs Actual Outcomes

The project aimed to reduce travel times through the roundabout, while anticipating minor disbenefits to the metered road. The key links were Springs Road Northbound and Shands Road Northbound in the morning peak. Before data was only provided by weekday, Monday data has been replicated below. Modelled data for the before scenario was not provided.

Table 3-2: Predicted travel times on key approaches

Location	Actual Travel Time Before	Modelled Travel Time After	Actual Travel Times After
Springs Road, northbound at 8am	16min	7min	8min
Shands Road, northeast bound at 8am	14.5min	5.5 min	4min

In addition to the noted travel times here, it was noted that modelled and observed data presented a range of travel times (min / max / average).

This application of a Microsimulation model to a limited area was found to be highly effective in the short term. While long term behaviour was not modelled or predicted, it is noted that the assessment of the intervention focused only on the specific roundabout which was the focus of the intervention, not wider transport aspects within the model.

3.1.4 Assessment of Modelled Predictions

Overall, the use of a microsimulation model to understand the scale of travel time changes to users in this example was highly effective. While the benefits were underpredicted, the use of a model here can be considered a success as the modelling robustly identified key project outcomes and assisted decision makers effectively.

3.2 Mackays to Peka Peka

3.2.1 Project Overview

The Mackays to Peka Peka expressway was a Road of National Significance delivered as part of the Wellington Northern Corridor. The modelling relied on the SATURN Kāpiti Traffic Model v2, which was informed by the Wellington Strategic Model.

The project was located within the Kāpiti District, and its location within the Wellington Northern Corridor is highlighted in orange in Figure 3-2.

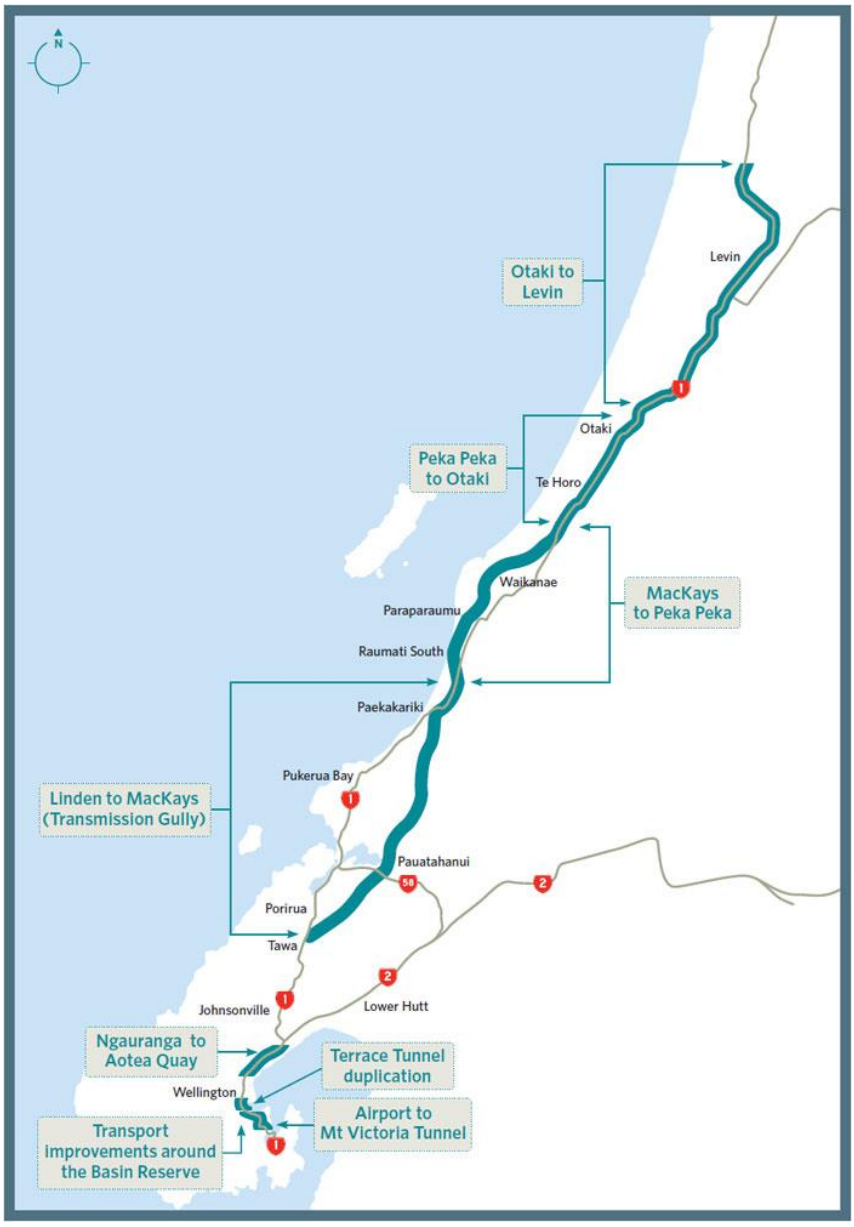

Figure 3-2: MacKays to Peka Peka Project area

The project was reviewed 2018 due to flows being higher than modelled flows, causing concerns about meeting noise related resource consents which were based on these values.

3.2.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in Table 3-3.

Table 3-3: MacKays to Peka Peka model key information

General	**Project Name**	**Mackays to Peka Peka**	
	Project Type	**Road of National Significance**	
	Project Physical Works Budget	$680,500,000	
	Year Constructed	2017	
	Year of prediction compared to actual	2018	
	Outcome Sought by Model	Inform economic analysis and matters relating to the resource consents	
Model Inputs	Type of Model	Deterministic traffic assignment model	
	Project Specific Model	Partial – the model was adapted from an existing district traffic model within the area but used specifically for the project	
	Software Used	SATURN	
	Traffic Matrix	Yes	Wellington Traffic Strategy Model
	Traffic Counts	Yes	2006 base year
	Travel Times	Yes	Assumed
Key Outputs	Volumes Critical	Yes	To inform economics and resource consents
	Travel Times Critical	Yes	A key project objective was to reduce travel times

3.2.3 Predicted vs Actual Outcomes

The project aimed to improve safety, reduce travel times through the district and improve travel time reliability. Traffic data has been sourced and compared to the modelled traffic volumes on the old and new highway. Travel times along the old and new highway are presented in Table 3-4.

Table 3-4: MacKays to Peka Peka travel times

Location	Actual Travel Time before	Modelled Travel Time After (2026)	Actual Travel Times After
M2PP Expressway	N/A	9.4 mins	8-10 mins
Old SH1	12-17 mins average 22 mins peak PM peak worse than AM	13 mins (AM Peak) 13-14 mins (PM Peak)	9-15 mins AM 8-13 mins PM

The model appears to have relatively accurately predicted the travel times in both the before and after for both the expressway and original highway. While this is using travel times from recently after the projects opening, due to roadworks on the old SH1 and the revocation project this is reasonable.

Traffic Count comparisons between the 2016 model and 2017 as well as a linear interpolation for 2022 are presented below in Table 3-5.

Table 3-5: Kāpiti modelled and actual traffic volumes

Location	2022 Modelled (Linear Est.)	2022 Actual	Difference
M2PP between Poplar and Kāpiti	13,200	20,100	-6,900
M2PP between Kāpiti and Waikanae	19,100	24,600	-5,500
Old SH1 – South of Kāpiti Road	20,500	9,300	11,200
Old SH1 – Lindale	14,100	8,800	5,300
Old SH1 – North of Elizabeth Street	8,500	6,900	1,600

It should be noted that some of the traffic counters used to inform the 2022 actual between Waikanae and Peka Peka did not appear to be operational, this may have been caused by the pavement rehabilitation works and it is therefore not reported.

Old SH1 south of Kāpiti Road is near where there was significant construction traffic resulting from the revocation works, this may have influenced its traffic counts.

