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2021-11-25

Bellgrove Rangiora Ltd.
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Dear Paul and Mike

Assessment of Potential Transport related Greenhouse Gas Emissions, generated at the Construction, Built and Operational phases for Bellgrove Subdivision Stage 1, Rangiora

1 Introduction

Bellgrove Rangiora Ltd ('BRL') commissioned Aurecon Ltd to prepare an assessment of the potential transport related greenhouse gas (GHG) emissions generated at the construction, built and operational phases for Stage 1 of the proposed Bellgrove residential development. This assessment will support the resource consent applications for Bellgrove Stage 1 to be lodged with the Environmental Protection Authority (EPA).

This assessment:

- estimates the potential transport related GHG emissions generated from Bellgrove Stage 1;
- identifies and outlines aspects of the development that may lead to lower GHG emissions than predicted by the model; and
- provides qualitative commentary regarding extent of projected emissions on the GHG emissions generated from Bellgrove Stage 1.

1.1 Bellgrove Stage 1

Bellgrove is approximately 1.2km from the Rangiora town centre, 5km from Woodend (via Rangiora Woodend Road), 12km from Kaiapoi (via SH71) and 28km from Christchurch City Centre (via SH1 and SH74) as shown in Figure 1.

Figure 1 – Bellgrove Location in a Regional Context

Bellgrove Stage 1 is located in the north-east of Rangiora and is the first step in development of BRL's landholding (the full extent of which is shown in Figure 2). This assessment considers the impacts of Stage 1 of the development only. Stage 1 will involve the development of approximately 20.8ha of land for the purpose of delivering:

- Approximately 200 residential lots / dwellings with a mixture of medium density (200 m² to 500m²) and general residential (>500m²);
- A large residential lot (approximately 2500m²) around the Bellgrove Historic Homestead (note the historic homestead will be retained);
- A commercial lot for future commercial development (approximately 5,000m²); and
- A larger residential super lot (approximately 2,400m²) for future development.

The subdivision layout includes the establishment of an internal road layout comprising a mixture of collector and local roads and cul-de-sacs. In addition, an integrated network of shared paths is proposed through the proposed esplanade and stormwater reserves; and establishment of two new intersections to Kippenberger Avenue (a four-legged roundabout at Kippenberger Avenue / MacPhail Avenue and a new T-intersection).

Figure 2 – Bellgrove (All Stages) Locality plan

2 Methodology

Transport related GHG emissions can be estimated by multiplying the average emission factor of a vehicle fleet (calculated in tonnes of CO_2eq[1] per km driven) against the total distance driven by all vehicles in the fleet over a given time period.

Fleet emission factors depend on multiple variables including type and size of vehicles (i.e. light vs. heavy-duty vehicles, fuel efficiency of vehicles, proportion of electric vehicles, etc.), average speed and carbon intensity of fuel (i.e. petrol, diesel, etc.). To predict these variables and average emission factors from vehicles in the New Zealand fleet, Waka Kotahi developed the Vehicle Emissions Prediction Model (VEPM). The VEPM estimates GHG emission factors and calculates the carbon dioxide equivalent emission factor for a range of vehicle types. The latest version of the VEPM (version 6.2 – dated 2021) also accounts for methane (CH_4) and nitrous oxide (N_2O) (which was not previously included in the model)[2].

The VEPM estimates emission factors for the New Zealand fleet based on the relative VKT (vehicle kilometres travelled) and average speed by each vehicle type. Average vehicle speeds depend on the posted speeds of the various roads in the network, stoppage time (i.e. at traffic lights) and congestion. The emission factors are relatively constant between vehicle speeds of 45km/hr and 110km/hr (i.e. within approx. 10%), but start to rise sharply as vehicle speeds decrease from 45km/hr to 10km/hr (i.e. the emission factor at 10km/hr average speed is 100% greater than the factor at 45km/hr).

The VEPM also has the ability to estimate changes to vehicle fleets anticipated in the future based on current future fleet predictions (i.e. from electric vehicle penetration).

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[1] Carbon dioxide equivalent (CO_2eq) is a measure used to compare the emissions from multiple greenhouse gases based upon their global warming potential.

[2] Waka Kotahi NZ Transport Agency (2021), Vehicle emissions prediction model (VEPM 6.2) technical report – July 2021

The methodologies and related assumptions to assess the potential transport related GHG emissions generated at the construction phase and operational phase are outlined below. Average vehicle speeds stated in the assumptions have been estimated using drive times on google maps throughout the day and include stoppage (i.e. engines idling at traffic lights) and congestion.

While Stage 1 proposes approximately 200 residential lots / dwellings, for the purposes of this assessment, the potential trip generation of the site was calculated based on a minimum residential density of 15 households per hectare as specified in the North-East Rangiora Outline Development Plan of the proposed Waimakariri District Plan (pWDP). This equated to 227 households for Stage 1 (excluding space allocated for stormwater facilities, esplanade reserves, and the proposed commercial allotment).

2.1 Construction Assumptions

The following assumptions have been made regarding vehicle movements during construction of Stage 1, which is expected to be completed over a 4-year period. All vehicle movements listed below are based on trips each way (i.e. 2 vehicle movements equates to 1 trip to the site and 1 trip from the site) for the 4-year period (as opposed to per annum), unless otherwise stated.

- Earthworks:
  - There is an estimated 38,000m^3 of cut and 40,000m^3 of fill required for the development of Bellgrove Stage 1.

