Hornby Library, Customer Services and the SW Leisure Centre – Traffic Modelling Technical Note 1

By:	Alex Lumsdon	**Date:**	14 March 2018
Subject:	Hornby Library, Customer Services and the SW Leisure Centre - LinSig Model Calibration	**Our Ref:**	4680251

1 Introduction

Beca Ltd (Beca) has been commissioned by Christchurch City Council (CCC) to develop the transport access strategy for the proposed Hornby Library, Customer Services and the South West Leisure Centre (the proposed development) to be located at Denton Park. As part of the access strategy review, Beca has prepared a traffic model of the nearby intersections to understand the current and future operation of the adjacent road network.

This technical note (Technical Note 1) details the work undertaken as part of the calibration of this traffic model against the weekday evening peak period. Validation will be undertaken by assessing the model performance during the weekend inter-peak period. The traffic model will then be used to assess the future impacts on the road network without and with the proposed development.

2 Modelled Network

The traffic model has been developed using LinSig software to allow for the modelling of multiple coordinated intersections. The intersections included in the model are detailed in **Figure 1**.

- **Chalmers Street / Main South Road / Goulding Avenue** (Signal Controlled)
- **Hornby Mall Access off Main South Road** (Give-way – Left In / Out Only)
- **Carmen Road / Main South Road / Shands Road** (Signal Controlled)
- **Chalmers Road / Carmen Road** (Give-way – No Right Turn Out from Chalmers Street)

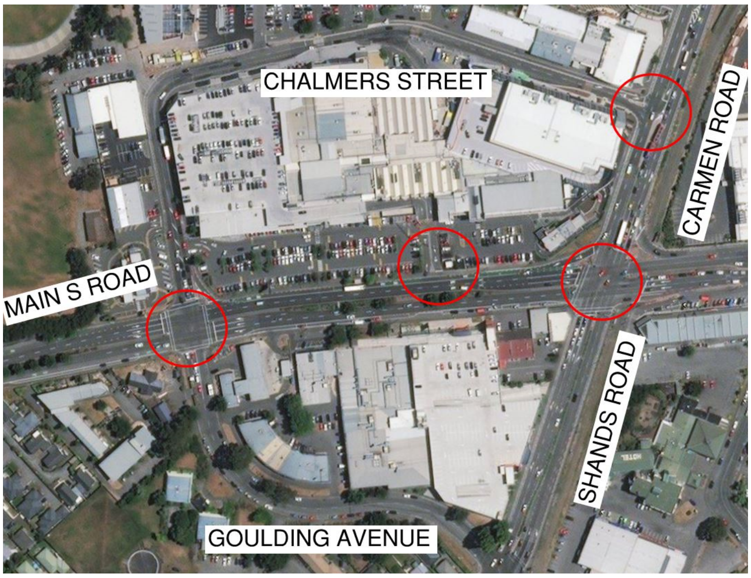


Figure 1: Modelled Intersections

3 Model Traffic Demands

The base model scenario consists of a one hour evening peak window (16:30-17:30) with the relevant existing intersection cycle times, phasing sequences and observed flow patterns from surveys undertaken on 7 December 2017 (16:00-18:00). Assessment of the PM peak is considered to be one of the critical periods, due to the combination of the current operation and the predicted traffic demands for the proposed facility. A weekend mid-day peak model will also be developed, based on a Saturday, which will also be critical to evaluating the impact of the development traffic.

For LinSig scenarios, each network plan needs to have an origin-destination (OD) matrix consisting of matched/observed movements to each zone within the model. The software will then run the traffic flows based on the matrix and provide detailed results at each intersection.

The traffic demand matrices used by LinSig have been derived from both observed turning movements and traffic patterns from the 2016 Christchurch Assignment and Simulation Traffic (CAST) Model afternoon (PM) peak model. The surveyed turning movement volumes have been used to determine the approach (origin) and departure (destination) volumes on the entry and exit links to the LinSig network. "Fully observed movements" (those where both the origin and destination zones were known from the surveyed turning movements, i.e. turning movements on the periphery of the network) were fixed at the observed volumes. The remaining matrix cells were set to the value forecast by the CAST model, with some limited interventions to adjust zero cells, where it was expected that there would be some trips.