It is also noted that the traffic count site North of Elizabeth Street was very inconsistent year to year.

3.2.4 Assessment of Modelled Predictions

Having noted the above point, the model shows mixed results and has been subject to a review to understand what caused issues with the traffic volume forecasting. This review noted many things, such as;

- discrepancies between highway and local road peak periods causing issues with the modelled periods
- failing to attract the correct amount of traffic onto the expressway
- inadequately predicting the amount of induced traffic
- matrix estimation reducing flows at the northern end of the model

Despite these issues predicting the flow, the travel times on the new and old highway were predicted accurately. This could be due to the extent of the capacity uplift, means that even with the additional vehicles the network can operate effectively.

It is also noted that there is an adjacent expressway which will be operating in a similar environment and the same district which would have used an updated version of the model. Once traffic patterns on the new Peka Peka to Ōtaki expressway settle, there is an opportunity to see if the updated version of the model has resolved the issues raised in the earlier review.

This model has not accurately predicted the impact of the new highway in terms of traffic volumes on the new or existing highway. While it has robustly predicted travel times, the model does not appear to be robust for understanding the impacts of the new highway.

3.3 Hutt Road Sustainable Transport Report

3.3.1 Project Overview

The Hutt Road Sustainable Transport Report evaluated and consolidated predictions about public transport, walking and cycling along the Hutt Road. It also noted the impacts of projects such as Te Ara Tupua.

The Wellington CBD to Ngauranga section of Te Ara Tupua, known as the Hutt Road Cycleway is a key cycleway connecting the CBD Ngauranga junction where cyclists can reach the northern suburbs or the Hutt Valley via the existing highway, and eventually connect to the under construction Ngā Ūranga to Pito-one section. It had a range of active mode and PT

The project differs to other predictions due to its use of research based cycleway forecasting. In line with the research is the use of four stage modelling for PT predictions. It's location within the wider network is outlined in Figure 3-3.

Figure 3-3: Project area for the Hutt Road Cycleway

The central section of the Wellington CBD to Ngauranga cycleway was completed in 2018. The northern and southern sections are being completed as part of the Let's Get Wellington Moving Progamme. At the time of writing, the Ngā Ūranga to Pito-one and Pito-one to Melling sections are under construction.

3.3.2 Overview of Project Modelling

Key information about the forecasting parameters and project are outlined in Table 3-6.

Table 3-6: Te Ara Tupua prediction summary

	Project Name	Hutt Road Sustainable Transport (inc Te Ara Tupua)
General	Project Type	Walking & Cycling
	Project Physical Works Budget	$360M Costs of Hutt Road Shared Path not confirmed
	Year Constructed	2018
	Year of prediction compared to actual	2018
	Outcome Sought by Model	Inform economic analysis and design requirements for facility
Model Inputs	Type of Model	Cycle Forecasting based on RR 340 PT Patronage based on 4 stage model
	Project Specific Model	Cycling Yes – but based on spreadsheet models PT No
	Software Used	Excel EMME
	Traffic Matrix	Generated
	Traffic Counts	Yes Cordon survey to 2014

	Travel Times	No	
Key Outputs	Volumes Critical	Yes	To inform economics and design requirements
	Travel Times Critical	No	

3.3.3 Predicted vs Actual Outcomes

The project aims to increase the cycling level of service, infrastructure, uptake, safety and improve transport choices as well as improve the public transport experience.

Public transport forecasts for this section of the corridor were informed by WTSM which indicated limited growth. This was expected to grow PT patronage at 1.7% per annum for the 2011-2031 period. Due to the impacts of the Wellington Bus Network Change, Covid and bus driver shortage, PT patronage has been reducing within the wider network. For illustration, the total weekly patronage[1] of all services using Hutt Road from 2018-2023 is presented below in Figure 3-4.

Commentary that follows focusses on the pre-Covid period, 2011-2019.

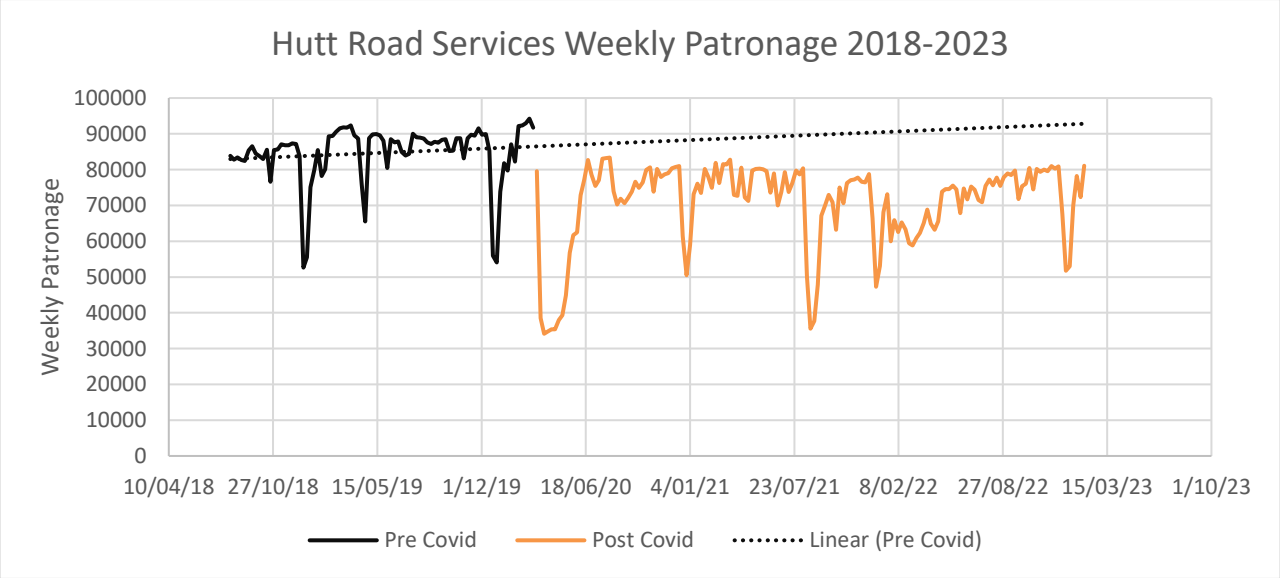

Figure 3-4: Weekly Patronage (including half Bus #1) along the Hutt Road

Prior to covid, patronage was growing at a rate of 2.6% compared to the forecasted growth of 1.7% inferred from the regional model. I.e. the modelling underpredicted PT patronage levels.

The report monitored bus performance over a 3 month period prior to publishing around 2016. The findings of the southbound AM peak against a week from March 2023 are outlined below. Specific definitions were not provided for average best trip or average worst trip.

[1] Includes half the patronage of the #1 service as the services serves both north and south of the CBD.

Table 3-7: Comparison between reported and current journey times (to check predicted 'stable' travel times)

Trip Type	2016 Reported	2023 Observed
Average	-	09:05
Max	26:35	12:46
Min	05:36	06:27
Median	-	08:46
Average best	06:28	-
Average worst	11:31	-

It can be seen that while the week evaluated in 2023 did not have the same significantly delayed service(s), there seems to be a change to the pattern of journey times, with more consistent travel times. The median being lower than the average indicates that when travel times are delayed, they are likely to be at the higher limit to increase the average. Without a clear definition of average best and average worst, it is hard to properly compare, but the average best travel time being similar to the 2023 fastest indicates that the fastest journeys are now slower, but the travel times are more consistent, noting the short time period for 2023 which was observed.

As the completed section of the cycleway is only part of a wider corridor and therefore the full forecasts may not be present.

The Hutt Road Sustainable Transport Report referred to the 2015 work detailed below but established a more refined basis for cyclists predictions.

