

BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Proposed Plan Change 37 - Nukuhau (private) by AN Rajasingham LPT Trustees No 124 Limited anors to the Taupo District Council to rezone c.78ha of land in the Nukuhau area from Rural Environment to a mix of General Residential and Mixed Density Residential with a Neighbourhood Shopping Centre overlay.

STATEMENT OF EVIDENCE OF RUIHAN CUI (TRAFFIC MODELLING)

Dated 20 OCTOBER 2021

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INTRODUCTION

1. My name is Ruihan Cui (also known as Emma Cui). I am employed as a Transportation Engineer in the Auckland office of WSP New Zealand Limited.
2. My qualifications include a Bachelor of Civil Engineering degree with Honours from the University of Auckland.
3. I am a Member of Engineering New Zealand (MEngNZ), and a Member of the Engineering New Zealand (EngNZ) Transportation Group.
4. I have been carrying out professional engineering tasks related to transport planning and traffic engineering for four years. In that time, I have worked on various traffic impact assessments and traffic modelling for various clients including public agencies (such as Waka Kotahi and local authorities) and, to a lesser extent, private individuals and/or organisations.
5. My evidence is given on behalf of AN Rajasingham LPT Trustees No 124 Limited and others (**Applicants**) in relation to the transport engineering implications of Proposed Plan Change 37 - Nukuhau (private) to the Taupo District Plan to rezone approximately 78 ha of land (**the Site**) in the Nukuhau area from Rural Environment to a mix of General Residential and Mixed Density Residential with a Neighbourhood Shopping Centre overlay (**PC37 or Plan Change**).
6. I am familiar with the area in which the Site is located and the local road network from which the Site will be accessed. I last visited the Site on 21 February 2019.
7. I have been involved in PC37 since 2019 when I was engaged to undertake a Traffic Impact Assessment (**TIA**) for the Applicants. I was the lead author of the November 2019 TIA (Issue 1) titled "Nukuhau Private Plan Change,

Taupo” (WSP, 2019). The TIA formed part of the Assessment of Environmental Effects lodged for PC37. The report was reviewed by my former colleague Mr Tobie Ueckermann, who agreed with and supported the contents of the report. Mr Ueckermann is a Principal Transport Engineer with 30 years of transportation and traffic engineering experience. Mr Ueckermann is no longer employed by WSP.

8. I was not directly involved with the preparation of the 28 October 2020 version of the TIA (Issue 2) which is Appendix E to the Plan Change request report. However, my name appears in the document history because of my involvement with Issue 1.
9. I was involved with preparation of the 22 September 2021 memorandum provided to Mr Hamish Crawford (WSP, 2021a) that describes the results of additional transport modelling carried out by myself and reviewed by Mr Allen Liu of WSP. Mr Swears was also involved in the preparation of the memorandum. For this statement of evidence I am reliant on the results of my modelling, which are described in the September 2021 memorandum and the subsequent October 2021 memorandum ((WSP, 2021a) and (WSP, 2021b) respectively).
10. My evidence concentrates primarily on the content and recommendations of the TIA and the additional traffic modelling described in the memorandum.

CODE OF CONDUCT

11. I confirm that I have read, and am familiar with, the Environment Court's Code of Conduct for expert witnesses and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying on the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

12. In this statement I have not included a comprehensive description of the Site or PC37 because these details are adequately defined in the Appendix E - Traffic Impact Assessment and elsewhere.

13. Primarily, my evidence addresses the following matters:
 - a) Commentary regarding the TIA, including the assumptions made in traffic models and a summary of the key findings and recommendations.

 - b) Commentary regarding the 22 September 2021 (WSP, 2021a) and the subsequent 12 October 2021 memorandum (WSP, 2021b).

 - c) An overview of the key differences between the traffic modelling carried out as part of the TIA and the subsequent analysis.

 - d) Response to matters raised in the Taupo District Council (**Council**) Section 42A Report.

 - e) Response to matters raised by submitters in relation to traffic modelling.

COMMENTARY REGARDING THE TRAFFIC IMPACT ASSESSMENT

Summary of Traffic Impact Assessment

14. The purpose of the original TIA (WSP, 2019), was to assess potential traffic impacts generated by PC37.

15. The revised TIA (WSP, 2020) was based on the original, however, I was not directly involved in preparing the revised TIA.
16. I visited the Site with Mr Ueckermann on 21 February 2019 to familiarise myself with the area.
17. Mr Ueckermann and I assessed PC37 from a traffic engineering perspective and proposed the indicative road network shown in Figure 5-1 of the TIA (WSP, 2020), which includes the following key features:
 - a) Various pedestrian access and cycleway connections including the existing Poihipi Road alignment becoming an active modes corridor.
 - b) Poihipi Road realignment. A section of the existing Poihipi Road is proposed to be closed to general traffic (as noted above), with the realigned Poihipi Road located further north and aligned to form a 4-leg intersection with Huka Falls Road.
 - c) Watene Lane extension.
 - d) Docherty Drive extension.
 - e) Acacia Bay Road extension.
 - f) Herapeka Street cul-de-sac.

Traffic Modelling for TIA

18. The Taupō Traffic Model was run for the following five scenarios, with each scenario including traffic models for the AM and PM peak hours:
 - a) Scenario 1: 2021 Base Model – without the traffic enabled by PC37 – 1 bridge.

- b) Scenario 2: 2041 Future Model – without the traffic enabled by PC37 – 1 bridge.
 - c) Scenario 3: 2041 Future Model – without the traffic enabled by PC37 – 2 bridges.
 - d) Scenario 4: 2041 Future Model – with the traffic enabled by PC37 – 1 bridge.
 - e) Scenario 5: 2041 Future Model – with the traffic enabled by PC37 – 2 bridges.
19. WSP engaged Stantec to run the Taupo Traffic Model for the five scenarios.
20. For each of the modelled scenarios, the modelling considered traffic generation from future land use with and without PC37. We enquired regarding the assumed future land use in the Model and were advised by Stantec (2019a) that “The council have said to assume development near the airport, so there is only a small amount of infill north of the river”.
21. SIDRA was used to analyse the performance of seven key intersections in the vicinity of the Site. Intersection turning volumes were extracted from the Taupō Traffic Model (Scenarios 1, 3 and 5) and used in SIDRA models for the key intersections for both AM and PM peaks. Results of the SIDRA modelling is summarised in Table 8-4 of the TIA (WSP, 2020).

COMMENTARY REGARDING THE 12 OCTOBER 2021 MEMORANDUM

Additional Modelling

22. We carried out additional SIDRA (v9) modelling to understand the performance of the Control Gates Bridge (**CGB or Bridge**), Norman Smith Street/Wairakei Drive intersection, and Spa Road/Tongariro Street

roundabout. As noted above, the modelling considered scenarios with existing permitted land development north of the Bridge (as listed in Figure 1 below) and with PC37 before there is a second bridge across the Waikato River to provide access to Taupō from the north.

Northern End of the Lake		Southern End of the Lake	
EOL	1,900	Kuratau/Omori	180
WEL	496	Mohi	50
Brentwood	120	Turang	400
Lakeside Brentwood	350	Whareroa	160
Vineyard on Huka falls	36	Undeveloped half charges	275
Acacia Bay	150	Total Southern End	1,065
Kinloch	334	Unzoned	
7 Oaks	162	Five Mile Bay site A and C	440
Undeveloped half charges	742	Nukuhau Private Plan Change	780
Total Northern End	4,290	Total Unzoned	1,220

Traffic Volumes used in the Traffic Models

Trip Generation and Distribution

23. Trip generation and distribution assessments were carried out to determine the additional trips generated from the permitted land developments and PC37. I refer to the memorandum included as **Appendix A** to my evidence (WSP, 2021b).

Assumptions Made

24. As noted in the memorandum, we made the following key assumptions:
- a) 70% of the trips generated by Kinloch will travel to and from the Taupo town centre via Control Gates Bridge. The other trips

generated by Kinloch will not involve journeys to and from the Taupo town centre;

- b) 80% of the peak hour trips generated by Acacia Bay, Brentwood and Lakeside Brentwood will travel to and from Taupo town centre via Control Gates Bridge;
- c) 85% of the peak hour trips generated by the Project will travel to and from Taupo town centre via Control Gates Bridge;
- d) 1% net annual traffic growth rate has been included to allow for additional traffic growth resulting from other land developments; and
- e) Any turning volumes for a particular movement at any intersection that were lower than 10 were rounded up to 10 vehicles.

Traffic Volumes and Modelling Scenarios

- 25. The 1% net annual traffic growth rate was applied to the base traffic volumes (2021 base model from the Taupo Traffic Model) to determine the base future traffic volumes in 2025 and 2030. Trips generated from the permitted land developments and PC37 were added to the base volumes to determine future traffic volumes.
- 26. Additional modelling in SIDRA (v9) was completed for the Norman Smith Street / Wairakei Drive intersection, Control Gates Bridge, and the Spa Road/Tongariro Street roundabout for the scenarios as shown in Table 1 below.

Table 1: Assessed Scenarios in the Subsequent Analysis

Scenario Name	Name in SIDRA	New	Growth from 2021	All permitted land	Undeveloped half charges	Nukuhau	Houses	Trips*
2021 Scenario #0	2021 no dev	N	0%	0%	0%	0%	0	0
2025 Scenario #1	2025 no Nukuhau	N	1% p.a.	50%	30%	0%	781	645
2025 Scenario #2	2025 with Nukuhau	N	1% p.a.	50%	30%	40%	1093	930
2030 Scenario #0	2030 S1	Y	1% p.a.	0%	0%	0%	0	0
2030 Scenario #1	2030 no Nukuhau	N	1% p.a.	100%	60%	0%	1561	1290
2030 Scenario #2	2030 S3	Y	1% p.a.	100%	60%	30%	1801	1490
2030 Scenario #3	2030 with Nukuhau	N	1% p.a.	100%	60%	80%	2185	1860
2030 Scenario #4	2030 S2	Y	1% p.a.	50%	30%	30%	1018	852

27. As noted in the memorandum (WSP, 2021b) we ran the models for each of the individual sites separately and together as a network. For each site, we reported both the individual site performance and the performance of the site in the network.
28. En-route travel time analysis was undertaken using the Route function in the modelled SIDRA networks.

