Quality Transport Planning

Papanui PAK'n Save

Peer Review of Traffic Modelling

November 2019

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Contents

1 Introduction and Peer Review Scope 1
1.1 Background 1
1.2 Information Provided for Review 2
1.3 Information Referred to in Review 2
1.4 Scope of Peer Review 3
2 Calibration and Validation 4
2.4 Model Network and Zone System 4
2.5 Base Year Demands 5
2.6 2018 Base Year Calibration 5
2.7 Turning Movements at Key Intersections 6
2.8 Travel Time 8
2.9 Future 2021 and 2031 Models 8
3 Fitness for Purpose 10
4 Model Limitations 11
5 Completeness of Documentation 12
5.4 Traffic Signal Optimisation 12
5.5 2018 Base Year 12
5.6 2020 Base Year 12
5.7 2021 with Development 13
5.8 2031 with Development 13
5.9 Intersection and Travel time Comparisons 13
5.10 New signalised Main North Road access 14
5.11 Vehicle Travel Totals 14
5.12 Summary of Modelled Effects of Proposal 15

Appendices

Appendix A – Review Register

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1 Introduction and Peer Review Scope

1.1 Background

1.1.1 QTP have been engaged collectively by Foodstuffs (South Island) Properties Ltd (**FSIL**) and Christchurch City Council (**CCC**) to undertake a Peer Review of the transportation modelling presented in the Integrated Transport Assessment (**ITA**) included[1] within the land use consent application[2] to establish a PAK'nSAVE supermarket and self-service fuel station on the application site at 171 Main North Road (Christchurch).

1.1.2 It is proposed that vehicle access to the site will be altered, including the addition of a signalised intersection along Main North Road between the intersection with Cranford Street and Northcote Road.

1.1.3 The transportation modelling presented in the ITA is sourced from an s-Paramics model developed specifically to support the Application. The primary purpose of the modelling is to indicate the traffic effects associated with the proposed development during a weekday evening peak period (which has been identified as the most critical periods in terms of network performance). This is to inform the Assessment of Effects in the Application.

1.1.4 I understand that prior to this review; transport experts representing FSIL have been working collaboratively with CCC Transport Team members to address initial RFI items raised relating to transport modelling. The agreed changes in methodology and reporting are addressed implicitly in an updated ITA (subject to this review).

1.1.5 The future year demands have been extracted from Council's CAST model by Council staff and are agreed between the Applicant and Council. The choice of modelling platform s-Paramics informed by CAST is also agreed between the Applicant and Council. Due to this agreement, further consideration of these items is excluded from the peer review scope.

1.1.6 As a result of recent transport modelling conferencing[3] between the Applicant, CCC, CTOC and NZTA's experts, the transportation modelling has been revisited and a new Technical Note prepared that supersedes the contents of section 8 (Transport Modelling Assessment) of the ITA.

[1] As Appendix F of the Application document.

[2] The Pre-hearing Application and ITA as publicly notified can be found at: https://www.ccc.govt.nz/the-council/consultations-and-submissions/haveyoursay/show/256

[3] October 2019

1.2 Information Provided for Review

1.2.1 This review is based primarily on the following information provided by FSIL:

- A copy of the ITA as per the notified application (Appendix F)[4], dated 18 July 2019 (hereafter referred to as the **ITA**).
- Revised section 8 of the ITA technical note which is consistent with the post-conferencing scenarios as agreed between all parties[5], dated 25 October 2019 (hereafter referred to as the **Technical Note**).
- Paramics model files[6], dated 25 October 2019. This includes base year and future year (2021 with and without development and 2031 with and without development) s-Paramics modelling files (five scenarios including base year) which are consistent with the post-conferencing scenarios to be presented in evidence as agreed between all parties. The raw model outputs were not provided (to keep file sizes manageable).
- A set of engineering drawings accompanying the application[7], dated 23 August 2019 (hereafter referred to as the **Site Plan**).

1.3 Other Information Referred to in Review

1.3.1 The Peer Review has been undertaken in accordance with Engineering New Zealand's Practice Note 2: Peer Review (**ENZPN**). The ENZPN usefully identifies key steps in the peer review process and what should be covered in reporting. However the specialised nature of traffic model build and Peer Review does not fit the 'types' of peer review described in the ENZPN. In this regard, the (draft) Peer Review Process Technical Note prepared by the New Zealand Modelling User Group (**NZMUGs**) is more pertinent and the peer review has been conducted in accordance with the concluding points of that document.

1.3.2 This includes the "review register" in Appendix A, which is set up to include all issue raised by a Reviewer, the response of the Modeller and the resolution which may include acceptance of the risk or professional disagreement.

1.3.3 NZTA Transport Model Development Guidelines (**TMDG**) have also been used to provide guidance in relation to comparisons between modelled and observed data.

[4] 'App F _ Integrated Transport Assessment _w.updated & signed safety audit 17.7.19.pdf"

[5] 'Post-Conferencing Transport Modelling Assessment Technical Note.pdf'

[6] 'Papanui PnS Final Paramics Models 23-10-2019.zip'

[7] 'RMA-2018-2029-Appendix-B-Architectural-Plans.PDF'

1.4 Scope of Peer Review

1.4.1 The agreed Peer Review brief limits the scope to specific components, summarised below:

1. **Calibration and Validation** – Checks that the models are suitably calibrated and validated in accordance with NZ Transport Agency's Transport Model Development Guidelines (TMDG);
2. **Fitness for Purpose** – Confirmation whether (or not) the models are fit-for-purpose for the primary purpose of informing an Assessment of Environmental Effects of the nature and scale of the Application under the RMA;
3. **Model Limitations** – Note any limitations or gaps in the modelling undertaken that might otherwise be reasonably expected to be included within the ITA;
4. **Completeness of Documentation** – Checks that the outputs presented in the ITA (and technical note replacing section 8 of the ITA) are logical, robust and can be relied upon by a decision maker under the RMA (acknowledging any limitations or gaps identified above).

1.4.2 The remaining sections of this review specifically address each of the scope components above. Any risks or matters potentially requiring resolution are identified in each case, and also summarised in the Review Register in **Appendix A**, where the modelling team has provided a response to address the issues and the peer reviewer has closed out those that have been reasonably resolved.

2 Calibration and Validation

2.1 The setup and calibration of the Paramics model is documented in Appendix A of the ITA. No changes to this have been made as a result of conferencing.

2.2 A model base year of 2018 has been established and comparisons have been made against surveyed traffic count data and travel times.

2.3 The comments below relate to various sections of Appendix A of the ITA using the same sub-headings (in order).

2.4 Model Network and Zone System

2.4.1 It is noted (in ITA Figure A1.1) that the 2018 base model consists of 13 zones. This is inconsistent with the future year models, which have 16 zones (as per ITA Figure A1.5). The 3 extra zones in the future year models are:

- Zone 14 – Winters Road and Fraser Street Residential Area (adjacent to Main North Road and Cranford intersection).
- Zone 15 – Meadow Street and Shearer Avenue area adjacent to Main North Road south of Cranford Street (effectively proposed development of the Cranford Basin).
- Zone 16 – Existing retail activity at the southwest corner of the Main North/QEII/Northcote intersection.

2.4.2 It is highly unusual to have different zone systems in base and future years. There is a risk that the additional zones may result in different traffic patterns or effects, even if the underlying land-use assumptions and overall traffic generation remains the same. A comparison of future traffic networks with the calibrated base then becomes problematic.

2.4.3 Multiple 'car-parks' (effectively 'floating' sub-zones) have been used for zones 11, 12, 13 and 15[8]. This is understandable for zones 11 and 12 (the development site area), but not for zones 13 and 15, which are residential areas. It would therefore be useful to understand the rationale behind this approach, and why this was considered to be better than other alternatives (e.g. increasing zone resolution and/or network detail, especially if it is a proxy for Cranford Basin link).

2.4.4 In this particular model application, the primary purpose of the 2018 base year model is to calibrate key network elements and vehicle characteristics based on 'known' traffic volumes and conditions. Once these have been calibrated and applied to future years, the base network is effectively discarded and serves no further purpose in the assessment of environmental effects. Therefore, the risk to the Client associated with the 2018 base zone discrepancies described above is considered to be low.

2.4.5 Documentation would however assist with understanding why different zone structures were adopted and reassurance that that this will not significantly impact on the assessment.