    Off Site Movements
  - Of the 38,000m^3 of cut material, 95% will be suitable for reuse as fill on site, with the remaining 5% unsuitable for reuse on site. The 5% of cut material unsuitable for reuse will be disposed of offsite at a landfill located approximately 40km from the site.
  - It is estimated the disposal of unsuitable fill will require in the order of 500 truck movements / trips (i.e. 250 trips to the site and 250 trips from the site) at an average of 40km per trip (the distance to the landfill) and average speed of 45km/hr[4]. The average emission factor for the trucks was assessed using the VEPM at 722 grams of CO_2eq per km[5].
  - Of the 40,000m^3 of fill material required, 4,000m^3 will be delivered from Eyre River, which is approximately 30km from the site, with the rest coming from the onsite cut material.
  - For the delivery of offsite fill material, it is estimated there will be in the order of 1,000 truck movements / trips at an average of 30km per trip and average speed of 45km/hr. The average emission factor for the trucks was assessed using the VEPM at 722 grams of CO_2eq per km.
  - Lastly, it is also estimated there will be 20 light vehicle trips daily at an average distance of 30km per trip and average speed of 45km/hr. These trips will be made 6 days a week over a 12-month period. The average emission factor for the light vehicles was assessed using the VEPM at 207 grams of CO_2eq per km[6].

[4] The average vehicle speed has been estimated using drive times on google maps throughout the day and includes stoppage (i.e. engines idling at traffic lights) and congestion time.
[5] This is based on the average emission factor for the heavy vehicle fleet at 45km/hr.
[6] This is based on the average emission factor for the light vehicle fleet.

On Site Movements

- For the onsite cut and fill operations, it is estimated there will be in the order of 2,700 truck movements at an average of 1km per movement and average speed of 10km/hr. The average emission factor for the trucks was assessed using the VEPM at 1,916 grams of CO_2eq per km[7].

- Civil works:
  - There is an estimated 2.6km of roads to be built within Stage 1. This will require approximately 17,000m^3 of roading materials (subbase, basecourse, asphalt), concrete, pipes, manholes, cabling and other miscellaneous materials.
  - For the delivery of these materials, it is estimated there will be in the order of 4,000 truck movements / trips at an average of 30km per trip and average speed of 45km/hr. The average emission factor for the trucks was assessed using the VEPM at 722 grams of CO_2eq per km.
  - It is estimated there will be 20 light vehicle trips daily at an average of 30km per trip and average speed of 45km/hr. These trips will be made 6 days a week over a 9-month period. The average emission factor for the light vehicles was assessed using the VEPM at 207 grams of CO_2eq per km.
- Building works:
  - Transport activities were based on building 227 residential dwellings in Stage 1 and construction of buildings for the future commercial lot has been excluded. Despite this given 227 residential dwellings is a worst case scenario, exceeding the approximate 200 residential dwellings proposed the assumptions provide sufficient contingency to account for any emissions associated with building on the commercial lot.
  - To build the foundations for the residential dwellings, it is estimated there will be approximately 1,400 concrete truck movements / trips (i.e. 700 trips to the site and 700 trips from the site) at an average of 10km per trip and average speed of 15km/hr[8]. The average emission factor for the trucks was assessed using the VEPM at 1,296 grams of CO_2eq per km.
  - It is estimated there will be 20 truck movements / trips per residential dwelling to delivery building materials at an average of 30km per trip and average speed of 45km/hr (i.e. a total of 4,540 vehicle movements). The average emission factor for the trucks was assessed using the VEPM at 722 grams of CO_2eq per km.
  - It is estimated there will be a further 50 light vehicle trips daily for the building works over those trips identified above and that these will comprise an average distance of 30km per trip and average speed of 45km/hr. These trips will be made 6 days a week over a 36-month period. The average emission factor for the light vehicles was assessed using the VEPM at 207 grams of CO_2eq per km.

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[7] This is based on the emission factor for a 30t+ rigid truck used for onsite soil haulage at 10km/hr.

[8] The low average speed is to account for the pour time.

2.2 Operational Transport Assumptions

Abley Ltd (Abley) were commissioned by Bellgrove Rangiora Ltd to estimate the change in VKT associated with traffic generated by the Bellgrove residential development. This was based on traffic modelling conducted by Abley on behalf Waimakariri District Council to assess the future impact development within the Rangiora North-East and the Rangiora South-East Development areas will have on traffic generation within Rangiora. Figure 3 illustrates the spatial extent of the network considered in the traffic model along with a heat map showing the main traffic flows within this network. The Bellgrove Subdivision VKT Analysis conducted by Abley is attached in Appendix A.

The model was run using the 2048-year Structure Plan test scenario, to show indicative changes in trips and VKT transport demands from the development. Resulting VKT outputs were then processed for the AM and PM 2-hour peak periods (07:00-09:00 and 16:00-18:00, respectively).

Figure 3 – Transport model boundary limits (Abley Ltd.)

To extract VKT projections from the Bellgrove Subdivision VKT Analysis the following assumptions were made:

- The potential trip generation of the site was calculated based on 227 households for Stage 1.
- As the transport model only considered VKT of vehicle trips within the boundary shown in Figure 3, the VKT for external trips past the boundary was estimated based on the following high-level assumptions:
  - 85% of external trips travelled to/from Christchurch City;
  - 14% of external trips travelled to/from Kaiapoi; and
  - 1% of external trips travelled to/from Woodend / Pegasus.
- To convert peak hour VKT to daily VKT, a factor of 9 was used. This is based on land use traffic generation data published by Waka Kotahi NZ Transport Agency (Research Report 453 – Trips and Parking Related to Land Use, November 2011).