A doubly constrained Furness process was then applied, whereby the other movements (cells specifying origin to destination movements) were iteratively scaled to match the origin totals and then the destination totals. This process continued until the origin and destination totals matched the observed origin and destination trip end totals. As the total number of vehicles counted entering and leaving the network area was not quite equal, the target matrix total over the hour (16:30-17:30) was taken. The average of these, with the trip ends to and from each zone, was scaled to match this average total.

Zone representation with CAST adjusted flows and observed flows (Furness matrices) have been provided in **Appendix A**.

4 Model Observations

4.1 Pedestrian Phasing

Observations of the model and SCATs data showed actuated pedestrian demands and phases. However, LinSig operates either with or without pedestrian demands.

Two scenarios have been included within the model to demonstrate these different scenarios for each flow group. This provides for a range of outcomes to be considered for each intersection, so the modelled outcomes could be practically compared with the actual signal operation. The weighted average of the two scenarios, based on the observed pedestrian phases, has then been used in reporting.

4.2 Carmen Road / Main South Road / Shands Road Intersection

The Main South Road (eastbound) filter right turn movement into Shands Road showed high queuing (64m) and abnormal degree of saturation flow (276%) in the furnessed matrices flow group. Traffic waiting to turn right was observed to queue back into the adjacent traffic lane, causing vehicles travelling through the intersection to be delayed.

The right turn movement from the Observed (furnessed) matrix states 163 vehicles over the PM peak hour. However, the movements shown in separate 2016 CCC turning counts (available online) show this movement to have 66 vehicles over the PM peak hour. The furnessed matrix and 2016 CCC count is therefore considerably different, when comparing the movements over the peak hour. The total 'green' time for right turning movements at the intersection is around 19 seconds, from the SCATs data, which does not allow vehicles to find enough gaps to negotiate the movement safely. Hence, the queuing on the eastbound approach on Main South Road within the model.

The difference between the observed traffic demand and SCATs operation at the intersection for this right turn and the other sources of data (CCC count, CTOC supplied data) indicates a discrepancy in the surveyed right turn demand, which has been addressed through the calibration process. This has taken consideration of the matter below.

4.3 Chalmers Street / Main South Road / Goulding Avenue

Information received from CTOC shows that vehicles entering the network from the west in the PM peak hour are more likely to use the filter right turn movement onto Goulding Ave, than proceed to the Shands Road intersection to turn right and head south.

This is a result of the total green time allocated for the right turn movement to Goulding Avenue being 61 seconds (compared to the 19 seconds to Shands Road). This allows for the opposing traffic to clear effectively and allow vehicles filtering right to have a better opportunity to exit Main South Road.

In effect, Goulding Avenue is operated in a way that allows it to operate as a bypass of the Shands Road intersection for drivers wanting to travel south on Shands Road. This helps alleviate right turn volumes and potential queuing at the Carmen / Shands / Main South Road signalised intersection.

5 Model Calibration

5.1 Calibration Process

Traffic and queue length counts were conducted on 7 December 2017 (16:00 – 18:00) at the relevant intersections to calibrate the LinSig Model. The parameters for calibration also included existing traffic signal plans with phasing information, SCATS operation data provided by CTOC for the same date/time as the 2017 counts.

Cycle times at each intersection were obtained by averaging the active cycle level for each 15 minute interval over the modelled hour (123 / 122 second cycle time, varying by intersection). The intersections in the model are co-ordinated based on the same parameters provided in the operation data.

LinSig calibration has been conducted using the observed queue lengths from the 2017 survey results and video data. CTOC has also provided further SCATS operational data, for the same date/time as the 2017 counts, to understand the optimum traffic signal cycle times (PM peak), existing phase setup and the amount of pedestrian demand at each intersection. It was important to make sure the data sources for calibration were consistent and the same demands/phasing had been used in each model.

The amount of data sources (SCATs/CCC and CAST) used for the calibration method has been studied extensively and we consider the observed counts were representative of typical demands.