[8] Zone 15 is included in future years only.

2.4.6 Based on the above, the following items have been added to the Review Register in Appendix A:

#	Issues Raised – Model Network and Zone System	Level of Client Risk
1	Inconsistent traffic zones between 2018 base and future models. Justification or further explanation is recommended.	Low
2	Further explanation of the rationale for applying car-parks to zones 13 and 15 is recommended, including potential advantages and limitations of this approach.	Low

2.5 Base Year Demands

2.5.1 The documentation describes a manual method for establishing trip distribution patterns. This method appears to be very similar to how the matrix estimation facility with Paramics works. It would therefore be useful to know why the algorithm based matrix estimation procedure was not used (i.e. what specific issues required a manual method to overcome), or even better, why initial demands from CAST were not used (given that this approach has been adopted for future years, it would make sense for the base as well).

2.5.2 As mentioned earlier in paragraph 2.4.4, for the purpose of model calibration (which is the sole purpose of the 2018 Base model), the underlying trip patterns are not particularly important (noting very limited route choice within this particular model) as long as the turning movement flows and delays at each intersection are reasonably represented (which appears to be the case here).

2.5.3 Therefore the risk to the Client is relatively low, however without improved documentation, the level of risk *perceived* to a reader may be of concern.

#	Issue Raised – Base Year Demands	Level of Client Risk
3	A 'manual' trip matrix estimation procedure was adopted. Justification or further explanation required why initial demands from CAST (as adopted for future year models) were not used in conjunction with matrix estimation where required to match observed counts.	Low

2.6 2018 Base Year Calibration

2.6.1 It is noted that calibration was required for the following elements.

- Preloading and queuing
- Traffic signal timings (informed by SCATS data)
- Reverse priority (suitably resolved by using 'yellow box junctions')
- Link speed limits
- Mean headway between vehicles
- Main North Road south approach to Cranford Street network coding

2.6.2 It is apparent that careful consideration was given to each parameter to ensure observed conditions are reflected. All of these adjustments appear to be necessary and are within

reasonable limits.

2.7 Turning Movements at Key Intersections

2.7.1 Comparisons of modelled and observed turning movements at three intersections (Main North/Northcote/QEII, Main North/Cranford and Main North/Vagues) have been provided.

2.7.2 There appears to be a reporting error in Tables A1.2 and A1.3 for the intersection totals, where the column totals are either incorrect and or out of sync with the data above.

2.7.3 Values reported in the tables are summarised by three periods (4-5pm, 5-6pm and combined as a total 4-6pm). The GEH values for the two hour period should be converted to hourly equivalents (this has not been done); therefore the values reported for 4-6pm are effectively overstated and not suitable for comparison with TMDG thresholds.

2.7.4 The reporting does not include any assessment made against the relevant criteria in the TMDG (as is usual practice). In this particular case, criteria for model Type F (Small area with limited route choice/corridor assessment) would apply. The guidelines state that the following comparisons are generally expected:

- Individual Tuning/Link GEH
- XY Scatter Plots
- Individual Turning Count Bands[9]

2.7.5 I have used the information provided in the ITA to make the above comparisons. Results are set out below, where results meeting the target criteria are in green and those that are just under are in orange:

Table 2-1: GEH Comparison

Measure	Target Criteria	Achieved 4-5pm	Achieved 5-6pm	Achieved 4-6pm
GEH < 5 (% Turns)	> 95%	95%	92%	96%
GEH < 7 (% Turns)	> 100%	100%	96%	96%
GEH <10 (% Turns)	> 100%	100%	100%	100%

Table 2-2: Individual Turning Count Bands

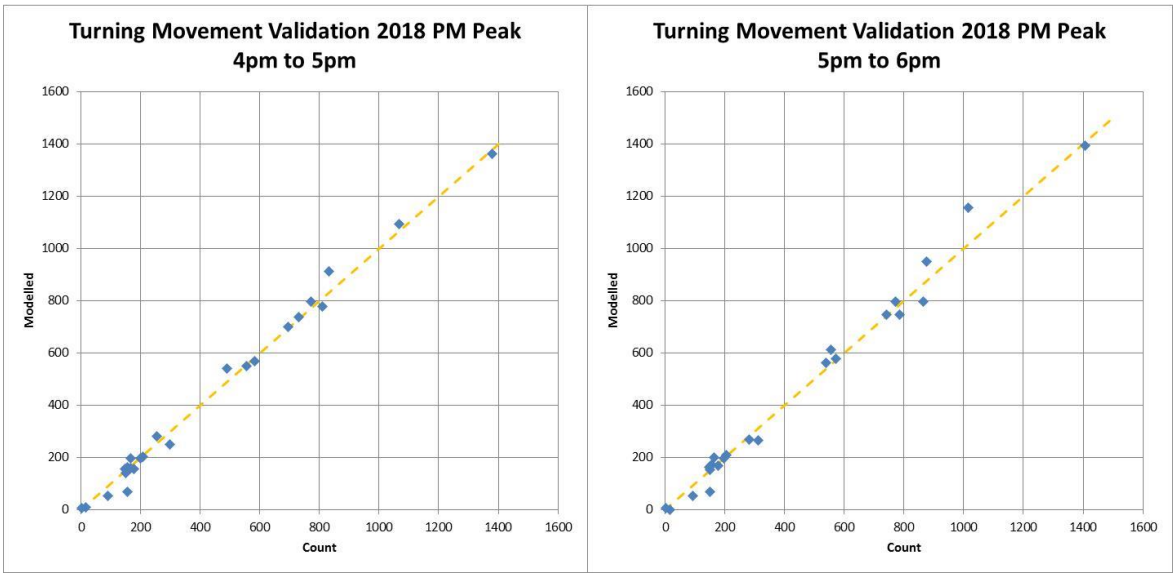
Measure	Target Criteria	Achieved 4-5pm	Achieved 5-6pm	Achieved 4-6pm
<400 (50vph)	> 95%	93%	93%	93%
400-2000 (12.5%)	> 95%	100%	90%	100%
>2000 (250vph)	> 95%	100%	100%	100%

Table 2-3: XY Scatter Plot (Summary)

Measure	Target Criteria	Achieved 4-5pm	Achieved 5-6pm	Achieved 4-6pm
R^2	> 0.95	0.99	0.99	0.99
Line of Best Fit	y= 0.97x – 1.03x	y = 0.99x	y = 0.98x	y = 0.99x

[9] TDMG state these are potentially useful rather than expected

Figure 2-1: XY Scatter Plot (Data Points)



2.7.6 From these results, I conclude the following

- A very high level of correlation is achieved between modelled and observed traffic flows at the turning movement level.
- The relevant TDMG are generally met. Where these criteria are not strictly met, they are very close (and relate to just one or two turning movements at Main North Vagues Road).
- The ITA identifies and comments on the Vagues Road movements and I am satisfied with this explanation (and was not particularly concerned about this movement anyway).

2.7.7 In my opinion, the TDMG criteria are extremely ambitious; the target tolerances can often exceed natural variations that occur in traffic counts between adjacent intersections.

2.7.8 I therefore consider that the level of validation/calibration achieved with respect to turning movements is at the upper end of what can practically be achieved by any model.

2.7.9 So while I am more than satisfied with this modelling outcome, I note the following reporting related issues that have been added to the Review Register in Appendix A:

#	Issues Raised -Turning Movements at Key Intersections	Level of Client Risk
4	Reporting error in Tables A1.2 and A1.3 for the intersection totals, where the column totals are either incorrect and or out of sync with the row data above.	High
5	GEH values reported for 4pm to 6pm are incorrect because they have not been converted to hourly equivalents.	Medium
6	Comparisons not made with relevant TDMG criteria in ITA (however, this has been resolved indirectly as part of this peer review).	Low

2.8 Travel Time

2.8.1 Comparisons of modelled and observed travel times along six main corridor routes through the model area have been provided.

2.8.2 The reporting does not include any assessment made against the relevant criteria in the TMDG (as is usual practice).

2.8.3 I have therefore made this comparison below. In this particular case, criteria for model Type F (Small area with limited route choice/corridor assessment) have been adopted.

2.8.4 The guidelines state that the following comparisons are generally expected:

- More than 90% of routes should be within 15% or 1 minute (if higher)
- All routes should be within 25% or 1.5 minutes (if higher)
- Journey time vs. distance graphs.