Modelling Outcome

29. We set up the routes in SIDRA Network in all modelled scenarios to understand the overall en-route travel between (and including) the Norman Smith Street/Wairakei Drive intersection and the Spa Road roundabout via Control Gates Bridge. The routes modelled, and the summarised predicted results, are described in the tables below.

Table 2 En-route Travel Time AM Peak

Scenarios	AM En-route Travel Time (minutes)			
	Route 1	Route 2	Route 3	Route 4
2030 Scenario #0 (0/0/0)	2.8	2.7	2.8	2.8
2030 Scenario #1 (100/60/0)	6.8	6.1	6.8	6.1
2030 Scenario #2 (100/60/30)	6.3	7.9	6.3	7.9
2030 Scenario #3 (100/60/80)	7.5	9.1	7.5	9.1

Table 3 En-route Travel Time PM Peak

Scenarios	PM En-route Travel Time (minutes)			
	Route 5	Route 6	Route 7	Route 8
2030 Scenario #0 (0/0/0)	3.5	3.3	2.8	2.6
2030 Scenario #1 (100/60/0)	14.9	14.7	5.0	4.8
2030 Scenario #2 (100/60/30)	16.0	15.8	6.2	6.0
2030 Scenario #3 (100/60/80)	18.1	18.0	7.1	7.0

30. We compared the modelled outputs of travel time for the permitted land development only against the permitted land development with that enabled under PC37 (2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)):

- a) In the AM peak, the worst route was Route 4¹ (right turn out from Norman Smith Street intersection, across the CGB and then straight ahead at the Spa Road roundabout), which had a travel time increase of around 3 minutes (181 seconds).
- b) In the PM peak, the worst route was Route 6 (southwest approach of the Spa Road roundabout, across the CGB and then left turn at

¹ The routes described in this statement are illustrated in the memoranda (WSP, 2021a) and (WSP, 2021b).

Norman Smith Street intersection), which had a travel time increase of around 3.3 minutes (199 seconds).

31. Acknowledging that the graphical information was not included in the memoranda, **Appendix B** of this statement contains diagrams illustrating the relative levels of service for different elements of the routes that were considered. These diagrams illustrate the point raised by Mr Swears in his statement (paragraph 43) that the Bridge is not necessarily the constraint that results in increased travel times.
32. The full details of the modelling outcomes are set out in Section 3.3 of the memorandum in **Appendix A** (WSP, 2021b).

KEY DIFFERENCES BETWEEN TIA AND SUBSEQUENT MODELLING

Traffic Volumes

33. We used different traffic volumes in the SIDRA models for those referred to in the TIA and those in the subsequent modelling. In response to the matter raised by Submitter 9, regarding the lack of modelling for a year between 2021 and 2041, we determined traffic volumes to use in modelling for 2030.
34. The traffic volumes used in the SIDRA models described in the TIA were a direct output from the Taupo Traffic Model with assumptions made for the future land use. As noted by Stantec (2019b) “...there is only a small amount of infill north of the river [...] although there is growth in Acacia Bay and Kinloch that will impact the bridge”.
35. For the subsequent SIDRA models, we developed traffic volumes based on the 2021 Taupo Traffic Model and the future land use described by Property Economics (2021), which is shown in Figure 1 of this statement.

36. As noted in **Appendix C**, the traffic volumes used for our 2030 modelling are generally higher² than those used for the 2041 traffic modelling described in the TIA, which are direct outputs from the 2041 Taupo Traffic Model. Therefore, the 2030 modelling is conservative compared to the 2041 modelling. However, the extent of the residential development assumed for the 2041 modelling is as described in paragraph 34 of this statement, which is potentially less extensive than some of the development scenarios described in the memoranda based on the Property Economics (2021) information.
37. For example, the traffic volume southbound across the Control Gate Bridge in the 2041 AM peak was 1853 vph, whereas the equivalent traffic volume used in our Scenario #3 (100/60/80) 2030 modelling was 2506 vph.
38. The modelled effects of residential development to the north of the river will be heavily dependent on the extent of the residential development.

SIDRA Intersection and SIDRA Network

39. The modelling described in the memoranda considers the performance of individual intersections (determined using SIDRA Intersection) as well as the network performance (determined using SIDRA network). Whereas the SIDRA models described in the TIA only considers individual site performance (determined using SIDRA Intersection).

JOINT WITNESS STATEMENT AND RESPONSE TO MATTERS RAISED IN THE TAUPO DISTRICT COUNCIL SECTION 42A REPORT

40. I attended the Traffic Expert Conferencing conducted via a Teams meeting on 12 October 2021, and subsequent meetings with the traffic experts on

² The exception to this is the 50/30/30 Scenario #4 for which the traffic volumes are similar.

15 and 18 October, during which we developed the Joint Witness Statement (JWS) dated 18 October 2021.

- 41. I have reviewed the statement of evidence prepared by Mr Smith dated 30 September 2021, which forms part of the Section 42A (s42A) report.
- 42. The JWS sets out the matters from Mr Smith’s evidence that I agree with.
- 43. The JWS also sets out where we have a difference in opinion, including in the route considered by Mr Smith and I. The figures below illustrate those differences.

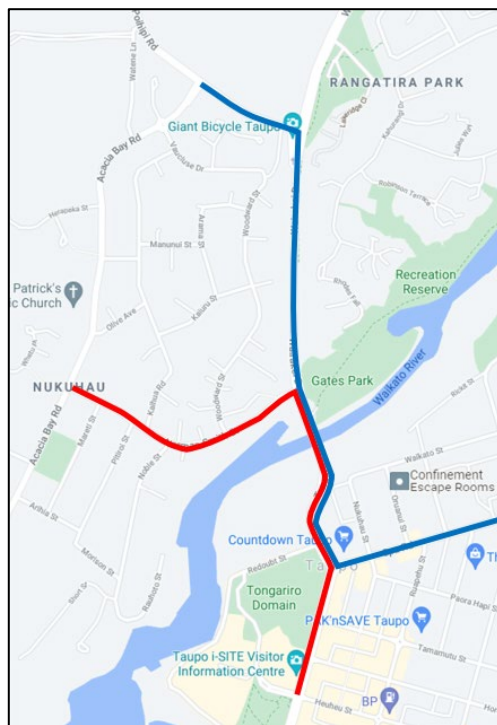


Figure 2: Routes Assessed by Mr Smith

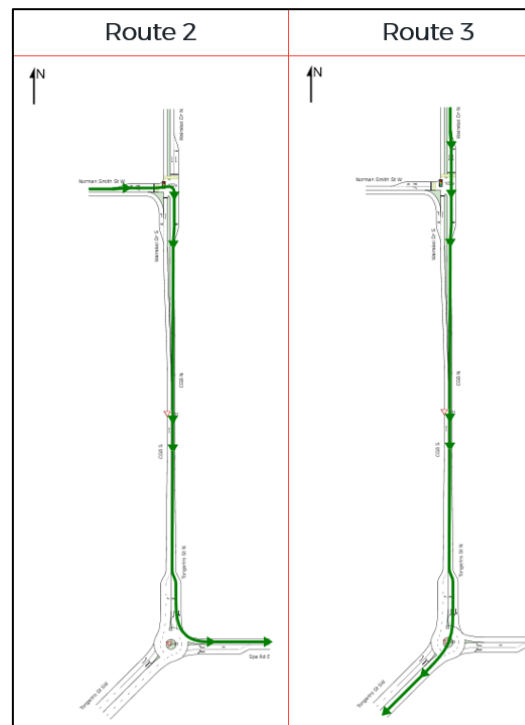


Figure 3: Routes Assessed by Ms Cui

RESPONSE TO RELEVANT SUBMISSIONS

- 44. Mr Daniel Pearl and Ms Rebecca Lawson (Submitter 9) raise that there is no traffic modelling assessment done to represent a time between 2021 to 2041. The reason for this is because (as noted by Stantec (2019a)) there was no 2031 model. I consider that the traffic models for 2025 and 2030,

which are described in the memoranda referred to in my evidence above,
address the concern that has been raised.

Ruihan Cui

20 October 2021

Appendix A: Memorandum dated 12 October 2021

Memorandum

To	Hamish Crawford
Copy	Cheryl Cleary
From	Emma Cui and Allan Liu
Office	Auckland Westhaven
Date	20 October 2021
File/Ref	2-37400.00
Subject	Nukuhau Plan Change

1 Introduction

Further to our memo of 22 September 2021, we have carried out additional SIDRA (v9) modelling to understand the performance of the Control Gates Bridge (CGB), Norman Smith Street/Wairakei Drive intersection and Spa Road/Tongariro Street roundabout with permitted land developments north of the Bridge (refer left-hand column of Figure 1) and with the proposed Nukuhau Plan Change, before there is a second bridge across the Waikato River to provide access to Taupō from the north.

The additional traffic models¹ also compare the traffic operation performance of the Control Gates Bridge, Norman Smith Street/Wairakei Drive intersection and Spa Road/Tongariro Street roundabout with and without Nukuhau Plan Change.

APPENDIX 1: DISTRICT RESIDENTIAL SUPPLY BREAKDOWN

Northern End of the Lake		Southern End of the Lake	
EOL	1,900	Kuratau/Omori	180
WEL	490	Mohi	50
Brentwood	120	Turang	400
Lakeside Brentwood	350	Whareroa	160
Vineyard on Huka falls	36	Undeveloped half charges	275
Acacia Bay	150	Total Southern End	1,065
Kinloch	334	Unzoned	
7 Oaks	162	Five Mile Bay site A and C	440
Undeveloped half charges	742	Nukuhau Private Plan Change	780
Total Northern End	4,290	Total Unzoned	1,220

Figure 1: Permitted Land Development North of Bridge, Taupo Residential Dwelling Demand Addendum Report (July 2021)

¹ Note that the naming convention for the models referred to in this memo is different to the naming convention used in our 22 September memo.

2 Trip generation and distribution assessments

Trip generation and distribution assessments were carried out to determine the additional trips generated from the permitted land developments and Nukuhau Plan Change.

2.1 Assessed Household Numbers

We assessed several scenarios as shown in Table 1 below. The number of dwellings for each scenario is not obtained by direct multiplication of the values in Figure 1; reference should be made to Section 2.5 of this memo, which describes assumptions made regarding trip distribution.

