

Resource Consent Applications for subdivision
and land use for a rural lifestyle development at
Horahora Road, Lake Karapiro

K & L Tylee

Applicant

South Waikato District Council

Consent Authority

STATEMENT OF EVIDENCE OF JUDITH VICTORIA MAKINSON
Transportation Engineering

Dated: 7 October 2026

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1. Witness Introduction, qualifications, experience

1.1 My full name is Judith Victoria Makinson.

1.2 I am a Director at CKL (NZ) Ltd, specialising in transportation engineering and hold a Bachelor's degree in civil engineering and a Master's degree in transportation engineering and planning from the University of Salford (UK). I am a Chartered Professional Engineer and am a Chartered Member of Engineering New Zealand. I am also a Chartered Engineer in the United Kingdom and a Member of the Institution of Civil Engineers. I have over 25 years' international experience working as a transportation engineer in both New Zealand and the United Kingdom with Arup, WSP Group, Gifford, TDG, Stantec and CKL.

1.3 I have the following experience relevant to the subject matter of this evidence:

(a) I have undertaken Integrated Transportation Assessments ("ITAs") for major developments such as for 180ha of industrial land at Southern Gateway in Auckland and 450 residential dwellings at Northview in Hamilton. I have experience in assessing the traffic and transportation effects of rezoning land through plan change processes, including acting for South Waikato District Council ("SWDC") in relation to rezoning 40ha of rural land to industrial in Putāruru;

(b) I undertook a Road Safety Review of Horahora Road on behalf of SWDC in 2021; and

(c) I am qualified as an Independent Hearing Commissioner and in this role, I have experience of considering the effects of major infrastructure projects through notice of requirement processes, rezoning of land as well as individual resource consent applications. These include the Te Ahu a Turangi Manawatū Gorge Road replacement, Te Pūtahi Ladies Mile rezoning and the Kiwirail Regional Freight Hub at Bunnythorpe.

2. Code of Conduct for expert witnesses

- 2.1 I have read the Code of Conduct for expert witnesses in the Environment Court Practice Note 2023. In preparation of this evidence I have complied with, and in the course of these hearing proceedings I will comply with, that Code of Conduct. My evidence is within my area of expertise except where I am relying on the evidence of another witness, as stated in my evidence. I have not omitted to consider any material fact known to me that might alter or detract from any opinion expressed.

3. Scope of evidence

- 3.1 My evidence addresses the following matters:
- (a) A summary of the assessment undertaken, conclusions reached and proposed mitigations of traffic effects under the Integrated Transportation Assessment (“ITA”) and s92 responses;
 - (b) Confirmation of the key changes to the development which may affect the earlier assessment of effects;
 - (c) An update of the effects assessment to take into account the changes to both the proposed development and also the current transportation environment;
 - (d) Consideration of and responses to submission points relevant to this evidence;
 - (e) Responses to s42A report and supporting Gray Matter peer review relevant to this evidence; and
 - (f) Conclusions and recommendations.

4. Description and summaries of reports/other supporting documents that I have prepared

- 4.1 I have previously supervised the production of the following information relating to this application for resource consent:
- (a) An ITA report dated 9 June 2023; and
 - (b) Responses to two s92 requests for further information SWDC dated May and June 2025.

4.2 The ITA assessed the effects of the originally proposed 83 residential lot subdivision at 597 Horahora Road including the construction of two new local road intersections to Horahora Road. The northern intersection served up to 31 lots while the southern intersection served up to 15 lots. All internal road networks were proposed to operate with a posted speed limit of 50km/h or less. The remaining 37 lots were served by a mix of four shared / right of way accesses (12 lots) and private vehicle crossings (25 lots).

4.3 The original report described the existing road environment, considered road safety effects, traffic and access effects, assessed compliance of the development against the relevant transport provisions of the South Waikato Operative District Plan (“ODP”) and identified appropriate mitigations and consent conditions. I have summarised the ITA and s92 responses as follows:

(a) *Existing Road Environment:* Horahora Road is classified as a secondary collector road with a posted speed limit of 100km/h and has a 6.3m wide two lane, two-way carriageway. The carriageway is delineated with centreline markings and edge marker posts along its full length. Horahora Road contains a number of minor to moderate horizontal and vertical curves which can affect available sight distances. Horahora Road contains no formed cycle or pedestrian paths however the Karapiro section of the Waikato River Trail (“the Trail”) is located along the full length of the development, within the road reserve, between the carriageway and the property boundary

(b) *Traffic Volumes:* At the time the ITA was prepared, Horahora Road had traffic volumes of approximately 885 vehicles per day (“vpd”) with up to 142 heavy commercial vehicles (“HCVs”) per day, approximately 16% of the daily traffic volumes. Peak hour traffic was assessed at 10% of the daily traffic volumes or approximately 89 vehicles per hour (“vph”) or one vehicle every 40 seconds.

(c) *Road Safety:* A review of the New Zealand transport Agency “NZTA Crash Analysis System (“CAS”) database showed a total of seven

crashes consisting of one serious injury, two minor injury and four non-injury crashes along the site frontage within the 5-year period, 2018 to 2023. All of these crashes were reported to be due to loss of control and five were reported to have occurred on an out-of-context curve along the site frontage located immediately south of proposed Stage 1 development. It was assessed that this out-of-context curve was an existing issue. A review of the NZTA Megamaps road corridor risk ratings identified Horahora Road as having personal and collective road safety risk ratings¹ of low. The risk rating was assessed as being in keeping with the crash records along the wider Horahora Road corridor, noting the pattern of single vehicle loss of control crashes at the out of context bend.

- (d) *Future / Committed Developments*: The Arapuni Concept Plan, dated June 2021, identified a proposed expansion of the Pokaiwhenua Bridge from single to two lanes and future speed mitigation around the Pokaiwhenua River Trails carpark, however no timeframe for these works was identified.
- (e) *Traffic Effects*: The 83-lot residential development was assessed as generating 706vpd and 91vph as new trips to the existing network using the average trip generation rates of 8.5vpd and 1.1vph per lot from the NZTA Research Report 453 'Trips and Parking Related to Land Use ("RR453") Table C1. Daily traffic demand on Horahora Road as a result of the development was expected to increase from 885vpd to 1,591vpd. As a collector road corridor, Horahora Road was assessed as having a single lane capacity of between 1,400vph to 1,800vph. The combined peak hour traffic demand of the existing and development traffic was assessed as being approximately 10% to 13% of the capacity of a single lane and well within the network operating capacity.

¹ The collective road safety risk rating is the likelihood of a crash occurring. The personal road safety risk rating is the likelihood that if an event occurs, it will involve a given individual. These risk ratings are typically applied to a length or section of road and not to one single point along it.

(f) *Access Effects*: Visibility requirements were established by determining the operating speed of Horahora Road via a manual speed survey at four locations along the site. The survey was undertaken in January 2023 and established average speeds of 87km/h across the northern half of the site and 92km/h across the southern half of the site. The visibility requirements for vehicle crossings were then calculated based on NZTA 'RTS6 Guidelines for Visibility at Driveways' ("RTS6") to be 123m and 218m for the northern and southern halves of the site respectively. All vehicle crossings were assessed to be able to provide compliant sight distances, subject to localised vegetation removal and some cutting back of the exiting banks. Minimum safe intersection sight distance ("SISD") of 248m for the two new intersections based on the standards from Austroads Guide to Road Design ("AGRD") Part 4A could also be achieved. Both proposed intersections were demonstrated to achieve compliant SISD.

(g) *Mitigations*: A number of mitigations and specific requirements were identified:

- a. Due to the proximity of the Trail it was recommended that vehicle crossings be combined where possible to lessen the potential impact to trail users and positioned such that they are located in areas of good visibility. Some crossings also required cutting back of existing banks and removal of vegetation.
- b. All vehicle crossings were recommended to be provided at a gradient of no more than 1:12 for a minimum of the first 6m back from the road reserve.
- c. At the out of context bend:
 - i. Installation of raised reflective pavement markers ("RRPMs") on the carriageway centre line and edge lines on approach to and through the bend from both approaches;
 - ii. Installation of missing edge marker posts;

- iii. Reflective paint to be used to increase the visibility on the sight rail for northbound traffic;
 - iv. Relocation of existing advance curve warning sign and supplementary speed advisory as they are currently incorrectly placed; and
 - v. Installation of large chevron sight boards on both approaches.
- d. Shoulder widening suitable to allow the construction of basic right turn treatments in general accordance with AGRD Part 4A Figure 7.1 at the two new intersections.

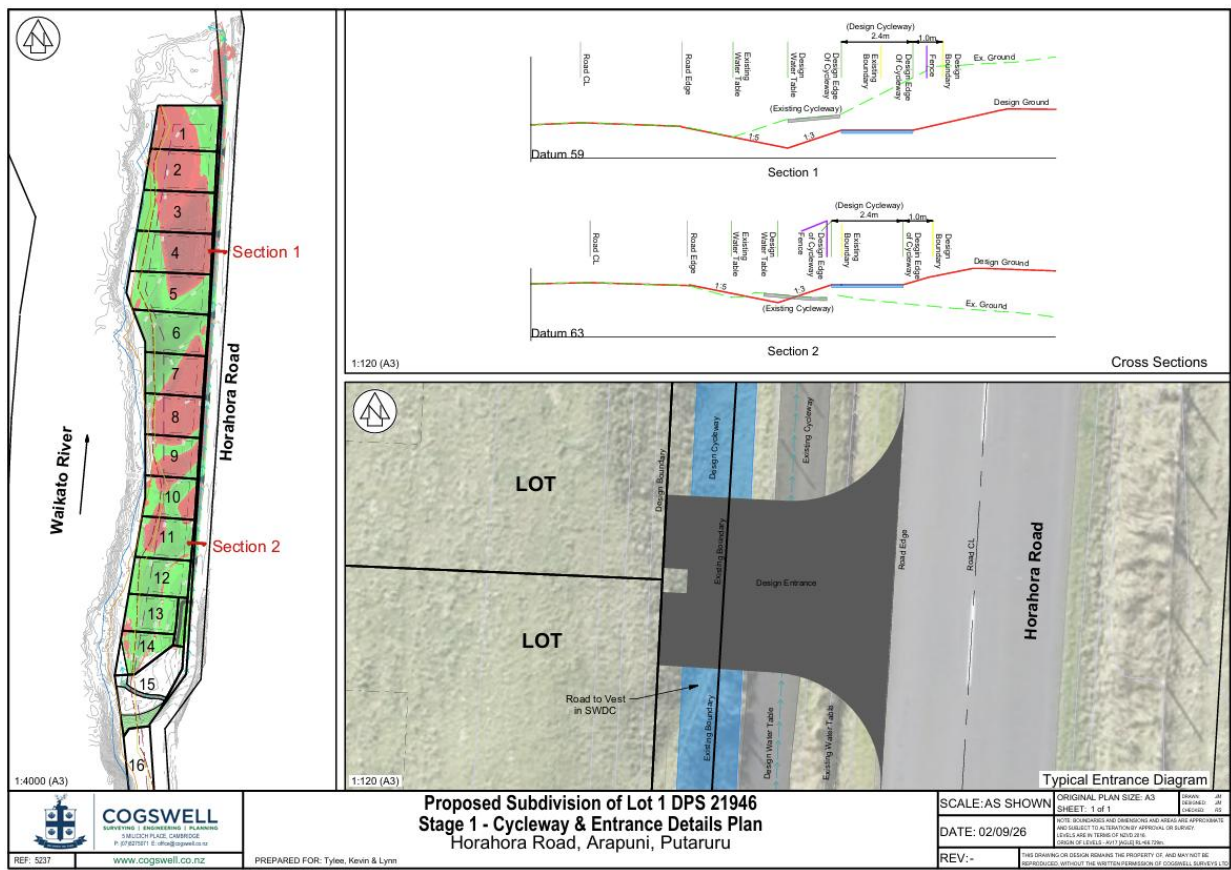
5. Amendments to the Applicant's proposal since those reports were prepared.