- To convert daily VKT to an annual VKT, a factor of 309 was used. This is based on 235 weekdays per year and 120 weekend days and public holidays at 53% weekday rates.
- The average emission factor for the vehicles from the Bellgrove residential development was assessed using the VEPM for the year 2048 at 78 grams of CO_2eq per km[9].
- To assess the impact of traffic generated from Stage 1 in 2048, the following annual VKT estimates across the greater Christchurch transport network were used as a baseline (i.e. no Bellgrove development). These are based on the Christchurch Assignment and Simulation Traffic (CAST) v18 transport model (updated in 2018):
  - Light and heavy vehicles: 5,430 million km/year
  - Buses: 20 million km/year
- The average emission factor for the light and heavy vehicles across greater Christchurch was assessed using the VEPM for the year 2048 at 106 grams of CO_2eq per km. A factor of 560 grams of CO_2eq per km for the bus fleet was assessed using the VEPM. It is noted the bus fleet factor only has a 25% penetration of electric buses in the VEPM, which is conservative. The NZ Government is aiming for decarbonisation of public transport buses by 2035.

[9] This is based on the average emission factor for the light vehicle fleet assuming an average speed of 40km/hr. Please note, this factor is much lower than other factors provided in this document due to the assumed electric vehicle (EV) penetration in 2048 that the VEPM accounts for.

3 Results

The forecasted transport related GHG emissions generated during construction and then during operations of the Stage 1 development are outlined below. The GHG emissions are reported as tonnes of carbon dioxide equivalent using the emission factors from the VEPM and the assumptions outlined above.

3.1 Construction transport GHG emissions

GHG emissions from construction related transport activities are estimated to be approximately 150 tonnes of CO_2eq per year over the expected 4-year construction period.

3.2 Operational transport GHG emissions

The projected annual VKT from traffic generated is estimated to be approximately 4 million kms in the year 2048. This equates to projected GHG emissions of approximately 300 tonnes of CO_2eq in the year 2048.

4 Assessment

In combination with the assumptions, there are several aspects of the development that are likely to result in lower GHG emissions than those predicted by the model. These are discussed below.

4.1 Construction transport GHG emissions

According to Statistics NZ[13], the Canterbury region emitted 11.865 million tonnes of CO_2eq in 2018 and 62% of these emissions were from energy related sources. Under energy, there are multiple sources of emissions including transport. However, Statistics NZ does not breakdown emissions from energy into these individual sources. According to the Ministry for the Environment's emission tracker[14], transport emissions made up 47% of energy related emissions across New Zealand in 2019. Therefore, for the purposes of this assessment the 2018 baseline annual emissions from transport across Canterbury is estimated to be approximately 1,700 kilo-tonnes of CO_2eq.

Relative to the total GHG emissions in 2018 from transport across Canterbury, the estimated emissions generated during the construction of Bellgrove Stage 1 from transport movements are estimated to equate to approximately 0.01% of this total. While there is no data to measure against average emissions from construction transport generated at other greenfield residential developments, the construction methodology is in line with standard practices and thus projected emissions can be expected to be relatively similar.

Furthermore, to support the reduction of construction vehicle emissions it is noted that the applicant will look to engage local contractors where possible and encourage them to source their building materials from local building merchants to help reduce the amount of greenhouse gases used transporting materials from the supplier to the site.

Additional factors assisting to reduce construction transport emissions from the development are as follows:

- The Stage 1 site is relatively flat, limiting the volume of earthworks required, reducing the number of truck movements and potential GHG emissions.

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[13] https://www.stats.govt.nz/information-releases/greenhouse-gas-emissions-by-region-industry-and-household-year-ended-2018
[14] https://emissionstracker.mfe.govt.nz/#NrAMBoEYF12TwCIByBTALo2wBM4eiQCc2AHEltEA

- By achieving a development density of approximately 13 ha, a greater amount of residential housing can be provided for equivalent concrete and building materials than would be the case for standard greenfield residential development in the Waimakariri District. This means there will be less truck deliveries and therefore lower GHG emissions per household from construction related transport.
- The potential transport related GHG emissions generated for construction of Bellgrove Stage were assessed based on a series of assumptions. It is noted the estimated emissions from construction traffic included an assumption that light vehicles travelled an average of 30km to and from the site. Consequently, light vehicle trips comprise over 50% of the construction transport emissions. This distance was based on majority of the workers living within the Christchurch City area, which is likely conservative. If workers live in or close to Rangiora, the resulting emissions will be substantially lower than the estimated emissions above.

4.2 Operational transport GHG emissions

Transport emissions are forecasted using VKT identified through transport modelling. The transport model assessed the future impact of development within the Rangiora North-East Development and the Rangiora South East Development areas and assumes future residents of Bellgrove will follow the same trip-making patterns as existing residents of Rangiora.

Based on the transport model and assumptions outlined above, the potential transport GHG emissions during operation are estimated to be approximately 300 tonnes of CO_2eq in the year 2048. Using the outputs from the CAST v18 transport model and the VEPM (version 6.2), transport GHG emissions across the Greater Christchurch network are estimated to be approximately 600 kilo-tonnes of CO_2eq in 2048. Therefore, operational transport emissions from Bellgrove Stage 1 are predicted to be in the order of 0.05% of transport emissions from the Greater Christchurch network.

It is noted that these VKT projections do not account for a reduction in traffic elsewhere on the network from people moving into the development who may otherwise be living somewhere else on the network (i.e. the VKT is assumed to be additive only). This means the estimated increase in GHG emissions is conservative.