Table 1: Assessed Scenarios

Scenario Name	Name in SIDRA	New	Growth from 2021	All permitted land	Undeveloped half charges	Nukuhau	Houses	Trips*
2021 Scenario #0	2021 no dev	N	0%	0%	0%	0%	0	0
2025 Scenario #1	2025 no Nukuhau	N	1% p.a.	50%	30%	0%	781	645
2025 Scenario #2	2025 with Nukuhau	N	1% p.a.	50%	30%	40%	1093	930
2030 Scenario #0	2030 S1	Y	1% p.a.	0%	0%	0%	0	0
2030 Scenario #1	2030 no Nukuhau	N	1% p.a.	100%	60%	0%	1561	1290
2030 Scenario #2	2030 S3	Y	1% p.a.	100%	60%	30%	1801	1490
2030 Scenario #3	2030 with Nukuhau	N	1% p.a.	100%	60%	80%	2185	1860
2030 Scenario #4	2030 S2	Y	1% p.a.	50%	30%	30%	1018	852

*Trips: Additional trips generated from the development and 1% growth in base traffic volumes go to and from Taupo town centre via the Control Gates Bridge

Subsequent to completing our modelling analysis we noted that we had inadvertently omitted the trip generation associated with the 36 dwellings from Vineyard on Huka Falls. While this oversight results in a slight reduction in the overall trip generation from the permitted development, the volume of additional traffic is less than 1% of the total traffic volume, therefore, we conclude that the effect of the oversight is negligible on the results of our analysis.



Figure 2: Location of Permitted Land Development and Proposed PC 37 Nukuhau

2.2 Trip Generation Rate

We have used the trip generation rates from the Taupō Traffic Model, which is part of the Waikato Regional Transportation Model (WRTM); namely:

AM Peak 0.72 trips/household/hr

PM Peak 0.85 trips/household/hr

2.3 Trip Arrival and Departure Rate

We have used the trip arrival and departure rates from the Taupō Traffic Model (part of Waikato Regional Transportation Model).

Table 2: Trip Arrival and Departure Rates

Period	Movement	% Movements
AM Peak Hour	Arrival Split (Trips In)	0.25
	Departure Split (Trips Out)	0.75
PM Peak Hour	Arrival Split (Trips In)	0.63
	Departure Split (Trips Out)	0.37

2.4 Trip Distribution

Travel Route

We have assumed that different routes will be used for accessing Wairakei Drive, depending on the origin / destination of particular journeys. Table 3 below describes the assumed route assignments for the different origins.

Table 3: Travel Routes

	Pohipi Road and Wairakei Drive to and from Taupo town centre via CGB (Blue Route)	Norman Smith Street from Taupo town centre via CGB (Red Route)
Seven Oaks and Kinloch	100%	0%
Acacia Bay	0%	100%
Brentwood and Lakeside Brentwood	0%	100%
Undeveloped half charges	75%	25%
PC37 Nukuhau	50%	50%



Figure 3: Travel Route and Trip Distribution

2.5 Assumptions made

We have made the following assumptions in assigning trips to Wairakei Drive and Control Gates Bridge.

- 70% of the trips generated by Kinloch will travel to and from the Taupo Town Centre; the route used for all these trips will be via Poihipi Road, Wairakei Drive, and Control Gates Bridge in the AM and PM peak. The other trips generated by Kinloch will be not involve journeys to and from the Taupo Town Centre;
- 80% of the trips generated by Acacia Bay, Brentwood and Lakeside Brentwood will travel to and from Taupo Town Centre; the route used for all these trips will be via Norman Smith Street and Control Gates Bridge in the AM and PM peak;
- 85% of the trips generated by the Nukuhau Plan Change development will travel to and from Taupo Town Centre; the route used for these trips will be distributed between Norman Smith Street and Poihipi Road (as described in Table 3), with all these trips using Control Gates Bridge in the AM and PM peak;
- 1% net linear annual traffic growth rate, additional traffic growth subject to land developments aside from those listed above;
- any turning volumes for a particular movement at any intersection that were lower than 10 were rounded up to 10 vehicles.

2.6 Additional Trips

Tables 4 to 9 below summarise the additional trips generated by each of the permitted land developments and Nukuhau Plan Change.

Table 4: Additional Trips 2025 #1

	2025 #1			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	0	0	0	0
Total	166	158	164	157

With regard to these additional trips, it is important to note that while, in some cases (but not in others), there appears to be a direct correlation between AM peak and PM peak values, the reason for this is a mathematical coincidence rather than a mistake. The points below illustrate the basis on which values in the table have been calculated:

- Seven Oaks and Kinloch AM peak: $496 \text{ households} \times 50\% \text{ developed} \times 70\% \text{ to and from Taupo CBD} \times 0.72 \text{ AM peak trips per household} \times 75\% \text{ into Taupo CBD} = 93.7 \approx 94$ trips towards CBD on Control Gates Bridge.
- Seven Oaks and Kinloch PM peak: $496 \text{ households} \times 50\% \text{ developed} \times 70\% \text{ to and from Taupo CBD} \times 0.85 \text{ PM peak trips per household} \times 63\% \text{ away from Taupo CBD} = 92.9 \approx 93$ trips away from CBD on Control Gates Bridge.
- Acacia Bay AM peak: $150 \text{ households} \times 50\% \text{ developed} \times 80\% \text{ to and from Taupo CBD} \times 0.72 \text{ AM peak trips per household} \times 75\% \text{ into Taupo CBD} = 32.4 \approx 32$ trips towards CBD on Control Gates Bridge.
- Acacia Bay PM peak: $150 \text{ households} \times 50\% \text{ developed} \times 80\% \text{ to and from Taupo CBD} \times 0.85 \text{ PM peak trips per household} \times 63\% \text{ away from Taupo CBD} = 32.1 \approx 32$ trips away from CBD on Control Gates Bridge.

Table 5: Additional Trips 2025 #2

	2025 #2			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	72	72	71	71
Total	237	230	235	228

Table 6: Additional Trips 2030 #1

	2030 #1			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	0	0	0	0
Total	332	316	329	313

Table 7: Additional Trips 2030 #2

	2030 #2			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	54	54	53	53
Total	385	370	382	367

Table 8: Additional Trips 2030 #3

	2030 #3			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	187	0	186	0
Acacia Bay	0	65	0	64
Brentwood and Lakeside Brentwood	0	203	0	201
Undeveloped half charges	144	48	143	48
PC37 Nukuhau	143	143	142	142
Total	475	459	471	455

Table 9: Additional Trips 2030 #4

	2030 #4			
	Additional Trips into Town via Wairakei Dr (AM)	Additional Trips into Town via Norman Smith St (AM)	Additional Trips out of Town via Wairakei Dr (PM)	Additional Trips out of Town via Norman Smith St (PM)
Seven Oaks and Kinloch	94	0	93	0
Acacia Bay	0	32	0	32
Brentwood and Lakeside Brentwood	0	102	0	101
Undeveloped half charges	72	24	72	24
PC37 Nukuhau	54	54	53	53
Total	220	212	218	210

3 Traffic Model

3.1 Modelling Input

3.1.1 Traffic Volume

To determine future traffic volumes in the year 2025 and 2030, we have:

- Applied a 1% net linear annual traffic growth rate to the base traffic volumes (2021 base model from Taupo Traffic Model)
- Included additional forecast trips generated from the permitted land developments and Nukuhau Plan Change development

Additional modelling in SIDRA (v9) has been completed for the Norman Smith Street / Wairakei Drive intersection, the Control Gates Bridge, and the Spa Road/Tongariro Street roundabout for the scenarios summarised in Table 1.

3.1.2 Phasing and Timing

We have adopted Optimum Cycle Time for the Norman Smith signalised intersection. SIDRA identifies the cycle time for the model that will minimise overall delay for the intersection; Figure 4 below illustrates the option selected within SIDRA.

Sequences	Sequence Editor	Phase & Sequence Data	Timing Options	Movement Data
Selected Sequence (For Editing) Opposed Turns Quick Input View Display				
Site Cycle Time Option				
<input type="radio"/>	Practical Cycle Time			
	Maximum Cycle Time	NA		
	Cycle Rounding	NA		
<input checked="" type="radio"/>	Optimum Cycle Time			
	Cycle Time - Lower Limit	Input		
		50 sec		
	Cycle Time - Upper Limit	150 sec		
	Cycle Time - Increment	10 sec		

Network Cycle Time and Site Phase Times option specified for Coordinated Sites in the Network Timing dialog under the Network tab will override the Cycle Time Option specified here subject to various conditions.

If the Optimum Cycle Time option is selected when the Signal Analysis Method is Actuated (data in Sequences tab) and no Coordinated movement exists (data in the Vehicle Movement Data dialog, Signals tab), the program will apply the Practical Cycle Time option.

Optimum Maximum Green Settings option is not accessible if Signal Analysis Method is EQUISAT (Fixed-Time / SCATS) (data in Sequences tab).

Figure 4: Phasing and Timing Input for the Norman Smith Intersection

3.1.3 Gap Acceptance

We have not calibrated the models based on observation of queuing and delay of the actual sites due to the lack of actual survey data. Instead we have used the SIDRA default or programmed gap acceptances for the Spa Road roundabout and the left turn from Norman Smith Street.

The SIDRA manual states that “For roundabouts, program / Input drop-down list controls the Critical Gap and Follow-up Headway data fields. The Program option (default) means that the Critical Gap and Follow-up Headway parameters will be determined by the program as a function of the roundabout geometry, circulating flow rate and other factors.”

