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Memorandum

TO	Mark Brown	FROM	Deborah Ryan & Alida Van Vugt
	Davie Lovell-Smith Ltd	DATE	20 May 2021
RE	Hughes Development's Greenhouse Gas Assessment of Road Traffic Emissions		

1.0 Scope

The Faringdon South West and South East development in Rolleston, Selwyn (Project) was approved as a referred project under the COVID-19 Recovery (Fast-track Consenting) Act 2020 (Act). Resource consent applications progressed under that Act for that Project must include an emissions assessment addressing effects and mitigation measures relating to the emissions impact of the project design, and the opportunities to reduce emissions as a result of providing housing supply closer to amenities and/or work centres.

Transport-related carbon dioxide (CO_2) emissions are considered to be the principal form of greenhouse gas (GHG) emissions that can be attributed to the Project. Pattle Delamore Partners (PDP) has therefore focussed its GHG emissions assessment on emissions associated with traffic changes predicted to occur from the proposed land use pattern associated with the Project.

2.0 Background

The consent application describes the locations and densities of the proposed housing supply, associated reserves and commercial activities, which comprise the Project. The traffic environment is described and roads such as SH1, Selwyn, Shands and Springs Roads are identified as important corridors for private vehicles and freight traffic travelling between Christchurch, Prebbleton and Rolleston, and Lincoln and further afield. The information provided also notes that the traffic environment is changing with the Christchurch Southern Motorway Stage 2.

Vehicle traffic estimates associated with the Project were required to inform an analysis of the GHG impacts of the Project. PDP received traffic estimates from Abley who used the Christchurch Transport Model (CTM) to evaluate the effects on the greater Christchurch transport network. The CTM calculates transport demands incorporating forecasts for population, households, schools and employment across the entire network applying projections consistent with Statistics NZ for Christchurch City and Wamakariri and Selwyn Districts (QTP,2019). Forecasts are either distributed to individual meshblocks or this is done independently by the territorial local authority (TLA). The projected data, or scenarios, are converted to CTM land use files.

Attachment A is a figure that illustrates the spatial extent of the network considered in the CTM. The CTM is then applied to consider the impact of land use changes on transport and traffic. Based on discussions with Abley, PDP understands that the CTM is multi-modal and automatically factors in the projected trips that would be undertaken by alternative modes such as walking and cycling, although it would not account for enhanced uptake due provision of purpose-built facilities. PDP understands that trips by alternative modes was not a readily available output from the CTM.

Abley ran the CTM with the new land use pattern associated with the Project. Abley advised that the growth associated with the Project is purely additive in the CTM i.e. it is additional to growth from population projections that have already been incorporated within the CTM. We note that this approach will overestimate the actual impact of the land use change on traffic because the development would likely offset growth elsewhere in the network, but this is unaccounted for.

3.0 Method

PDP used the Waka Kotahi Vehicle Emissions Prediction Model (VEPM version 6.1) to develop emission factors as grams per kilometre for estimating the direct discharges of CO_2. The VEPM has historically been used for air quality assessments and does not currently have emission factors for methane (CH_4) and nitrous oxide (N_2O), which are identified by Ministry for the Environment (MfE, 2020) as contributing carbon dioxide equivalent (CO_2e) emissions from fuel combustion. The VEPM factors, including those for fuel consumption are projected for future years based on fleet and technology changes.

Attachment B sets out the national emission factors for fuel combustion from MfE based on total fuel by type. The national factors were converted to a relative percentage contribution of CO_2e associated with CH_4 and N_2O compared to direct CO_2 emissions. CO_2e from CH_4 and N_2O were estimated for this assessment based on the ratio of the national emission factors to fuel consumption that was estimated with VEPM emission factors.

PDP used the data generated by Abley as inputs for VEPM, which generated the relevant CO_2 emission factors as grams per kilometre and fuel use as litres per 100 kilometers relevant for the study years.

Data from the CTM was provided as vehicle kilometers travelled (VKT) from light vehicles and heavy vehicles. It is noted that these classifications do not directly translate to the vehicle classifications used in the VEPM. While this introduces some uncertainty, PDP expects the magnitude of this to be small. The default VEPM fleet distribution was prorated to give a weighted average emission factor according to the light vehicle and heavy vehicle VKT split that was predicted from the CTM.

The latest baseline year available from the CTM, 2018, was used as the starting point for a 10-year timeframe to assess the transport-related GHG emissions. To assess the impact of the Project on traffic, two scenarios were run in the CTM for both 2018 and 2028; the base case scenario (without Project) and the proposed scenario (with the Project).