2.8.5 All reported routes are within 15% of observed, except the East to West route, where the model is 30% faster than observed but the difference is less than 1 minute. A reasonable explanation has also been provided in ITA Table A1.4 why this might be the case.

2.8.6 Because the model area is rather compact, journey time vs. distance graphs (while nice to have) are not strictly necessary in this case. It would however be very useful if each route distance (path length) could be included in ITA Table A1.4 so that the vehicle speeds can be inferred (or also reported).

2.8.7 I agree with the ITA conclusion that "*…the model generally reflects existing speed conditions on the major links*". Additionally, I do not think that the model is significantly different to the observed data on any particular route, and I am satisfied that the 2018 base model is not consistently faster or slower than observed conditions (which indicates that a reasonable level of calibration has been achieved).

#	Issue Raised – Travel Time	Level of Client Risk
7	Journey time vs. distance graphs have not been provided. As an alternative to providing these, it would be very useful if each route distance (path length) could be included in ITA Table A1.4 so that the vehicle speeds can be inferred (or ideally also reported)	Medium

2.9 Future 2021 and 2031 Models

2.9.1 There are very few details (other than in the introduction to the revised section 8 of the ITA) about how CAST demands were applied to Paramics. It is simply mentioned that "*the CAST model was used to inform the future year demand scenarios*." This statement has some ambiguity (e.g. whether any adjustments were made, other than altering trip generation for the proposed supermarket?).

2.9.2 Inspection of the Paramics demand matrices indicate that demands at some external locations can vary significantly between the base and development networks. Some of

these differences imply wider network route changes beyond the Paramics model area (e.g. an increase in trips originating from QEII Drive with a corresponding decrease from Main North Road south external). Such changes are realistic and most likely reflect alternative route choice available in CAST to avoid congestion on Main North Road (with development). However, it also implies that there may be additional effects outside the Paramics model area that are not currently being captured in the assessment of effects (e.g. trips re-routing from Main North Road to QEII Drive must travel additional distance not currently picked up in the assessment, and this missing 'cost' is likely to be similar to travel time on the congested Main North Road route).

2.9.3 There also appears to be an overall reduction in vehicle trips at external locations for the 'with development' networks. At 2021 there are approximately 100 less two-way trips and at 2031 there are approximately 50 less two-way trips crossing the model boundary in the 'with development' network. This indicates the number of vehicles that effectively avoid[10] the Paramics model area due to increased congestion.

2.9.4 Again, this may be a realistic model response. But consequently, performance of the 'with development' network relative to the Base network may appear to be more favourable than it would if the 'missing' diverted traffic was also included in the assessment.

2.9.5 This could possibly be addressed by normalising the existing results, so that they reflect the same vehicle trip totals (with the only difference being the 20% primary trip generation associated with the proposed development).

#	Issue Raised – 2021 and 2031 Models	Level of Client Risk
8	From the reporting in the revised section 8 of the ITA and Appendix A of the ITA, very few details are provided about how CAST demands were translated into Paramics and whether any additional adjustments were required (other than altering trip generation for the supermarket). Further clarification through reporting would assist with understanding. It currently appears that the adopted methodology results in additional traffic effects outside the Paramics model area that are not currently being captured in the assessment of effects.	Medium
9	There are some significant differences between the Base and with development network at the model external boundary, with a net reduction of traffic in the 'with development' network. This implies that some traffic is being pushed out beyond the Paramics model area and the effects of this are not captured. Normalising the current outputs to take this into account is recommended.	Medium

[10] Most likely through reassignment in CAST

3 Fitness for Purpose

3.1 The TMDG notes that a model that does not meet the target levels may still be suitable for application if the discrepancies are acceptable due to known, noted, and accepted issues (i.e. observed data limitations) and any larger discrepancies are concentrated away from the areas of most importance to the appraisal. Conversely, a model which passes the suggested acceptability levels but has significant discrepancies in key areas may be unacceptable.

3.2 Whether a model is "suitably" calibrated or not is invariably be a subjective decision based on the intended model purpose and implications on the level of risk in using model outputs resulting from any constraints or limitations (noting that some of these are covered in the following section 4).

3.3 Based on the adopted modelling methodology and confirmation that the model has been calibrated and validated to a high standard, I am satisfied that the Paramics model is in principle[11] fit-for-purpose for informing an Assessment of Environmental Effects of the nature and scale of the Application under the RMA.

[11] It is important to note that while a model can be deemed fit for purpose, the actual effectiveness of the model is highly dependent on how the model is applied in practice.

4 Model Limitations

4.1 It is important to note that while the model has been deemed fit for purpose, the effectiveness of the model is highly dependent on how the model is actually applied.

4.2 In the context of this assessment, a potential limitation is that delays are based on sets of predefined 'paths'. This can be problematic in some situations. If the path is too short, then it might not pick up the full extent of queuing and delay. Conversely, if the path is too long, then it may not pick up all potential sources of traffic and effectively have a reduced or skewed sample. A trade-off is therefore required, which requires good judgment by the modeller.

4.3 Queue lengths have not been observed or validated in the model. TDMG discussed difficulty of this (and defining the queue in general). I am more comfortable with delay (as adopted in the current assessment) being the preferred indicator for congestion and network performance.

4.4 No weekend period model has been prepared. While the weekday evening peak has been determined to be the most critical period, that should not necessarily imply that adverse traffic effects won't occur during weekends given the high level of traffic and different patterns. This is also true for the morning peak, however it is likely to be less critical than the weekend period.

4.5 Based on the adopted methodology of using CAST to estimate future traffic patterns, there appears to be potential wider network effects that are not reflected within the Paramics model (as described in section 2.9). A proposed work around to address this has been recommended in that section.

4.6 The Paramics model used static signal timings whereas in reality these are dynamically controlled using SCATS. This may result in reduced efficiency indicated by the model. Similarly, complex human behaviour related to vehicle following, gap acceptance and lane choice is modelled using a relatively few model parameters. These simplifications of reality may also result in reduced efficiency indicated by the model.

4.7 The model does not necessarily provide an accurate prediction of what might occur in the future (nor does it need to), but rather provides an objective indication of relative effects based on very specific assumptions agreed for very specific scenarios.

4.8 Based on responses provided by the modelling team in Appendix A, it is apparent that a side-effect of the adopted methodology[12] is that there are several inconsistences between the future year models with and without development related to traffic signal phasing at Main North Road/QEII Drive/Northcote, small changes in offsets and green times and CAST demands (reflecting minor wider area differences). While resulting model outputs do reflect expected operation, these inconsistencies make isolation of development (only) effects very difficult. Model outputs therefore need to be interpreted with this in mind.

[12] Agreed between Abley and CCC.

5 Completeness of Documentation

5.1 Section 2 of this review (Calibration and Validation) has identified several potential issues relating specifically to documentation of Appendix A of the ITA. These will not be repeated here (noting that they are also included in the Review Register in Appendix A).

5.2 This section checks that the outputs presented in the ITA and Technical Note are logical, robust and can be relied upon by a decision maker under the RMA (acknowledging any limitations or gaps identified in the preceding section 4).

5.3 The comments below relate to various sections of the Technical Note using the same sub-headings.

5.4 Traffic Signal Optimisation

5.4.1 The ITA indicates that the proposed development is dependent on a revised layout of Main North/Northcote/QEII intersection (with separate phases for north and south approaches with remarked lanes allowing dual line right turn on the south approach).

5.4.2 It is mentioned in the ITA that "*Preliminary tracking shows that the two vehicles can turn side by side with adequate clearance (refer to Appendix B to the ITA). However, it is noted that tracking was undertaken on an aerial image and that it should be undertaken on a topography survey for accurate results*".

5.4.3 Given how critical this single issue is, I recommend that tracking is redone on a suitable georeferenced base.

5.5 2018 Base Year

5.5.1 It would be useful if Table 1.2 of the Technical Note included distance information so that speeds can be inferred (or implied average speeds added to the table). The reported average excess travel times do however appear to be intuitively sensible.

5.5.2 Checks have been made against the latest CAST (v18) 2018 network, and reported traffic flows are generally consistent.

5.6 2020 Base Year

5.6.1 Section 1 (a) of the technical note indicates that a key modelling assumption arising from the conferencing is that the 2021 and 2031 permitted baseline includes traffic volumes which are consistent with the existing Toll operations on the 2 Lydia Street site (which is consistent with the current industrial zoning).