As with the construction transport GHG emissions, the model is likely to overestimate operational GHG emissions from the development:

- The VEPM includes a functionality that predicts the proportion of EVs in the NZ fleet. However, incentives like the Clean Car Package introduced by the NZ Government in June 2021 are likely to result in greater EV uptake rates that anticipated by the model. For example, the Climate Change Commission's final report: 'Ināia tonu nei: a low emissions future for Aotearoa', estimates electric vehicles will comprise approximately 10% by 2030 and 30-40% by 2035 of the light vehicle fleet (compared with 3-4% in 2030, 10% in 2035 and 55% in 2048 as given in the VEPM). If there is a greater proportion of EVs in the fleet, transport emissions from the development will be lower than calculated by this assessment.
- Transport models give an indication of what might happen based on a series of assumptions and historical travel behaviours. Therefore, there are inherent uncertainties relating to travel behaviours and the future of workplaces (i.e. work from home arrangements that may change a result of Covid which will not be considered by the model). If a proportion of residents in the Bellgrove development work from home instead of commuting into Christchurch City for employment, there will be a significant reduction in the projected GHG emissions.
- The proposed Bellgrove residential development is designed to encourage walking and cycling, and public transport. This may result in a greater number of people using active and public

transport options, reducing car use and VKT. If there is less VKT generated from the development, there will also be lower operational GHG emissions than predicted above.

- To facilitate active and public transport, the design incorporates cycle and pedestrian paths throughout the development, and safe pedestrian access will be provided across Kippenberger Avenue to an existing bus stop (illustrated in). Furthermore, the Stage 1 site is located within a 1.6km radius (or 20 minute walking time) from a range of day to day amenities, as shown in Figure 5. By providing good access to the local public transport network and proximity to the town centre, residents in the development can use active and public transport options for a number of everyday trips, thereby minimising the reliance on private motor vehicles. These design features along with the location of the development complements Waka Kotahi's mode shift plan, 'Keeping Cities Moving'[17], that seeks to grow the share of travel by public transport, walking and cycling through shaping urban form and making shared and active modes more attractive.

Figure 4 – Pedestrian and cycle paths within the development

17 https://www.nzta.govt.nz/assets/resources/keeping-cities-moving/Christchurch-regional-mode-shift-plan.pdf

- In further support of public transport mode share, the Greater Christchurch Public Transport Futures business case proposed a new route to provide direct services to Christchurch City from Rangiora and Kaiapoi. If this is to be implemented, then there is also potential for this route to be integrated with the Bellgrove subdivision, thereby increasing the attractiveness of taking public transport to Christchurch City and Kaiapoi.

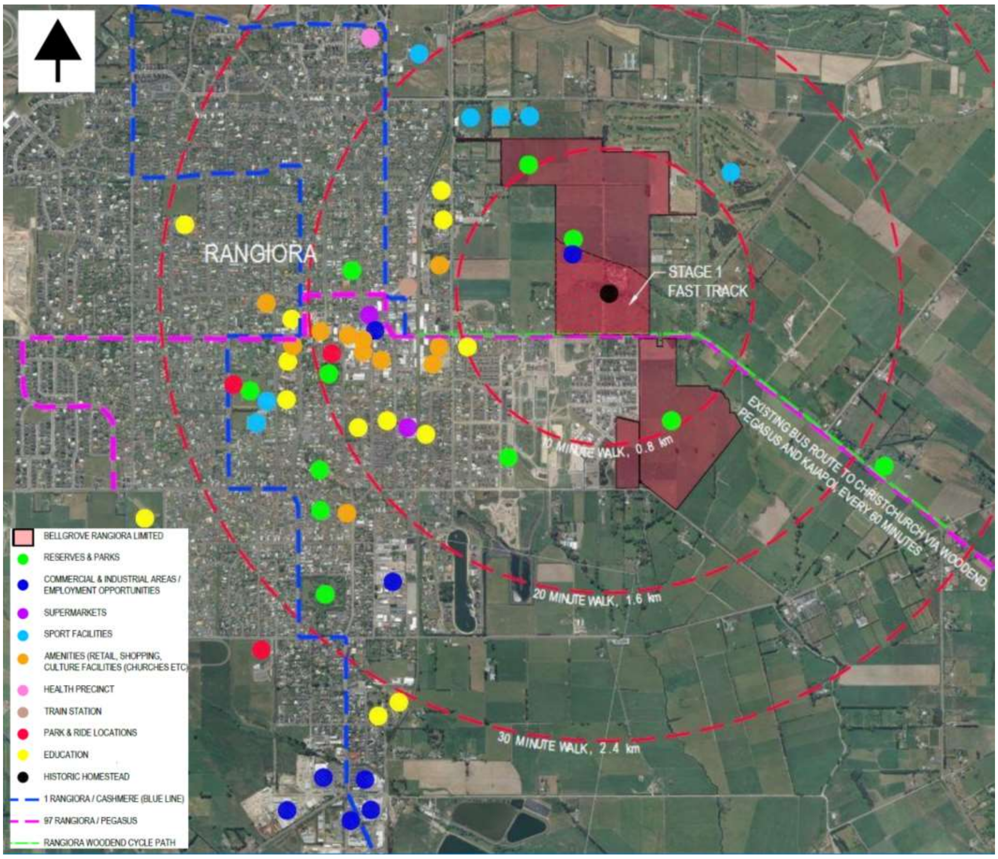

Figure 5 – Proximity of Stage 1 to core community and commercial facilities

5 Conclusions

In summary, this letter provides an assessment of the potential transport related greenhouse gas (GHG) emissions generated at the construction, built and operational phases for Stage 1 of the proposed Bellgrove residential development. Based on several conservative assumptions and the outputs of a transport model, the projected GHG emissions from transport activities are estimated to be:

- 150 tonnes of CO_2eq per year during the construction phase over an anticipated 4-year period, which is approximately 0.01% of the total GHG emissions in 2018 from transport across Canterbury.
- 300 tonnes of CO_2eq during the operational phase in the year 2048, which is approximately 0.05% of the predicted GHG emissions from transport in 2048 across the Greater Christchurch network.