5.1 Key amendments to the proposal since the preparation of the ITA and s92 RFI responses are as follows:

- (a) Revised Scheme Plan reduces the number of proposed lots from 83 to 73 (-10) compared to the original ITA. The revised plans show amended staging and access information as follows:
- a. Stage 1 contains lots 1 to 15 including one shared access serving three lots and six combined vehicle crossings (Cogswell drawing 5237 Proposed Subdivision of Lot 1 DPS 21946 sheet 2 of 6 , Stage 1 Revision J);
 - b. Stage 2 contains 21 lots including the southern intersection serving 15 lots, one shared access serving three lots, one combined vehicle crossing and one individual vehicle crossing (Cogswell drawing 5237 Proposed Subdivision of Lot 1 DPS 21946 sheet 3 of 6, Stage 2 Revision J); and
 - c. Stage 3 contains 37 lots including the northern intersection serving 24 lots, one shared access

serving four lots, four combined vehicle crossings and one individual vehicle crossing (Cogswell drawing 5237 Proposed Subdivision of Lot 1 DPS 21946 sheets 4 of 6 to 6 of 6, Stage 3 Revision J).

(b) The Trail is widened to 2.4m and relocated further from the carriageway along the majority of the site frontage. An example of the revised cross section of the Trail and its location relative to the road is shown in Cogswell drawing 5237 Proposed Subdivision of Lot 1 DPS 21946 - Stage 1 Cycleway and Entrance Details Plan. And includes below for ease of reference. Visibility splays at each vehicle crossing and intersection are also proposed as discussed later in my evidence, along with the suitability of the proposed upgrades.



6. Assessment of the current proposal.

- 6.1 I have assessed the effects of the current proposal against the key metrics of traffic volumes, road safety and visibility.

Traffic Volumes and Effects

- 6.2 To update the existing traffic volumes along Horahora Road within the vicinity of the site, a seven-day pneumatic automatic tube count ("ATC") was commissioned at two locations along Horahora Road. The first ATC was located approximately outside 275 Horahora Road in order to identify existing traffic passing the established housing. The second ATC was located near the proposed northern intersection, approximately central along the frontage of the proposed development in order to identify traffic passing the site. The ATCs were conducted between 13th August 2026 and 20th August 2026.
- 6.3 At Location 1, the ATC recorded a seven-day average daily traffic ("ADT") of 1,177vpd with morning and evening peak hour volumes of 83vph and 114vph respectively. This is an increase of 292vpd and 29vph compared to the 2023 data. At Location 2, the ATC recorded a seven-day ADT of 1,122vpd with morning and evening peak hour volumes of 82vph and 112vph respectively. This is an increase of 237vpd and 23vph compared to the 2023 data. ATC summary results are attached in Annexure A. The ATC also identified 85th percentile operational speed data profiles at each location. This data demonstrated operating speeds of 95km/h at Location 1 and 103km/h at Location 2.
- 6.4 In conjunction with the ATCs, peak hour intersection counts for the Horahora Road / SH1 intersection were undertaken on Thursday 20th August. The counts were recorded in 15-minute intervals between the hours of 7am to 9am and between 3:30pm and 6pm. The AM peak hour was recorded to be between 8am and 9am with a total of 875 vehicle movements through the intersection, of which 115 were to or from Horahora Road. The PM peak hour was recorded to be between 3:30pm to 4:30pm with a total of 1,104 vehicle movements through the intersection, of which 136 were to or from Horahora Road. I consider that these traffic volumes align with the recorded peak hour movements captured by the ATCs,

allowing for some variation due to property access between the intersection and ATC locations.

- 6.5 Horahora Road is classed as a secondary collector road on the Mobile Road website, which is based on council RAMM data. This classification is based on the One Network Road Classification (“ONRC”) system. A secondary collector is generally defined as a road that links local areas and which may be the only route available in some areas². They typically carry more than 200vpd. I note that a primary collector road under the ONRC system typically carries more than 1,000vpd, suggesting that Horahora Road may already be functioning as a higher order road, noting that traffic volume is not the only consideration in road classifications.
- 6.6 However, the ONRC was replaced by the One Network Framework (“ONF”) a number of years ago. The key difference between the two classification systems is that the ONRC primarily considered movement function, whereas the ONF considers both movement and place function of roads. As such, there is no direct correlation between the ONRC and ONF systems. A rural secondary collector under ONRC could be assessed as any one of four road classifications under ONF depending on the degree of place function.
- 6.7 Under the NZTA ‘ONF Classification Guide’³, I consider that Horahora Road has a place function of P5 (negligible pedestrian activity and mostly rural adjoining land use) and a movement function of M4 (mostly local trips or trips connecting to connector roads with around 300vpd – 4,000vpd)⁴. This classifies Horahora Road as a ‘rural road’. A rural road is generally defined under the ONF as having low levels of traffic and roadside activity, whilst acknowledging that some rural roads have a higher recreational tourism function⁵.

² NZTA ‘ONE Network Road Classification (ONRC) Performance Measures: A General Guide’

³ Appendix A, Table 3 and Table 4

⁴ NZTA ‘One Network Framework Classification Matrix’

⁵ NZTA ONF Street Categories Fact Sheet

6.8 The reduction in total number of lots for the revised scheme plan of the proposed development to 73 lots is expected to generate some 621vpd and 80vph to the network based on the average trip rates from RR453. Application of this to the updated ATC data indicates the revised traffic volumes along Horahora Road could be expected to be some 1,800vpd and up to 194vph during peak hour at Location 1 following completion of the development. The volumes at Location 2 would be slightly lower. This volume of traffic equates to approximately 14% of the capacity of a single lane. I consider this increase in traffic as being a less than minor effect, that this change in traffic volumes does not alter the function or nature of Horahora Road and that its classification under either the ONRC or ONF would not change as a result of the development.

6.9 I have also supervised SIDRA v9 modelling of the SH1 / Horahora Road intersection for both the existing traffic flows and also for 'with development' volumes. This is based on the observed turning counts and the assignment of development traffic to the intersection based on the peak hour ATC proportions of northbound and southbound traffic flows on Horahora Road. In the AM peak hour, some 57% of trips are northbound and 43% are southbound, whereas in the PM peak hour the proportions are 47% and 53% respectively. I have also considered traffic growth over time, assuming a 10-year build out of the development. I have applied an annual growth rate of 9.81% to traffic to and from Horahora Road and a 2.76% annual growth rate for through traffic on SH1. This is based on the observed growth from 2023 to 2026 for Horahora Road and on NZTA Traffic Monitoring System ("TMS") data for SH1 traffic. The SIDRA analysis results are provided in Annexure B. In summary:

(a) In the 2026 AM peak period, the intersection operates with all movements at level of service ("LOS") A or B, with delays of no more than 14 seconds and 95th percentile queue lengths of around 1m – 2m both without and with development. Allowing for 10 years' growth, the worst movement is still operating at LOS C, with delays of some 24 seconds and queues of 4m – 6m. This is a good level of operation and above the typical future year target of LOS D.

(b) In the 2026 PM peak hour, the right turn out of Horahora Road is already operating at LOS F with delays of around 64 seconds, with all other movements operating at LOS A. The 95th percentile queue length is around 3.2m which equates to one car only. The poor level of service is due to comparatively high through traffic flows on SH1. With the development in place, the delay is modelled as increasing to approximately 70 seconds with a 95th percentile queue of 4.6m. In my opinion, through traffic volumes remain as the key constraint on right turns out of Horahora Road with the addition of development traffic having a negligible effect. The minimal change in queue length and delay means that generally, only one vehicle is delayed, with there occasionally being two vehicles waiting. With the development in place, the number of occurrences when two vehicles are waiting increases slightly. The overall number of right turning vehicle is very low (less than five an hour).

(c) When allowing for 10 years' traffic growth, the operation of the right turn out in the PM peak hour deteriorates significantly, however all other movements continue to operate at LOS A or B. In the base case, the right turn out of Horahora Road is likely to experience 210 seconds of delay on average with a queue of around 19m (about 3 vehicles). The addition of development traffic to the intersection is likely to add 9 seconds to the average delay and 4m (less than 1 car) to the 95th percentile queue length. I consider this to be a less than minor effect.

6.10 Overall, I assess that the traffic effects of the proposed development on the capacity, function and classification of the road network are less than minor.

Road Safety Records and Effects

6.11 I have also updated the search of the CAS database for the full five-year time period of 2021 – 2025 and 2026 as far as 17th September. A total of eight crashes has been reported along the development frontage including one serious injury, three minor injury and four non-injury as shown in Figure 2. This is an increase of one crash, noting that there is on overlap between the original and updated crash assessment periods.



Figure 2: Crash Locations 2021 to 2026

6.12 A summary of the crashes is provided in Table 1.

Table 1: Crash Summary 2021 – 2026

Timing and Conditions	Location	Crash Details	Severity
2021- 1am, dark	Approaching / at out of context bend	Fallen asleep at the wheel and not wearing seatbelt	Serious Injury
2021 - 5pm, heavy rain	Approaching / at out of context bend	Single vehicle loss of control	Minor injury
2023 – 3am, dark, light rain	Approaching / at out of context bend	Off roadway due to avoiding oncoming driver over the centreline	Minor injury
2026 – 5.30am, dry	Stage 3 frontage	Fallen asleep at the wheel	Minor injury
2021 – 11am, light rain	Approaching / at out of context bend	Single vehicle loss of control	Non-injury
2021 – 9pm	Stage 2 frontage	Inexperienced driver using mobile phone whilst driving	Non-injury
2022 – 8pm, dry, bright	Approaching / at out of context bend	Single vehicle loss of control; speeding under the influence of alcohol	Non-injury
2025 – 6am winter, dark, light rain	Stage 1 frontage	Obstruction in the road	Non-injury

- 6.13 Of the reported crashes, two involved drivers falling asleep at the wheel, including the only serious injury crash where the degree of injury will have been exacerbated by the driver not wearing a seatbelt. One involved a driver having consumed alcohol, one involved a driver using their mobile phone and one was as a result of an obstruction in the road. I note the pattern of crashes occurring at the out of context bend and also note that there is a pattern of crashes occurring in dark and / or wet conditions in this location.
- 6.14 I have also considered the crash records for the remainder of the route from the site along Horahora Road to SH1 to the north and supervised an assessment of existing and future expected crash rates using the NZTA Crash Estimation Compendium ("CEC") both with and without development.
- 6.15 The Horahora Road corridor has been split into three sections based on context as shown in Figure 3.