5.6.2 The 2020 Base demands for zone 10 (2 Lydia Street site) has zero modelled trips. It appears that the pre-conferencing assumption that the site has been vacated and construction of a college (referred to in section 3.7 of the ITA) has been retained instead of adopting the revised permitted baseline agreed during conferencing.

5.6.3 The 2031 Base year however appears to reflect the baseline agreed during conferencing.

5.7 2021 with Development

5.7.1 Figures 1.3 and 1.4 of the Technical Note have been checked in detail and appear to be accurate and reasonable on all links that are common to the Base and Development networks.

5.7.2 It is however noted that the increased development traffic is not displayed on the internal development links in Figure 1.4. This could be confusing for readers (e.g. decision maker under the RMA) because at the bandwidth scale shown, this 'missing' traffic is significant, noting that the relevant values are indicated in Table 1.10 of the Technical Note.

5.7.3 The peak hour[13] trip matrix demand associated with proposed supermarket (zones 12) is 411 vehicle trips to the site and 417 from the site resulting in 828 trips per hour. This is less than the 870 (or 876 with fuel) trips (2way) set out in Table 7.1 (Trip Generation) of the ITA.

5.8 2031 with Development

5.8.1 Similar to Figure 1.4 of the Technical Note, it is noted that the increased development traffic is not displayed on the internal development links in Figure 1.8. This could be confusing for readers (e.g. decision maker under the RMA) because at the bandwidth scale shown, this 'missing' traffic is significant (noting that the values indicated in Table 1.11 of the Technical Note).

5.8.2 The peak hour trip matrix demand associated with proposed supermarket (zones 12) is 413 vehicle trips to the site and 420 from the site resulting in 833 trips. This is less than the 870 (or 876 with fuel) trips set out ion Table 7.1 (Trip Generation) of the ITA.

5.9 Intersection and Travel time Comparisons

5.9.1 Many of the results presented appear illogical. With development, there is effectively a 6% increase in vehicle trips on the modelled network and an additional set of traffic signals to traverse, but yet the reported results indicate (in most cases) that this performs better than the base.

5.9.2 It can easily be demonstrated that introducing mid-block traffic signals (without any other changes) would result in increased travel time, unless they are perfectly coordinated (which is seldom possible in two directions), in which case travel time would remain similar, but not reduce.

5.9.3 Similarly, adding more traffic locally (all else remaining the same) would result in similar or increased travel times, but not a reduction. Therefore the current results imply that either a 'fair' comparison is not being made, or that there may be errors in extracting the model outputs (or possibly both).

5.9.4 I've checked network coding and can confirm that this appears to be generally consistent between the base and development networks (with only relatively minor optimisation adjustments noted at traffic signals).

5.9.5 There does however appear to be some inconsistencies in the path files used to compile

[13] Note that a flat traffic profile has been adopted for the supermarket (zone 12), so trips leaving the supermarket have a constant flow 'peak' rate throughout the entire modelled 2 hour modelled PM peak.

delay. The differences appear to be significant. For example:

- 'Main N QEII E' – where Base starts at node 75 and with Development at node 72 (approximately 330m shorter than the base).
- 'Main N QEII S1' – where Base starts at node 59 and with Development at node 113 (approximately 40m shorter than the base).
- 'Main N QEII S2' – where Base starts at node 60 and with Development at node 61 (approximately 26m shorter than the base).
- 'CranfordMainN N' – where Base starts at node 41 and with Development at node 51 (approximately 200m longer than the base).

5.9.6 It is therefore recommended that the path files are updated to be fully consistent and results re-extracted.

5.9.7 Other items identified earlier in this review (e.g. some traffic re-routing to avoid the Paramics study area and modelled development demand being less than the trip generation estimated in the ITA) may also be unintentionally contributing to a skewed comparison in favour of the propose development.

5.9.8 It is reasonable to expect that traffic effects with development might be similar to the base, but intuitively they should not result in an improvement (as currently indicated). Therefore, any model outputs that indicate an improvement over the base will need to have a robust explanation as to how this is possible.

5.9.9 Table 1.5 of the Technical Note has a typo (digit missing) for the 2021 base flow from Main North Road (South approach).

5.9.10 Tables 1.5 to 1.8 of the Technical Note are summarised at the approach level rather than the movement level (as provided in Tables 1.3 and 1.4). It is therefore difficult to understand other possible reasons for the unintuitive outputs. It is recommended that Tables 1.5 to 1.8 are expanded to the movement level.

5.10 New signalised Main North Road access

5.10.1 Table 1.11 of the Technical Note indicates an average delay of 60 seconds for the Main South Road south approach through (northbound) movement at the new access intersection. However, this does not seem to reconcile with Table 1.9 where the northbound delay on Main North Road to the north is indicated to be 111 seconds quicker with development, and Cranford Street is only 3 seconds more with development. Some signal optimisation and coordination is acknowledged, but this result is unintuitive and therefore further explanation would be useful.

5.11 Vehicle Travel Totals

5.11.1 Table 1.13 in the Technical Note provides a useful summary of total travel within the model area (excluding traffic accessing the development).

5.11.2 It is noted (and understood) that the total non-development vehicle trips decrease with the addition of development traffic (due to pass-by and diverted components). It would therefore be useful to normalise the results to understand the potential effects on an average per vehicle basis.

5.12 Summary of Modelled Effects of Proposal

5.12.1 The summary provided a good explanation of the key outcomes of the modelling.

5.12.2 Some of these outcomes may however be subject to change depending on further investigation and possible resolution of matters described above.

5.12.3 I note the following reporting related issues that have been added to the Review Register in Appendix A:

#	Issues Raised – Completeness of Documentation	Level of Client Risk
10	It is recommended that vehicle tracking for two HCVs simultaneously turning right from Main North Road to QEII Drive is redone on a proper georeferenced base.	High
11	It would be useful if Table 1.2 of the Technical Note included distance information so that speeds can be inferred (or implied average speeds added to the table)	Medium
12	It appears that the pre-conferencing assumption that the site has been vacated and construction of a college (referred to in section 3.7 of the ITA) has been retained instead of adopting the revised permitted baseline agreed during conferencing.	High
13	It is however noted that the increased development traffic is not displayed on the internal development links in Figures 1.4 and 1.8. This could be confusing for readers (e.g. decision maker under the RMA) because at the bandwidth scale shown, this 'missing' traffic is significant.	High
14	The future year (2021 and 2031) trip matrix demand associated with the supermarket site (zones 12) appears to be less than the 870 trips (or 876 with fuel) set out ion Table 7.1 (Trip Generation) of the ITA.	High
15	There appear to be some significant inconsistencies in the path files used to compile delay, where different starting nodes adopted in the base and with development networks result in different path lengths which distorts the relative travel time.	High
16	It is reasonable to expect that traffic effects with development might be similar to the base, but intuitively they should not result in an improvement (as currently indicated). Therefore, any model outputs that indicate an improvement over the base will need to have a robust explanation as to how this is possible.	High
17	Table 1.5 of the Technical Note has a typo (digit missing) for the 2021 base flow from Main North Road (South approach).	High
18	Tables 1.5 to 1.8 of the Technical Note are summarised at the approach level rather than the movement level (as provided in Tables 1.3 and 1.4). It is therefore difficult to understand other possible	Medium

	reasons for the unintuitive outputs. It is recommended that Tables 1.5 to 1.8 are expanded to the movement level.	
19	Table 1.11 of the Technical Note indicates an average delay of 60 seconds for the Main South Road south approach through (northbound) movement at the new access intersection. However, this does not seem to reconcile with Table 1.9 where the northbound delay on Main North Road to the north is indicated to be 111 seconds quicker with development, and Cranford Street is only 3 seconds more with development. Some signal optimisation and coordination is acknowledged, but this result is unintuitive and needs further explanation.	Medium
20	It would be useful to normalise the results in Table 1.13 in the Technical Note to understand the potential effects on an average per vehicle basis (while still excluding development traffic).	High

6 Peer Review Close Out

6.1 Modelling Team Responses

6.1.1 The first version of this peer report was provided to the modelling team for consideration.

6.1.2 A response technical note[14] has been provided which includes responses to all the issues raised in the Review Register (Appendix A) and included appended information where any previously reported item has changed as a result of any action associated with the response.