These projected GHG emissions are likely comparable to other greenfield residential developments in Greater Christchurch with similar household numbers. However, it is important to note that the transport model used for this assessment is based on historical travel behaviour of existing residents in Rangiora and does not account for potential changes in future travel behaviours (i.e. as a result of mode shift and/or changes in travel patterns such as more work from home).

The model also does not take into consideration the specific details of the proposed Bellgrove residential development which will help encourage people to walk, cycle, and take public transport. A development pattern that supports alternative transport modes is anticipated to help reduce car use and therefore GHG emissions, relative to other residential developments in Greater Christchurch. Also, as more people work from home due to Covid, there may be less commuter trips and as the majority of these commuter trips are assumed to be to and from Christchurch City, this may result in further reductions in GHG emissions.

6 Limitations

This memorandum has been prepared by Aurecon on the basis of information provided by Bellgrove, and Abley. Aurecon has not independently verified the provided information and has relied upon it being accurate and sufficient for use by Aurecon in preparing the memorandum. Aurecon accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This memorandum has been prepared by Aurecon on the specific instructions of Bellgrove for the limited purposes described in the memorandum. Aurecon accepts no liability if the memorandum is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk

Yours sincerely

Peter Algie
Associate, Transport

Enc: Bellgrove Subdivision VKT Analysis from Abley Ltd.

Copies: Jason Trist (Aurecon), Michelle Ruske-Anderson (Aureonc)

Appendix A – Bellgrove Subdivision VKT Analysis

Transport + Location Intelligence

Bellgrove Subdivision VKT Analysis

Prepared for: Bellgrove Rangiora Ltd

Job Number: BGRL-J001

Revision: Draft

Issue Date: 16 November 2021

Prepared by: Chris Blackmore, Senior Transportation Planner

Reviewed by: Dave Smith, Technical Director

1. Introduction

Bellgrove Rangiora Ltd have commissioned Abley Ltd to derive an estimate of the change in vehicle kilometres travelled (VKT) associated with traffic generated by the Bellgrove subdivision.

This analysis is based on previous work completed for Waimakariri District Council (WDC) and utilises the Rangiora Microsimulation Model, which is developed by Abley and owned by WDC. The use of the Rangiora Microsimulation Model for this purpose has been approved by WDC.

2. Modelled Network and Development

The model has been run using the 2048-year Structure Plan test scenario where future urban development was included for three structure plans:

- Rangiora West, 1350HH to the north and south of Johns Rd,
- Rangiora East, 1350HH between Boys Rd and Kippenberger Ave, and
- Rangiora North-East, 1350HH to the north of Kippenberger Ave.

Local roads within the Structure Plan areas were included in line with the indicative designs provided by WDC, noting that these will be superseded by Outline Development Plans as each area is progressed. The structure plans used to inform modelling for the Rangiora North-East and Rangiora East development areas are shown in **Figure 2.1**.

The modelled network includes Rangiora transport infrastructure interventions as included in the WDC Long Term Plan 2021-31. Also included is the Eastern Arterial connection between Lineside Rd and Boys Rd. This link is intended to enable increased development in East Rangiora and is included to be consistent with modelling completed for WDC.

Trip generation for the Bellgrove subdivision area was undertaken from first principles using the calibrated trip rates from existing residential activity in Rangiora. The two-hour trip rates for the morning and evening peak periods are shown in **Table 2.1**.

Trip distribution has also been informed by existing residential activity in Rangiora, including interaction with the town centre, industrial areas, and trips to / from the Greater Christchurch area.