The CTM network traffic projections included the estimated time and distance travelled by vehicles relating to the Project i.e. dwellings and associated land uses, across the Greater Christchurch network. Abley provided a summary of the inputs used in the CTM, which is included as Attachment C. Based on the CTM outputs, PDP assumed an average speed in VEPM of 43 km/hour for light vehicles and 48 km/hour for heavy vehicles.

4.0 Results

Table 1 presents the results of the projected CO_2 emissions in tonnes from each scenario using the emission factors generated from VEPM. The estimated CO_2e emissions using the relative ratios from the MfE GHG emission factors are also presented. Table 2 presents the estimated increased CO_2e predicted to be generated by the traffic impacts associated with the Project for 2018 and 2028. The approximate increased CO_2e across the network with the Project is around 0.6% compared to without the project for both years.

Table 1: GHGs with and without project tonnes (T) per year 2018 & 2028					
Model Scenario	**Annual VKT (million kms)**	**CO_2 (T)[1]**	**CH_4 (T)[2]**	**N_2O (T)[2]**	**CO_2e (T)[2,3]**
Without project 2018	3,898	936,500	8,100	26,800	971,400
Without project 2028	4,517	1,008,800	8,700	28,900	1,046,300
With project 2018	3,925	942,400	8,200	27,000	977,600
With project 2028	4,545	1,014,600	8,800	29,000	1,052,400

Notes:

1. *Carbon dioxide estimated using VEPM6.1 2020 with Abley supplied input data*
2. *All other values are proxied off estimated carbon dioxide values using MfE greenhouse gas emission factors 2020.*
3. *CO2e is a measurement unit for all greenhouse gases converted into their comparative impact in carbon dioxide equivalents.*

Table 2: Increase in CO_2e for with proposal (2018 & 2028)		
Year	**Annual CO_2e (T)**	**Percentage increase**
2018	6200	0.64%
2028	6100	0.57%

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5.0 Assessment

Using the traffic estimates from the CTM with the VEPM the Project is predicted to increase the CO_2e from the base case emissions across the Greater Christchurch road network by around 6,000 tonnes per year or an increase of around 0.6% for both 2018 and 2028.

PDP considers the CO_2e projections to be an overestimate of the additional "project induced" emissions because the housing growth associated with the Project in the CTM is purely additive. That is, we would assume that growth in Rolleston as result of the Project would offset growth that would have occurred elsewhere in the network, but the associated reduction in traffic elsewhere is not accounted for.

Greater Christchurch Partnership[1] reports that for 2017 all transport sources represent 53.1 per cent of the Christchurch City CO_2e emissions, followed by stationary energy (22.7 per cent), agriculture (10.5 per cent), waste (9 per cent) and industry (4.7 per cent).

Statistics NZ[2] published GHG inventory data by region for 2018. Total emissions of CO_2e for the Canterbury Region in 2018 were 11,864 kilo-tonnes CO_2e. While the contribution for energy was 3,604 kilo-tonnes (kT) CO_2e, the transportation sector component was not reported separately from the total energy emissions. Nationally MBIE[3] reports that domestic transport contributed 51.7% of the total energy sector emission in 2018, therefore the regional transport component could be estimated at around 1900 kilo-tonnes CO_2e. The increase of 6 kT CO_2e as a result of the project represents around a 0.3% increase on regional emissions as an upper value.

[1] https://www.greaterchristchurch.org.nz/our-work/indicators/environment/greenhouse-gas-emissions
[2] https://www.stats.govt.nz/information-releases/greenhouse-gas-emissions-by-region-industry-and-household-year-ended-2018
[3] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-statistics-and-modelling/energy-statistics/new-zealand-energy-sector-greenhouse-gas-emissions/

Te Manatū Waka and Waka Kotahi (2020) reports the total GHGs as around 1,600 kilo-tonnes from land transport for the Canterbury Region in 2018, assumed as direct CO_2 emissions and excluding the CO_2e contribution from N_2O and CH_4. This data aligns with the findings based on the Stats NZ data.

6.0 Speed sensitivity uncertainty analysis

Average speed across the network can be expected to vary considerably depending on the roadway level of service and the posted speed, whereas only one average speed value of between 40 and 50 km per hour was available from the CTM representing traffic over the entire network.

To assess the influence of vehicle speed assumptions on the results, the sensitivity of emission factors with speed was assessed. Figure 1 is a graph of the speed versus CO_2 fleet emission factors and fuel consumption rates. Lower speeds result in increased fuel consumption rates and higher emissions of CO_2 per kilometre, while the curve from about 40 up to 110 km per hour is relatively flat.