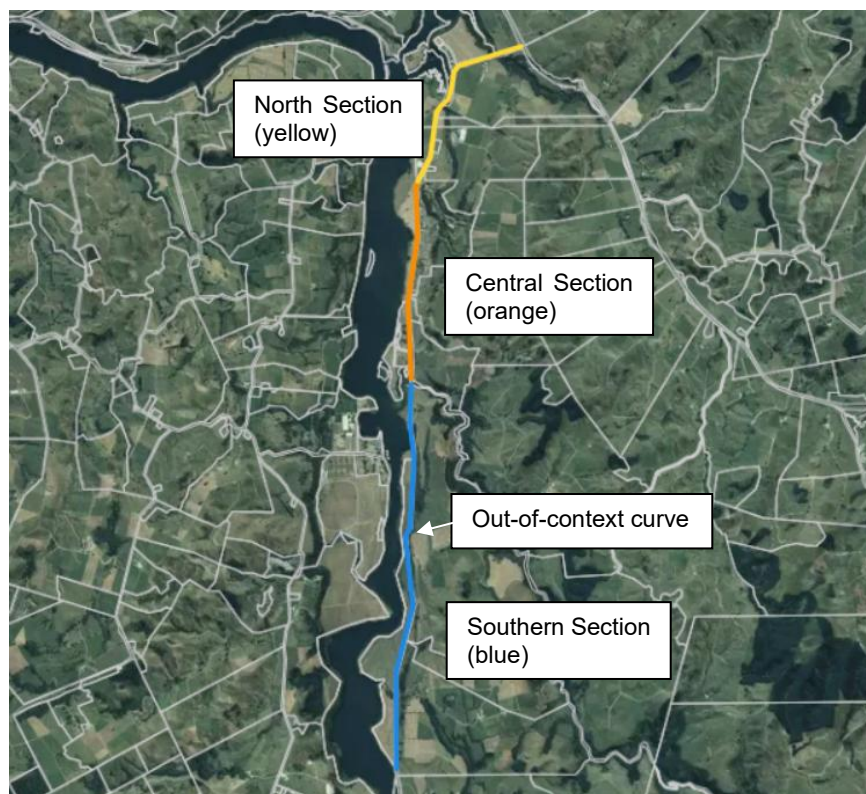


Figure 3: CEC Corridor Sections

- 6.16 The northern section of Horahora Road reflects the limited density of existing development as well as the more hilly and winding section of the road. It is some 2.1km in length. The central section of Horahora Road represents the existing residential development from 213 Horahora Road to the Pokaiwhenua Bridge, a distance of some 2.1km. The southern section of Horahora Road measures 4.2km in length and extends south of the Pokaiwhenua Bridge and along the entire proposed development frontage. The southern section has been further split into subsections to reflect the changing intensity of development along the length of the development and the cluster of crashes at the out of context curve.
- 6.17 I have adopted a generally consistent geometric profile including lane width and absence of sealed shoulder for the entire road corridor. The ATC data was used to provide the daily traffic volumes for each section of road, along with the daily traffic generation for the proposed development. I have provided a summary of results in Table 2. This analysis is based on present day traffic volumes and assumes the full development is in place. This results in a conservative assessment of crash rate effects as the proportional increase in traffic due to the development is greater in the existing context than in the 10-year future context. It is also important to note that the CEC calculations are a methodology for assessing risk and cannot take into account real world random events. As such number of years for an additional crash to occur provided in Table 2 should be read as a measure of risk, not as a prediction of eventualities.

Table 2: Summary of Crash Estimation Calculations

Road Section	Location	Length (km)	Expected Injury Crashes per year	Projected Number of Additional Injury Crashes with Development Based on Expected Crash Rates	Expected Number of Injury Crashes (5 years)	Actual Number Injury Crashes Reported in 5 Years	Projected Number of Additional Injury Crashes with Development Based on Observed Crash Rates
North	From SH1 south to 213 Horahora Road	2.1	0.335	+0.45 (+0.090/yr, or 1 additional injury crash every 11 years 1 month)	1.67	1 (0.2 / yr or 1 crash every 5 years)	+0.27 (+0.054/yr, or 1 additional injury crash every 18 years 6 months)
Central	From 213 Horahora Road south to one-way bridge	2.2	0.351	+0.47 (+0.095/yr, or 1 additional injury crash every 10 years 6 months)	1.75	3 (0.6/yr or 1 injury crash every 1 year 8 months)	+0.81 (+0.162/yr, or 1 additional injury crash every 6 years 2 months)
Southern Sub Sections							
Stage 1 Frontage	South of one-way bridge to out-of-context curve	1.6	0.244	+0.34 (+0.069/yr or 1 additional injury crash every 14 years 6 months)	1.22	0	-
Out-of-context curve	Between Stages 1 and 3	0.1	0.015	+0.02 (+0.004/yr or 1 additional injury crash every 250 years)	0.08	3 (0.6/yr or 1 injury crash every 1 year 8 months)	+0.75 (+0.15/yr, or 1 additional injury crash every 6 years 8 months)
Stage 3 Frontage	out-of-context curve south to northern intersection	1.25	0.191	+0.27 (+0.054/yr, or 1 additional injury crash every 14 years 6 months)	0.95	1 (0.2 / yr or 1 crash every 5 years)	+0.27 (+0.054/yr, or 1 additional injury crash every 18 years 6 month)
Stage 2 Frontage	South of northern intersection along remaining frontage	1.26	0.192	+0.27 (+0.054/yr or 1 additional injury crash every 14 years 6 months)	0.96	0	-

6.18 From Table 2, it is clear that the section of Horahora Road outside the existing residential dwellings is experiencing more injury crashes per year than expected. Similarly, the out of context bend also currently experiences more injury crashes than expected. However, there are also some sections of road experiencing fewer crashes than might typically be expected based on the CEC calculations. Based on the expected number of injury crashes, the proposed development is likely to increase risk by one crash every 10 to 250 years, depending on location.

6.19 I have also applied the observed crash rates to the future 'with development' traffic volumes to assess the likely future injury crash rate assuming a continuation of current injury crash trends. This shows that based on the observed crash history, the increase in risk is likely to be one additional injury crash every 6 to 7 years at the out of context bend and

along the central section of Horahora Road with the development in place. Whilst any crash is best avoided, and acknowledging the personal cost of any degree of injury, in overall road safety terms, I do not consider this level of change to be significant in the context of the existing crash rate of one injury crash per year.

- 6.20 Notwithstanding that, I have also revisited the Megamaps personal and collective risk ratings for the Horahora Road corridor. These ratings have been upgraded to high and medium for personal and collective respectively. The NZTA 'High Risk Rural Road Guide' Figure 4-6, shown in Figure below, indicates that this combination of risk ratings identifies that a safety management treatment philosophy is recommended. Safety management actions typically include speed management, better delineation and other low cost upgrades.

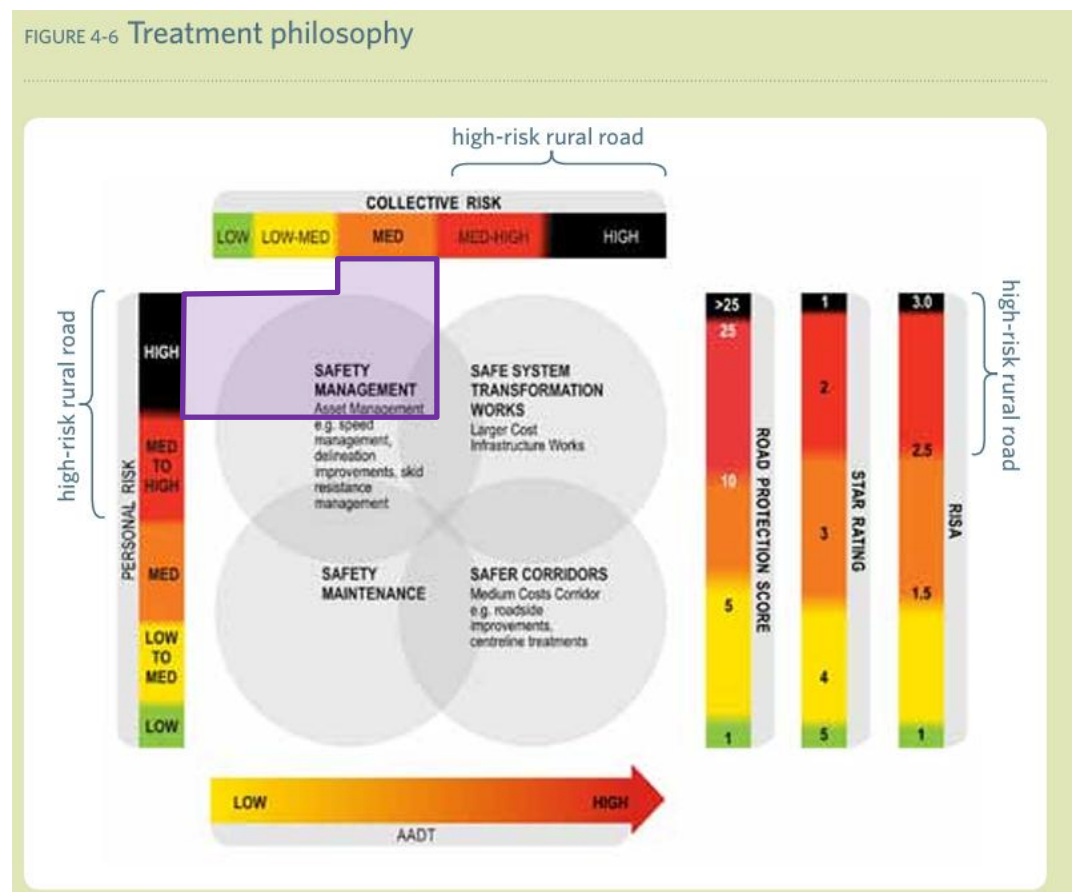


Figure 4: Excerpt of NZTA High Risk Rural Roads Guide Figure 4-6

6.21 A review of the signage at the out of context bend shows that some of the advance warning signage is not appropriately located and could be contributing to the loss of control crashes. Correct placement of the signs is the responsibility of the road controlling authority to address the existing crash issue and is an appropriate safety management response. I also consider that the proposed works to the out of context bend along the site frontage as set out in paragraph 4.3 (g) are also an appropriate safety management response and should improve driver awareness and assist in addressing the existing crash cluster. In my opinion, these works are the responsibility of SWDC, however, I note that the Applicant has previously agreed to undertake these works and remain committed to doing so.

6.22 It is also worth noting that the road markings along the central section of Horahora Road changed at some point in 2025 where no overtaking lines were installed between 293 Horahora Road and 343 Horahora Road. The temporary 80km/hr speed limit was also installed at this time as can be seen from Figure 5. I also note that of the three injury crashes that occurred along this section of road, only one has potentially occurred since the alteration to the road markings and speed limit. These changes are broadly consistent with recommendations made in the 2021 Road Safety Review for Horahora Road commissioned by SWDC and which I authored, and fall within the 'safety management' category of works.