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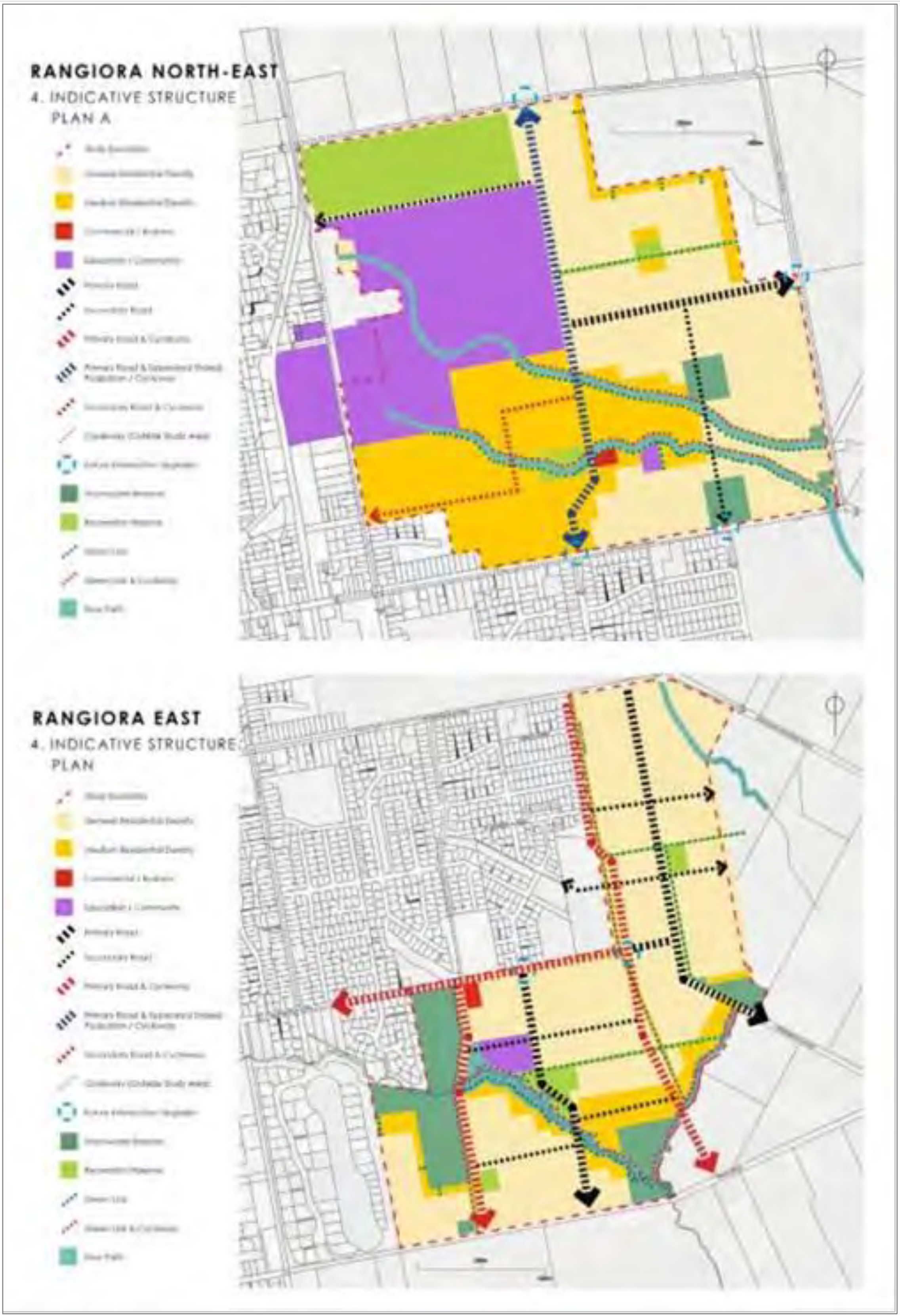

Figure 2.1 Rangiora North-East and Rangiora East Structure Plans

Table 2.1 Rangiora North-East and Rangiora East Structure Plan Trip Generation

Period	Households	2-hour Trips	2-hour Trips / HH	Peak Hour Trips/HH
AM Peak	2,700	3,300	1.2	0.7
PM Peak	2,700	4,850	1.8	1.0

3. Results

3.1 Change in Volumes

The Bellgrove Subdivision development increases traffic volumes along Kippenberger Ave and Northbrook Rd (to / from town centre area) as well as significant increases along the Eastern Arterial (to / from Greater Christchurch area). By comparison, increases along Southbrook Rd were much more muted as Southbrook Rd is operating at or near capacity in the baseline models.

The change in volumes resulting from the inclusion of the Bellgrove subdivision is shown in **Figure 3.1** for the morning peak period and in **Figure 3.2** for the evening peak period. The change in two-way volume along Kippenberger Ave is shown in **Table 3.1**. Turning volumes at the access points with Coldstream Rd and Golf Links Rd are attached as **Appendix A**.

Figure 3.1 Morning peak period change in volume with inclusion of Bellgrove subdivision

Figure 3.2 Evening peak period change in volume with inclusion of Bellgrove subdivision

Table 3.1 Change in two-way, two-hour volumes on Kippenberger Ave with inclusion of Bellgrove subdivision

	Baseline		Inc Bellgrove		Change	
	AM	PM	AM	PM	AM	PM
E of East Belt	1,165	1,643	1,744	2,434	+579	+791
W of Golf Links	1,152	1,629	1,312	1,831	+160	+202

3.2 VKT and External Trip Changes

All outputs have been processed and reported as two-hour totals and includes VKT associated with the full completion of the trip within the study area (including if the trip ends after the end of the two hour period). This maintains run to run consistency within the simulation and ensures a representative comparison between the baseline and Bellgrove models. If this is not done there is potential for increased network congestion to reduce the number of trips which successfully complete in the measured peak hour, incorrectly reducing VKT and trips/HH in the results. To estimate peak hour values a factor of 1.75 is recommended.

The trip count and VKT change is shown in **Table 3.2** and **Table 3.3** for the morning and evening two-hour peak periods (07:00-09:00 and 16:00-18:00, respectively). This corresponds to a morning peak hour generation of around 0.7 trips/HH and an evening peak hour generation of around 1.0 trips/HH for the Bellgrove subdivision which is consistent with other residential areas in the Rangiora model.

The VKT for external trips represents the in-model distance to the southern boundary of the model – approximately the intersection of Fernside Rd / Lineside Rd / Power Rd.