- In 2015 the detailed business case for the Melling to Wellington CBD route noted that there was:
- About 480 cyclist and pedestrian trips daily between the Hutt Valley and Wellington. With investment in a fully separated cycleway this would be increased by:
- 280 commuter cyclists and 65 tourism related cyclists
- A growth rate of 6% per annum for the first 10 years and 3% onwards after that.
- These predictions were based on the forecasting procedure presented in McDonald, A et al (2007) Estimating demand for new cycling facilities in New Zealand, Research Report 340, Land Transport New Zealand.

The 2021 Estimate has been estimated by means of a linear interpretation between the 2015 and 2031 peak hour figures, however excludes the 100 peak hour cyclists expected from the Ngauranga to Petone section. The cycle counter data has been used for comparison, and is broadly consistent with the WCC 2021 cycle cordon survey.

Table 3-8 outlines the estimated 2021 peak hour demand, along with the 99th percentile and peak hour cycle counts on the Hutt Road both north and south of the Kaiwharawhara intersection 2019, 2021 and 2022. Multiple years have been used to show the variability in the numbers observed by the cycle counters. The 2021 peak hour estimate excludes the step change of 100 cyclists expected in the peak hour due to the Te Ara Tupua construction as that not been completed as expected.

Table 3-8: Cyclist predictions and observations on key sections

Location	Model	Cycle Counter						Diff to 2021 99th %ile	
	2021 Peak Hour (Linear Est.)	99th %ile			Max				
		2020	2021	2022	2020	2021	2022		
North of Kaiwharawhara Road	460	136	124	92	354	226	169	336	271%
Kaiwharawhara to Tinakori Road	650	227	226	173	615*	363	296	424	188%

For Table 3-8, the 99th percentile was picked based on being exceeded in around one third of commuting working days to try reflect fact that some cyclists choose not to cycle on all days for reasons such as poor weather. It is noted that the peak hour in 2020 reflected a protest about the quality of cycling facilities providing in the region, the next busiest hour had 387 recorded cyclists.

3.3.4 Assessment of Modelled Predictions

Bus Patronage prior to covid was underestimated relative to the observed growth in July 2018 to February 2020 (observed growth around 2.6% and modelled growth around 1.7%).

Bus Travel Time were broadly consistent compared to the predicted travel times with a narrower range in the week compared to the observed time.

In terms of predicted cycle volumes, the growth observed and predicted to continue does not appear to have materialised resulting in predictions significantly higher than the observed. This could be in part due to an incomplete network now expected to be completed through the Let's Get Wellington Moving programme and the Te Ara Tupua to the north.

3.4 Te Ara Kahikatea – Whakatu Arterial Link

3.4.1 Project Overview

The Te Ara Kahikatea (Whakatu Arterial link) road was a capital project in the Hastings District aiming to remove Heavy Vehicles from the Coastal Route (SH51) to Napier.

The project was located within the Hastings District, and it linkedSH51 to Pakowhai Road to SH51 with a direct connection to enable easier access to the Hawkes Bay expressway. The project location is in Figure 3-5.

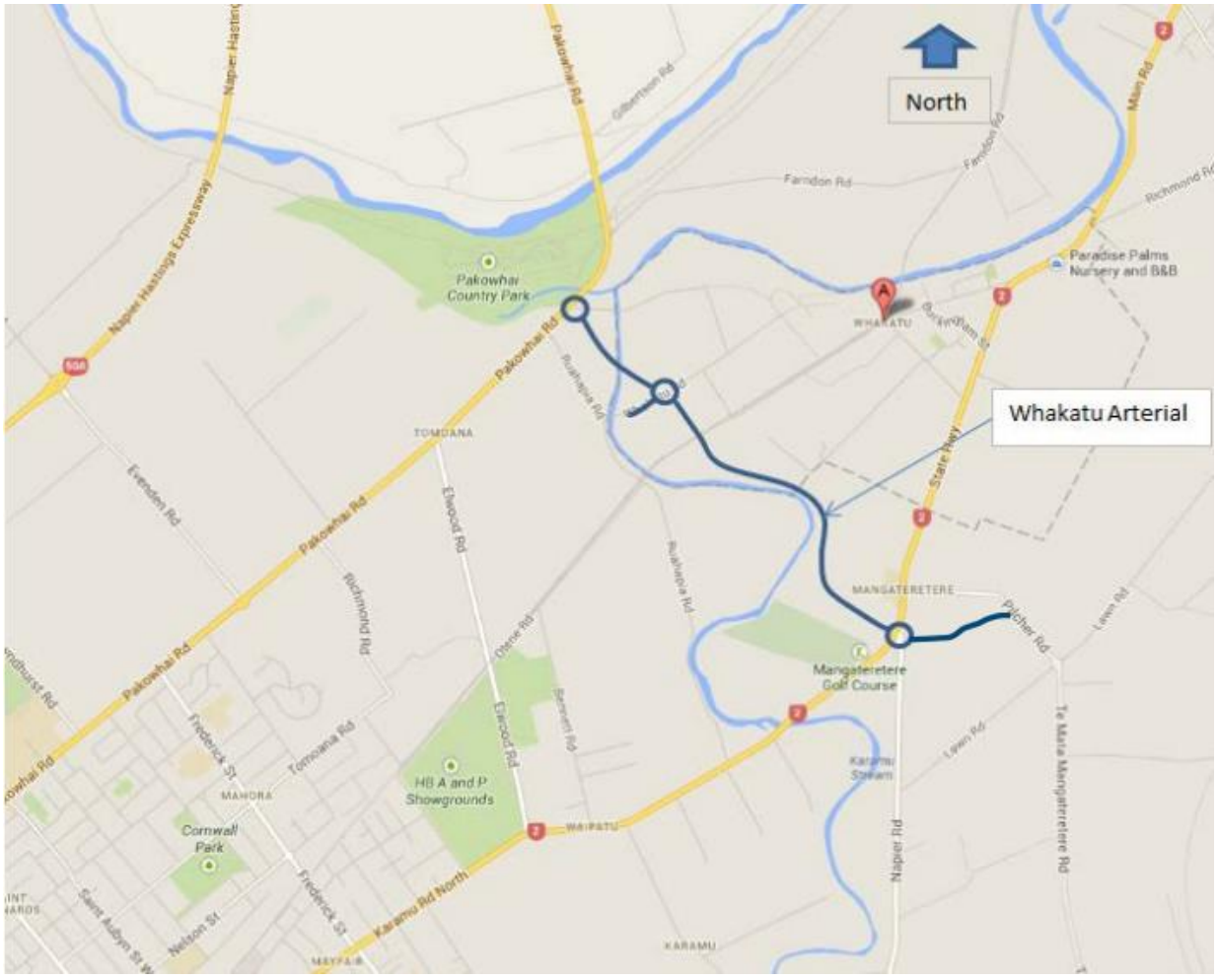

Figure 3-5: Whakatu Arterial Link project area

3.4.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in Table 3-9.

Table 3-9: Whakatu Arterial Link Model;ling Key Information

General	Project Name	Whakatu Arterial	
	Project Type	**Capital**	
	Project Physical Works Budget	$21,700,000	
	Year Constructed	2019	
	Year of prediction compared to actual	2021	
	Outcome Sought by Model	Inform economic analysis and design requirements	
Model Inputs	Type of Model	Project Link Added to Regional Model	
	Project Specific Model	No – the modelling was added to the existing regional transport models	
	Software Used	Cube Voyager	
	Traffic Matrix	Yes	Informed from HPTS Model
	Traffic Counts	Yes	2009 base year
	Travel Times	Yes	Assumed
Key Outputs	Volumes Critical	Yes	To inform economics and resource consents
	Travel Times Critical	Yes	Travel times represented the majority of monetised benefits

3.4.3 Predicted vs Actual Outcomes

The project aimed to improve safety, reduce travel times through the district and improve travel time reliability. Traffic data has been sourced and compared to the modelled traffic volumes on link, Pakowhai Road and SH51.