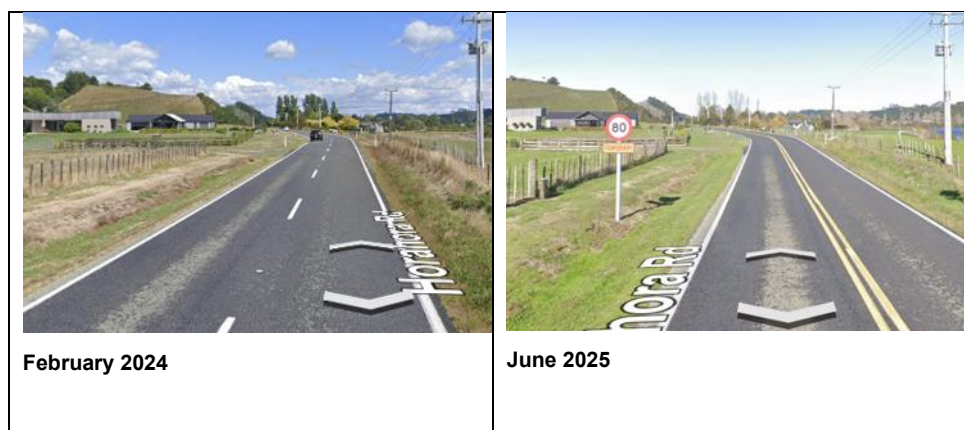


Figure 5: Changes to Horahora Road Markings and Speed Limit

6.23 Overall, I consider that the recent changes to road markings and speed limits by SWDC, as well as the works proposed by the Applicant to the out of context curve appropriate road safety actions in relation to the observed

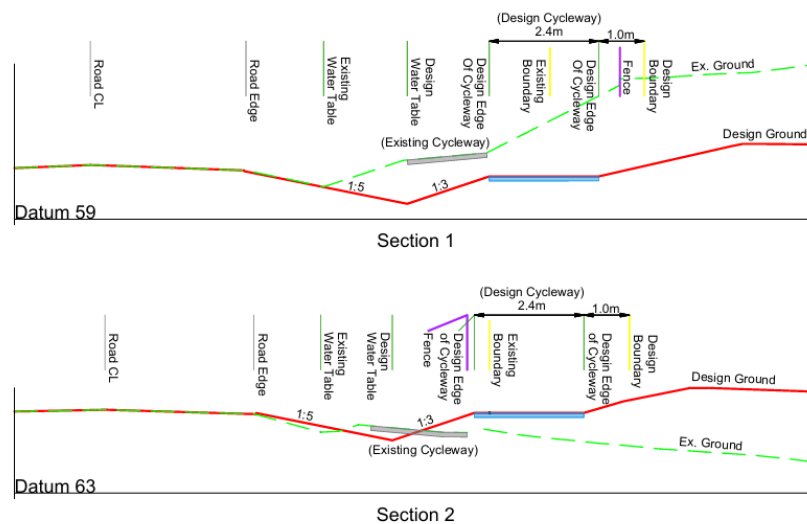
and assessed future injury crash rates. As such, I consider that the road safety effects of the proposed development can be suitably mitigated to less than minor.

Access Effects

- 6.24 All individual property accesses are expected to be constructed to the standards of Regional Infrastructure Technical Specification ("RITS") Section 3.3.11.4. All vehicle crossings approach Horahora Road at gradient of no more than 1:12 for at least the first 6m of each driveway and are graded downhill towards the Trail and Horahora Road.
- 6.25 The updated plans demonstrate that the shared access for lots 13 to 15 has been relocated to the northern extent of Lot 13 to maximise sight distances in both directions. It is expected that the previously identified embankment works and establishment of sight envelopes will be completed to provide compliant sight distance to the north for Lots 1 and 2.
- 6.26 It is also expected that the sight envelope to the north will be established for Shared Access 2, serving Lots 20, 21 and 22 to address the slightly reduced sightline availability due to vegetation. This sight envelope was discussed in Section 8 of the ITA and demonstrated in Figure 12 and also within Figure 8 and Figure 9 of the first s92 response dated 16 May 2025.
- 6.27 Given the increase in 85th percentile speeds along Horahora Road, I have reviewed the requirements of RTS 6. For a low volume vehicle crossing (serving <200vpd) to a collector road, the recommended visibility in a 100km/hr speed environment is 160m. Increases in visibility provisions at vehicle crossings within Stage 1 to ensure compliance with this sight distance are recommended and can be confirmed through detailed design. Similarly, I have reviewed AGRD Part 4A Table 3.2 to confirm the SISD for the two new intersections under a 100km/hr operating speed. The recommended SISD is 248m which is consistent with the original assessment.
- 6.28 Section 2.2.3 of the design document 'Ngā Haerenga New Zealand Cycle Trails Design Guide' details characteristics for different grades of trail. For Grade 3 trails which are considered suitable for riders with some fitness

and skills to avoid obstacles and loose sections, the preferred minimum width is 2.0m, gradients should not exceed 15% over more than 5m and areas where there is risk of serious injury as a result of a fall should have handrails.

- 6.29 As part of the development, the Trail is to be flattened, widened and moved further away from the carriageway for the majority of its length along the site frontage as shown in the Cogswell Drawing 5237 Proposed Subdivision of Lot 1 DPS 21946 - Stage 1 Cycleway and Entrance Details Plan and as per Figure 6.



Cross Sections

Figure 6: Waikato River Trail Cross-Sections (Plan Excerpt)

- 6.30 The upgraded section of trail will exceed the minimum width of 2m, which this current section of Trail does not meet. It will also move riders further away from the live carriageway which, in my opinion, is also a significant benefit. In the event that somebody does fall from their bicycle or ride off the Trail, there is a reduced likelihood of coming into contact with traffic and therefore a reduction in risk of a serious injury or fatality occurring.
- 6.31 Further to the relocation and widening of the Trail, the new scheme plans also include a standard detail to ensure there is good intervisibility at driveways between drivers and cyclist on the Trail. This is based on

the Auckland Transport 'Practice Note 7 Vehicle Crossings Design Standards'. Section 3.7 'Entry and Exit Visibility' recommends 24m visibility along the cycle path at a point measured some 3m from the closest edge of the path. The proposed development seeks to exceed this requirement by applying a sight envelope of these dimensions within the property boundary, which is offset from the Trail, at each vehicle crossing location. Within this sight envelope, it is recommended that no planting shall exceed 0.5m in height and any fencing should be open, allowing drivers to see oncoming trail users. This low planting height ensures visibility to child cyclists and is more onerous than the RTS 6 and AGRD Part 4A standards. The proposed visibility splay is shown in Figure 7.

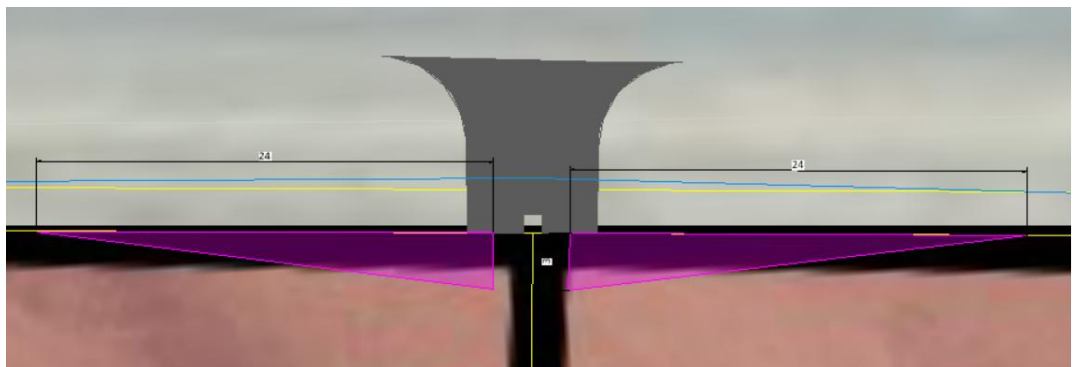


Figure 7: Visibility Splay From Driveways to Waikato River Trail

- 6.32 To give context to this, the outcome is similar to the visibility achieved at vehicle crossings adjacent to the peri-urban Maungatautari Road section of the Te Awa Cycle Trail. This trail is flat and straight and is suitable for less experienced cyclists. The occurrence of vehicle crossings is also similar to that of the proposed development, being at 50m – 200m spacing where adjoining development is present.
- 6.33 At intersections, a similar, albeit larger splay is recommended, with the setback from the trail being 10m as opposed to 3m at vehicle crossings. In my opinion, this can be addressed through the detailed design of the intersections
- 6.34 In my opinion, the proposed design criteria will provide safe interaction between the Trail and vehicle crossings or intersections and are consistent with provision elsewhere along similar cycle facilities in the region.

- 6.35 I consider that the relocation of the Trail further away from the carriageway will be a significant benefit for trail users, noting that the short section past the out of context bend cannot be relocated due to existing physical constraints. I note from Table 1 that of the five crashes which occurred at the bend three occurred in the dark or in the late evening when it is unlikely that the Trail will be in use, and one occurred in heavy rain, also a condition where the Trail is less likely to be in use. Overall, it is my opinion that the change in crash risk as a result of increasing traffic associated with the development is likely to have a less than minor effect on the safety of cyclists over this particular section of the Trail.
- 6.36 It is my opinion that the proposed development is likely to have a less than minor effect on road safety along Horahora Road and that the proposed upgrade of the Trail combined with the controls over means of access to the development lots appropriately mitigates potential effects on Trail users to less than minor.

7. Responses to submission points relevant to this evidence;

- 7.1 A number of submitters have raised a range of traffic and transportation concerns. I have grouped these into the following topics:
- (a) Outdated speed and traffic volume data;
 - (b) Safety effects on the Waikato River Trail of multiple vehicle crossings;
 - (c) Construction traffic effects
 - (d) Lack of clarity of means of access;
 - (e) Bottleneck effect at the Pokaiwhenua Bridge and Bridge Upgrade;
 - (f) Significant increase in traffic demands and resulting pollution and congestion effects;
 - (g) Form of SH1 / Horahora Road intersection and its operation;
 - (h) Existing speed limits; and
 - (i) General road safety concerns.

Outdated Speed and Traffic Volume data (Kristina and Roger Belfield, Sue Burnett)

- 7.2 The data presented in the ITA was relevant at the time of writing. Given the elapse of a number of years since it was completed, I agree that it is

appropriate to update the traffic survey speed and volume data. I have presented this in paragraph 6.2 to 6.4 and Annexure A of my evidence and consider that these submissions points have been addressed. The updated data does not change any of my assessments or conclusions.

Safety Effects on Waikato River Trail (Outdoor Access Commission, Rachel O'Reilly)

- 7.3 I have discussed this in paragraphs 6.28 to 6.35 of my evidence in relation to Trail safety effects and in paragraphs 6.5 to 6.8 in relation to the nature of Horahora Road. In my opinion, the proposed widening of the Trail, its relocation further way from the existing carriageway and the visibility splays at each vehicle crossing based on the AT best practice guidance and existing provisions along the Maungatautari Road section of the Te Awa Trail provide suitable mitigation of development effects.

Construction Traffic Effects (Bates Family Trust, Brendon Cornes)

- 7.4 I acknowledge that construction is likely to occur over a number of years. However the staging of development means that construction effects associated with bulk earthworks and providing subdivision infrastructure such as internal roads and vehicle crossings will most likely be limited to relatively short durations throughout the overall timeframe for all lots to be built on.
- 7.5 The construction effects of individual lots are likely be no different from any other individual dwelling build such as might be expected on the vacant lots within the existing rural residential area north of the Pokaiwhenua Bridge. In my experience, construction traffic effects can be managed through a Construction Traffic Management Plan ("CTMP") and this can be required by way of a consent condition in relation to the relocation of the Trail and subdivision construction activities. Construction associated with individual dwelling builds is likely to be low level in volume and duration and in my opinion does not require control.
- 7.6 I also acknowledge Mr Corne's concern that temporary speed limits may be required as part of the CTMP and his suggestion that an access ramp be provided to enable construction traffic to enter and leave Horahora

Road 'at speed'. I consider it unlikely that such a ramp would be a safe or appropriate outcome as it is preferable to control vehicle speeds through road works or where there is a construction access in order to reduce the likelihood of collision. I also consider that reduced speeds limits during the construction phases are likely to be of relatively short duration and would be temporary only. The need for these two controls or other temporary controls would be assessed at the point any CTMP is lodged and agreed with SWDC. I consider the potential for temporary speed limits during construction to be a less than minor and temporary effect.