Table 3.2 Morning peak change in trips and VKT

	Baseline		Inc Bellgrove		Change		Per Belgrove HH	
	Trips	VKT	Trips	VKT	Trips	VKT	Trips	VKT
To External	3,436	18,683	4,136	22,200	700	3,517	0.26	1.30
Model Internal	11,681	40,901	14,290	49,031	2,609	8,130	0.97	3.01
Total	15,117	59,584	18,425	71,231	3,309	11,647	1.23	4.31

Table 3.3 Evening peak change in trips and VKT

	Baseline		Inc Bellgrove		Change		Per Belgrove HH	
	Trips	VKT	Trips	VKT	Trips	VKT	Trips	VKT
To External	5,012	25,481	5,798	29,210	786	3,728	0.29	1.38
Model Internal	14,827	50,701	18,888	63,811	4,061	13,111	1.50	4.86
Total	19,839	76,182	24,686	93,021	4,847	16,839	1.80	6.24

4. Conclusion

The additional vehicle trips and VKT resulting from development of the Bellgrove subdivision have been analysed using the Rangiora Microsimulation Model. To provide a comparison the model has been run with and without the structure plans relating to the full development of the Bellgrove subdivision. This totals 2,700 households over the Rangiora North-East and Rangiora East development areas.

Development of the Bellgrove subdivision results in an increase in demand of 3,309 trips in the morning peak period and 4,847 trips in the evening peak period which is consistent with other residential development in the simulation. This trip increase corresponds to a VKT increase of 4.31km per HH in the morning peak period and 6.24km per HH in the evening and adds between 0.26 and 0.29 additional trips per HH beyond the southern boundary of the model.