5.2 Observed Queuing Lengths and Movements

As described (**Section 4**), it was evident that the modelled queues on the eastbound approach to the Carmen / Shands / Main South Road intersection did not match those observed from the 2017 counts and video survey data.

The observed queueing lengths from the 2017 surveys were only recorded once in every five minute intervals. This does not typically provide evidence of the realistic queuing information in each phase, i.e. the maximum queue that may occur.

The right turn movement therefore had to be carefully studied. The priority controlled movements, i.e. left turns and filtered right turns had to be considered first to get the queuing lengths matching to those observed from the counts over the hour. The weighted average mean maximum queue in each lane was adjusted by editing the opposing movement coefficients, however, this provided little or no difference to model saturations flows and queueing lengths.

Information from CTOC concluded that the cycle times for the modelled intersections ran at a typical time of 111 seconds, which led to further examinations of traffic data for normal days outside of the 2017 surveys. Additional techniques continued by observing phase sequence timings in the video surveys to match those in the model. Applying the new cycle and phasing times showed more realistic queueing lengths within the model for all intersections.

5.3 Lane Based Capacities

In the model, the capacities were determined by geometric conditions, rather than what actually happens in reality or from what was being observed.

This then required some adjustment to the traffic signal timings, so that the modelled queues were closely representative of those actually observed for the same traffic demand. This meant that in the model free-flow lane capacities were slightly lower than those observed from the count data.

A summary of the observed and modelled intersection performance is provided in **Appendix B**.

6 Conclusion and Next Steps

The conclusion of the study has identified that the model has been calibrated appropriately to match those observed from the survey data, also taking into account other available information.

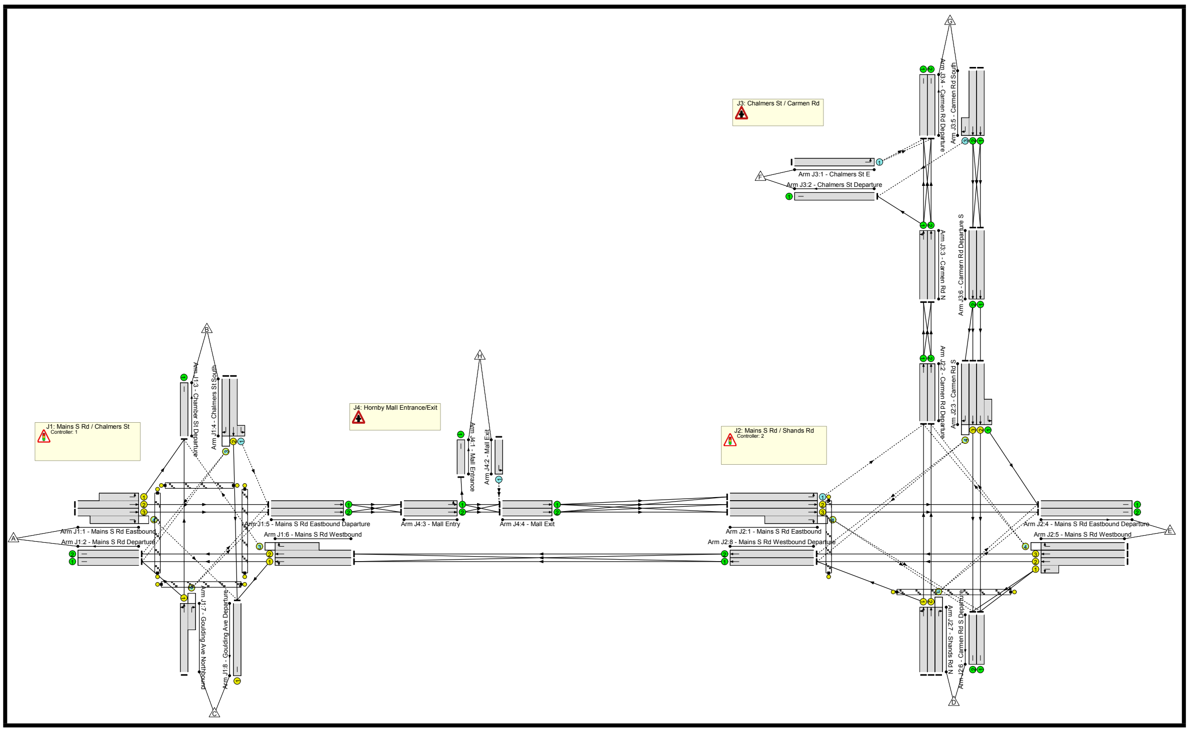
The completed base model will now be validated using the weekend inter-peak period surveys and then used to assess the future operation of the transport network. This will consider without and with the proposed development in both the PM and weekend (Saturday) peak hours.