3.1.4 Bridge Saturation flow

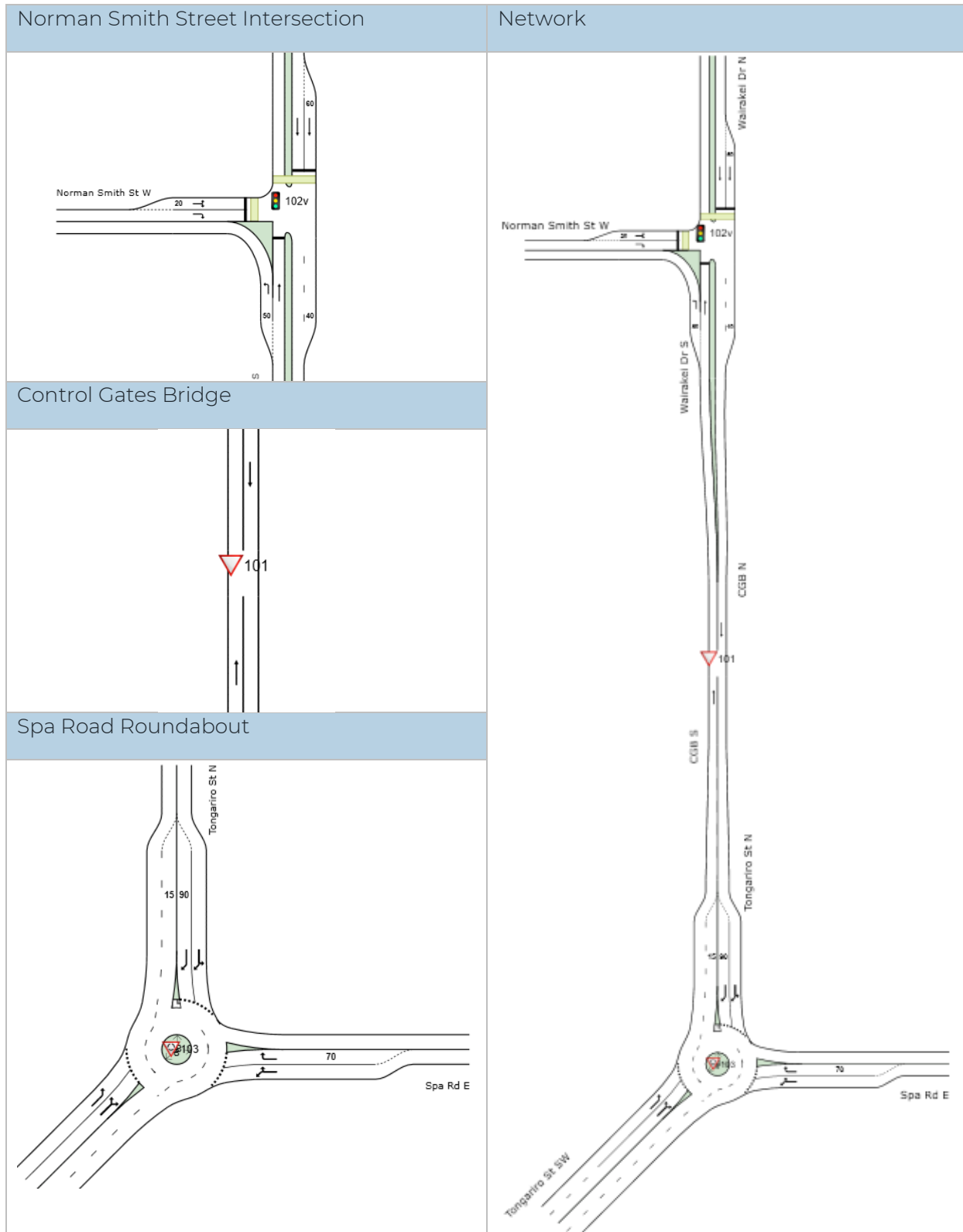
We have adopted a saturation flow rate of 1550 vph per direction for the CGB, which is similar to historic traffic volumes on the bridge. We note that this rate is at the lower end of the range of "1550-1600 vehicles per lane per hour" described by Mr Smith in paragraph 4.11a of his statement of 30th September 2021. Therefore, our analysis of the CGB is likely to be conservative.

Vehicle queues are likely to develop in the models when the modelled traffic flows are greater than the designed saturation flow (designed capacity).

3.2 Site Layout

We ran models for three discrete sites on the network; namely, Norman Smith Street intersection, Control Gates Bridge, and the Spa Road roundabout. We also modelled travel along various routes (using the Route function under SIDRA network) that combined the three discrete sites into a small network. Table 10 illustrates the discrete sites and a truncated version of the network configuration.

Table 10: SIDRA Site and network Layouts



3.3 Modelling Output

The following sections summarise the outputs from the SIDRA models.

We ran the models for each of the individual sites separately and together as a network. For each site, we have reported both the individual site performance and the performance of the site in the network. Listed below are the key differences in the reporting for the individual sites and the network:

1. Queue Length: SIDRA models report the 95th percentile (95thile) queue for individual sites and the average queue for the site in a network. That is, the queue lengths for the site outputs are not directly comparable with the queue lengths for the Network outputs.
2. Arrival Flow: In the network, arrival flow value is reduced if there is a capacity constraint (capacity restrained) in upstream lanes. Essentially, if an upstream site limits the rate at which vehicles can arrive at a downstream site, the modelling for the downstream site is based on the arrival rate dictated by the upstream constraint.
3. Approaching Distance: Approaching distance is set up as 500 m when assessing an individual site. In the network, the approaching distance is set up to align with the actual distance between the sites. This has been measured using Google Maps.

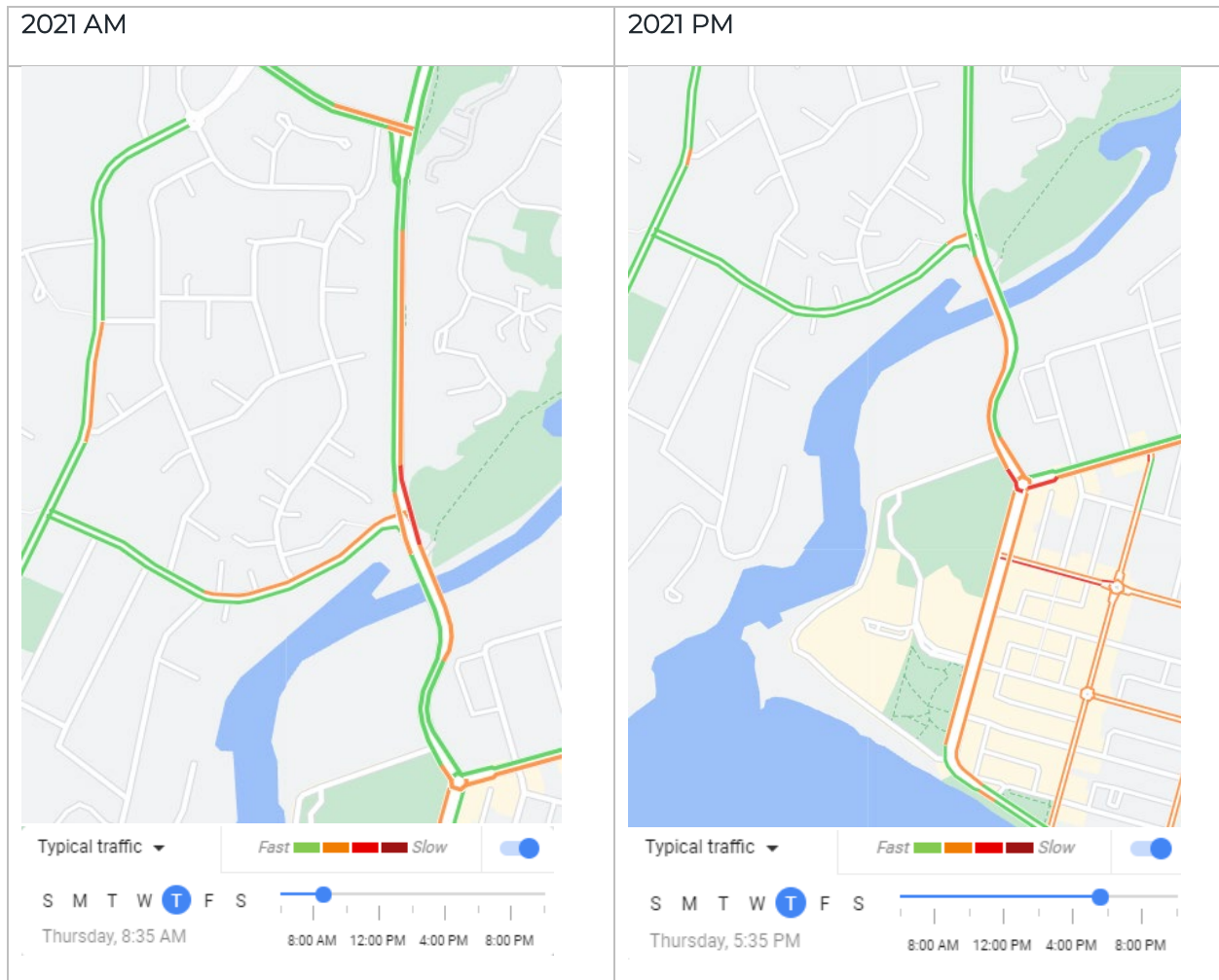
We have also reported total travel time for eight different routes in the network (Table 23 and Table 25), four for each peak period and compared the travel times between different scenarios.

3.3.1 Current Model vs Google Typical Traffic

Google records the operational performance of typical traffic and it can be compared with the 2021 modelled results.

For the comparison, we have chosen Thursday, which is the “worst” day of the week in Google Maps and the time period that presents the worst conditions for the peak period.

Table 11: Google Maps Typical Traffic Speed



3.3.2 Norman Smith Street/Wairakei Drive Intersection

For the Norman Smith intersection, we have reported modelling results for the overall site and the two movements that have the longest queues and greatest delays for each peak period. While there is some queuing and delay on the third approach in each case, it is less significant, therefore, we have focused on the worst cases.

In the tables below, we have included three numeric values in parentheses beneath the name of each scenario. These values represent the assumed percentage development for each of (Brentwood, Lakeside Brentwood, Vineyard on Huka Falls, Acacia Bay, Kinloch, and Seven Oaks combined / Undeveloped half charges / Nukuhau).

Table 12: Norman Smith Street Intersection – Site Output AM

AM Site performance	LOS Intersection	Average Delay (sec)	Southbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	95%ile Queue (m)	Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	C	21	28	115	22	142
2025 Scenario #1 (50/30/0)	E	70	105	409	79	530
2025 Scenario #2 (50/30/40)	F	105	144	518	130	698
2030 Scenario #0 (0/0/0)	C	29	39	154	36	215
2030 Scenario #1 (100/60/0)	F	180	255	803	215	995
2030 Scenario #2 (100/60/30)	F	217	222	923	318	1548
2030 Scenario #3 (100/60/80)	F	281	300	1103	397	1736
2030 Scenario #4 (50/30/30)	F	119	179	574	138	707

By way of explanation, as an example, the results in Table 12 illustrate the following:

- (a) Adding 50% of all other developments (except Nukuhau) and 30% of the Half charges (2025 Scenario #1) to the 2021 base (2021 Scenario #0) volumes reduces the level of service for the intersection from LOS C to LOS E and increases the average delay from 21 seconds to 70 seconds.
- (b) Adding 40% of the traffic from Nukuhau (2025 Scenario #2) to the 2025 Scenario #1 traffic volumes reduces the level of service for the intersection from LOS E to LOS F, and increases the delay from 70 seconds to 105 seconds.
- (c) Reducing additional traffic for Nukuhau from 40% to 30% and adding 1% traffic growth per year to base traffic volumes (2030 Scenario #4) results in no change to the level of service, when compared with 2025 Scenario #2, and increases the average delay from 105 seconds to 119 seconds.