While travel times were a significant benefit of the project, no specific route predictions could be found to review. A linear interpolation was created from 2009 and 2026 model results. This and actual traffic volumes for the nearby routes are presented in Table 3-10.

Table 3-10: Whakatu Arterial modelled and actual traffic volumes

Modelled	2021 Modelled (Linear)	2021 Actual	Difference	Difference %
Whakatu Arterial North	15700	6500	9200	59%
Whakatu Arterial South	9100	9500	-400	-4%
Pakowhai Road North	10900	13400	-2500	-23%
Pakowhai Road South	14600	15900	-1300	-9%
SH51 North	12000	10100	1900	16%
SH51 South	16900	11300	5600	33%
South of Clive	10100	14000	-3900	-39%

The report highlighted a range of roads in the district which were expected to be influenced by the new link and had a substantial change in traffic.

3.4.4 Assessment of Modelled Predictions

Overall, the predictions had mixed results. The model appears to have overpredicted the impact that the arterial link will have. While predictions to the south on the new route have proved to be reasonably robust, the northern end of the link is vastly underutilised compared to the predicted volume. The modelling predicted less traffic along Pakowhai Road, in both directions but has predicted the SH51 traffic in the vicinity of the new link.

3.5 Te Ara Nui o Te Rangihaeata (Transmission Gully) Impacts

3.5.1 Project Overview

Te Ara Nui o Te Rangihaeata, known as Transmission Gully (TG) was a road of national significant on SH1, bypassing a coastal section of the old SH1 (now SH59). It was modelled in the North Wellington Saturn Model, informed by the Wellington Transport Strategic Model.

While traffic count data on TG is not yet loaded into the TMS system, impacts to SH59 and SH58 are recordable. These are being reported separately due to the impact that other projects were expected to have on SH58.

The project links Wellington, Porirua to the Kāpiti District, and its location within the Wellington Northern Corridor is highlighted in orange in Figure 3-6.

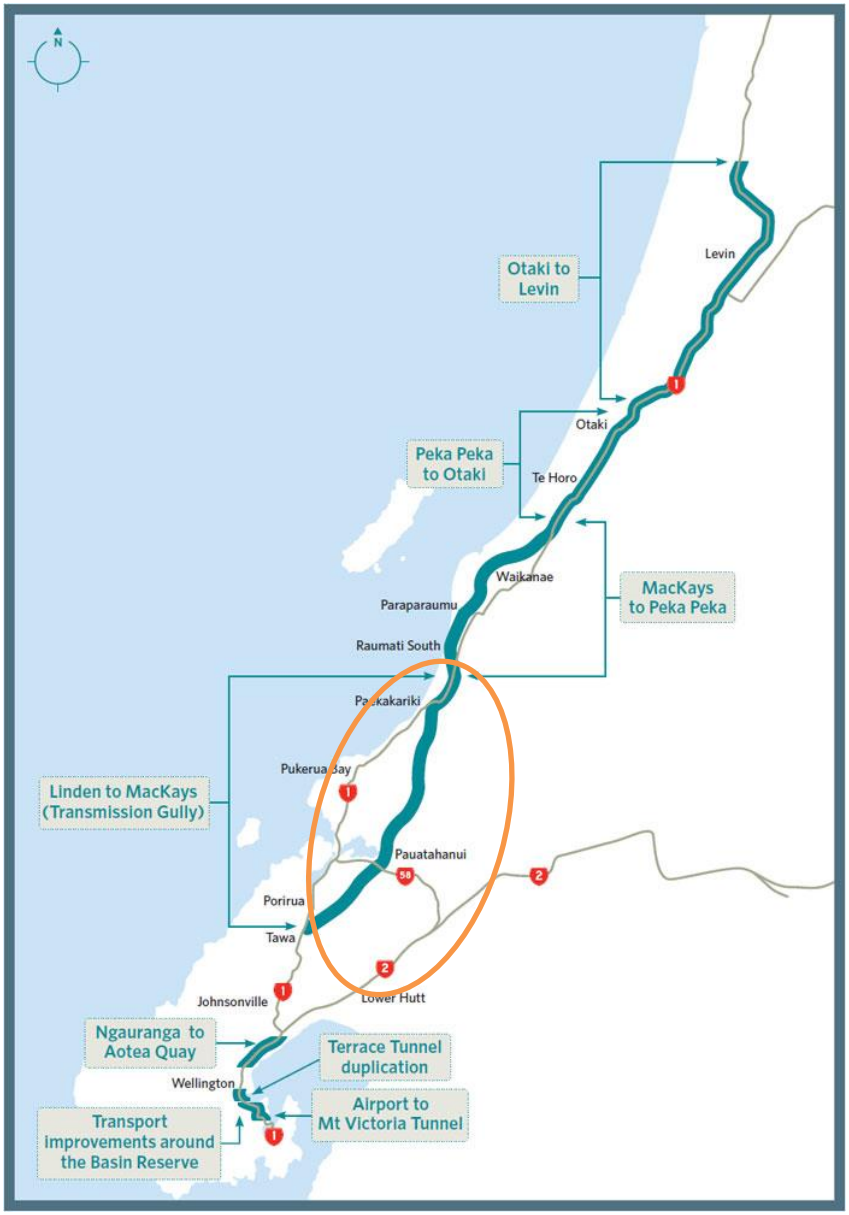

Figure 3-6: Te Ara Nui o Te Rangihaeata (Transmission Gully) project area

Te Ara Nui o Te Rangihaeata opened in March 2022.

3.5.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in **Error! Reference source not found.**.

Table 3-11: Springs Road Roundabout Model Key Information

	Project Name	Te Ara Nui o Te Rangihaeata
General	Project Type	**Road of National Significance**
	Project Physical Works Budget	$1,400,000,000
	Year Constructed	2022
	Year of prediction compared to actual	2022 (latter half)

	Outcome Sought by Model	Inform economic analysis and matters relating to the resource consents	
Model Inputs	Type of Model	Regional Model and Deterministic Traffic Assignment Model	
	Project Specific Model	Partial – the model was adapted from an existing district traffic model within the area but used specifically for the project	
	Software Used	SATURN EMME	
	Traffic Matrix	Yes	Wellington Traffic Strategy Model
	Traffic Counts	Yes	2006 base year
	Travel Times	Yes	Assumed
Key Outputs	Volumes Critical	Yes	To inform economics and resource consents
	Travel Times Critical	Yes	A key project objective was to reduce travel times

3.5.3 Predicted vs Actual Outcomes

3.5.3.1 Travel Time Predictions

Travel times were predicted from the model, however the exact locations of the routes was not easily discernible from the documentation reviewed.

Google travel times were obtained with a departure time of 7:30am. This is presented in Table 3-12.

Table 3-12: Table 3-12: AM Travel time comparisons between 2026 predicted and Google Travel times

Route	Predicted	Google Travel
Linden to MacKays via SH59	25-26	22-28
Linden to MacKays via TG	16-17	16-20
Mackays to Linden via SH59	25	22-26
Mackays to Linden via TG	16-17	16-20
Linden to SH2 via SH59	20-21	20-28
Linden to SH2 via TG	14	16-24
SH2 to Linden via SH59	17-18	18-24
SH2 to Linden via TG	13-14	14-18
Mackays to SH2 via SH59	34	30-45
Mackays to SH2 via TG	18-19	18-26
SH2 to Mackays via SH59	34	30-40
SH2 to Mackays via TG	18-19	18-22

3.5.3.2 SH59 Impacts

Traffic data has been sourced and compared to the modelled traffic volumes on the old and new highway.
As traffic volume predictions were only made in the future years, the 2026 forecasts have been compared to traffic volumes for July 2022-Feb 2023 SH59 which are presented below in Table 3-13.