Means of access to Horahora Road(Bates Family Trust, Peter Martin et al)

- 7.7 The revised scheme plans show all vehicle crossings and subdivision road connections to Horahora Road and I therefore consider this matter to have been addressed.
- 7.8 Concerns have also been raised regarding the provision of direct property access to Horahora Road. I have addressed this in paragraphs 6.24 to 6.35 of my evidence and recommended specific controls on visibility provisions.

Bottleneck Effect at the Pokaiwhenua Bridge and Bridge Upgrade (Chris and Julia Hogg, Kristina and Roger Belfield, Arapuni Village Community Association, Unknown)

- 7.9 The single lane Pokaiwhenua Bridge has been assessed using a Monte Carlo modelling simulation. Monte Carlo simulation is a numerical modelling technique used to assess systems where outcomes depend on variables that vary randomly over time. Rather than assessing a single fixed sequence of vehicle arrivals, the method simulates a large number of possible arrival patterns and statistically evaluates the resulting operating conditions. The technique is appropriate where performance is governed by the interaction between individual vehicles, and where the timing of arrivals rather than the total volume of traffic determines how any delay and queuing occur. A single-lane bridge under priority control is such a case: the same hourly demand may

produce negligible delay under one arrival pattern and sustained queuing under another.]

- 7.10 Details of the modelling are provided in Annexure C. In summary, over the 500 model simulations for both the PM peak hour under 'with development' conditions, 82% of vehicles are likely to experience no delay or queue at the bridge. For those who do meet at the bridge, average delay was modelled at around 1 second with queues of around a single vehicle. The longest queue observed across all model runs was three vehicles.
- 7.11 With respect to widening of the Pokaiwhenua Bridge, I have reviewed the SWDC Long Term Plan 2024 – 2034 ("LTP"). The Transport and Roading section of the LTP refers to a general road widening budget but does not make specific mention of upgrading the Pokaiwhenua Bridge to two-lanes. I have also found on evidence of committed funding in the 2026 – 2027 Annual Plan. The Arapuni Concept Plan also identifies the upgrade as a community priority under item 14 of the action plan.
- 7.12 I acknowledge that a model that is designed to assess random situations is not the same as real world and that an individual may meet another vehicle at the bridge on a daily basis due to their own particular travel habits. However, the model is useful in quantifying probabilities and effects. In my opinion, the one lane bridge is likely to continue to operate efficiently with the vast majority of people experiencing no queue or delay and therefore the effect of the proposed development is negligible. On that basis, I consider that there is no causal link between development effects and the need to upgrade the bridge and that a specific contribution to the upgrade outside of development contributions is not appropriate. I also conclude that the proposed development will not lead to unbudgeted spend by SWDC to upgrade the bridge.

Increase in Traffic Volumes and Congestion (Aaron Gilmore, Andrea Parlane, Evelyn Winter, Kristina and Roger Belfield, Rachel O'Reilly, Sue Burnett, Unknown)

7.13 I have discussed traffic volumes with and without development, road classification and road capacity in paragraphs 6.2 to 6.8 of my evidence. In my opinion, the proposed development is likely to have a less than minor effect on traffic volumes and congestion at either the SH1 / Horahora Road intersection or the Pokaiwhenua Bridge or on Horahora Road itself.

Operation of SH1 / Horahora Road Intersection (Unknown)

7.14 I have addressed the operation of the SH1 / Horahora Road intersection in paragraphs 6.9 to 6.10 and Annexure B of my evidence. In my opinion, the proposed development is likely to have a less than minor effects on its safe and efficient operation.

Speed Limits (Bredon Corne, Janine and Brendon Andrews, Sue Burnett, Unknown)

7.15 Mr Corne has raised a concern that the existing 100km/hr speed limit along the site frontage would be reduced in future to 80km/hr. Ms Burnett also raises the need for future speed management as an issue of concern.

7.16 Any future reduction in speed limit is governed by the 'Land Transport Rule: Setting of Speed Limits 2024' which requires each council to develop a Speed Management Plan. The Land Transport Rule defines the considerations that a Council must take into account when considering future speed limits, including a cost benefit analysis covering expected crash savings, travel time impacts and cost of implementation. I note that the current SWDC Speed Management Plan⁶ assesses the full length of Horahora Road and recommends a reduction in speed limit to the north of the Pokaiwhenua Bridge only.

7.17 In the event that the speed limit along the site frontage were to be reduced from 100km/hr to 80km/hr, the travel time along the site frontage would increase from 2 minutes 30 seconds to 3 minutes 9

⁶ SWDC Speed Management Plan Section 5.2.1

seconds on average. Given the rural nature of the area and the likely longer journey times this necessitates, I consider that the potential increase of 39 seconds journey time in the event that a lower speed limit were to be implemented to be a negligible effect.

- 7.18 Conversely, Janine and Brendon Andrews and the Arapuni Village Community Association wish to see an 80km/hr speed limit imposed along the development frontage to facilitate safe development access. In my opinion, the design controls proposed for vehicle crossings address this concern. Any future review of speed limits is a function of SWDC and would need to be undertaken in accordance with their Speed Management Plan and the Land transport Rule.

General Road Safety Concerns (Chris and Julia Hogg, Peter Martin et al, Daniela Forsythe, Sue Burnett)

- 7.19 Submitters have raised concerns regarding the suitability of Horahora Road to carry increased traffic volumes from a road safety perspective. I have assessed this in detail in paragraphs 6.11 to 6.23 of my evidence.
- 7.20 In my opinion, the proposed development traffic is likely to have a less than minor effect on road safety and that with the proposed control in place, safe access to Horahora Road can be provided through a range of shared and single vehicle crossings and road intersections.

8. Responses to s42A report and peer review issues relevant to this evidence

- 8.1 I have reviewed the Gray Matter memo dated 29 September 2026 and generally agree with the conclusions reached by Ms Parsons as follows:
- (a) The future traffic demands with the development in place are within the capacity of a Horahora Road and are unlikely to result in unacceptable road safety or efficiency effects;
 - (b) Mitigation of the out of context curve is appropriate;

- (c) The proposed development is unlikely to result in an unacceptable efficiency or road safety effect at the Horahora Road / SH1 intersection;
- (d) Vehicle crossings have been paired to minimise interruptions to people using the Trail and mimic the arrangements of the existing rural lifestyle development to the north of the Pokaiwhenua Bridge;
- (e) Widening of the Pokaiwhenua Bridge is not needed to support the proposed development and the additional traffic is unlikely to result in unacceptable road safety or efficiency effects;
- (f) Construction traffic effects can be appropriately managed via a consent condition requiring a CTMP that will confirm TTM and matters such as corridor access requests which are standard practice.

8.2 Ms Parsons recommends that the speed limit along the site frontage be reviewed by SWDC if the proposal is frontage consent. I agree that this potential future action sits with SWDC.

8.3 I also note a number of other specific recommendations made by Ms Parsons in relation to matters to be included in consent conditions:

- (a) Covenants restricting the development of additional vehicle crossings to Horahora Road in future. I consider this to be unnecessary as any new vehicle crossing would be assessed against the relevant ODP standards on its individual merits and need against the environment prevailing at the time;
- (b) Covenants restricting fencing and planting to maintain visibility splays. I agree with the principle of this, noting that the Applicant is proposing a more extensive visibility splay of 3m x 24m at all vehicle crossings and 10m x 24m at intersections;
- (c) Signage and markings on the out of context curve differ in detail but I agree with the principle of the mitigation;

(d) I agree with the need for appropriate approvals of detailed design matters such as grading of the Trail, design of intersections and visibility at vehicle crossings, noting that the requirements for detailed design and post construction Safe System Audits are a requirement of RITS.

8.4 I have reviewed the draft consent conditions relating to traffic, access, roading and the Trail as provided in Appendix A of the s42A report and make the following comments:

(a) Condition 12 (f) and (j) as they relate to access and the Trail are reasonable;

(b) Condition 17 relating to the Construction Management Plan refers to the need to consider site access and construction traffic arrangements however it does not refer specifically to the provision of a Construction Traffic Management Plan or Temporary Traffic Management. There also appears to be no condition referring to the need for a Corridor Access Request for undertaking works within the road corridor. I recommend that specific conditions addressing these matters be included in any subdivision consent.

(c) Condition 31 (d) refers to transportation mitigations identified in two specific documents. In my opinion, it would be more helpful to specify those improvements in the consent conditions.

(d) Conditions 32 to 38 are reasonable. However, I note that Condition 35 refers to RTS 6 and AGRD Part 4A SISD standards of how to measure visibility along the road, including setbacks, but no reference is made within the condition (or other conditions) in relation to the proposed visibility splays to ensure good visibility to the Trail. In my opinion, this condition should be amended to specifically refer to those visibility splays, and the need for their ongoing protection via a consent notice or other suitable mechanism.

- (e) Conditions 39 and 40 relate specifically to works needed to ensure visibility to access to Lots 1 and 2 which are already covered by the general provisions of Conditions 34, 35, 36 and 38. In my opinion, Conditions 39 and 40 can be deleted.
- (f) Conditions 41 and 42 relate to the Lot 13 – 15 shared access. Relocation of this has already been proposed as per the revised subdivision plans, and the conditions also cover specific works needed to achieve the visibility required under Condition 35. In my opinion, the majority of this is unnecessary detail as it is already covered by Conditions 34, 35, 36 and 38. Condition 41 (e) requiring the headlight screening and Condition 42 (c) in relation to the visibility envelope are reasonable and should be retained. In my opinion, it would be beneficial to include the protection of sight envelopes as a specific requirement for all vehicle crossings. Whilst it is partially implied in Condition 135 in relation to the design of fencing, Conditions 123 to 125 regarding landscaping require retention of landscaping as per the approved plans but do not expressly require no planting above 0.5m to be included in the visibility splays. In my opinion, a specific requirement for maintaining all visibility splays or sight envelopes free of all obstructions above 0.5m in height would be beneficial.
- (g) Conditions 44 to 45 relating to rights of way and gates are reasonable.
- (h) Condition 46 addresses the proposed mitigations at the out of context curve and is reasonable.
- (i) Conditions 47 – 49 address the Waikato River Trail. Conditions 47 and 48 are reasonable, however, Condition 49 does not consider the permanent relocation of the Trail as proposed by the Applicant, and subject to detailed design. It is my recommendation that this condition be amended to allow for the permanent relocation of the Trail as proposed.

9. Conclusions

- 9.1 I have assessed the transportation effects of the revised proposal for a 73-lot rural residential development in the context of updated traffic counts, speed data and crash records. I note that Horahora Road has experienced traffic growth since the original ITA, however, it continues to operate well within its available capacity and in my opinion, the proposed development will have a less than minor effect on this. It is also my opinion that the proposed development will not alter its function or classification.
- 9.2 The SH1/Horahora Road intersection operates well in the morning peak. Whilst the right turn out of Horahora Road experiences delay in the evening peak, this is principally due to existing SH1 through-traffic volumes. Development traffic makes a negligible difference to that movement, with very low right-turn demand. I conclude that the proposed development traffic will have a negligible effect on the operation of this intersection.
- 9.3 The updated road safety assessment has considered the effect of the additional development traffic in the context of the existing crash history along Horahora Road. While the assessment identifies an existing crash pattern at the out-of-context bend, it is my opinion that the additional traffic associated with the development is not expected to result in a significant increase in road safety risk. The proposed delineation and curve-warning improvements at the bend are an appropriate safety-management response to that existing crash history. Subject to the proposed works, it is my opinion that the road safety effects of the additional development traffic can be appropriately mitigated to less than minor.
- 9.4 In terms of access to individual lots, it is my recommendation that visibility in accordance with RTS6 for a 100km/hr speed environment be provided at all crossings, with all accessways being at no more than a 1:12 gradient for the first 6m from the road corridor. This can be confirmed through the detailed design process.
- 9.5 It is also my recommendation that shoulder widening suitable to allow the construction of basic right turn treatments in general accordance with AGRD Part 4A Figure 7.1 at the two new intersections should be provided,

as per the original assessment of traffic effects. This can be confirmed through the detailed design process.