Table 13: Norman Smith Street Intersection – Network Output AM

AM Site performance in network	LOS Intersection	Average Delay (sec)	Southbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	Average Queue (m)	Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	C	21	28	71	22	87
2025 Scenario #1 (50/30/0)	E	70	105	251	79	325
2025 Scenario #2 (50/30/40)	F	105	144	317	130	427
2030 Scenario #0 (0/0/0)	C	29	39	94	36	132
2030 Scenario #1 (100/60/0)	F	180	255	492	215	610
2030 Scenario #2 (100/60/30)	F	217	222	565	318	949
2030 Scenario #3 (100/60/80)	F	281	300	676	397	1064

2030 Scenario #4 (50/30/30)	F	118	179	352	138	433
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Table 14: Norman Smith Street Intersection – Site Output PM

PM Site performance	LOS Intersection	Average Delay (sec)	Northbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	95%ile Queue (m)	Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	B	11	15	84	18	65
2025 Scenario #1 (50/30/0)	D	45	114	374	63	173
2025 Scenario #2 (50/30/40)	E	63	154	495	97	229
2030 Scenario #0 (0/0/0)	B	13	15	93	24	92
2030 Scenario #1 (100/60/0)	F	99	226	724	178	364
2030 Scenario #2 (100/60/30)	F	111	267	848	178	364
2030 Scenario #3 (100/60/80)	F	133	300	999	239	442
2030 Scenario #4 (50/30/30)	E	71	161	513	128	290

Table 15: Norman Smith Street Intersection – Network Output PM

PM Site performance in network	LOS Intersection	Average Delay (sec)	Northbound Through		Right turn out from Norman Smith Street	
			Delay (sec)	Average Queue (m)	Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	B	11	15	51	18	40
2025 Scenario #1 (50/30/0)	B	12	16	59	20	46
2025 Scenario #2 (50/30/40)	B	12	15	57	22	50
2030 Scenario #0 (0/0/0)	B	12	17	58	19	48
2030 Scenario #1 (100/60/0)	B	14	17	58	22	57
2030 Scenario #2 (100/60/30)	B	13	17	60	21	52
2030 Scenario #3 (100/60/80)	B	16	13	56	37	77
2030 Scenario #4 (50/30/30)	B	13	16	58	21	52

3.3.3 Control Gates Bridge

For the CGB, we have reported modelling results for the worst movement, which we have identified as being the movement with the greatest delays for each peak period. While there is delay on the other approach it is essentially insignificant by comparison. SIDRA determines the delay for a network feature like the CGB based on comparison between the modelled flow rate and the saturation flow rate. Delay and LOS will deteriorate as the modelled flow rate

approaches and exceeds the saturation flow rate (designed capacity), which in this case we have set as 1550 vph per lane.

Table 16: Control Gates Bridge – Site Output

Site performance	LOS Worst Movement		Average Delay (sec)		AM - Southbound Delay (sec)	PM - Northbound Delay (sec)
	AM	PM	AM	PM		
2021 Scenario #0 (0/0/0)	B	A	10	4	14	7
2025 Scenario #1 (50/30/0)	F	F	94	71	128	110
2025 Scenario #2 (50/30/40)	F	F	130	102	173	155
2030 Scenario #0 (0/0/0)	E	D	34	19	49	32
2030 Scenario #1 (100/60/0)	F	F	194	158	254	234
2030 Scenario #2 (100/60/30)	F	F	223	184	288	268
2030 Scenario #3 (100/60/80)	F	F	272	228	346	325
2030 Scenario #4 (50/30/30)	F	F	138	108	185	166

Table 17: Control Gates Bridge – Network Output

Site performance in network	LOS Worst Movement		Average Delay (sec)		AM - Southbound Delay (sec)	PM - Northbound Delay (sec)
	AM	PM	AM	PM		
2021 Scenario #0 (0/0/0)	A	A	2	3	3	6
2025 Scenario #1 (50/30/0)	C	E	18	25	24	41
2025 Scenario #2 (50/30/40)	D	E	19	28	26	46
2030 Scenario #0 (0/0/0)	B	C	7	14	11	23
2030 Scenario #1 (100/60/0)	D	F	21	32	29	53
2030 Scenario #2 (100/60/30)	D	F	24	41	33	67
2030 Scenario #3 (100/60/80)	D	F	26	36	35	58
2030 Scenario #4 (50/30/30)	D	F	18	27	25	45

3.3.4 Spa Road Roundabout

For the Norman Smith Street intersection, the modelling results were reported based on a single movement for each approach, however, we have reported the modelling outcomes based on approaches for the Spa Road roundabout. This is because traffic volumes for individual movements approaching the Spa Road roundabout are affected by other movements (Figure 5) whereas the effect is less pronounced for the approaches to the Norman Smith Street intersection. As such, at the Spa Road roundabout, the delays for some movements, where traffic volumes are low, may be relatively significant. However, we do not want to underrepresent the delays for those other movements.

For the Spa Road roundabout, we have reported modelling results for the overall site and the two approaches that have the longest queues and greatest delays for each peak period. While there is some queuing and delay on the third approach in each case, it is less significant, therefore, we have focused on the worst cases.

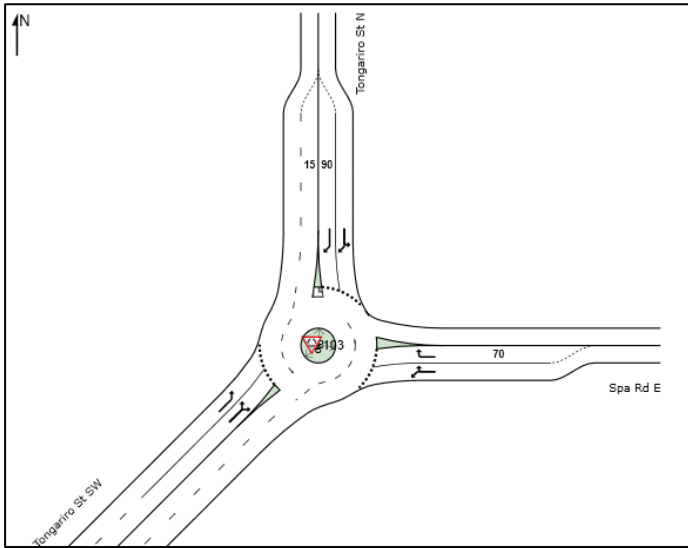


Figure 5: Spa Road Roundabout Layout

Table 18: Spa Road Roundabout – Site Output AM

AM Site performance	LOS Intersection	Average Delay (sec)	Southbound Approach		Westbound Approach	
			Average Delay (sec)	95%ile Queue (m)	Average Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	A	7	6	35	12	23
2025 Scenario #1 (50/30/0)	A	8	6	56	17	41
2025 Scenario #2 (50/30/40)	A	8	6	67	21	51
2030 Scenario #0 (0/0/0)	A	7	6	42	14	32
2030 Scenario #1 (100/60/0)	B	12	6	99	49	113
2030 Scenario #2 (100/60/30)	B	19	7	119	99	212
2030 Scenario #3 (100/60/80)	D	45	7	170	307	540
2030 Scenario #4 (50/30/30)	A	9	6	71	25	63

Table 19: Spa Road Roundabout – Network Output AM

AM Site performance in network	LOS Intersection	Average Delay (sec)	Southbound Approach		Westbound Approach	
			Average Delay (sec)	Average Queue (m)	Average Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	A	7	6	14	12	9
2025 Scenario #1 (50/30/0)	A	7	6	14	12	10
2025 Scenario #2 (50/30/40)	A	7	6	14	12	10
2030 Scenario #0 (0/0/0)	A	7	6	14	12	11
2030 Scenario #1 (100/60/0)	A	7	6	14	12	11
2030 Scenario #2 (100/60/30)	A	7	6	14	12	11

2030 Scenario #3 (100/60/80)	A	7	6	14	12	11
2030 Scenario #4 (50/30/30)	A	7	6	14	12	11

Table 20: Spa Road Roundabout – Site Output PM

PM Site performance	LOS Intersection	Average Delay (sec)	Northeast bound Approach		Westbound Approach	
			Average Delay (sec)	95%ile Queue (m)	Average Delay (sec)	95%ile Queue (m)
2021 Scenario #0 (0/0/0)	B	11	17	84	13	56
2025 Scenario #1 (50/30/0)	F	107	324	1082	24	156
2025 Scenario #2 (50/30/40)	F	170	499	1536	43	288
2030 Scenario #0 (0/0/0)	C	23	55	239	16	82
2030 Scenario #1 (100/60/0)	F	266	689	2070	121	722
2030 Scenario #2 (100/60/30)	F	304	742	2253	177	1019
2030 Scenario #3 (100/60/80)	F	382	879	2632	245	1402
2030 Scenario #4 (50/30/30)	F	176	500	1566	63	390

Table 21: Spa Road Roundabout – Network Output PM

PM Site performance in network	LOS Intersection	Average Delay (sec)	Northeast bound Approach		Westbound Approach	
			Average Delay (sec)	Average Queue (m)	Average Delay (sec)	Average Queue (m)
2021 Scenario #0 (0/0/0)	B	11	17	34	13	23
2025 Scenario #1 (50/30/0)	F	107	324	435	24	63
2025 Scenario #2 (50/30/40)	F	170	499	618	43	116
2030 Scenario #0 (0/0/0)	C	23	55	96	16	33
2030 Scenario #1 (100/60/0)	F	266	689	832	121	291
2030 Scenario #2 (100/60/30)	F	304	742	906	177	410
2030 Scenario #3 (100/60/80)	F	382	879	1060	245	564
2030 Scenario #4 (50/30/30)	F	176	500	630	63	157

3.3.5 Network En-route travel time

En-route travel time analysis has been undertaken using the Route function in the modelled SIDRA networks.