Table 3-13: SH59 modelled traffic and 2022 observed volumes

Location	With TG 2026	2022 Actual	Difference
Paekākāriki	3,100	6,000	2,900
Mana	20,500	16,300	-4,200
South of Whitford Brown	44,100	38,500*	-5,600

South of Whitford Brown was calculated from counters at Mungavin interchange including on and off ramps between the interchange and the Whitford Brown. The northbound counter was not working and it was therefore estimated by the using the average northbound to southbound traffic ratio in previous years and applied that to the southbound traffic to create an estimate.

Outside of Paekākāriki, the model has overestimated the remaining traffic on SH59. For the traffic estimates near Paekākāriki, it could be that trip redistribution effects have not accurately been estimated by the regional model demand now that accessing the road is significantly easier.

For the Mana and South of Whitford Brown areas, the differences are much less significant, and with additional traffic growth between now and 2026, there is the potential for the gap to reduce further.

3.5.3.3 SH58 Impacts

State Highway 58 has been subject to a large amount of traffic modelling due to both Transmission Gully and the Petone to Grenada Link Road modelling. Later model runs indicated that the opening of Transmission Gully would result in a 'step change' in the traffic volumes.

The impacts to traffic volumes have been significantly varied depending on the time of the prediction and the wider network.

A range of the predicted traffic volumes with and without the Petone to Grenada Link Road (P2G) from a range of models is presented below (the North Wellington Saturn Model (NWSM), and the Regional WTSM model).

Table 3-14: 2021 SH58 predictions from various model runs compared to 2022 Counts

Model	2021 P2G, TG	2021 No P2G, TG	2022 Actual (April Onwards)	Comparison with no P2G
NWSM 2015	17,073	21,909	16,940	4,969
NWSM 2016	16,500	21,000		4,060
WTSM 2011	14,689	20,162		3,222

The traffic volumes observed on SH58 do appear to have had an impact from the opening of Transmission Gully, however, with the disruption to travel patterns from the covid pandemic, it appears this has just been the return to normal, with 2022 from April onwards being remarkably similar to 2019. 2023 has been higher than 2022 so far this year, but is closely following the 2019 traffic pattern. This is shown in Figure 3-7.

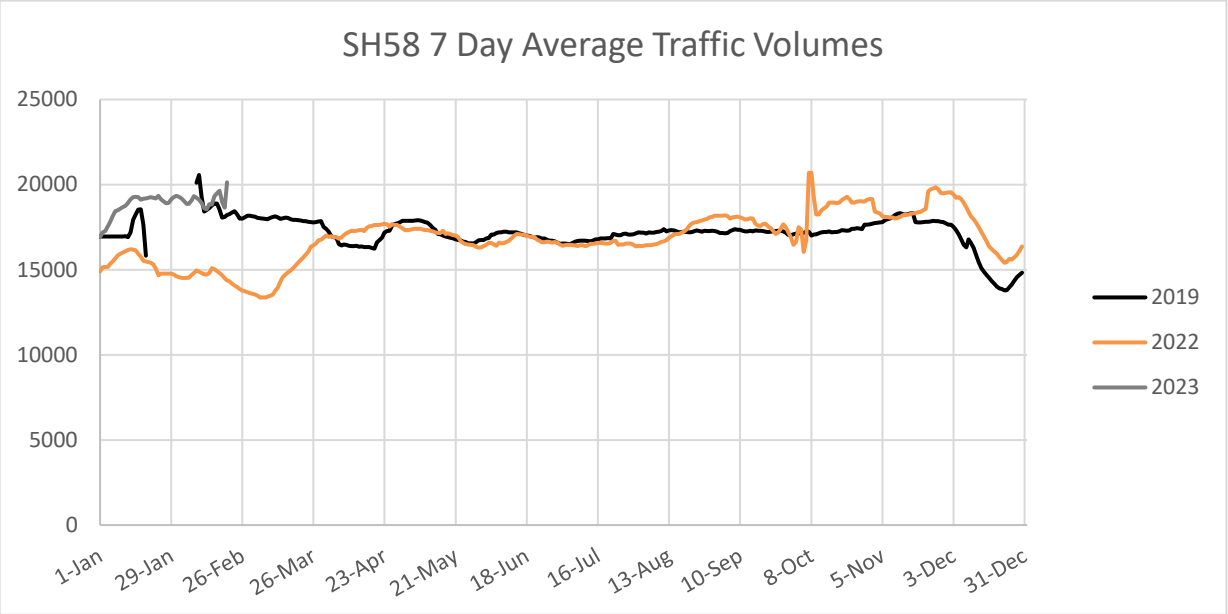

Figure 3-7: SH58 Traffic volumes

3.5.4 Assessment of Modelled Predictions

Overall, the modelling for Te Ara Nui o Te Rangihaeata (TG) had mixed results for estimating the impacts to the wider transport network.

Overall, the travel times along the new highway were accurate. However, the actual travel times along SH59 are subject to much variability which was not noted in the predictions. Should the travel times remain similar over the next few year, it would be fair to conclude the travel times were predicted accurately.

The key findings related to traffic volumes are;

- SH59 in Porirua was minorly overestimated, but the gap will likely reduce further
- SH59 within Kāpiti was significantly underestimated
- SH58 was incorrectly predicted in multiple modelling runs
- Travel times along TG were well estimated, but the alternative routes estimates were on the optimistic side

The traffic modelling can be considered relatively successful, however the traffic volume predictions around SH58 and SH59 at Paekākāriki raise concerns about the ability to accurately estimate the trip redistribution effect from a new and desirable corridor.

3.6 Waterview Tunnel

3.6.1 Project Overview

The Waterview Tunnel was a Road of National Significance delivered as part of the Western Ring Route. The modelling reviewed relied on the Auckland Regional Traffic Model (ART3) and the Project Assignment Model both conducted in EMME.

The project was located within Auckland, and its location within the western inner area is displayed in Figure 3-8.

Figure 3-8: Waterview Tunnel project area

The tunnel opened in 2017. To avoid traffic associated with the novelty of a new tunnel and the covid impacts, 2018 was chosen as the year to review.

3.6.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in Table 3-15.

Table 3-15: Waterview Tunnel Modelling Key Information

	Project Name	Waterview Tunnel Modelling
General	Project Type	Road of National Significance
	Project Physical Works Budget	$1,400,000,000
	Year Constructed	2017
	Year of prediction compared to actual	2016/2017
	Outcome Sought by Model	Predict the value of travel time savings and rereouting of traffic due to the new road.
Model Inputs	Type of Model	Project Model from Regional Model
	Project Specific Model	No – the model was adapted from an existing Microsimulation model within the area

	Software Used	EMME	
	Traffic Matrix	Yes	Auckland Regional Transport 3
	Traffic Counts	Yes	September 2006 Base Year
	Travel Times	Yes	
Key Outputs	Volumes Critical	Yes	
	Travel Times Critical	Yes	

3.6.3 Predicted vs Actual Outcomes

The modelling work sought to understand the change to the traffic patterns following the change in network.

Traffic volume estimates for 2018 have been created from forecasts for 2016 and 2026. Traffic volumes on key parts of SH16 and key arterial local roads are presented below in Table 3-16.

Table 3-16: Waterview Tunnel Traffic Volume predictions and actuals

Location	2018 Modelled (Linear)	2018 Actual	Difference	Difference percentage
Waterview Tunnel	72,400	72,640	-240	-0.3%
SH16 – Newton Road to St Lukes	149,900	146,400	3,500	-2.4%
SH16 – St Lukes to Great North Road	140,600	116,700	23,900	20.5%
SH16 – Great North to Rosebank	98,800	120,800	-22,000	-18.2%
SH16 – Rosebank to Patiki	103,800	107,100	-3,300	-3.1%
SH16 – Patiki to Ta Atatu Road	121,300	122,200	-900	-0.7%
SH16 – Te Atatu Road to Lincoln Road	96,700	97,900	-1,200	-1.2%
Carrington Road	23,000	15,470	7,530	48.7%
Dominion Road	16,880	22,750	-5,870	-25.8%
Great North Road	42,600	41,910	690	-1.6%
Manukau Road	28,820	13,560	15,260	112.5%
Mt Albert Road	14,040	11,520	2,520	21.9%
New North Road	29,520	20,340	9,180	45.1%
Sandringham Road	13,140	16,360	-3,220	-19.7%
St Lukes Road	27,460	27,930	-470	-1.7%

Many of the routes assessed had very close traffic volumes, however there were some discrepancies on the local roads and one section of SH16. A check of the 2022 traffic volumes was done to see if this was an outlier with the outcomes reported in Table 3-17.