- 9.6 The proposed widening and relocation of the Waikato River Trail, together with visibility splays, low planting and open fencing requirements at vehicle crossings and intersections, will provide safe interaction between vehicles and Trail users. In my opinion, these measures appropriately mitigate potential effects on Trail users to less than minor.
- 9.7 I have assessed the operation of the single-lane Pokaiwhenua Bridge and consider that it will continue to operate efficiently, with the modelling showing that most vehicles will experience no delay or queuing. In my opinion, the proposal has a negligible effect on bridge operation and does not create a causal need for its upgrade or a separate development contribution beyond any applicable development contributions regime.
- 9.8 I acknowledge that construction traffic can cause nuisance. However, it is a temporary effect and is typically managed via a Construction Traffic Management Plan. I recommend that construction traffic effects associated with the subdivision works and Trail relocation should be managed through a Construction Traffic Management Plan required by a consent condition. Construction traffic associated with individual dwellings will be comparatively low in volume and duration and does not require separate control.
- 9.9 I have reviewed the submissions relevant to transportation matters. Subject to the recommended conditions and works identified in my evidence, I am satisfied that the transportation matters raised by submitters have been appropriately addressed.
- 9.10 I have reviewed the SWDC s42A report and Gray Matter peer review and agree with the conclusions drawn by Ms Lonnberg- Shaw and Ms Parsons that the proposed development is unlikely to have an unacceptable effect on road safety and efficiency and that appropriate mitigations can be provided of those effects that would arise. There are currently some minor differences of opinion as to the detail of the mitigations at the out of context curve but I consider that these can be addressed at detailed design.

9.11 I have reviewed the SWDC draft consent conditions and consider that whilst they are largely reasonable in relation to matters relating to road design and access, there are some conditions that I consider superfluous (Conditions 39 – 42). I also consider that some matters such as the diversion of the Waikato River Trail, the need for the ongoing protection of all visibility splays and provision of a Construction Traffic Management Plan have not been addressed. It is my recommendation that suitably worded consent conditions be developed to address this.

9.12 Overall, subject to the recommended mitigation and refinement of consent conditions, I consider that the transportation effects of the proposed development will be less than minor.

A handwritten signature in black ink, appearing to read 'J. Makinson', is positioned above the printed name.

Judith Makinson

7 October 2026

Annexure A – Summary ATC Data

Horahora Road Traffic Survey Analysis - August 2026							
Seven-day tube counts on Horahora Road and manual turning counts at the SH1 intersection							
Location	7-day ADT	Weekday avg	Weekday AM peak	Weekday PM peak	Mean speed	Daily 85th %ile	HCV share
RP 2.660 - north of site	1172.3	1189.0	82.8	114.0	82.9	92.2-94.7 km/h	8.4%
RP 7.258 - southern Stage 3 intersection	1122.3	1142.4	82.2	111.8	92.2	101.9-103.0 km/h	9.5%

SH1 / Horahora Road	Observed peak hour	Total junction flow	Horahora entry	Horahora exit	SH1 through
AM	08:00-09:00	875	66	49	760
PM	15:30-16:30	1104	64	72	968

Annexure B – SIDRA Intersection Analysis

SITE LAYOUT

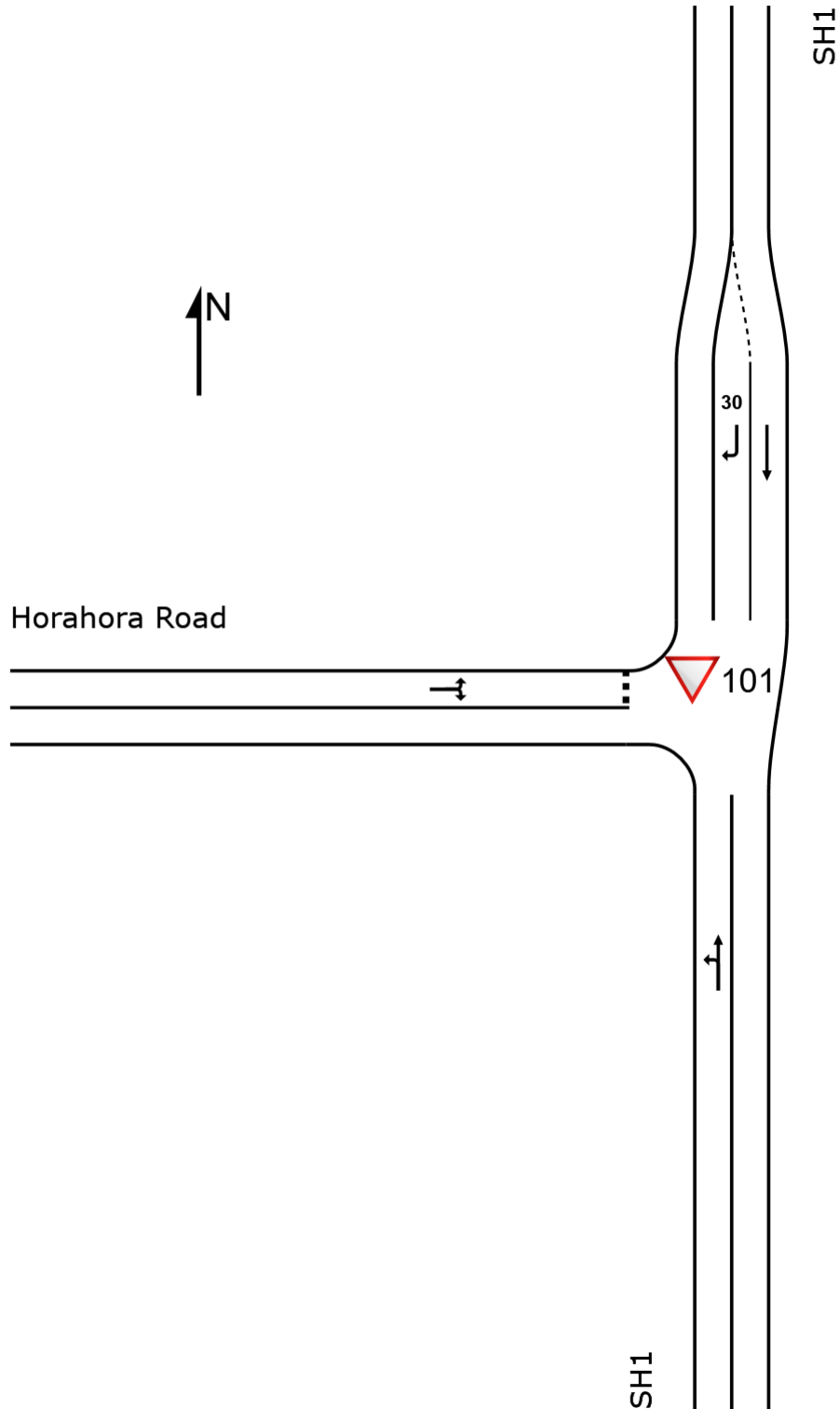
▽ Site: 101 [Horahora / SH1 Int - Existing AM (Site Folder: General)]

New Site

Site Category: (None)

Give-Way (Two-Way)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Existing AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total HV]	%	[Total HV]	%	v/c	sec		[Veh. veh	Dist] m				km/h
South: SH1															
1	L2	All MCs	2	0.0	2	0.0	0.184	4.6	LOS A	0.0	0.0	0.00	0.00	0.00	48.7
2	T1	All MCs	329	13.1	329	13.1	0.184	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach			332	13.0	332	13.0	0.184	0.1	NA	0.0	0.0	0.00	0.00	0.00	49.9
North: SH1															
8	T1	All MCs	471	13.2	471	13.2	0.262	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	67	10.9	67	10.9	0.057	6.1	LOS A	0.2	1.9	0.43	0.61	0.43	44.7
Approach			538	12.9	538	12.9	0.262	0.8	NA	0.2	1.9	0.05	0.08	0.05	49.2
West: Horahora Road															
10	L2	All MCs	49	6.4	49	6.4	0.050	5.9	LOS A	0.2	1.4	0.42	0.59	0.42	44.9
12	R2	All MCs	2	0.0	2	0.0	0.050	13.9	LOS B	0.2	1.4	0.42	0.59	0.42	44.8
Approach			52	6.1	52	6.1	0.050	6.3	LOS A	0.2	1.4	0.42	0.59	0.42	44.9
All Vehicles			921	12.6	921	12.6	0.262	0.9	NA	0.2	1.9	0.06	0.08	0.06	49.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Existing PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows		Arrival Flows		Deg. Satn	Aver. Delay	Level of Service	95% Back Of Queue		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed
			[Total HV]	%	[Total HV]	%	v/c	sec		[Veh. veh	Dist] m				km/h
South: SH1															
1	L2	All MCs	3	0.0	3	0.0	0.296	4.7	LOS A	0.0	0.0	0.00	0.00	0.00	48.6
2	T1	All MCs	528	13.1	528	13.1	0.296	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.8
Approach			532	13.1	532	13.1	0.296	0.1	NA	0.0	0.0	0.00	0.00	0.00	49.8
North: SH1															
8	T1	All MCs	491	12.4	491	12.4	0.272	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	64	4.9	64	4.9	0.068	7.2	LOS A	0.3	2.0	0.54	0.70	0.54	44.3
Approach			555	11.6	555	11.6	0.272	0.9	NA	0.3	2.0	0.06	0.08	0.06	49.1
West: Horahora Road															
10	L2	All MCs	74	7.1	74	7.1	0.118	7.3	LOS A	0.4	3.2	0.59	0.75	0.59	43.5
12	R2	All MCs	2	100.0	2	100.0	0.118	63.8	LOS F	0.4	3.2	0.59	0.75	0.59	42.0
Approach			76	9.7	76	9.7	0.118	8.9	LOS A	0.4	3.2	0.59	0.75	0.59	43.5
All Vehicles			1162	12.1	1162	12.1	0.296	1.1	NA	0.4	3.2	0.07	0.09	0.07	49.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
 Vehicle movement LOS values are based on average delay per movement.
 Minor Road Approach LOS values are based on average delay for all vehicle movements.
 NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
 Two-Way Sign Control Capacity Model: SIDRA Standard.
 Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
 Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
 Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
 HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
 Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Future AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. Dist] veh m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: SH1															
1	L2	All MCs	2	0.0	2	0.0	0.184	4.6	LOS A	0.0	0.0	0.00	0.00	0.00	48.7
2	T1	All MCs	329	13.1	329	13.1	0.184	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach			332	13.0	332	13.0	0.184	0.1	NA	0.0	0.0	0.00	0.00	0.00	49.9
North: SH1															
8	T1	All MCs	471	13.2	471	13.2	0.262	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	67	10.9	67	10.9	0.057	6.1	LOS A	0.2	1.9	0.43	0.61	0.43	44.7
Approach			538	12.9	538	12.9	0.262	0.8	NA	0.2	1.9	0.05	0.08	0.05	49.2
West: Horahora Road															
10	L2	All MCs	89	3.5	89	3.5	0.090	5.9	LOS A	0.3	2.5	0.43	0.61	0.43	44.9
12	R2	All MCs	4	0.0	4	0.0	0.090	14.4	LOS B	0.3	2.5	0.43	0.61	0.43	44.8
Approach			94	3.4	94	3.4	0.090	6.3	LOS A	0.3	2.5	0.43	0.61	0.43	44.9
All Vehicles			963	12.0	963	12.0	0.262	1.1	NA	0.3	2.5	0.07	0.10	0.07	49.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Sensitivity AM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh Dist] m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: SH1															
1	L2	All MCs	2	0.0	2	0.0	0.184	4.6	LOS A	0.0	0.0	0.00	0.00	0.00	48.7
2	T1	All MCs	329	13.1	329	13.1	0.184	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
Approach			332	13.0	332	13.0	0.184	0.1	NA	0.0	0.0	0.00	0.00	0.00	49.9
North: SH1															
8	T1	All MCs	471	13.2	471	13.2	0.262	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	67	10.9	67	10.9	0.057	6.1	LOS A	0.2	1.9	0.43	0.61	0.43	44.7
Approach			538	12.9	538	12.9	0.262	0.8	NA	0.2	1.9	0.05	0.08	0.05	49.2
West: Horahora Road															
10	L2	All MCs	113	2.8	113	2.8	0.112	5.9	LOS A	0.4	3.2	0.44	0.62	0.44	44.9
12	R2	All MCs	5	0.0	5	0.0	0.112	14.6	LOS B	0.4	3.2	0.44	0.62	0.44	44.8
Approach			118	2.7	118	2.7	0.112	6.3	LOS A	0.4	3.2	0.44	0.62	0.44	44.9
All Vehicles			987	11.7	987	11.7	0.262	1.2	NA	0.4	3.2	0.08	0.12	0.08	48.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akcelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Future PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. Dist] veh m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: SH1															
1	L2	All MCs	5	0.0	5	0.0	0.297	4.7	LOS A	0.0	0.0	0.00	0.01	0.00	48.6
2	T1	All MCs	528	13.1	528	13.1	0.297	0.1	LOS A	0.0	0.0	0.00	0.01	0.00	49.8
Approach			534	13.0	534	13.0	0.297	0.2	NA	0.0	0.0	0.00	0.01	0.00	49.8
North: SH1															
8	T1	All MCs	491	12.4	491	12.4	0.272	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	104	3.0	104	3.0	0.109	7.2	LOS A	0.4	3.2	0.55	0.73	0.55	44.3
Approach			595	10.8	595	10.8	0.272	1.3	NA	0.4	3.2	0.10	0.13	0.10	48.8
West: Horahora Road															
10	L2	All MCs	74	7.1	74	7.1	0.121	7.3	LOS A	0.4	3.2	0.60	0.76	0.60	43.4
12	R2	All MCs	2	100.0	2	100.0	0.121	69.8	LOS F	0.4	3.2	0.60	0.76	0.60	42.0
Approach			76	9.7	76	9.7	0.121	9.1	LOS A	0.4	3.2	0.60	0.76	0.60	43.4
All Vehicles			1204	11.7	1204	11.7	0.297	1.3	NA	0.4	3.2	0.09	0.11	0.09	48.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 [Horahora / SH1 Int - Sensitivity PM (Site Folder: General)]

