AIR QUALITY ASSESSMENT

WICKHAM WOOLSTORES

Investec Australia Limited

27 April 2020

Job Number 19040945

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Air Quality Assessment
Wickham Wool stores

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	18/06/2019	E McDougall & P Henschke	A Todoroski
DRAFT - 002	19/06/2019	E McDougall	A Todoroski
FINAL - 001	21/06/2019	E McDougall	A Todoroski
DRAFT REV - 001	15/01/2020	E McDougall & P Henschke	A Todoroski
FINAL - 002	27/04/2020	E McDougall	A Todoroski

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1 INTRODUCTION

Todoroski Air Sciences has prepared this report for Investec Australia Limited. It presents an air quality assessment for the proposed development of the Woolstores facility at Wickham, New South Wales (NSW) (hereafter referred to as the Project).

This air quality impact assessment has been prepared in general accordance with the NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

This report is prepared as part of the response to the NSW Environment Protection Authority (EPA) comments in a letter dated 27 March 2019 regarding the *Air Quality Impact Assessment Caltex, Wickham Facility* (**AECOM, 2018**). In particular, the comments regarding the application of the GRAL dispersion model in the Air Modelling Report.

An amended report titled *Air Quality Impact Assessment Caltex, Wickham Facility* (**AECOM, 2019**) (hereafter referred to as the Air Modelling Report) was issued to clarify some issues in the original 2019 assessment.

The assessment in the Air Modelling Report is based on the GRAL model. The Todoroski Air Sciences assessment set out in this report used the CALPUFF modelling suite and independently and alternatively replicates the AECOM dispersion modelling using the same information set out in the Air Modelling Report. This modelling however applies a higher emission rate for the Vapour Recovery Unit (VRU), up to the EPA licence limit. This assessment addresses the NSW EPA comments in relation to GRAL and the VRU emission rate.

This report incorporates the following aspects:

- A brief background and description of the Project;
- A description of the dispersion modelling approach used to assess potential air quality impacts; and,
- Presentation of the predicted results and a discussion of the potential air quality impacts.

A separate letter accompanies this report, and considers specific issues raised by the EPA, but in essence these issues are resolved via this Air Quality Assessment.

2 PROJECT BACKGROUND

2.1 Local Setting

The Project site is located on Annie Street and Milford Street Wickham, adjacent to the existing Wickham Caltex fuel storage and distribution facility (hereafter referred to as Caltex).

Figure 2-1 presents the location of the Project and the Caltex site.

Figure 2-1: Project location

Figure 2-2 presents a representative three dimensional visualisation of the terrain features surrounding the Project location. The local topography is mostly flat, sloping to higher elevations to the southwest and northwest of the site. Throsby Creek and the junction with the Hunter River and the Pacific Ocean is located to the east of the site.