Table 3-17: Review of outlier points with 2022 traffic data

Location	2018 (Linear)	2018 Actual	2022 Actual	Comments
SH16 – St Lukes	140,600	116,700	119,300	Very similar to 2018 observed, count likely correct.
Carrington Road	23,000	15,470	16,400	Very similar to 2018 observed, count likely correct.
Dominion Road	16,880	22,750	16,200	Closer to the modelled value, potential 2018 count was incorrect or influenced by something unknown.
Manukau Road	28,820	13,560	30,000	New volume is almost exactly the modelled volume, likely the 2018 count was incorrect.
New North Road	29,520	20,340	17,800	Even lower, it is likely the 2018 count was correct.

Of the five sites identified with predictions differing from the actual, it appears counts on two of the sites were either incorrect or influenced by something external and the 2022 counts were very close to the modelled values, with the remaining the sites appearing to have issues.

3.6.4 Assessment of Modelled Predictions

Overall, the modelling for the Waterview tunnel has done a very good job of determining traffic volumes. There are a limited number or roads found to have different traffic volumes, it was more common to overestimate traffic volumes than underestimate them and this only occurred at three sites.

3.7 Christchurch Southern Motorway

3.7.1 Project Overview

The Christchurch Southern Motorway was a Road of National Significance delivered as part of the Christchurch Motorways Project. The modelling reviewed relied on the Christchurch Transportation Model (CTM2) and the Christchurch Southern Motorway 2 and Main South Road Four Laning model (CSM2) both conducted in Cube. An operational microsimulation model was also developed in VISSIM, but has not been reviewed as part fo this work.

The project was located within Canterbury, and its location within the area is displayed in Figure 3-9.

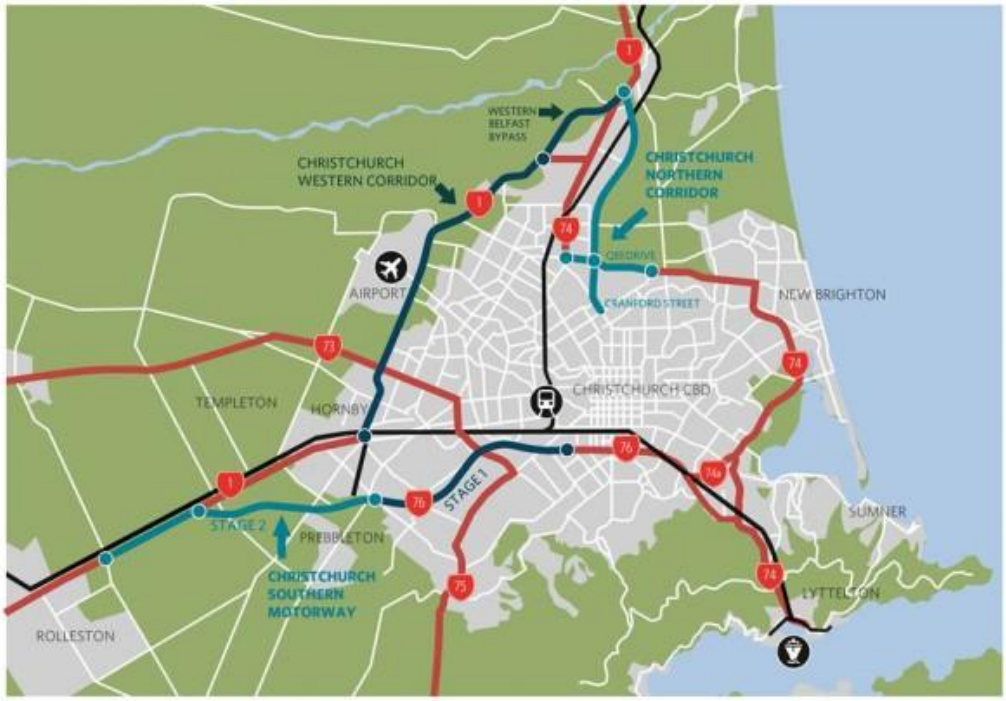

Figure 3-9: CSM2 project area

Stage 1 opened in 2012 and stage 2 opened in 2020.

3.7.2 Overview of Project Modelling

Key information about the modelling parameters and project are outlined in Table 3-18.

Table 3-18: Springs Road Roundabout Model Key Information

	Project Name	**Christchurch Southern Motorway Stage 2**	
General	Project Type	Road of National Significance	
	Project Physical Works Budget	$195,000,000	
	Year Constructed	2020	
	Year of prediction compared to actual	2021/2022	
	Outcome Sought by Model	Predict the value of travel time savings and rereouting of traffic due to the new road.	
Model Inputs	Type of Model	Project Model from Regional Model	
	Project Specific Model	Yes – the model was adapted from an existing Microsimulation model within the area	
	Software Used	Cube Voyager	
	Traffic Matrix	Yes	Christchurch Transport Model
	Traffic Counts	Yes	2006 Base Year
	Travel Times	Yes	
Key Outputs	Volumes Critical	Yes	
	Travel Times Critical	Yes	

3.7.3 Predicted vs Modelled Outcomes

The modelling work sought to understand the change to the traffic patterns following the change in network created by the extension of the southern motorway and four laning of Main South Road to Rolleston.

Two routes had documented predicted travel times. While these were reported for all time periods, only the peak direction has been reported on compared to observed travel times from Google. Google trips were based on a departure of 7:30am or 4:30pm and are presented in Table 3-19.

Table 3-19: CSM2 Travel time predictions and observed

	2023 Linear Interpolation	**Observed Actual**
AM: Rolleston to Brougham Street	15.0	16-26
PM: Brougham Street to Rolleston	16-26	16-26
AM: Lincoln to Main South Road	13.5	14-20
PM: Main South Road to Lincoln	13.0	14-18

While these journey times are close to what is observed, they are more optimistic than the ranges likely to be experienced by a commuter. Reviewing the data available, the variability occurs at the ends of the journeys, i.e. where there are a significant number of busy urban intersections.

2021 estimates have been prepared from 2016 and 2026 forecasts, these estimates and traffic volumes on key parts of SH76 (CSM1 &2) and key arterial roads are presented below in Table 3-20.

Table 3-20: Predicted and actual traffic volumes

Location	2021 Modelled (Linear)	2021 Actual	Difference	Difference percentage
Brougham Street – West of Selwyn Street	49,250	45,651	3,599	7.9%
CSM1 – Barrington to Curletts	48,625	46,987	1,638	3.5%
CSM1 – Curletts to Halswell	43,500	37,250	6,250	16.8%
CSM2 Between Shands and MSR	18,875	19,875[1]	-1,000	-5.0%
MSR – South of Halswell Junction	18,250	17,472	778	4.5%
MSR – South of Rolleston Drive	27,875	27,164	711	2.6%
Shands Road – South of Trends Road[2]	10,750	13,348	-2,598	-19.5%
Springs Road – South of Robinsons Road[2]	2,875	6,029	-3,154	-52.3%
Jones Road – South of Weedons Ross Rd[2]	1,000	3,619	-2,619	-72.4%

[1]: This number was taken from a video survey on a single day
[2]: 2022 traffic volumes, compared to 2021 for State Highways.