6.1.3 The responses from the response technical note have been copied[15] across directly to the corresponding response field of the Review Register in Appendix A of this document (along with the appended information provided in the response technical note).

6.2 Conclusion

6.2.1 Overall, I am satisfied that all issues raised have been reasonably resolved through either additional information, making corrections, or acknowledging and accepting minor inconsistences (and interpreting model outputs with these in mind).

6.2.2 A side-effect of the adopted methodology[16] is that there are several inconsistences between the future year models with and without development:

- Split signal phasing adopted at Main North Road/QEII Drive/Northcote for development scenario but not corresponding future base
- Traffic signal optimisation (small changes in offsets and green times)
- CAST demands (reflecting minor wider area differences with and without development)
- Trip generation (small differences from reported values)

6.2.3 These inconsistencies, while acknowledged to relatively small in isolation, collectively introduce multiple secondary effects that make a 'pure' comparison of development only effects very difficult.

6.2.4 Therefore, the reported effects relate to not just a change in development (and the access intersection), but also include other secondary effects which increase the uncertainty of the quantified effects. The net result is that a general improvement in network performance is indicated to be the outcome of the proposed development.

6.2.5 I am not necessarily convinced that this will be the actual outcome. I consider a more practical approach is to acknowledge some uncertainty and limitations in the model.

6.2.6 On that basis, there is strong evidence that the model is in the right ball-park and adequately reflecting future year operation with development in place. It is reasonably clear that the anticipated traffic effects are likely to be less than minor, but (allowing for uncertainty and model limitations) not necessarily an improvement as currently reported.

[14] Model Peer Review Response, prepared by Abley, dated 14th November 2019. "*FSIL-J047nte3 Model Peer Review Response v2.docx*"

[15] Appending the entire response technical note was considered, but would have resulted in much duplication with the original (unpopulated) Review Register in Appendix A.

[16] Agreed between Abley and CCC.

Appendix A – Review Register

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	Reviewer	Reviewer	Response	Reviewer
#	**Issue Raised**	**Level of Client Risk**	**Proposed Resolution**	**Close out**
1	Inconsistent traffic zones between 2018 base and future models. Justification or further explanation is recommended.	Low	The Paramics model was initially set up (both base and futures) with a 2018 zone set and was based on the CTM model. Following a directive from Council, the futures were converted to receive CAST demands which had additional internal zones. These demands and new zones were included in the future Paramics models to simplify the demand conversion process and the 2018 model was unaffected.	Purpose of 2018 Base used for initial calibration and validation only. Having established this, and carrying calibrated element's to future networks, it served no further purpose. STATUS - reasonably resolved.
2	Further explanation of the rationale for applying car-parks to zones 13 and 15 is recommended, including potential advantages and limitations of this approach.	Low	Paramics can distribute traffic across multiple links in terms of the origin of a trip (proportions are set by the link length) but will seek out the lowest cost route to the destination zone. Carparks were used in some cases so that the "zonal links" had the same proportion of origin and destination trip ends in order to evenly distribute traffic and simplify the matrix. Carparks in the zones identified were not used as a proxy to estimate CAST demands or other interactions.	STATUS – reasonably resolved through additional information contained in response.

3	A 'manual' trip matrix estimation procedure was adopted. Justification or further explanation required why initial demands from CAST were not used (as adopted for future year models).	Low	The CAST process was developed well after the models were developed. There also was no 2018 CAST model available (the base year at the time was 2013) which could be used to undertake calibration and validation against. A manual matrix would have been required to obtain a decent prior matrix so engineering judgment was used to set up the prior as close as possible with minor furnessing applied to achieve inbound/outbound targets.	STATUS – reasonably resolved through additional information contained in response.
4	Reporting error in Tables A1.2 and A1.3 for the intersection totals, where the column totals are either incorrect and or out of sync with the row data above.	High	The values in the Table are offset in the last row by one column. The revised tables are attached including an hourly equivalent GEH for the two-hour totals (from issue #5 below).	STATUS – confirm corrected in response document.
5	GEH values reported for 4pm to 6pm are incorrect because they have not been converted to hourly equivalents.	Medium	The revised tables are attached (with correction from issue #4 above) and generally reflect better GEH values than previously reported and are considered an overall good level of fit.	STATUS – confirm corrected in response document.
6	Comparisons not made with relevant TDMG criteria in ITA (however, this has been resolved indirectly as part of this peer review)	Low	The analysis undertaken by the peer reviewer is acknowledged and the conclusions drawn from this analysis are considered appropriate.	STATUS – reasonably resolved
7	Journey time vs. distance graphs have not been provided. As an alternative to providing these, it would be very useful if each route distance (path length) could be included in ITA Table A1.4 so that the vehicle speeds can be inferred (or ideally	Low	The implied surveyed and modelled speeds are included in an updated Table A1.4 attached.	STATUS – confirm corrected in response document.

	also reported)			
8	From the reporting in the revised section 8 of the ITA and Appendix A of the ITA, very few details are provided about how CAST demands were translated into Paramics and whether any additional adjustments were required (other than altering trip generation for the supermarket). Further clarification through reporting would assist with understanding. It currently appears that the adopted methodology results in additional traffic effects outside the Paramics model area that are not currently being captured in the assessment of effects.	Medium	The base model has not been based upon CAST as discussed the response to item #1. As agreed with Council the future models have taken CAST matrices directly without any adjustments to reflect a base year matrix estimation or other calibration process. This was agreed with Council to be appropriate as the future receiving environment is very different with the introduction of the CNC by 2021 and CNC and Cranford Basin link in 2031. It is also noted that network operation calibration from the base year has been carried forward to the future year models. The key vehicle interactions and conflicts arising due to the development are typically contained within the Paramics modelled area and any wider effects are considered to occur outside the area due to redistribution and rerouting occurring within the CAST model. This is discussed further in item #9 below.	STATUS – reasonably resolved through additional information contained in response.
9	There are some significant differences between the Base and with development network at the model external boundary, with a net reduction of traffic in the 'with development' network. This implies that some traffic is being pushed out beyond the Paramics model area and the effects of this are not captured. Normalising the current	Medium	The demands of the Paramics model has been checked for consistency with the CAST demands sent through on 9/09/2019 by CCC for the Base years and 13/09/2019 for the future years. The demands have been confirmed to pass through the translation process with the same demand levels at the end where Paramics	A side-effect of the adopted methodology is that there are several inconsistences between the future year models with and without development: • Split signal phasing

	outputs to take this into account is recommended.		demands are created. Note that no adjustment has been made to the final demands based on the results of a Matrix Estimation, so they represent the CAST demands as is. The only adjustment to the demands is to scaled back the supermarket demands from 15trips/100sqm gfa to 12.5trips/100sqm gfa which will result in some reduction on the network. The base 'no development' demands sets have been extracted from CAST with the existing phasing arrangement and lane configuration at Main North Rd/QE2 Dr/Northcote Rd intersection which has right turn filtering enabled on all but the QE2 Dr approach. The 'with development' demands from CAST have the proposed split phasing and lane arrangement. This makes it difficult to undertake a direct comparison between the two demand sets as there are changes in the intersection layout and phasing, the new signals on Main North Road are introduced and development traffic is added. We note however that these were the only demand sets made available during modelling caucusing and we have been reliant on Council in that regard. It is our view that the difference in operation at the Main North Rd/QE2 Dr/Northcote Rd intersection and to an extent the new signals on	• Signal optimisation • CAST demands (reflecting legitimate minor wider area differences, but resulting in inconsistency within the Paramics model area) These inconsistencies each introduce secondary effects that cloud a 'pure' comparison of development only effects. It needs to be acknowledged that reported effects relate to not just a change in development, but also include other secondary effects which increase the uncertainty of the reported values. The modelled network performance indicated with development is however likely to be reasonably representative of what might be expected based on the adopted assumptions. STATUS – Model results to be interpreted with this issue in mind.