Appendix A – Access Volumes at Coldstream Rd and Golf Links Rd

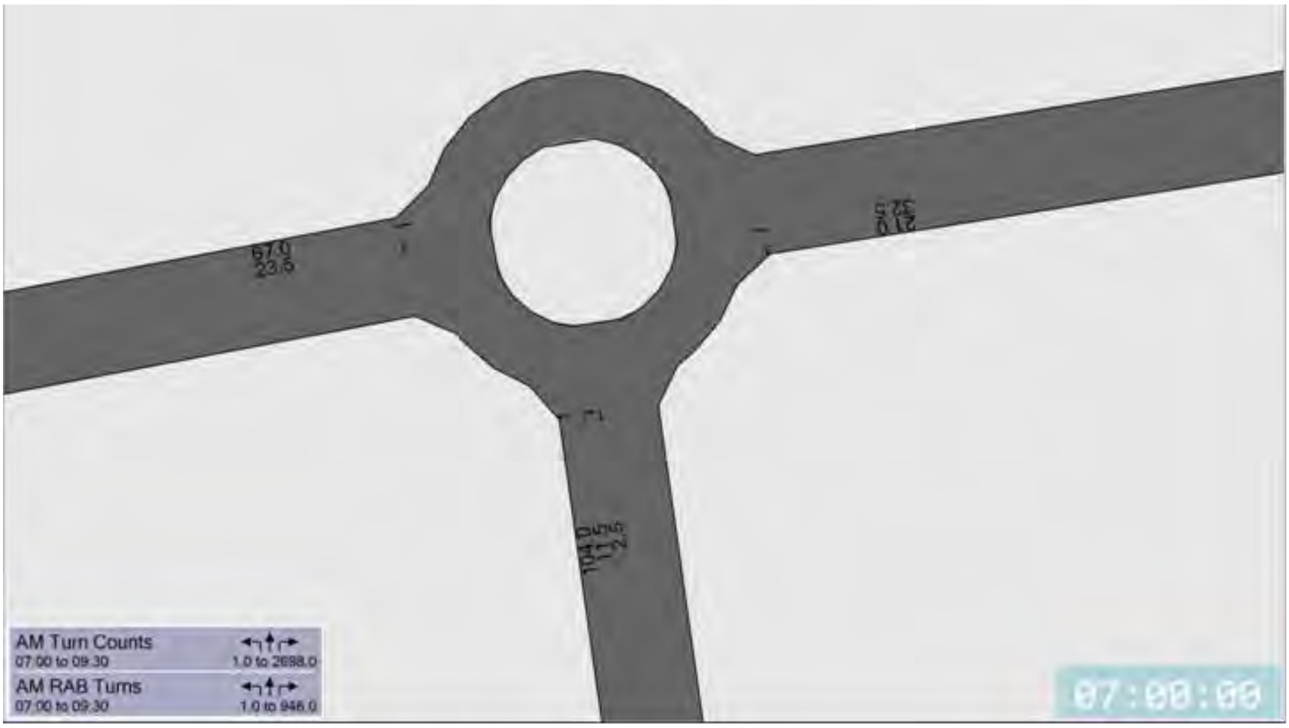

Figure 0.1 Access / Coldstream Rd morning peak intersection turning movements

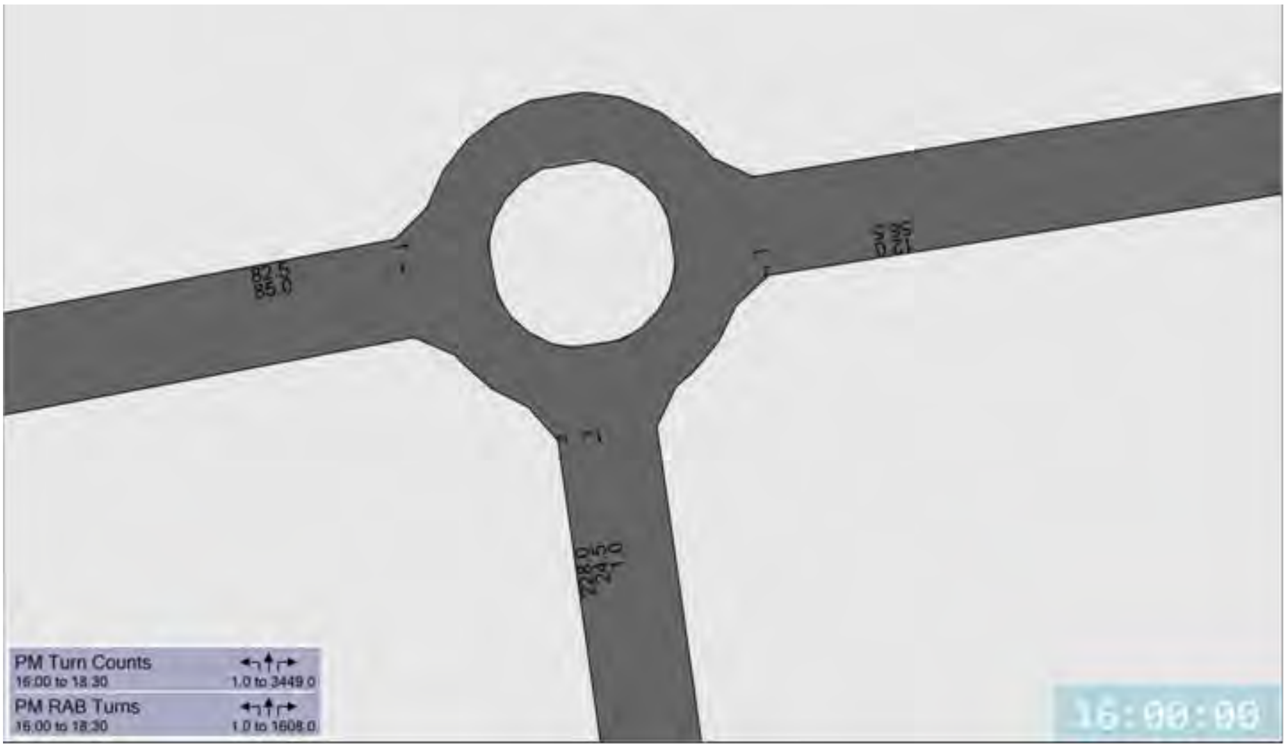

Figure 5.2 Access / Coldstream Rd evening peak intersection turning movements

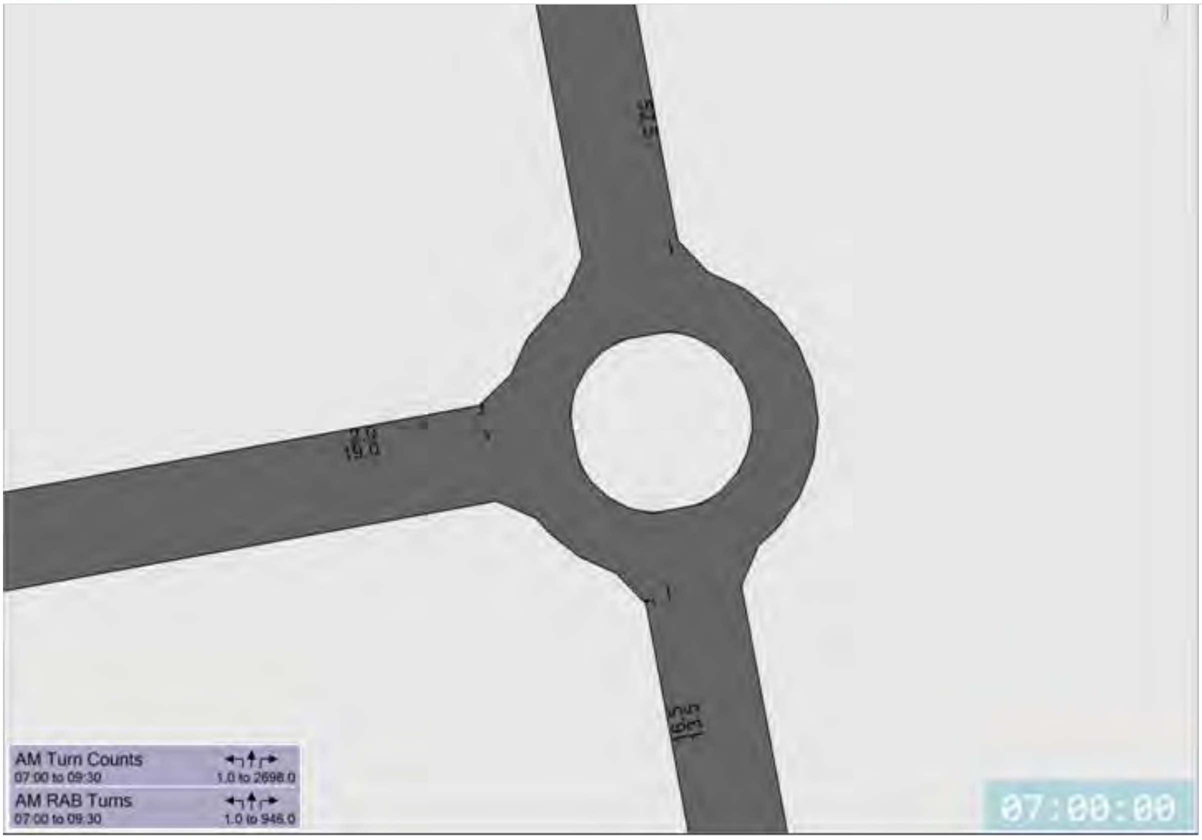

Figure 0.2 Access / Golf Links Rd morning peak intersection turning movements

Figure 0.3 Access / Golf Links Rd evening peak intersection turning movements