Output produced by SIDRA INTERSECTION Version: 9.1.1.200

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance															
Mov ID	Turn	Mov Class	Demand Flows [Total HV] veh/h %		Arrival Flows [Total HV] veh/h %		Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. Dist] veh m		Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: SH1															
1	L2	All MCs	6	0.0	6	0.0	0.298	4.7	LOS A	0.0	0.0	0.00	0.01	0.00	48.6
2	T1	All MCs	528	13.1	528	13.1	0.298	0.1	LOS A	0.0	0.0	0.00	0.01	0.00	49.8
Approach			535	13.0	535	13.0	0.298	0.2	NA	0.0	0.0	0.00	0.01	0.00	49.8
North: SH1															
8	T1	All MCs	491	12.4	491	12.4	0.272	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	49.9
9	R2	All MCs	126	0.0	126	0.0	0.128	7.1	LOS A	0.5	3.8	0.55	0.73	0.55	44.4
Approach			617	9.9	617	9.9	0.272	1.5	NA	0.5	3.8	0.11	0.15	0.11	48.6
West: Horahora Road															
10	L2	All MCs	74	7.1	74	7.1	0.123	7.3	LOS A	0.4	3.3	0.60	0.76	0.60	43.4
12	R2	All MCs	2	100.0	2	100.0	0.123	73.1	LOS F	0.4	3.3	0.60	0.76	0.60	41.9
Approach			76	9.7	76	9.7	0.123	9.2	LOS A	0.4	3.3	0.60	0.76	0.60	43.4
All Vehicles			1227	11.2	1227	11.2	0.298	1.4	NA	0.5	3.8	0.09	0.13	0.09	48.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Parameter Settings dialog (Options tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

Annexure C – Pokaiwhenua Bridge Monte Carlo Modelling

1 Bridge Delay and Queueing Analysis

1.1 Modelled scenarios

Operation of the bridge has been assessed for the AM and PM peak hours using a Monte Carlo simulation model. The modelling methodology, adopted parameters, and assumptions and limitations are set out in Appendix 1.

The models were run for the PM demands presented in Table 1. Northbound traffic operates as the priority movement, and HCVs were treated as single vehicles.

Table 1 'With Development' modelled traffic demands

Scenario	Northbound (priority)	Southbound (give way)	Total
PM peak	78 vph	81 vph	159 vph

1.2 Summary of modelled operating conditions

Results are summarised in Table 2, with the distribution of queue lengths given in Table 3. Results are reported across every arriving vehicle, including those experiencing no delay or queue, except where explicitly stated.

Table 2 Delay and queueing, PM peak hours

	PM northbound	PM southbound
Vehicles not delayed	83%	82%
Vehicles encountering no queue	84%	84%
Average delay, all vehicles	0.9 s	1.1 s
95th percentile delay	7 s	8 s
Average queue, all vehicles	0.18 veh	0.18 veh
Average queue where present	1.18 veh	1.20 veh
Longest queue modelled	3 veh	3 veh

Table 3 Distribution of queue length on arrival

Vehicles queued ahead	PM northbound	PM southbound
None	84%	84%
One	14%	14%
Two	2%	2%
Three or more	<1%	<1%

1.3 Modelling Summary

The bridge operates with minimal delay in both peak periods. Average delay does not exceed 1.1 seconds per vehicle in any direction, and the vast majority of vehicles (around 82%) proceed without stopping at all.

Where queuing does occur, it is almost always a single vehicle. As shown in Table 3, a queue of two vehicles arises for around 2% of arrivals, and queues of three vehicles occur in fewer than 1% of cases. The longest queue arising across all 500 simulated hours was four vehicles.

Conditions are closely comparable between the two directions despite the priority arrangement, reflecting the near-balanced two-way flows recorded in Table 1 and the short crossing and clearance times relative to the intervals between arrivals (see Appendix).

1.4 Conclusion

The modelling indicates that the single-lane bridge operates satisfactorily under priority control in both peak periods. Delays are negligible, queues are short and infrequent, and the worst outcome arising across 1,000 simulated peak hours was a queue of four vehicles. No additional control or geometric provision is considered necessary for the forecast demand.

These conclusions should be read alongside the assumptions and limitations set out in Appendix 1.

Appendix 1 – Monte Carlo Modelling Methodology

1.1 Overview

Monte Carlo simulation is a numerical modelling technique used to assess systems where outcomes depend on variables that vary randomly over time. Rather than assessing a single fixed sequence of vehicle arrivals, the method simulates a large number of possible arrival patterns and statistically evaluates the resulting operating conditions.

The technique is appropriate where performance is governed by the interaction between individual vehicles, and where the timing of arrivals rather than the total volume of traffic determines whether delay and queuing occur. A single-lane bridge under priority control is such a case: the same hourly demand may produce negligible delay under one arrival pattern and sustained queuing under another.

1.2 Model structure

A Monte Carlo model has been developed to simulate operation of the single-lane bridge. The model assigns priority to northbound traffic, with vehicles approaching from the opposing direction required to give way, in accordance with the sign posted control.

The model represents the key parameters governing operation of the bridge, including:

- the time required for a vehicle to travel between the crossing points;
- the headway between successive vehicles travelling in the same direction;
- the maximum waiting time after which a vehicle is assumed to enter the bridge; and
- the clearance time required before traffic from the opposing direction can enter.

Travel times have been estimated from the adopted operating speeds and the known distance between the crossing points. The parameter values adopted for the assessment are summarised in Table A.

Table A: Adopted model parameters

Parameter	Value	Note
Crossing time	7 s	Time to cross the main part of the bridge (vehicle in the same direction will follow if it arrives less than 7s after the vehicle already on the bridge, irrespective of direction).
Opposing movement clearance time	9 s	Time required for opposing movements to fully clear (175 m between passing points at 70 km/h). An oncoming vehicle can proceed after this time has lapsed.
Platoon headway	3 s	Spacing of consecutive vehicles in the same direction
Priority threshold	5 s	Give-way vehicle proceeds where it arrives no more than 5 s before an opposing vehicle

Parameter	Value	Note
Replications per scenario	500	—
Simulation period	1 hour	Peak hour. Weak flows do not require a ‘pre-loading’ period

1.3 Generation of vehicle arrivals

Vehicle arrivals from each direction are generated probabilistically based on the adopted traffic demands. Arrivals have been modelled as random, which is the conventional assumption for traffic that is not platooned by upstream signals or other forms of control, and is appropriate for the rural, low-volume environment in which the bridge operates. Figure A shows an example of arrivals in each direction in 5-minute periods

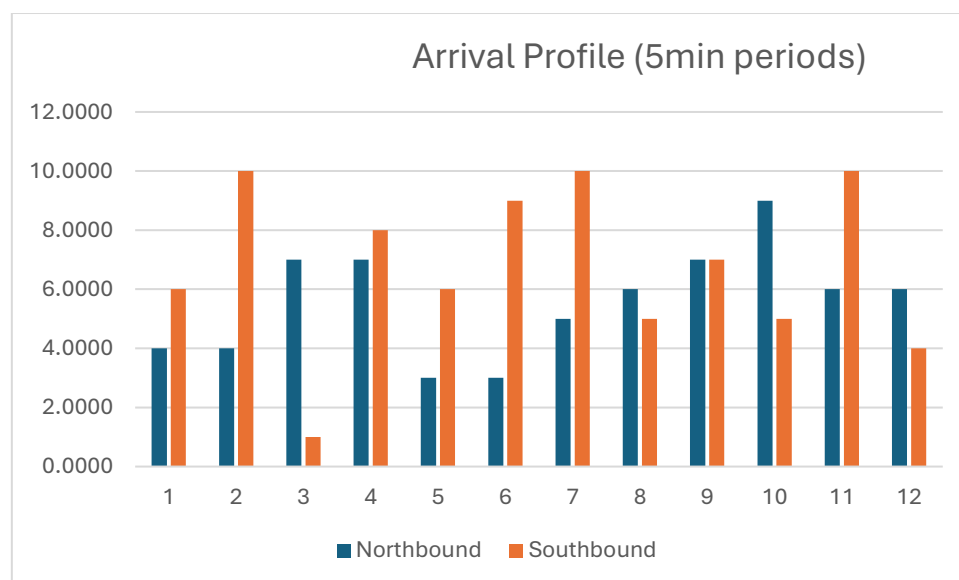


Figure A – Example of Arrival Profile (PM Peak)