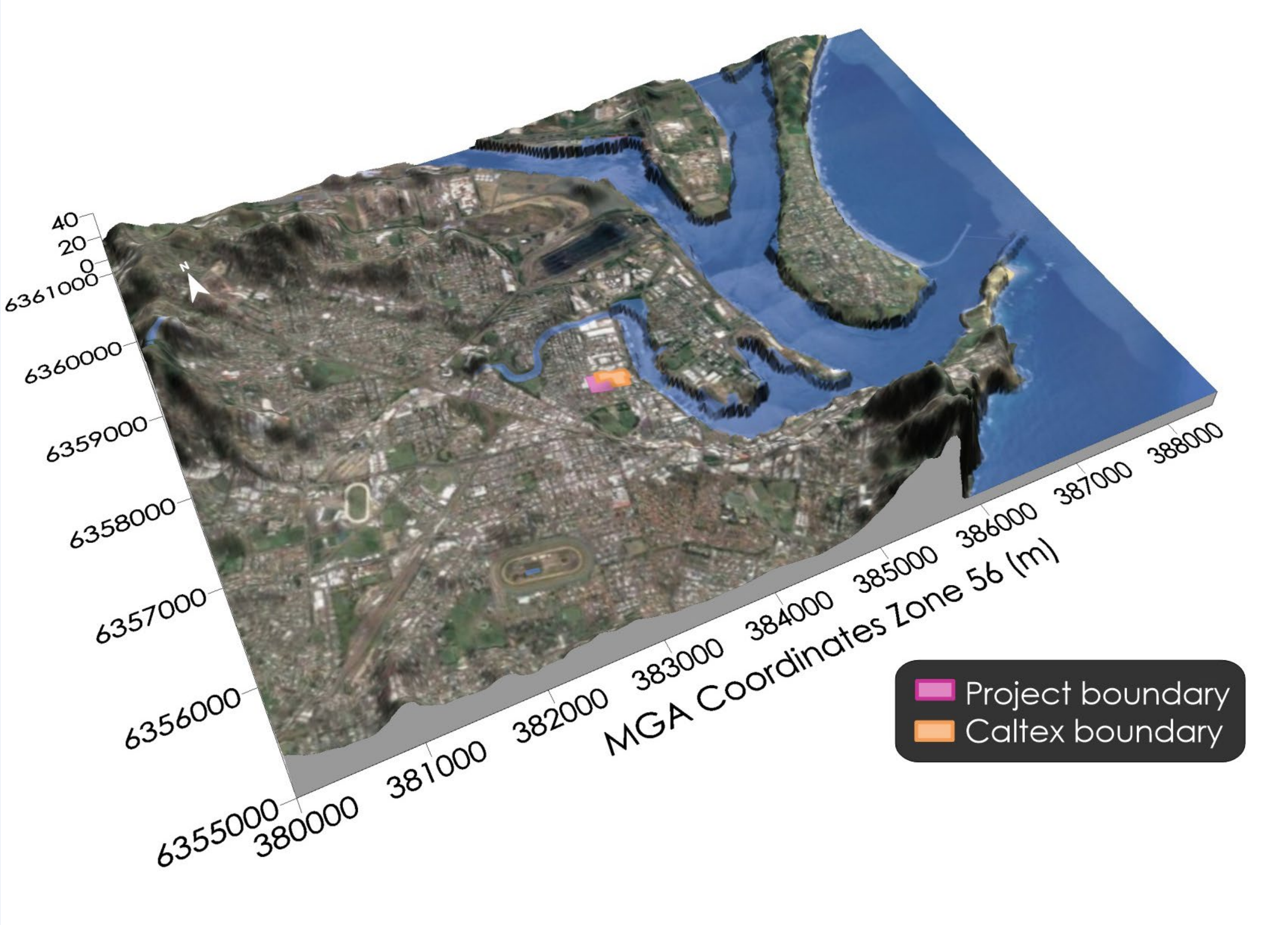

Figure 2-2: Representative visualisation of the local topography surrounding the Project

2.2 Project description

The Project is essentially seeking to develop the land at the site and convert the existing woolstores buildings into a mix of residential dwellings and commercial premises.

The development at the site includes two new buildings and a community park in addition refurbishing the existing woolstores. The proposed site is planned to accommodate residential apartments, commercial and retail premises, and community space.

3 AIR QUALITY CRITERIA

3.1 Preamble

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The section below identifies the potential air emissions and the applicable air quality criteria of relevance to this study.

3.2 Assessed pollutants

Table 3-1 summarises the air quality goals that are relevant to this assessment as outlined in the NSW EPA document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (**NSW EPA, 2017**).

Table 3-1: Air quality criteria for the relevant pollutants

Pollutant	Averaging Period	Criteria (µg/m^3)	Percentile	Criteria Type
Benzene	1 hour	29	99.9th	Air toxic
Cyclohexane	1 hour	21	99.9th	Air toxic
Ethylbenzene	1 hour	19,000	99.9th	Air toxic
Hexane	1 hour	8,000	99.9th	Air toxic
Cumene	1 hour	3,200	99.9th	Odorous pollutant
Toluene	1 hour	360	99.9th	Odorous pollutant
Xylene	1 hour	190	99.9th	Odorous pollutant

4 DISPERSION MODELLING APPROACH

4.1 Introduction

The following sections are included to provide the reader with an understanding of the model and modelling approach.

For this assessment the CALPUFF modelling suite is applied to dispersion modelling. The CALPUFF model is an advanced "puff" model that can deal with the effects of complex local terrain on the dispersion meteorology over the entire modelling domain in a three dimensional, hourly varying time step. CALPUFF is an air dispersion model approved by NSW EPA for use in air quality impact assessments.

The model setup used is in general accordance with methods provided in the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modeling System for Inclusion into the 'Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia'* (**TRC Environmental Corporation (TRC)**, **2011**).

4.2 Modelling methodology

Modelling was undertaken using a combination of The Air Pollution Model (TAPM) and the CALPUFF Modelling System. The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets.

TAPM is a prognostic air model used to simulate the upper air data for CALMET input. The meteorological component of TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical coordinate for 3D simulations. The model predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of larger scale meteorology provided by synoptic analysis.

CALMET is a meteorological model that uses the geophysical information and observed/simulated surface and upper air data as inputs and develops wind and temperature fields on a 3D gridded modelling domain.

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources, simulating dispersion processes along the way. It typically uses the 3D meteorological field generated by CALMET.

CALPOST is a post processor used to process the output of the CALPUFF model and produce tabulations that summarise the results of the simulation.

4.2.1 Meteorological modelling

TAPM was applied to the available data to generate a 3D upper air data file for use in CALMET. The centre of analysis for TAPM analysis followed parameter settings listed in the Air Modelling Report. The simulation used in this assessment involved an outer grid of 30km, with three nested grids of 10km, 3km and 1km with 35 vertical grid levels.