			Main North Road results in traffic reassignment within CAST. The routing of traffic in CAST with and without the development will also be sensitive to the operation of the Northcote-QEII and Main North Road corridors including the signal coordination and the optimisation of signal performance. CAST implements an equilibrium assignment which means that for trips from every origin to every destination the minimum generalised cost will be sought. In a busy grid-based network like Christchurch with a large number of potential vehicle paths (and this is prominent in the vicinity of the site) the routing of traffic for each origin-destination pair is likely to be sensitive to small changes in generalised costs, and this is the most likely explanation for the reduction in some flows. As agreed during conferencing the base and with-development models in Paramics have the proposed split phasing and lane arrangement.	
10	It is recommended that vehicle tracking for two HCVs simultaneously turning right from Main North Road to QEII Drive is redone on a proper georeferenced base.	High	Agree with this comment. Vehicle tracking was undertaken to investigate the viability of two vehicles turning right simultaneously. As requested by CCC, a 23m B-Double truck side by side with an 8m medium rigid truck was tested. Preliminary tracking shows that that the two vehicles can turn side by side with adequate clearance. However, it was noted in the ITA that tracking was undertaken on an aerial image and	STATUS – reasonably resolved through additional information contained in response.

			that it should be undertaken on a topography survey for accurate results. Consequently, in the Road Safety Audit, Abley as the designer recommended that "minor alterations at the pedestrian island and slip lane (Main North Road North approach) could improve manoeuvrability". This was signed off by the CCC safety engineer with the following recommendation "It is proposed that this issue is addressed at detailed design stage of the project and the applicant is agreeable to a condition of consent to ensure that vehicle tracking is satisfactorily addressed".	
11	It would be useful if Table 1.2 of the Technical Note included distance information so that speeds can be inferred (or implied average speeds added to the table)	Medium	The scenario peak hour comparisons of key route travel times have been converted to implied speeds and attached below under Item #11.	STATUS – reasonably resolved through additional information contained in response.
12	It appears that the pre-conferencing assumption that the site has been vacated and construction of a college (referred to in section 3.7 of the ITA) has been retained instead of adopting the revised permitted baseline agreed during conferencing.	High	Agreed. This pre-conferencing assumption was inadvertently retained in 2021 and due to the very low traffic generation it was not evident in the simulation. Note that the 2031 industrial activity on 2 Lydia St was correctly in the matrices. The demands from the site are not considered to have any noticeable impact on network performance of either the base or with-development models in 2021 given the total is approximately 60 two way trips over two hours. This equates to one vehicle in every four minutes and one vehicle out every four minutes.	STATUS – 2021 model results to be interpreted with this issue in mind.

13	It is however noted that the increased development traffic is not displayed on the internal development links in Figures 1.4 and 1.8. This could be confusing for readers (e.g. decision maker under the RMA) because at the bandwidth scale shown, this 'missing' traffic is significant.	High	This is an unfortunate limitation of the software and the traffic will be manually added as best as possible. It is noted that the diagrams may get cluttered due to the number of closely spaced links.	STATUS – Response acknowledged. Perhaps a footnote could be added in the technical note explaining this issue and refer to tables that contain access flows.
14	The future year (2021 and 2031) trip matrix demand associated with the supermarket site (zones 12) appears to be less than the 870 trips (or 876 with fuel) set out ion Table 7.1 (Trip Generation) of the ITA.	High	The future models that were initially prepared had peak hour generation applied over the two peak period hours modelled from 4-6pm so the Paramics loading profile was flat to enable this. In the transition to CAST based demands in the futures the combination of the flat profile and lower generation peak shoulder periods mean the actual peak generation was understated as noted in the review. This is approximately 40 two way trips (one vehicle in every three minutes and one vehicle out every three minutes) and once distributed across multiple accesses serving the site and wider network is not considered to have any noticeable impact on network performance.	Acknowledged minor inconsistency. STATUS – Model results to be interpreted with this issue in mind.
15	There appear to be some significant inconsistencies in the path files used to compile delay, where different starting nodes adopted in the base and with development networks result in different path lengths which distorts the relative travel time.	High	The inclusion of the access signals made the paths and delay calculations very complicated. There multiple entry/exit point northbound between Cranford and Northcote on Main North Road and multiple paths were set up in this segment to analyse the delays for the Main North Road south approach to QE2 Dr in order	STATUS – Appears to be resolved, with updated tables provided.

			to capture all possible movements via and average weighted approach. This was further complicated by access to the head office closing and moving hence some of the changed paths starting positions. southern approach movements at the northern end. In the final results issued the delays are reported for the main traffic movement between major intersections, so some paths (northbound in particular) passed though vehicle activity points. The general delay has been reported and it is noted that some paths are only used to report vehicle turning movement counts (not delays). The paths have been double checked for consistency to ensure that a fair comparison has been made. This has adjusted some of the travel time results and new values are presented in the appended tables.	
16	It is reasonable to expect that traffic effects with development might be similar to the base, but intuitively they should not result in an improvement (as currently indicated). Therefore, any model outputs that indicate an improvement over the base will need to have a robust explanation as to how this is possible.	High	There is an overall improvement in performance for several reasons: -the new midblock signals on Main North Road provide a safe facility for Foodstuffs head office traffic to turn right in and right out of the site reducing U-turns at Main North Road, and removing circuitous travel via Northcote, Sawyers Arms and/or Vagues Roads. -connectivity through the site has been improved such that divert and pass-by vehicles can visit	Acknowledge and agree with reasons why performance may be improved, however not convinced that these are sufficient to offset adverse effects associated with increased development traffic and introduction of new signalised intersection. Cannot be resolved without a breakdown of contributions from each component. But I acknowledge that

			the site without passing through the Main Nth Rd/QEII/Northcote signals -the inclusion of midblock signals on Main North Road allows for more controlled progression of traffic along the corridor so the impact of coordination has been improved;	note this is onerous, so noting time constraints, a practical way forward may be to simply acknowledge uncertainty in the model (as also noted for other responses above). On that basis, it can be accepted that the model is in the right ball-park and anticipated traffic effects are indicated to be relatively minor, but not necessarily positive as currently indicated in the reporting. STATUS – Model results to be interpreted with this issue in mind.
17	Table 1.5 of the Technical Note has a typo (digit missing) for the 2021 base flow from Main North Road (South approach).	Medium	Yes a Typo was present and does not affect the overall result of the intersection.	STATUS – Corrected in response.
18	Tables 1.5 to 1.8 of the Technical Note are summarised at the approach level rather than the movement level (as provided in Tables 1.3 and 1.4). It is therefore difficult to understand other possible reasons for the unintuitive outputs. It is recommended that Tables 1.5 to 1.8 are expanded to the movement level.	Medium	These are appended to this technical note.	STATUS – Reasonably resolved through additional information contained in response.
19	Table 1.11 of the Technical Note indicates an average delay of 60 seconds for the Main South Road south approach through (northbound) movement at the new access intersection.	Medium	During the expert conferencing there were concerns that the QEII Drive /Northcote Road approaches exhibited disproportionate delays compared to Main North Road approaches in	Response acknowledged. More weight should therefore be given to full length key corridor paths

	However, this does not seem to reconcile with Table 1.9 where the northbound delay on Main North Road to the north is indicated to be 111 seconds quicker with development, and Cranford Street is only 3 seconds more with development. Some signal optimisation and coordination is acknowledged, but this result is unintuitive and needs further explanation.		some scenarios and that SCATS would likely balance out the delays with higher delays expected on the south approach. One of the difficulties with this was that delay for the Main North Road southern approach was captured on the southern approach to the new signals and the reported delay at the time was essentially capped to the length of road between the site signals and QE2 Drive (In the order of 45-55 seconds). Summing up the delay on the southern approach to the new signals would give a similar delay for the whole northbound segment from Cranford to QE2 but vehicles are not typically subject to the average delay at both intersections heading north as signal coordination is set up to help vehicles only stop once if possible. Because of this, and acknowledging that we were reporting on the effects at the two main intersections, the full path from Cranford to QE2 was reported for the average delays on the southern approach at the Main North Rd/QE2 Dr/Northcote Rd intersection. The allocation of timing for each phase in the models were re-optimised for the conferencing on this basis such that delay balancing between approaches was simpler to track. This also means that while the site signals has	rather than short sub-sections (e.g. intersection approaches). Also results are likely to reflect minor inconsistencies and uncertainty in the model discussed earlier (split phasing at MNR/QEII/Northcote with development only, CAST demand differences (wider network) etc.) STATUS – Model results to be interpreted with this issue in mind.