We have set up the following routes in the SIDRA network in all modelled scenarios to understand the overall en-route travel between (and including) the Norman Smith Street / Wairakei Drive intersection and the Spa Road roundabout via Control Gates Bridge.

The routes modelled and the summarised predicted results are described in the tables below.

Table 22: SIDRA Network En-Route AM

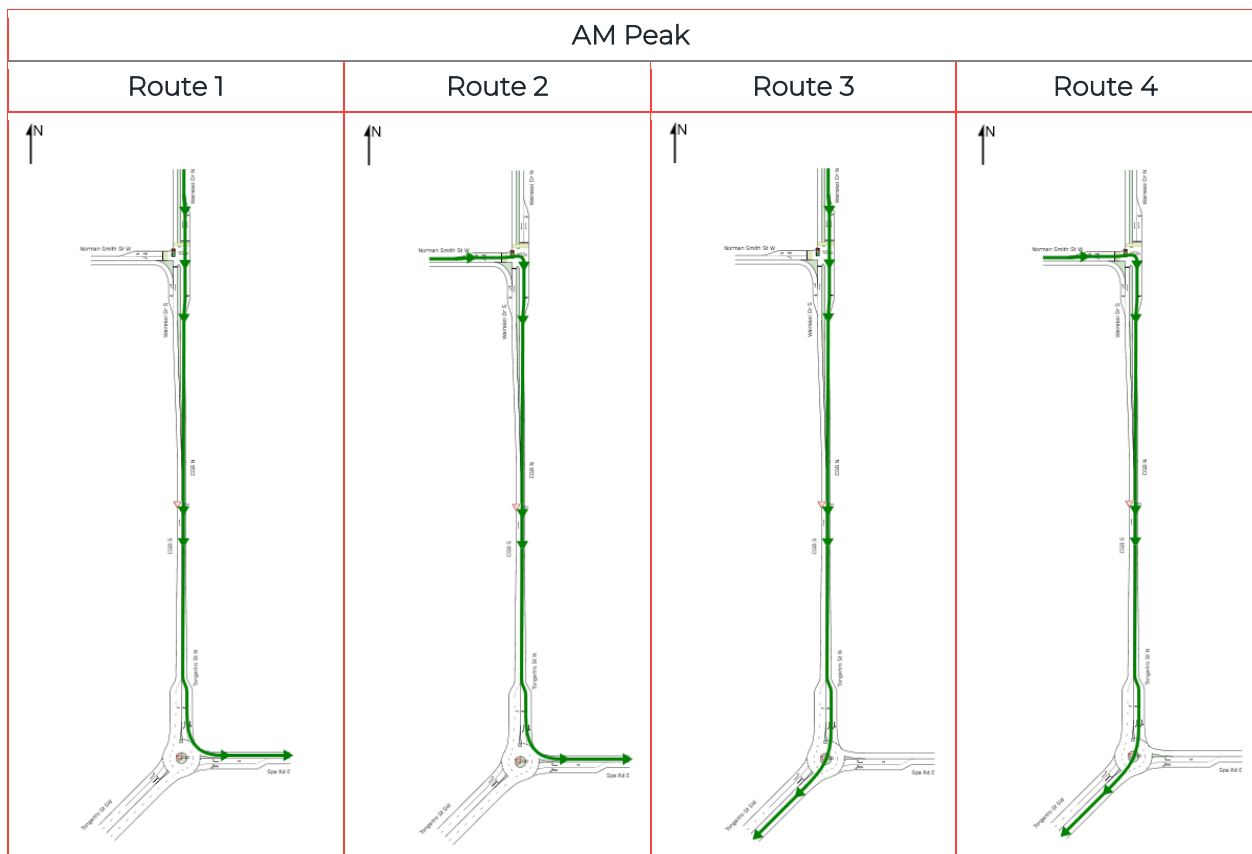


Table 23: En-Route Travel Time AM

Scenarios	AM En-route Travel Time (seconds)			
	Route 1	Route 2	Route 3	Route 4
2021 Scenario #0 (0/0/0)	149	142	150	144
2025 Scenario #1 (50/30/0)	247	220	249	221
2025 Scenario #2 (50/30/40)	289	274	291	275
2030 Scenario #0 (0/0/0)	166	164	168	166
2030 Scenario #1 (100/60/0)	405	364	407	365
2030 Scenario #2 (100/60/30)	375	472	377	474
2030 Scenario #3 (100/60/80)	448	544	449	546
2030 Scenario #4 (50/30/30)	324	281	326	283

Table 24: SIDRA Network En-Route PM

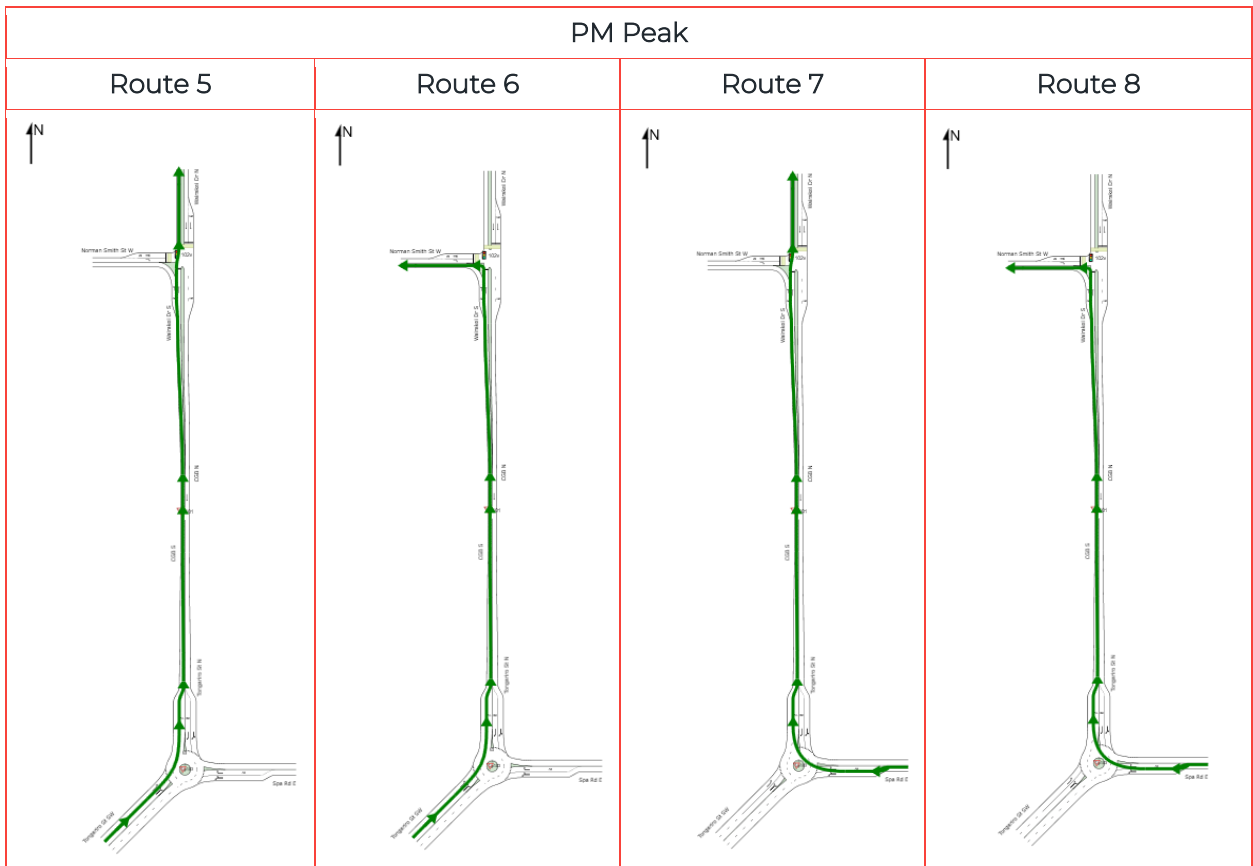


Table 25: En-Route Travel Time PM

Scenarios	PM En-route Travel Time (seconds)			
	Route 5	Route 6	Route 7	Route 8
2021 Scenario #0 (0/0/0)	148	139	145	135
2025 Scenario #1 (50/30/0)	505	493	192	181
2025 Scenario #2 (50/30/40)	688	678	215	205
2030 Scenario #0 (0/0/0)	208	195	168	155
2030 Scenario #1 (100/60/0)	891	879	302	290
2030 Scenario #2 (100/60/30)	959	947	372	360
2030 Scenario #3 (100/60/80)	1086	1078	428	420
2030 Scenario #4 (50/30/30)	690	679	235	224

4 Summary

4.1 Individual vs. Network

As noted in this memo, discrete elements of a transport network do not function in isolation, but rather they are components of the network. Therefore, in this summary section, we have compared the site individual outputs and the site network outputs for the three discrete elements of the network when modelled. Listed below are the key findings.

4.1.1 AM Peak

Norman Smith Intersection

In the AM Peak, the individual and network delay time is the same at this intersection; this is because the intersection is acting as the upstream constraint for the southbound vehicles approaching the bridge. Southbound vehicles in the network queue at this intersection before crossing the bridge, therefore, the number of vehicles that can travel south through the bridge is controlled by the capacity of the intersection to release those vehicles.

Control Gates Bridge

The network model indicated less delay time for the network site compared to the individual site. This is because the southbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Norman Smith Street intersection.

Spa Road Roundabout

Similar to above, the network site indicated less delay time compared to the individual site. This is because the southbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Norman Smith Street intersection.

4.1.2 PM Peak

Spa Road Roundabout

In the PM Peak, the individual and network delay time is the same at the Spa Road roundabout. This is because this intersection is acting as the upstream constraint for the northbound vehicles approaching the bridge. Northbound vehicles in the network queue up at this intersection before going through the bridge.

Control Gates Bridge

The network model indicated less delay time compared to the individual site. This is because the northbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Spa Road roundabout.

Norman Smith Intersection

The network model indicated less delay time compared to the individual site. This is because the northbound arrival flow value is reduced due to the capacity constraint of the oversaturated upstream lanes at the Spa Road roundabout.

4.2 En_Route Travel Time

We have also compared the route travel times between the key scenarios and summarised the results in Table 26 and Table 27.