3.7.4 Assessment of Modelled Predictions

These volumes do have some discrepancies which could in part be accounted for by the additional growth seen in the Selwyn District following the Christchurch earthquake, where the impact on growth would not have been apparent in 2012 when the modelling was documented. However, if the model volumes were scaled up to match the total traffic observed travelling south from Christchurch, then it becomes clear that the model appears to have underestimated the traffic on the local roads while overestimating the relative attractiveness of the state highways.

Overall, these predictions are able to be considered relatively close to the observed volumes on the busier routes, and Shands Road was the only route with higher predicted volumes which was not approximately correct. This could be driven by the large amount of growth that has occurred in the Selwyn District during the years following the earthquake which would not have been apparent to the project when the modelling was undertaken.

3.8 Basin Bridge

3.8.1 Project Overview

The modelling work relating the Basin Bridge provides a unique opportunity to evaluate the predictions of the 'do-minimum'. The Basin bridge was modelled in both a deterministic assignment model (Saturn) and microsimulation (Paramics) to understand the operational performance of the option relative to the do minimum. The microsimulation model was tightly constrained (limited to peaks, did not include key alternative route choice), and was fed by the deterministic assignment model (Saturn) in turn fed by the Regional model.

The modelled results in this section present a mix of both Saturn and Paramics outputs.

The project is located north of the Basin Reserve in Wellington City and the microsimulation area is outlined in red as shown in Figure 3-10.

Figure 3-10: Basin Bridge Paramics model extent

3.8.2 Overview of Project Modelling

The project was denied resource consent and limited work has occurred in the area while the Let's Get Wellington Moving project has commenced its investigations into the works required for the City.

Key information about the modelling parameters and project are outlined below.

Table 3-21: Basin Bridge model key information

General	**Project Name**	**Basin Bridge**
	Project Type	**Road of National Significance**
	Project Physical Works Budget	$92,000,000
	Year Constructed	N/A
	Year of prediction compared to actual	2021
	Outcome Sought by Model	Inform matters relating to the resource consents and design
Model Inputs	Type of Model	Microsimulation – Travel Time Deterministic Traffic Assignment – Traffic Volumes

	Project Specific Model	Yes – the model was developed to assess impacts of the Basin Bridge proposal.	
	Software Used	S-Paramics SATURN	
	Traffic Matrix	Yes	Wellington City SATURN Model Regional Model
	Traffic Counts	Yes	February and March 2009
	Travel Times	Yes	Floating car surveys
Key Outputs	Volumes Critical	Yes	To inform economics and resource consents
	Travel Times Critical	Yes	A key project objective was to reduce travel times

3.8.3 Predicted vs Actual Outcomes

The project aimed to improve travel times and journey time reliability by grade separating the highway flow from local traffic. The do-minimum assumed a similar network with no grade separation.

3.8.3.1 Travel Time

Average travel times on a range of routes were presented for the 2021 do min network based on the S-Paramics model. These have been rounded to the nearest half minute and presented against Google Travel times in Table 3-22.

Table 3-22: 2021 modelled and actual travel times in the Wellington CBD

Route	Predicted AM	Actual AM	Predicted PM	Actual PM
SH1 EB	8	7-16	8	9-18
SH1 WB	14	6-12	13	10-30
Kent Terrace to Adelaide Road	4	3-6	5	4-12
Adelaide Road to Cambridge Terrace	5	4-10	4	4-10
Adelaide Road to Taranaki Street	5	4	4	4-10
Taranaki Street SB	3	2-6	4	3-8
Taranaki Street NB	4	5	3	4-9

With exception to the SH1 westbound travel times, the predicted travel times are within the range of observed times but consistently towards the lower range of the observed travel times reported from Google. It was noted that when reporting actual travel times, a range was presented, but the project options only reported averages.

3.8.3.2 Traffic Volumes

2021 predicted and actual traffic volumes along the highway are presented below in Table 3-23.

To remove the impacts of the Covid related lockdowns, traffic volumes from the six-week period 18 August to 28 September were excluded from the averages. This was sense checked against historic traffic trends (2010-2019), which are broadly consistently with exception to the Mt Victoria tunnel IP volumes and the AM peak Eastbound through the tunnel. These were the only volumes which differed by more than 10%.

In the table below the modelled results are taken from the Saturn deterministic assignment model.

Table 3-23: 2021 predicted and actual traffic volumes in Wellington CBD highways

Peak Hour / Time Period	2021 Modelled	2021 Actual	Diff	% Diff
AM - Terrace Tunnel NB	1,875	1,797	78	4.18%
AM - Terrace Tunnel SB	1,530	1,278	252	16.44%
AM - Arthur Street	1,543	1,870	-327	-21.18%
AM - Vivian Street	1,488	1,370	118	7.94%
AM - MT Vic WB	1,530	1,369	161	10.53%
AM - Mt Vic EB	1,386	1,103	283	20.44%
IP - Terrace Tunnel NB	1,596	1,603	-7	-0.41%
IP - Terrace Tunnel SB	1,494	1,327	168	11.21%
IP - Arthur Street	1,628	1,714	-86	-5.28%
IP - Vivian Street	1,727	1,375	353	20.41%
IP - MT Vic WB	1,388	1,208	180	12.99%
IP - Mt Vic EB	1,263	1,092	171	13.56%
PM - Terrace Tunnel NB	2,000	1,970	30	1.51%
PM - Terrace Tunnel SB	1,545	1,209	336	21.72%
PM - Arthur Street	2,022	1,887	135	6.66%
PM - Vivian Street	1,784	1,315	469	26.31%
PM - MT Vic WB	1,338	1,214	124	9.30%
PM - Mt Vic EB	1,631	1,321	310	19.01%
AADT - Terrace Tunnel NB	23,717	26,690	-2,973	-12.54%
AADT - Terrace Tunnel SB	21,083	20,465	618	2.93%
AADT - Arthur Street	23,410	28,129	-4,719	-20.16%
AADT - Vivian Street	25,074	21,664	3,410	13.60%
AADT - MT Vic WB	19,620	19,183	437	2.23%
AADT - Mt Vic EB	18,668	18,038	630	3.38%

This modelling shows better accuracy in the west/northbound predictions while consistently having wider gaps in the southbound / eastbound direction. The largest concern is the Mt Victoria traffic volume predictions which were consistently predicted above the observed data. It is noted that when compared to the trendline data from 2010-2019 data, the Mt Victoria tunnel was underrepresented, perhaps influenced by the lower air travel observed in 2021.

2022 local road data is provided below in **Error! Reference source not found.** ,again modelled data is taken from the S aturn model.

Table 3-24: Local road predictions (2022 prediction)

Street	Location	2021 Modelled	2021 Actual	Diff	Diff %
AM - Taranaki Street	Between Buckle and Vivian	1,337	1,297	40	2.99%
AM - Taranaki Street	Between Vivian and Dixon	1,062	1,161	-99	-9.32%
AM - Willis Street	Between Vivian and Dixon	828	497	331	39.98%
AM - Victoria Street	Between Vivian and Dixon	970	620	350	36.08%
AM - Kent Terrace	Between Vivian and Courtenay	875	771	104	11.89%
AM - Cambridge Terrace	Between Vivian and Courtenay	1,149	670	479	41.69%
AM - Adelaide Road	South of Basin Reserve	1,901	1,715	186	9.78%
IP - Taranaki Street	Between Buckle and Vivian	1,440	1,088	352	24.44%
IP - Taranaki Street	Between Vivian and Dixon	1,135	1,126	9	0.79%
IP - Willis Street	Between Vivian and Dixon	427	402	25	5.85%
IP - Victoria Street	Between Vivian and Dixon	769	807	-38	-4.94%
IP - Kent Terrace	Between Vivian and Courtenay	745	699	46	6.17%
IP - Cambridge Terrace	Between Vivian and Courtenay	1,026	768	258	25.15%
IP - Adelaide Road	South of Basin Reserve	1,583	1,490	93	5.87%
PM - Taranaki Street	Between Buckle and Vivian	1,482	1,341	141	9.51%
PM - Taranaki Street	Between Vivian and Dixon	1,380	1,327	53	3.84%
PM - Willis Street	Between Vivian and Dixon	839	495	344	41.00%
PM - Victoria Street	Between Vivian and Dixon	808	1,014	-206	-25.50%
PM - Kent Terrace	Between Vivian and Courtenay	1,180	848	332	28.14%
PM - Cambridge Terrace	Between Vivian and Courtenay	1,140	805	335	29.39%
PM - Adelaide Road	South of Basin Reserve	1,851	1,685	166	8.97%

This shows several roads having accurately predicted volumes; however, some sections were significantly overpredicted, with only Victoria Street being underpredicted.