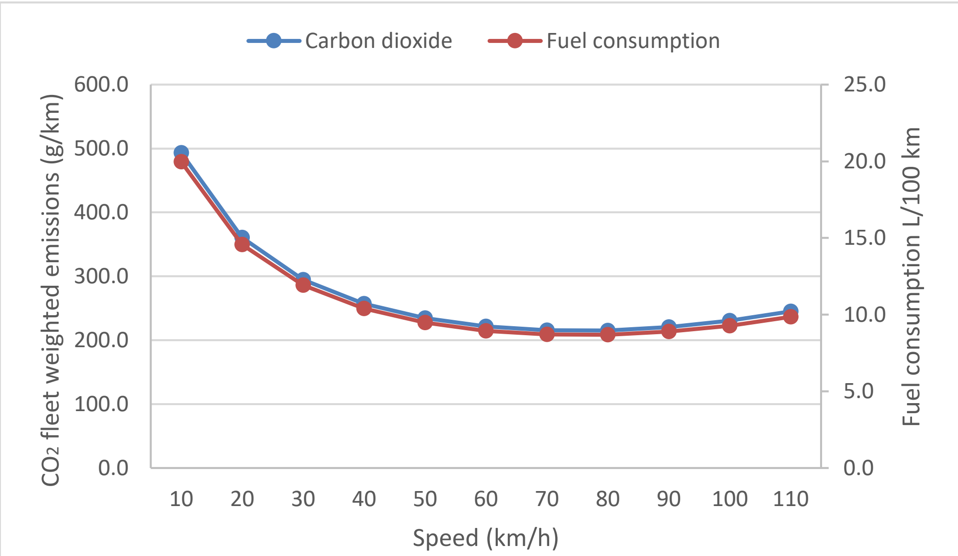

Figure 1: CO_2 and fuel consumption fleet weighted emission factor versus speed (2018)

The average speeds for the model runs were assumed at 43 and 48 km for light vehicles and heavy vehicles respectively. Therefore, the calculated CO_2e for this assessment can be considered relatively insensitive to speed if most of the VKT induced by the Project is at higher speeds, such as on the open road. If the induced traffic significantly contributed to increased congestion, and lower traffic speeds, then there could be a degree of underestimation in the calculated CO_2e.

7.0 Limitations

PDP has relied on the available data from the CTM as provided by Abley. The CTM data had limitations in relation to quantifying the GHG impacts induced by the proposal including the following:

- The CTM was unable to provide an estimate for emissions avoided with the proposal such as for the number of journeys that will be done by alternative modes i.e. vehicle trips avoided through the project design enhancing local walking and cycling), commuter trips by public transport, and commuter trips avoided through provision of facilities locally, although PDP understands that these variables are factored in to the CTM VKT estimate at least to some extent.
- Due to the CTM being a network model for the Greater Christchurch area, PDP assumes that some of the VKT generated "with-Project" would have occurred anyway as a result of growth that has been assumed in some other part of the network but that would not now occur. The CTM has not

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accounted for reduction in growth elsewhere that would offset the projected VKT and emissions for this Project to some extent.

- One average speed value for the network VKT projection for light vehicles and heavy vehicles is available from the CTM outputs, whereas the average speed will vary greatly throughout the network. For road links with higher posted speeds, however, the estimate uncertainty should be relatively small with increased average speed compared to the assessed speed.

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Hughes Development Limited and others not directly contracted by PDP for the work, including Davie Lovell-Smith Ltd and Abley. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This memorandum has been prepared by PDP on the specific instructions of Hughes Development Limited for the limited purposes described in the memorandum. PDP 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.

8.0 References

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Waka Kotahi NZ Transport Agency (2020), Vehicle emissions prediction model (VEPM 6.1) User Guide.

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Attachment A Spatial extent of CTM