Future year (2021 and 2031) traffic demands being obtained from the CAST model. A process for determining an appropriate proxy for the weekend peak hour is currently being developed

An assessment of the potential traffic generation and distribution for the proposed development will be undertaken and this will be included in the LinSig model by applying this to the origin-destination matrix.

Alex Lumsdon

Appendix A – Zone Representation with Observed and CAST Adjusted Flows



Observed Flows (Furness Matrices)

	Destination									
Origin		A	B	C	D	E	F	G	H	Tot.
	A	0	167	114	42	332	0	143	48	846
	B	183	0	34	105	215	0	0	0	537
	C	155	123	0	0	10	0	41	4	333
	D	0	0	0	0	245	125	733	0	1103
	E	730	168	33	189	0	30	235	0	1385
	F	0	0	0	0	0	0	165	0	165
	G	106	0	155	721	349	140	0	0	1471
	H	0	0	0	16	33	0	106	0	155
	Tot.	1174	458	336	1073	1184	295	1423	52	5995

CAST Adjusted Flows

	Destination									
Origin		A	B	C	D	E	F	G	H	Tot.
	A	0	222	18	0	337	0	109	0	686
	B	131	0	80	2	122	0	0	0	335
	C	98	144	0	0	28	0	31	0	301
	D	0	0	0	0	100	0	1057	0	1157
	E	560	141	42	143	0	1	439	0	1326
	F	0	0	0	0	0	0	57	0	57
	G	130	0	30	1130	564	123	0	0	1977
	H	0	0	0	31	54	0	72	0	157
	Tot.	919	507	170	1306	1205	124	1765	0	5996

Appendix B – Intersection Summary

PM Peak 2017 Counts – Pedestrian Demands (123/122 Cycle Time)

Controller	Stream	PRC (%)	Total Delay for stream (pcuHr)
C1 - Mains S Rd / Chalmers St	1	60.35	22.02
C2 - Mains S Rd / Shands Rd	1	-206.88	306.75
Total Network Delay: 346.46 pcuHr			
Worst PRC: -206.88 % (On Lane J2:1/3 in Stream 1)			
Level Of Service: F			

PM Peak 2017 Counts – No Pedestrian Demands

Controller	Stream	PRC (%)	Total Delay for stream (pcuHr)
C1 - Mains S Rd / Chalmers St	1	63.39	20.84
C2 - Mains S Rd / Shands Rd	1	-206.88	306.75
Total Network Delay: 345.29 pcuHr			
Worst PRC: -206.88 % (On Lane J2:1/3 in Stream 1)			
Level Of Service: F			

PM Peak 2017 Counts – Pedestrian Demands (111 Cycle Time)

Controller	Stream	PRC (%)	Total Delay for stream (pcuHr)
C1 - Mains S Rd / Chalmers St	1	55.04	25.53
C2 - Mains S Rd / Shands Rd	1	-7.35	71.34
Total Network Delay: 113.47 pcuHr			
Worst PRC: -7.35 % (On Lane J2:5/3 in Stream 1)			
Level Of Service: D			

PM Peak 2017 Counts – No Pedestrian Demands (111 Cycle Time)

Controller	Stream	PRC (%)	Total Delay for stream (pcuHr)
C1 - Mains S Rd / Chalmers St	1	57.37	23.41
C2 - Mains S Rd / Shands Rd	1	-7.35	71.40
Total Network Delay: 111.42 pcuHr			
Worst PRC: -7.35 % (On Lane J2:5/3 in Stream 1)			
Level Of Service: D			