Comparing the modelling output of travel time for permitted land only with permitted land plus Nukuhau (2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)):

- In the AM peak, the worst route (right turn out from Norman Smith Street intersection) had an increase of around 3 minutes (181 seconds).
- In the PM peak, the worst route (southwest approach of the Spa Road roundabout) had an increase of around 3.3 minutes (199 seconds).

Table 26: Difference in Travel Time AM

Compared scenarios		AM additional En-route Travel Time (seconds)			
		Route 1	Route 2	Route 3	Route 4
2030 Scenario #1 (100/60/0) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted land only	239	200	239	199
2030 Scenario #3 (100/60/80) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted land and Nukuhau	282	380	281	380
2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)	Delay time added due to Nukuhau on top of permitted land	43	180	42	181
2030 Scenario #4 (50/30/30) minus 2030 Scenario #0 (0/0/0)	Delay time added due to reduced development of permitted land and Nukuhau	158	117	158	117

Table 27: Difference in Travel Time PM

Compared scenarios		PM additional En-route Travel Time (seconds)			
		Route 5	Route 6	Route 7	Route 8
2030 Scenario #1 (100/60/0) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted Land Only	683	684	134	135
2030 Scenario #3 (100/60/80) minus 2030 Scenario #0 (0/0/0)	Delay time added due to permitted Land and Nukuhau	878	883	260	265
2030 Scenario #3 (100/60/80) minus 2030 Scenario #1 (100/60/0)	Delay time added due to Nukuhau on top of permitted land	195	199	126	130
2030 Scenario #4 (50/30/30) minus 2030 Scenario #0 (0/0/0)	Delay time added due to reduced development at permitted Land and Nukuhau	482	484	67	69

Appendix B: SIDRA Network Modelling Output Diagrams

1. The diagrams included in this appendix illustrate examples of the components of the network which contribute most to the travel time increases described in the memoranda ((WSP, 2021a) and (WSP, 2021b)).
2. Each diagram contains a legend that shows the level of service meaning for each of the colours in the diagrams. The three diagrams illustrate the performance of the network for the following scenarios:

2030 Scenario #0: 0/0/0 (Figure 4)

2030 Scenario #1: 100/60/0 (Figure 5)

2030 Scenario #2: 100/60/30 (Figure 6)

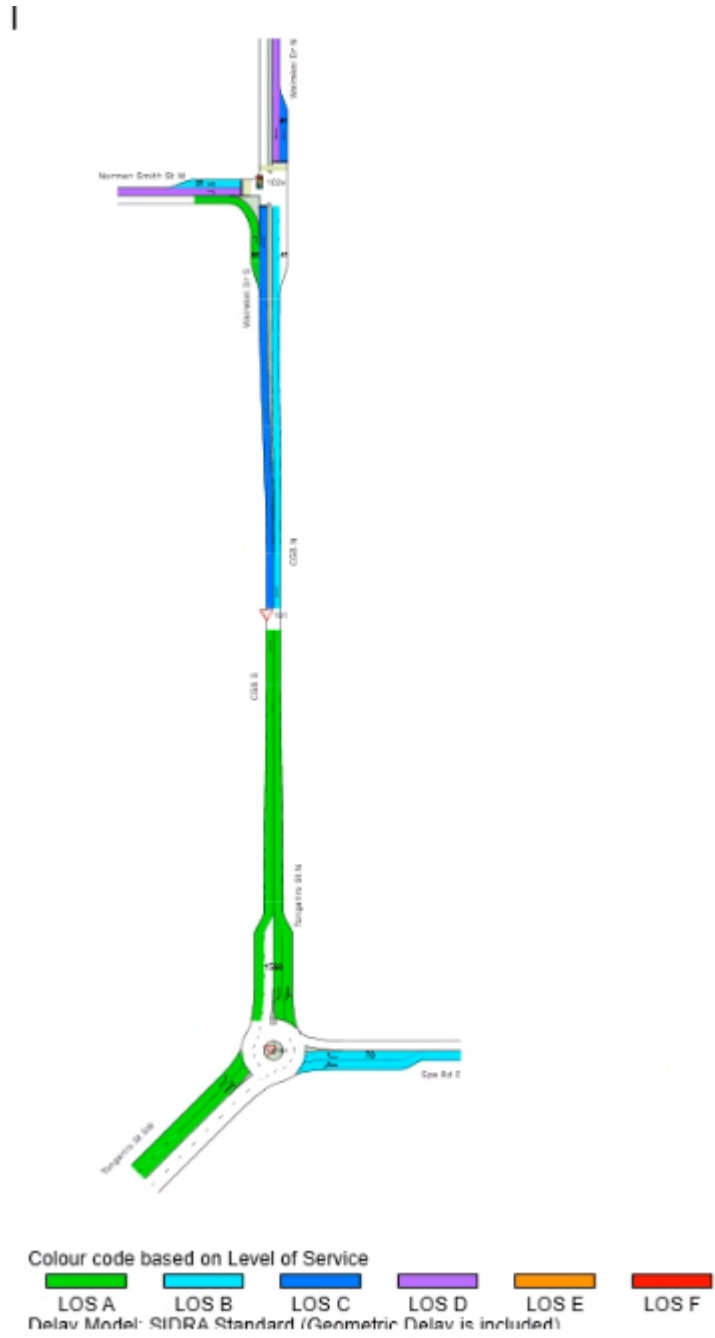


Figure 4: 2030 Scenario #0: 0/0/0 - the diagram illustrates the lowest level of service (LoS D - purple) for the southbound and eastbound approaches to the Norman Smith Street/Wairakei Drive intersection. The LoS B (light blue) on the southbound approach to the Bridge has the upstream constraint of the intersection and the downstream constraint of the Bridge. The southbound approach to the Spa Road roundabout has LoS A (green) because upstream elements constrain the rate at which traffic can arrive at the roundabout

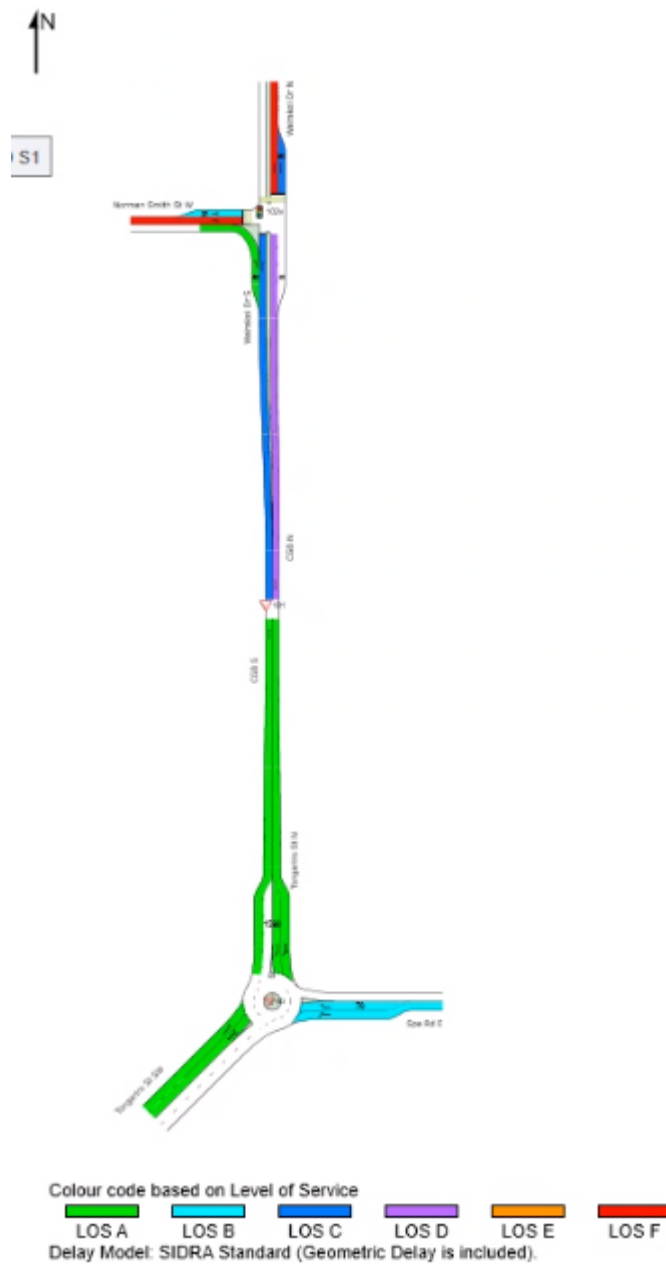


Figure 5: 2030 Scenario #1: 100/60/0 - the diagram illustrates the lowest level of service (LoS F - red) for the southbound and eastbound approaches to the Norman Smith Street/Wairakei Drive intersection. The LoS D (purple) on the southbound approach to the Bridge has the upstream constraint of the intersection and the downstream constraint of the Bridge. The southbound approach to the Spa Road roundabout has LoS A (green) because upstream elements constrain the rate at which traffic can arrive at the roundabout.