Each simulation therefore represents a different possible sequence of vehicle arrivals and interactions at the bridge. This can result in different queue lengths and delays even where the overall traffic demand remains unchanged. An overview of a single run is provided in Figure B, and shows actual arrival times and the length of queue for each vehicle. Vehicles on the time axis get through the bridge unimpeded

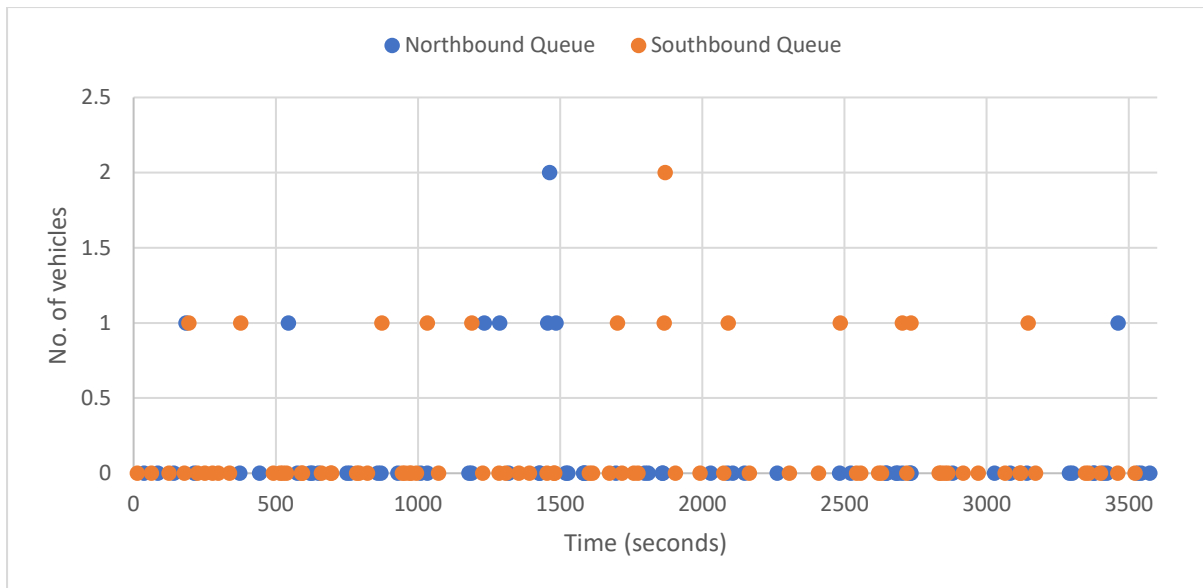


Figure B – Example of Model Behaviour (Arrival Time and Queuing, PM Peak)

1.4 Simulation runs and recorded outputs

Each simulation represents a one-hour period at the adopted demand. A total of 500 independent randomly generated replications were undertaken for each assessed hour.

Outputs are recorded on a per-vehicle basis. As each vehicle arrives at the bridge, the number of vehicles already queued ahead of it is recorded, together with the delay subsequently incurred. Results therefore describe the conditions encountered by an arriving driver.

1.5 Evaluation of results

The simulation is repeated a large number of times, and the results are statistically evaluated

The full modelled distributions of delay and queue length are set out below. Percentages are proportions of all arriving vehicles in the direction stated, and are rounded to the nearest whole percent; columns may not sum to exactly 100%.

Table D Distribution of delay, PM peak hour

Delay	Northbound	Cumulative Northbound	Southbound	Cumulative Southbound
No delay	83%	83%	82%	82%
Up to 5 s	10%	93%	9%	91%
5 to 10 s	6%	99%	8%	99%
10 to 15 s	1%	100%	1%	100%
Over 15 s	0%	100%	0%	100%

Figure C shows the distribution of delays for all vehicles, clearly demonstrating that the vast majority of drivers will experience no delay. Figure D excludes vehicles that are not affected by oncoming traffic. Drivers that are required to stop are not going to be delayed by more than 15 seconds.

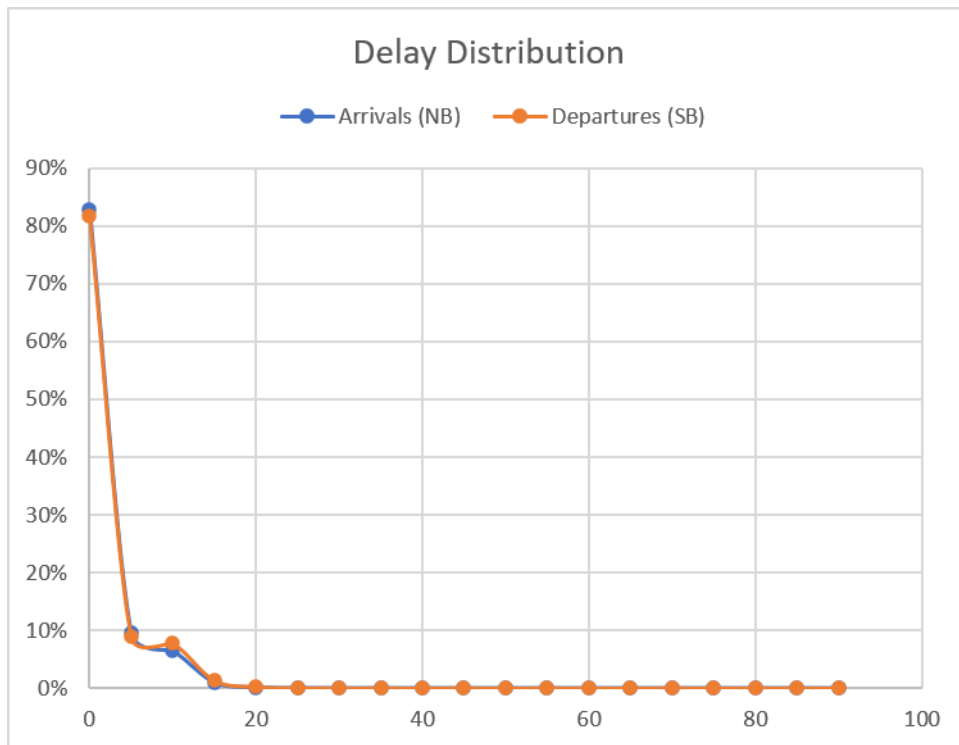


Figure C – Delay Distribution (all vehicles)

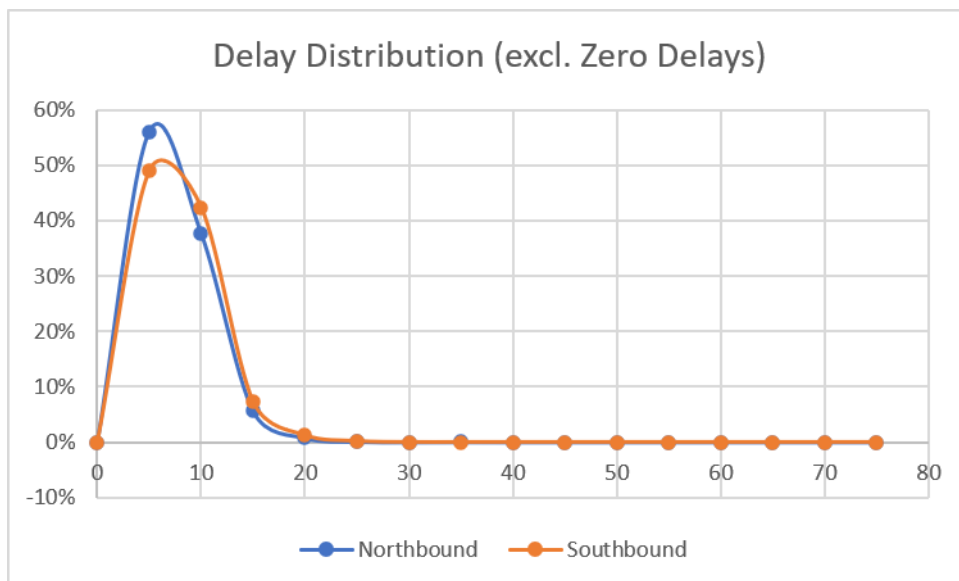


Figure D – Delay Distribution (only delayed vehicles)

Table C Distribution of queue length on arrival, PM peak hour

Vehicles queued ahead	Northbound	Cumulative Northbound	Southbound	Cumulative Southbound
None	84%	84%	84%	84%
One	14%	98%	14%	98%
Two	2%	100%	2%	100%

Vehicles queued ahead Northbound Cumulative Southbound Cumulative

Three	<1%	100%	<1%	100%
Four or more	0%	100%	0%	100%

Figure E provides the predicted queue distribution (excluding zero queues). More than 80% of queued vehicles will be the only vehicle held at the conflict point.

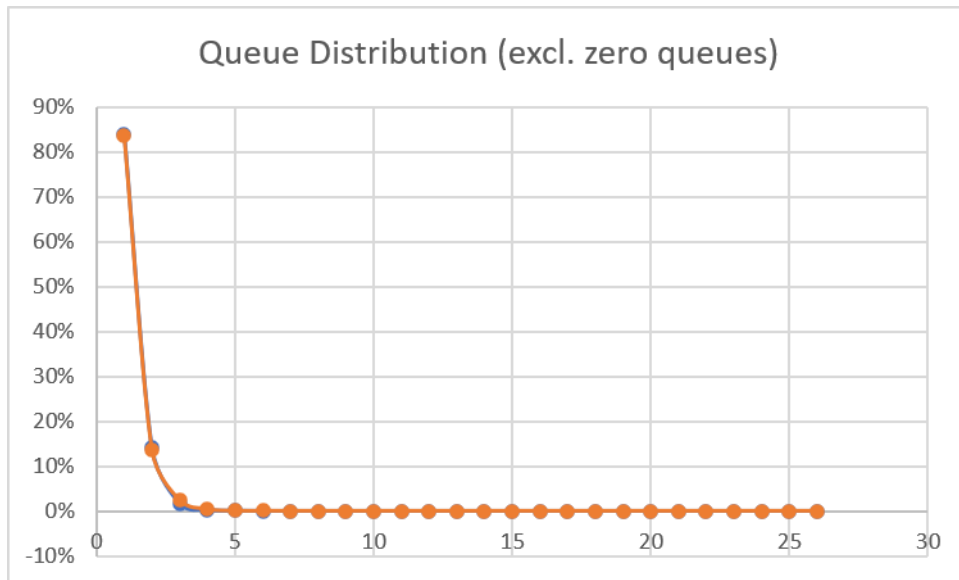


Figure E –PM Peak Queue Distribution (zero queues excluded).

1.6 Summary Statistics

Table E Summary statistics

Statistic	PM northbound	PM southbound
<i>Delay — all vehicles</i>		
Average	0.9 s	1.1 s
5th percentile	0 s	0 s
25th percentile	0 s	0 s
50th percentile	0 s	0 s
75th percentile	0 s	0 s
95th percentile	7 s	8 s
<i>Queue — all vehicles</i>		

Statistic	PM northbound	PM southbound		
Average	0.11 veh	0.12 veh	0.18 veh	0.18 veh
50th percentile	0	0	0	0
75th percentile	0	0	0	0
90th percentile	0	1	1	1
95th percentile	1	1	1	1
99th percentile	1	2	2	2
<i>Queue — occasions when a queue is present</i>				
Average	1.10 veh	1.13 veh	1.18 veh	1.20 veh
5th percentile	1	1	1	1
25th percentile	1	1	1	1
50th percentile	1	1	1	1
75th percentile	1	1	1	1
95th percentile	2	2	2	2
99th percentile	2	3	3	3