The CALMET domain was run on a 15 x 15km area with 0.15km grid resolution. The available meteorological data for the 2016 calendar year from surrounding meteorological monitoring sites were included in this run. The 2016 calendar year is the same modelling period considered in the Air Modelling Report. **Table 4-1** outlines the parameters used from each station.

Table 4-1: Surface observation stations

Weather stations	Parameters						
	WS	WD	CH	CC	T	RH	SLP
Williamtown RAAF (BoM) (Station No. 061078)	✓	✓	✓	✓	✓	✓	✓
Newcastle Nobbys Signal Station AWS (BoM) (Station No. 061055)	✓	✓			✓	✓	
Newcastle (NSW OEH)	✓	✓			✓	✓	
Carrington (NSW OEH)	✓	✓			✓	✓	
Mayfield (NSW OEH)	✓	✓			✓	✓	
Stockton (NSW OEH)	✓	✓			✓	✓	
Wallsend (NSW OEH)	✓	✓			✓	✓	
Beresford (NSW OEH)	✓	✓			✓	✓	

WS = wind speed, WD= wind direction, CH = cloud height, CC = cloud cover, T = temperature, RH = relative humidity, SLP = station level pressure

Local land use and detailed topographical information was included in the simulation to produce realistic fine scale flow fields (such as terrain forced flows) in surrounding areas (**Figure 4-1**).

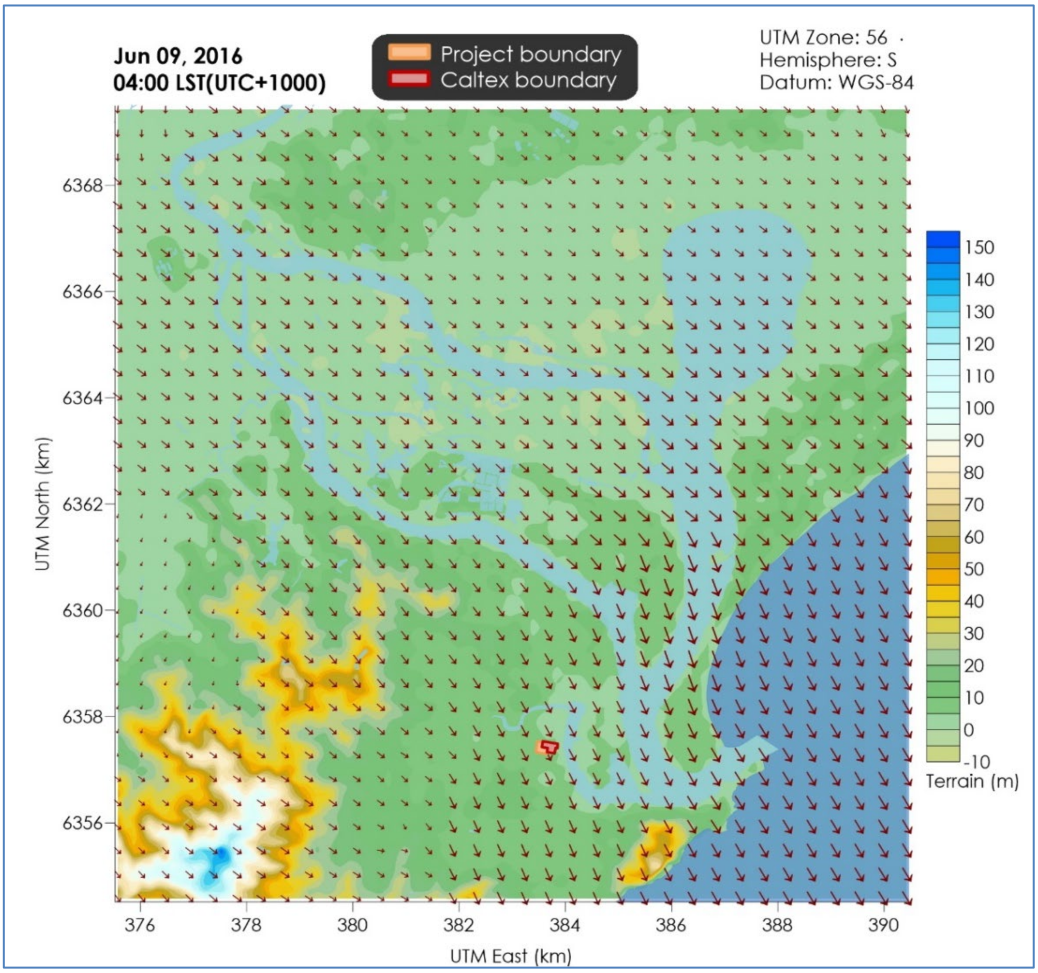

Figure 4-1: Representative snapshot of wind field for the Project

CALMET generated meteorological data were extracted from a point within the CALMET domain and are graphically represented in **Figure 4-2** and **Figure 4-3**.