In both the highways and local road predictions, there is a general trend for the Saturn modelled volumes to be above the observed volumes. This overprediction is most significant in the AM and IP periods (7 to 11%) but is less pronounced in the PM peak (2.5%).

3.8.3.3 Differences in modelled Do Minimum and Current On Street Layout

The project do-minimum included a range of improvements within the 2021 model including additional bus lanes and a 30 km/h speed limit zone on two central city streets. On the highways it also included inner city bypass optimisation, the Pukeahu War Memorial Tunnel and 8 laning the Aotea Quay to Ngauranga Gorge section of SH1. A comparison of the modelled do-min improvements and the current on street situation is presented in Table 3-25.

Table 3-25: Basin Bridge differences between Do-minimum and on street layout

Project / Transport Network Changes	Project Model	2021 Actual
Bus Lanes: Courtenay Place (All Peaks) Kent, Cambridge Terraces and Adelaide Road (AM and PM Peak only),	✓	✓
30Km/h speed zone Tory/ Tasman and Cuba Streets	✓	✓
Buckle Street Underpass	✓	✓
Inner City Bypass Optimisation (moderate intervention) WB to Terrace Tunnel, EB to Tory Street)	✓	✓
Aotea Quay to Ngauranga Gorge (8 laning)	✓	
Aotea Quay to Ngauranga Gorge (7 laning)		✓
Citywide 30 km/h speed limit (Excludes key arterials - SH, Terraces, Taranaki St & the Quays)		✓
Victoria Street Redevelopment		✓
Loss of 1,000 - 1,500 carparks		✓

This shows that there was good success in anticipating the probable future transport network. Of the expected projects impacting the CBD area, only the Aotea Quay to Ngauranga Gorge project was expected which did not come to complete fruition, and it was half completed before being paused.

Beyond this, the Victoria Street redevelopment could be considered part of the Inner City Bypass Optimisation, but without a clear scope of what that work included it is hard to be definitive. Beyond that, only the more recent decision to reduce speed limits in the city centre by the council and the loss of carparks relating to the 2016 Kaikoura earthquake have occurred which were not predicted, neither of which would be foreseeable based on the environment at the time of the model development.

3.8.4 Assessment of Modelled Predictions

The Basin Bridge 2021 modelling (constrained microsimulation, fed by higher tier SATURN and Regional models), shows mixed outcomes;

From the microsimulation modelling;

- The microsimulation modelled travel times are within the range of observed, albeit most modelled travel times are towards the lower end of the observed range.

From the Saturn modelling;

- The highway and local road traffic volumes were mostly overpredicted.
- The Mt Victoria Tunnel was more consistently overpredicted, and this was most noticeable in the eastbound direction (to the airport/suburbs) which can in part be attributed to the reduction in air travel associated with the Covid-19 pandemic.
- The impacts on the Arras Tunnel and northbound traffic were much better predicted, noting the underprediction of the use of Arthur Street in the morning peak
- Local road traffic volumes were poor, in particular the model assigned too much traffic to the one way routes and Cambridge Terrace into town.

A proportion of the overprediction may be explained by Covid traffic suppression effects, but this is only present in the last 3 years of the roughly 10-year forecast. Therefore the Saturn overpredictions appear to be more likely overprediction of throughput in a constrained network and/or forecast optimism bias.

Noting these findings, there were some minor changes to the network and some significant changes to the parking capacity, the results are quite good with some specific areas of concern. Routes departing the CBD in the morning peak were overestimated and these would not be impacted by the reduced carparking. There were also high forecasts leading into town in the PM peak which were not observed.

It is therefore felt that the model provided mixed results. When considering the wider events which will have influenced the predictions, the highway predictions can be considered fair, but there were still a large number of local road predictions that were substantially overpredicted. Travel time predictions were almost all within the observed range.

4 Summary

4.1 Modelling Trends Identified in Sample Projects

4.1.1 Travel Times

In terms of the modelled predictions of travel times, compared to actual observations, the projects reviewed identified;

- **Use of microsimulation models**: Robust prediction of travel time outcomes, in line with the desired project outcomes (two examples), however expanding reporting to include ranges would add value.

- **Use of strategic-style models**: Robust prediction of travel time outcomes. However, in a number of the predicted v actual examples reviewed the conditions were 'uncongested' and it would be expected that modelled predictions of travel times would be reliable in 'free-flow' conditions (three examples). Considering the upper bounds of observed travel times, the models are underestimating travel times (four examples).

4.1.2 Traffic Volumes

In terms of the modelled predictions of future traffic volumes on links in the study areas, compared to the actual counts, the projects reviewed identified;

- **Use of Project Regional models**: The results were mixed with one strong example (Waterview), one moderate example (Christchurch Southern Motorway) and one weaker example (Whakatu Link Road).

- **Use of Deterministic Assignment Models below Regional Models:** These results demonstrate a number of weaknesses in predicted link volumes (three examples) with there being examples of issues on both the modelled road (M2PP) and other arterial routes (North Wellington & Basin).

4.1.3 Cycle Volumes

The example reviewed shows an overestimation of predicted cycle volumes using the method from Research Report 340 (one example).

4.1.4 PT Patronage and PT Travel Times

The example reviewed showed an underprediction of PT patronage, though had correctly predicted the broadly similar travel times (one example).

4.2 Review of Feasibility of Research Process

4.2.1 Challenges

This preliminary Predicted vs. Actual modelling project identified a number of challenges;

1. **Lack of published reports / modelling data**: It was difficult to obtain clear reported model information. The identified projects tended to be larger highway examples as information was more easily obtained from these examples (e.g. published by Waka Kotahi).

2. **Understanding / background to project**: Investigating why differences may have occurred between modelled predictions and actual outcomes required either a reasonable understanding and background to the project, and/or some time and resource reviewing differences along with understanding how this may influence the actual traffic volumes and/or travel times.

3. **Minor difficultly in standardising:** Modelled information was in a mix of formats and varying model outputs. For example, reported modelled travel times were more difficult to obtain than volumes.

Issues 1 and 2 could be overcome by contacting Clients for agreement on examining project information and involving the MUGs committee or the wider MUGs membership in

Although Issue 3 was a challenge, the research settled on a simple reporting structure – Project Overview, Overview of Project Modelling, Predicted vs. Actual Outcomes, and Assessment of Modelled Predictions. This proved to be a somewhat effective 'standardisation' of the process.

4.2.2 Straightforward Aspects

It was reasonably straightforward to obtain actual observed traffic count measurements and travel time estimates. Particularly this relates to current / very recent conditions. In the examples where the project was well known / understood by the researchers the review of outcomes was reasonably straightforward.

4.3 Recommendation

This work has concluded that a second stage is feasible and there are opportunities to inform learning for future modelling work.
Should a second stage of this work be conducted it is recommended that it seeks to review the following types of projects:

- Public transport projects including patronage and the impacts to wider network travel times and traffic volumes
- Review the modelling accuracy of intersection form changes and more minor network changes
- Review of predicted model travel times in congested conditions
- Review of more microsimulation modelled project examples

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