			an average delay for the northbound through movement in the order of 60s this is not additional to the travel time northbound between Cranford and QE2 in a sense. With the current result set the 2031 base northbound though movement average delay (that is crossing QE2) is 161 sec (refer to Table 2.3 of technical note) and with development is equivalent to 98 sec. If we report only the delay north of the site signals, we have 51 sec which when combined with the site signals movement of 61 sec, gives a similar result. This suggests that travel times won't increase in general with the site signals and delay is just shared across more stoplines. One of the reasons that the northbound travel time in 2031 improves with development is that the delay balancing has pushed congestion back along Main North Road towards Sawyers Arms Road in the base (without development) model. With this in mind, a sensitivity test (results are attached in a table under issue #19) of the impact on travel times if further optimisation was done in the base model which places more delay back onto Northcote Road. The table shows how travel times change and compare to the base and development scenario in 2031. The analysis demonstrates the sensitivity of the competing demands on the two corridors and an	

			overall general improvement in network performance.	
20	It would be useful to normalise the results in Table 1.13 in the Technical Note to understand the potential effects on an average per vehicle basis (while still excluding development traffic).	High	This has been done and results presented below. The gap between the base and with-development scenarios has decreased but still represents a general improvement.	This provides a more useful comparison. Similar to #16, I am not convinced that a general improvement will be the outcome. But acknowledging time constraints, a practical way forward may be to simply acknowledge uncertainty in the model (as also noted for other responses above). On that basis, it can be accepted that the model is in the right ball-park and consequently anticipated traffic effects are indicated to be relatively minor, but not necessarily an improvement as currently indicated in the reporting. STATUS – Model results to be interpreted with this issue in mind.

Appended Items

Item #4/5

Main North/ QEII/ Northcote intersection

Movement Description		4pm to 5pm					5pm to 6pm					4pm to 6pm (hourly equivalent GEH sum x 0.5)				
Approach	**Movement**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**
North	Left	162	155	7	0.6	105%	171	156	15	1.2	110%	333	311	22	0.9	107%
North	Through	702	694	8	0.3	101%	747	742	5	0.2	101%	1449	1436	13	0.2	101%
North	Right	158	149	9	0.7	106%	168	154	14	1.1	109%	326	303	23	0.9	108%
East	Left	156	179	-23	1.7	87%	170	179	-9	0.6	95%	326	357	-31	1.2	91%
East	Through	550	557	-7	0.3	99%	613	557	56	2.3	110%	1163	1114	49	1.0	104%
East	Right	141	150	-9	0.7	94%	155	150	6	0.4	104%	296	299	-3	0.1	99%
South	Left	199	168	31	2.3	118%	201	164	37	2.7	123%	400	332	68	2.5	120%
South	Through	1362	1380	-18	0.5	99%	1396	1406	-10	0.3	99%	2758	2786	-28	0.4	99%
South	Right	204	207	-3	0.2	99%	209	206	3	0.2	101%	413	413	0	0.0	100%
West	Left	160	166	-6	0.5	96%	163	148	15	1.2	110%	323	314	9	0.4	103%
West	Through	737	731	6	0.2	101%	748	785	-37	1.3	95%	1485	1516	-31	0.6	98%
West	Right	198	200	-2	0.1	99%	198	198	0	0.0	100%	396	398	-2	0.1	99%
Intersection		4729	4735	-6	0.1	100%	4939	4844	95	1.4	102%	9668	9579	89	0.6	101%

Main North/ Cranford intersection

Movement Description		4pm to 5pm					5pm to 6pm					4pm to 6pm (hourly equivalent GEH sum x 0.5)				
Approach	**Movement**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**
North	Left	540	491	49	2.2	110%	563	539	24	1.0	104%	1103	1030	73	1.6	107%
North	Through	568	583	-15	0.6	97%	578	572	6	0.3	101%	1146	1155	-9	0.2	99%
East	Left	281	254	27	1.7	111%	270	281	-11	0.7	96%	551	535	16	0.5	103%
East	Right	780	809	-29	1.0	96%	798	864	-66	2.3	92%	1578	1673	-95	1.7	94%
South	Through	912	831	81	2.7	110%	952	877	75	2.5	109%	1864	1708	156	2.6	109%
South	Right	251	298	-47	2.8	84%	267	311	-44	2.6	86%	518	609	-91	2.7	85%
Intersection		3332	3266	66	1.1	102%	3428	3444	-16	0.3	100%	6760	6710	50	0.4	101%

Main North/ Vagues intersection

Movement Description		4pm to 5pm					5pm to 6pm					4pm to 6pm (hourly equivalent GEH sum x 0.5)				
Approach	**Movement**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**	**Model**	**Survey**	**diff**	**GEH**	**%**
North	Through	799	773	26	0.9	103%	797	773	24	0.9	103%	1596	1546	50	0.9	103%
North	Right	54	90	-36	4.2	60%	55	94	-39	4.5	59%	109	184	-75	4.4	59%
South	Left	9	17	-8	2.2	53%	1	17	-16	5.3	6%	10	34	-24	3.6	29%
South	Through	1096	1067	29	0.9	103%	1156	1016	140	4.2	114%	2252	2083	169	2.6	108%
West	Left	68	156	-88	8.3	44%	70	151	-81	7.7	46%	138	307	-169	8.0	45%
West	Right	8	4	4	1.6	200%	8	4	4	1.6	200%	16	8	8	1.6	200%
Intersection		1983	2107	-124	2.7	94%	2047	2055	-8	0.2	100%	4030	4162	-132	0.5	99%

Item #7

Route	Mean surveyed travel times (s)	Mean modelled travel times (s)	Diff (s)	Diff (%)	Dist (m)	Implied surveyed speed (km/h)	Implied modelled speed (km/h)	Comments
C - N	425	459	34	8%	1601	13.6	12.6	Survey times mostly in 5-6pm hour so comparison with modelled 5-6pm.
E - W	189	133	-56	-30%	1248	23.8	33.8	Input volumes have been adjusted due to the closure of Grimseys Road so the model operates faster.
N - C	124	109	-15	-12%	976	28.3	32.3	Survey times mostly in 4-5pm hour so comparison with modelled 4-5pm
N - S	164	158	-6	-4%	1218	26.7	27.7	Survey times mostly in 5-6pm hour so comparison with modelled 5-6pm.
S - N	247	237	-10	-4%	1031	15.0	15.7	Survey times across both hours so comparison with modelled 4-6pm.
W - E	273	275	3	1%	1247	16.4	16.3	Comparison with modelled 5-6pm.

Item #11

As stated in the response table the update to the paths used in the model changed some of the travel time segments so the updated results and comparison is below.

Route	Movement	2018 Base			2021 Base		2021 with development		2031 Base		2031 with development	
		Ave. Travel Time (s)	Min. Travel Time (s)	Total delay (s)	Ave. Travel Time (s)	Change from 2018 Base	Ave. Travel Time (s)	Change from 2021 Base	Ave. Travel Time (s)	Change from 2021Base	Ave. Travel Time (s)	Change from 2031 Base
Main North Road to the north	Northbound	245	79	166	139	-106	125	-15	321	181	209	-112
	Southbound	165	72	93	154	-11	171	17	161	7	168	7
Cranford Street to the North	Northbound	352	92	260	195	-158	200	6	293	99	303	10
	Southbound	112	50	62	102	-11	112	10	106	5	127	20
QEII Drive – Northcote Road	Eastbound	136	76	60	139	3	130	-9	212	73	148	-64
	Westbound	246	109	137	144	-102	143	-1	130	-14	120	-10

Implied modelled speeds across scenarios have been calculated for the peak hour (1630-1730) so there will be minor differences to the travel time validation where the travel time was matched against 4-5pm and 5-6pm as specified in the comments field under item #7 updated output.