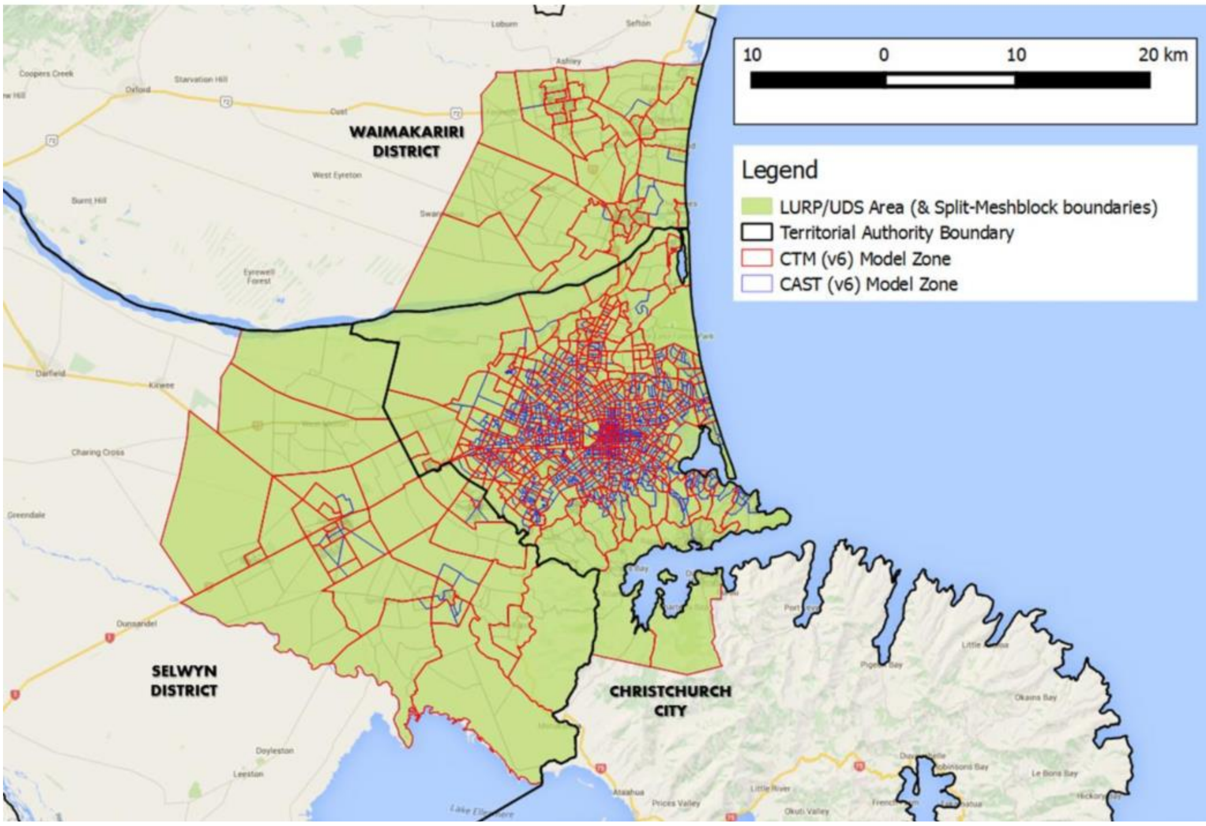

Figure A1 Transport Model Area (taken from QTP, 2019)

Attachment B MfE Transport Fuel Emission Factors (2020)

Fuel type	Unit	kg CO_2-e/unit	kg CO_2/unit	kg CH_4/unit (kg CO_2-e)	kg N_2O/unit (kg CO_2-e)	Uncertainties kg CO_2-e/unit
Regular petrol	litre	2.45	2.35	0.0276	0.0797	1.8%
Premium petrol	litre	2.45	2.34	0.0277	0.0801	1.8%
Petrol – default*	litre	2.45	2.34	0.0276	0.0798	1.8%
Diesel	litre	2.69	2.65	0.00354	0.0422	0.9%

Table B1: Percentage contributions of CO_2e from N_2O and CH_4 compared to MfE Transport Fuel CO_2

Fuel Type	CH_4	N_2O
Petrol - Default	1.2%	3.4%
Diesel	0.1%	1.6%

Notes: Estimated from the MfE greenhouse gas emission factors 2020.

Attachment C Project CTM Summary

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CTM Matrix Extraction Brief Tech Note

Prepared for: Deborah Ryan -Pattle Delamore Partners Ltd (PDP)
Issue Date: 23 April 2021
Prepared by: Jared White, Principal Transportation Engineer
Reviewed by: Chris Blackmore, Senior Transportation Planner

Introduction

Abley has been commissioned by PDP to run the Christchurch Transport Model (CTM) in order to extract transport statistics for an emissions analysis. The CTM is the strategic transport model for greater Christchurch, which calculates transport demands from landuse such as population, households, schools and employment. The emissions analysis is for the assessment of a residential plan change in the Selwyn District surrounding the existing Farringdon Subdivision.

An ITA has been prepared by Carriageway Consulting which forms the assessment of traffic effects and provides information to undertake the CTM modelling. Note that the ITA has been informed by the Rolleston Paramics model which has underlying demand inputs from the CAST model. The CAST model is a refined assignment and simulation tool that is informed by the CTM.