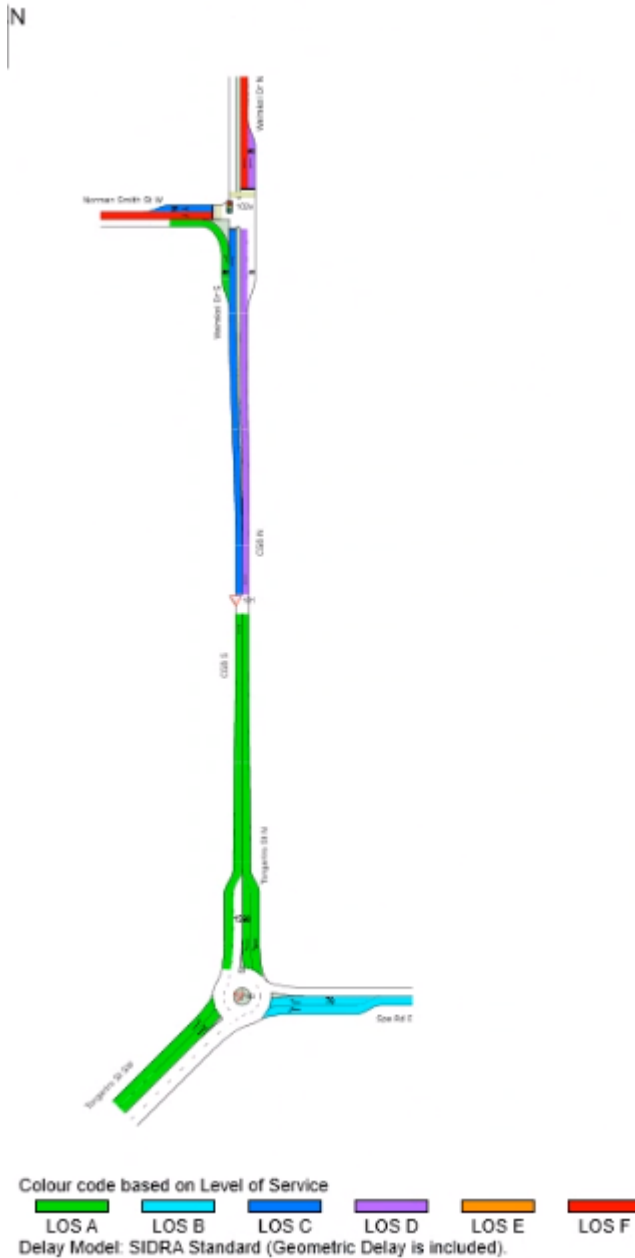


Figure 6: 2030 Scenario #1: 100/60/30 - the diagram illustrates the lowest level of service (LoS F - red) for the southbound and eastbound approaches to the Norman Smith Street/Wairakei Drive intersection. The LoS D (purple) on the southbound approach to the Bridge has the upstream constraint of the intersection and the downstream constraint of the Bridge. The southbound approach to the Spa Road roundabout has LoS A (green) because upstream elements constrain the rate at which traffic can arrive at the roundabout. The key differences between this diagram and Figure 3 are the one step deterioration in the level of service for the eastbound left turn and southbound left lane movements at the Norman Smith Street intersection.

Appendix C: 2041 Modelled Volumes Compared with 2030 Volumes

Appendix C: 2041 Modelled Volumes Compared with 2030 Volumes

- 1 The diagrams included in this appendix illustrate the 2030 Scenario #3 (100/60/80) traffic volumes used in the SIDRA modelling described in the memoranda ((WSP, 2021a) and (WSP, 2021b)), and the 2041 traffic volumes used in the SIDRA modelling described in the TIA ((WSP, 2019) and (WSP, 2020)).
- 2 Each diagram contains the turning volumes at the Norman Smith intersection and the Spa Road roundabout as well as the through traffic on the CGB in the AM and PM peaks:
 - (i) 2030 traffic volumes (Figure 7) for Scenario #3 (100/60/80) (1 Bridge), with land use assumptions based on information provided by Property Economics (2021).
 - (ii) 2041 traffic volumes (Figure 8) for the future scenario (2 Bridges) with the Project and land use assumptions contained within the Taupo Traffic Model.
- 3 The table below provides examples of the traffic volumes modelled for particular turning movements. It illustrates that for the 2030 scenarios where there is full development of the existing zoned land, there is a significant increase to the traffic volumes used described in the TIA for 2041.

Movement	Volume (vph)	
	2030	2041
Norman Smith right turn out AM	1410	1182
Control Gates Bridge southbound AM	2506	1853
Spa Road roundabout southbound through AM	1163	620
Spa Road roundabout northbound through PM	1127	576
Control Gates Bridge northbound PM	2442	1765
Norman Smith Street left turn PM	1412	1169

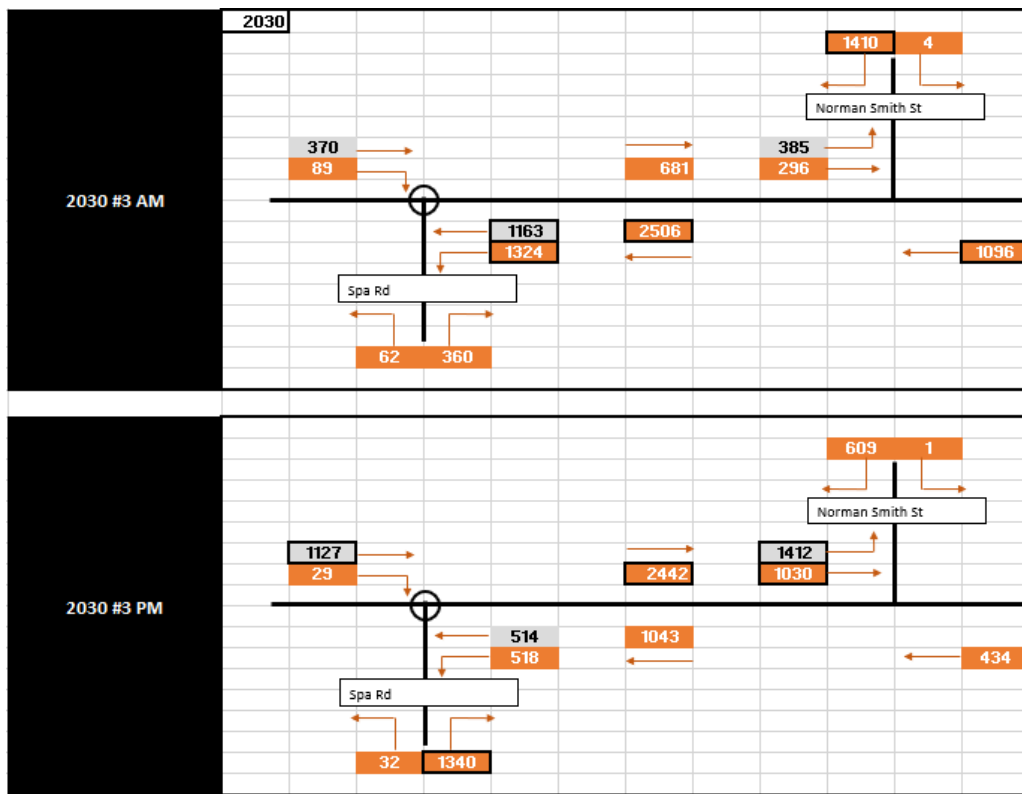


Figure 1: 2030 Traffic Volumes used in the Subsequent Modelling

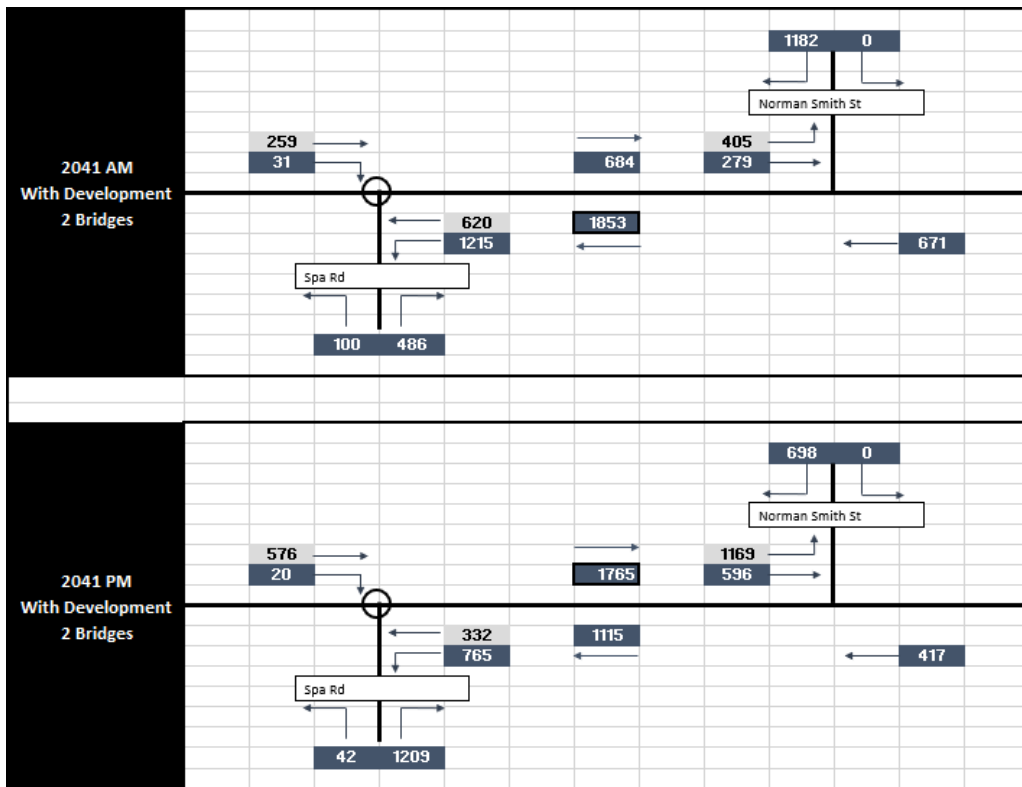


Figure 2: 2041 Traffic Volumes used in the TIA Modelling

Appendix D: References

I have referred to the following sources while preparing my evidence:

- a) Akcelik. (2020). *User Guide SIDRA Intersection 9: July 2020*. Greythorn, Victoria: Akcelik and Associates Pty.
- b) Property Economics. (2021). *Taupo Residential Dwelling Demand Addendum Report*. Auckland: Property Economics.
- c) Stantec. (2019a, May 22). RE: Nukuhau Plan Change Modelling; Email dated 22 May 2019 at 8:16 AM from Grant Smith (Stantec) to Emma Cui (WSP). Christchurch.
- d) Stantec. (2019b, May 22). RE: Nukuhau Plan Change Modelling; Email dated 22 May 2019 at 10:18 AM from Grant Smith (Stantec) to Emma Cui (WSP). Christchurch.
- e) WSP. (2019). *Nukuhau Private Plan Change, Taupo: Traffic Impact Assessment*. Hamilton, NZ: Williams Sale Partnership (WSP).
- f) WSP. (2020). *Nukuhau Private Plan Change, Taupo: Traffic Impact Assessment*. Hamilton, NZ: Williams Sale Partnership (WSP).
- g) WSP. (2021a). *Nukuhau Plan Change: memorandum dated 22 September 2021 from Emma Cui, Allan Liu and Robert Swears (WSP Auckland and Hamilton) to Hamish Crawford (WSP, Taupo)*. Auckland: Williams Sale Partnership (WSP).
- h) WSP. (2021b). *Nukuhau plan change: memorandum dated 12 October 2021 from Emma Cui and Allan Liu (WSP Auckland) to Hamish Crawford (WSP Taupo)*. Auckland: Williams Sale Partnership (WSP).