Route	Movement	2018 Base	2021 Base	2021 with development	2031 Base	2031 with development
Main North Road to the north	Northbound	15.1	26.6	29.8	11.6	17.8
	Southbound	26.6	28.5	25.7	27.2	26.0
Cranford Street to the North	Northbound	16.4	29.6	28.8	19.7	19.0
	Southbound	31.4	34.6	31.4	33.1	27.8
QEII Drive – Northcote Road	Eastbound	33.0	32.3	34.5	21.2	30.4
	Westbound	18.3	31.2	31.4	34.5	37.5

Item #18

2.4 Main North Rd / QEII Dr / Northcote Rd intersection operation comparison – PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Main North Rd (North)	L	172	24	C	**65.8**	**E**	196	14	B	**37.2**	**D**	207	21	C	**41.6**	**D**	205	14	B	**62.0**	**E**	192	16	B	**49.2**	**D**
	T	730	63	E			207	50	D			219	59	E			197	55	D			229	71	E		
	R	160	123	F			112	54	D			63	51	D			176	126	F			91	64	E		
QEII Dr (East)	L	164	14	B	**41.5**	**D**	389	20	C	**50.9**	**D**	441	18	B	**43.4**	**D**	393	22	C	**49.0**	**D**	475	20	B	**41.2**	**D**
	T	607	44	D			907	52	D			879	52	D			1102	49	D			998	44	D		
	R	152	59	E			126	137	F			122	72	E			116	139	F			128	102	F		
Main North Rd (South)	L	192	82	F	**103.0**	**F**	156	39	D	**65.8**	**E**	133	31	C	**64.5**	**E**	155	119	F	**153.3**	**F**	185	65	E	**100.1**	**F**
	T	1272	103	F			882	69	E			736	63	E			822	161	F			729	98	F		
	R	160	126	F			522	68	E			679	72	E			468	151	F			675	112	F		
Northcote Rd (West)	L	161	103	F	**121.7**	**F**	79	47	D	**68.5**	**E**	125	29	C	**50.9**	**D**	216	143	F	**145.5**	**F**	264	70	E	**78.7**	**E**
	T	757	134	F			960	73	E			921	55	D			1079	148	F			1013	82	F		

	R	198	91	F			216	57	E			55	34	C			205	136	F			76	60	E		
Intersection		4728			**87.0**	**F**	4752			**59.0**	**E**	4578			**52.2**	**D**	5133			**108.0**	**F**	5055			**70.6**	**E**

2.4 Main North Rd / Cranford St intersection operation comparison – PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Main North Rd (North)	L	566	11	B	**21.9**	**C**	188	8	A	29.7	**C**	168	8	A	26.0	C	244	8	A	25.1	C	280	8	A	21.2	C
	T	566	33	C			608	36	D			622	31	C			541	33	C			587	27	C		
Cranford St (East)	L	275	45	D	**102.8**	**F**	284	13	B	35.7	**D**	274	12	B	37.5	D	134	12	B	56.6	E	108	48	D	115.3	F
	R	794	123	F			557	48	D			539	50	D			604	67	E			580	128	F		
Main North Rd (South)	T	870	102	F	**98.8**	**F**	971	15	B	18.3	**B**	1038	14	B	15.4	B	911	129	F	125.3	F	1058	67	E	65.7	E
	R	251	88	F			372	28	C			281	21	C			145	104	F			111	53	D		
Intersection		3322			**73.9**	**E**	2980			26.3	**C**	2921			24.4	C	2580			75.1	E	2724			64.1	E

2.5 Main North Rd / Vagues Rd intersection operation comparison - PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Main North Rd (North)	L	789	17	C	18.2	C	826	15	B	16.3	C	841	17	C	18.0	C	593	13	B	16.8	C	640	16	C	17.7	C
	R	55	40	E			46	45	E			41	39	E			61	53	F			41	49	E		
Main North Rd (South)	L	5	27	D	55.1	F	5	0	A	9.5	A	4	0	A	9.0	A	4	35	D	56.5	F	2	39	E	26.9	D
	T	1037	55	F			1257	10	A			1221	9	A			962	57	F			1118	27	D		
Vagues Rd (West)	L	88	214	F	210.3	F	107	90	F	86.6	F	112	55	F	56.6	F	109	290	F	282.2	F	93	157	F	147.6	F
	R	13	187	F			15	61	F			11	70	F			16	230	F			13	82	F		
Intersection		1987			210.3	F	2255			86.6	F	2231			56.6	F	1745			282.2	F	1906			147.6	F

2.6 Main North Rd / Sawyers Arms Rd intersection operation comparison - PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Main North Rd (North)	L	602	17	B	23.1	C	652	16	B	20.8	C	685	17	B	20.2	C	468	15	B	19.0	B	530	16	B	19.6	B
	R	194	44	D			174	40	D			155	34	C			139	33	C			119	34	C		
Main North Rd (South)	L	105	30	C	54.0	D	113	12	B	22.1	C	111	13	B	20.5	C	121	33	C	60.3	E	127	14	B	24.9	C
	T	727	57	E			815	23	C			804	21	C			650	65	E			712	27	C		
Sawyers Arms Rd (West)	L	336	109	F	101.6	F	463	58	E	56.3	E	440	45	D	44.9	D	354	132	F	124.2	F	441	62	E	60.3	E
	R	103	76	E			62	47	D			56	42	D			64	82	F			64	51	D		
Intersection		2068			52.2	D	2279			29.5	C	2251			25.7	C	1797			61.2	E	1992			32.1	C

2.7 Northcote Rd / Lydia St intersection operation comparison - PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Northcote Rd (East)	L	6	8	A	12.0	B	9	0	A	8.8	A	31	9	A	9.3	A	15	7	A	8.1	A	27	7	A	9.8	A
	T	894	12	B			1040	9	A			923	9	A			1320	8	A			1192	10	A		
Lydia St (South)	L	120	33	D	33.3	D	21	20	C	20.3	C	79	24	C	23.6	C	70	17	C	17.4	C	106	15	B	14.8	B
	R	0	0	A			0	0				0	0	A			0	0	A			0	0	A		
Northcote Rd (West)	T	1139	30	D	30.1	D	1206	12	B	11.9	B	1037	9	A	11.1	B	1465	54	F	53.9	F	1317	12	B	13.1	B
	R	0	0	A			9	20	B			159	23	C			17	18	C			165	21	C		
Intersection		2158			33.3	D				20.3	C	2228			23.6	C	2887			53.9	F	2808			14.8	B

2.8 Northcote Rd / Vagues Rd intersection operation comparison - PM peak hour

Approach	Turn	2018 Base					2021 Base					2021 with development					2031 Base					2031 with development				
		Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS	Flow	Delay	LOS	App. Delay	App LOS
Northcote Rd (East)	L	78	26	C	**24.1**	**C**	20	26	C	**25.4**	**C**	39	23	C	**24.1**	**C**	35	16	B	**18.5**	**B**	34	15	B	**13.1**	**B**
	T	947	24	C			1051	25	C			973	24	C			1356	19	B			1274	13	B		
Vagues Rd (South)	L	167	164	F	**163.6**	**F**	121	53	D	**53.2**	**D**	124	43	D	**43.2**	**D**	157	93	F	**92.7**	**F**	153	147	F	**146.9**	**F**
Northcote Rd (West)	T	1157	13	B	**13.2**	**B**	1301	14	B	**14.3**	**B**	1289	14	B	**14.3**	**B**	1592	11	B	**11.0**	**B**	1579	11	B	**11.0**	**B**
Intersection		2349			**28.7**	**C**	2494			**21.0**	**C**	2425			**19.9**	**B**	3141			**18.4**	**B**	3041			**18.7**	**B**

Item #19

Example of sensitivity test to shift more time to QEII Drive/Northcote Road in the 2031 Base and effects on system travel times.

Route	Movement	Existing 2031 Base	Optimised 2031 Base	Change new to old base	2031 with dev	Change dev to new base	Change dev to old base
Main North Road to the north	Northbound	321	201	-120	11.6	8	-112
	Southbound	161	174	13	27.2	-5	7
Cranford Street to the North	Northbound	293	242	-51	19.7	60	10
	Southbound	106	113	7	33.1	14	20
QEII Drive – Northcote Road	Eastbound	212	286	74	21.2	-138	-64
	Westbound	130	134	4	34.5	-14	-10

Item #20

Scenario	Total Travel Time (s)	Total Distance (km)	Total Development Trips	Non-Peak	Average Trip Time (s)	Average Trip Distance (km)
2021 Base	2,181,078	20,150	12,216	179	1.65	
2021 with proposed development	2,090,080	19,298	12,216	171	1.58	
Change in 2021	**-90,998**	**-852**	**0**	**-7**	**-0.07**	
2031 Base	3,433,574	20,834	12,904	266	1.61	
2031 with proposed development	2,520,662	20,176	12,904	195	1.56	
Change in 2031	**-912,912**	**-658**	**0**	**-71**	**-0.05**	