The CTM outputs for use in the emissions analysis are the time (VHRST) and distance (VKMT) travelled in the way of matrices between the model zones.

Modelling Process

The latest version (V18) of the CTM has been utilised for this work. The existing models are utilised as the baselines for the assessment with the 2018 and 2028 timeframes adopted for the existing and future scenario tests.

The ITA describes the Plan Change as two main areas – with 405lots in one and 564lots in the other giving 964lots in total. The zone that the Plan Change has been assigned to within the CTM is Zone 384, which has existing landuse of 273 households and 529 households in 2018 and 2028 respectively and a range of household types and demographic breakdowns. The 2028 existing landuse has been used to distribute the proposed plan change households into the various household types and population makeup. This was done by developing per household rates for the various landuse categories and apply the rates to the proposed 964 household lots. Some commercial activity in the form of a local centre is expected to be part of the plan change and representing this in the CTM has been done by assuming 30 retail jobs and 30 community service jobs.

The landuse for the plan change is added to the landuse files for the 2018 and 2028 baseline to create the with development scenarios and then the CTM model is run and converged.

Post Modelling Analysis

Upon reaching convergence the peak period trip matrices are extracted from the model and the travel patterns were analysed including the distribution of the plan change zone. The proportion of trips between the plan change site and the Selwyn district were 52%, 58% and 50% in the morning, interpeak, and evening peak periods respectively. The data from the ITA which has the CAST-based demand forecast indicates the travel between the plan change site and Selwyn district is more in line with 60%.

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One of the outputs we are to provide is an estimate of the likely uptake in public transport and active modes. Recently the Greater Christchurch PT Futures combined business case has been released and this study indicates that up to 7% of trips may transfer to PT for trips bound to Christchurch and 5% for Rolleston based trips some of which will include active modes.

If these values are applied to the summary matrices in the morning and evening peak periods, then the proportion of trips between the plan change site and the Selwyn district increase to 57% and 56% respectively. This is in line with the interpeak period. (Note that only half of the Rolleston 5% reduction was applied due to the summary including the entire Selwyn district that falls within the greater Christchurch boundary).

By applying these reduction rates to the CTM matrices the resultant increase in proportion of trips between the plan change site and the Selwyn district helps to bring the CTM demand in line with the ITA assessment. As noted previously, the ITA assessment utilised the more refined CAST demand within the Paramics model.

To enable the emissions analysis to be undertaken the outputs need to be converted into an annual total, otherwise known as annualisation. The CTM includes four time periods, defined as:

- AM – (morning 7am to 9am)
- IP – (interpeak 9am to 4pm)
- AM – (evening 4pm to 7pm)
- ON – (overnight 7pm to 7am)

The sum of these periods gives the total daily value, but weekend travel is not accounted for. To estimate the weekend values a series of factors have been calculated from three traffic counts – one of which is in Christchurch, one in Rolleston, and one on a road in between. During the weekend, the daily traffic demands are quite typical of a weekday interpeak period so the weekday interpeak has been factored to determine an estimated equivalent weekend day (7am to 7pm). The Weekday overnight period is factored to determine an estimated equivalent weekend overnight (7pm to 7am). The factors are shown in the following table.

Period	Memorial Rd	Shands Rd	Springston Rolleston Rd	Average Factors
Weekday Overnight (7pm-7am)	3518	1863	1965	
Saturday Overnight (7pm-7am)	2986	1290	1533	
Sunday Overnight (7pm-7am)	2646	1065	1202	
Weekday Interpeak (9am-4pm)	11258	5717	4762	
Saturday Daytime (7am-7pm)	15053	8418	8597	
Sunday Daytime (7am-7pm)	12509	6997	7961	
Sat Night Factor	0.849	0.692	0.780	0.774
Sun Night Factor	0.752	0.572	0.612	0.645
Sat Day Factor	1.337	1.472	1.805	1.538
Sun Day Factor	1.111	1.224	1.672	1.336

In the annualization process the weekend value is calculated by summing the Saturday and Sunday night factors and multiplying the ON weekday period and by summing the Saturday and Sunday day factors and multiplying the IP weekday period. The EEM estimates 258 typical weekdays in the year so the sum of the four weekday periods can be multiplied by 258 and added to the weekend value that is multiplied by 52 weekends in the year to give the overall annualised value. The annualised travel statistics are in included within the spreadsheets containing the period based VHRST and VKMT matrices for the whole matrix and Zone 384.

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