Figure 4-2 presents the annual and seasonal windroses from the CALMET data. On an annual basis, winds tend to occur from the northwest and west-northwest. In summer winds predominantly originate from the east-northeast and the southeast quadrant. The wind distributions in autumn, winter and spring are similar to the annual distribution which is dominated by winds from the northwest and west-northwest.

Overall, the windroses generated in the CALMET modelling reflect the expected wind distribution patterns of the area as determined based on the available measured data and the expected terrain effects on the prevailing winds. **Figure 4-3** includes graphs of the temperature, wind speed, mixing height and stability classification over the modelling period and show sensible trends considered to be representative of the area.

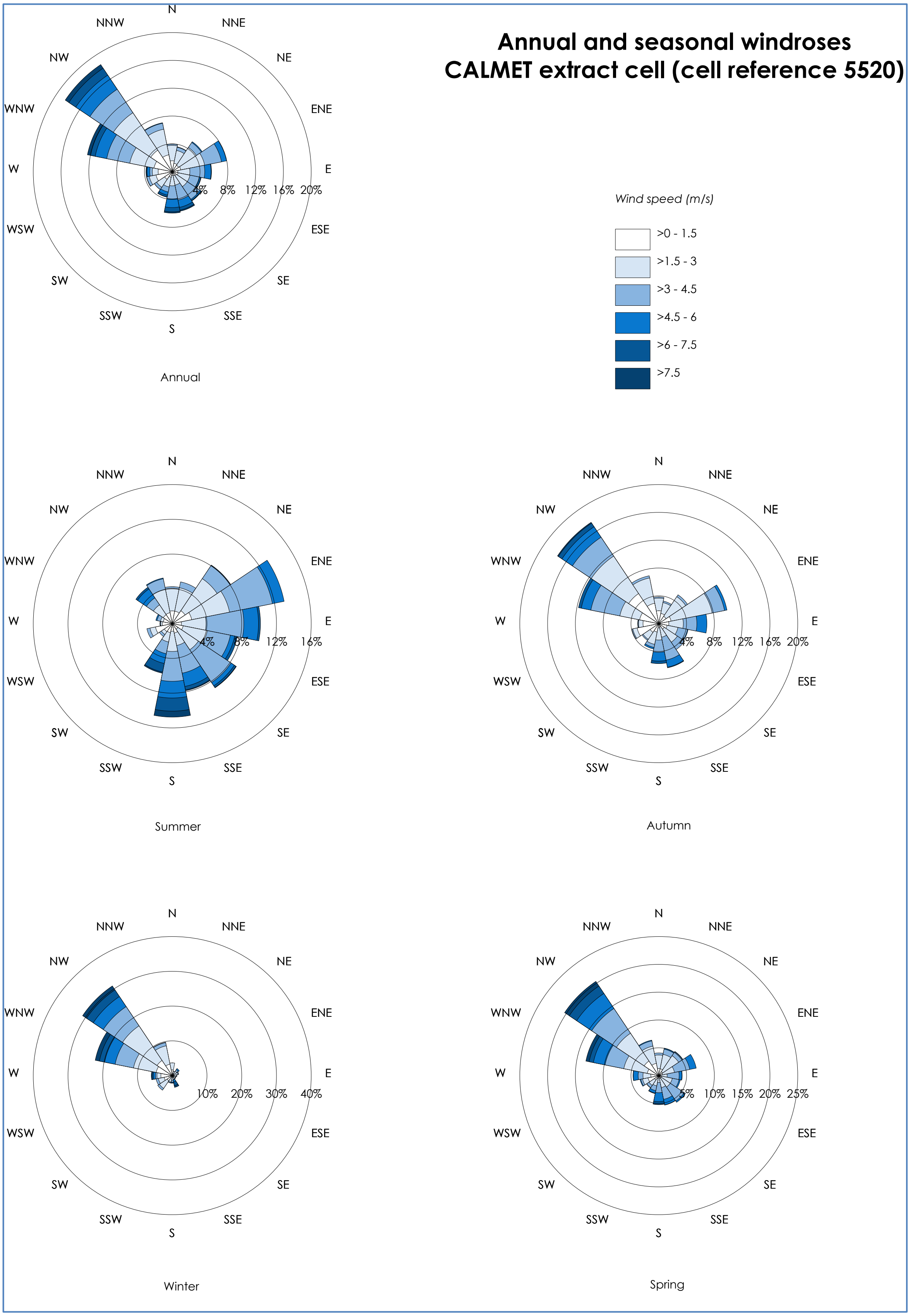

Figure 4-2: Annual and seasonal windroses from CALMET (cell ref 5520)

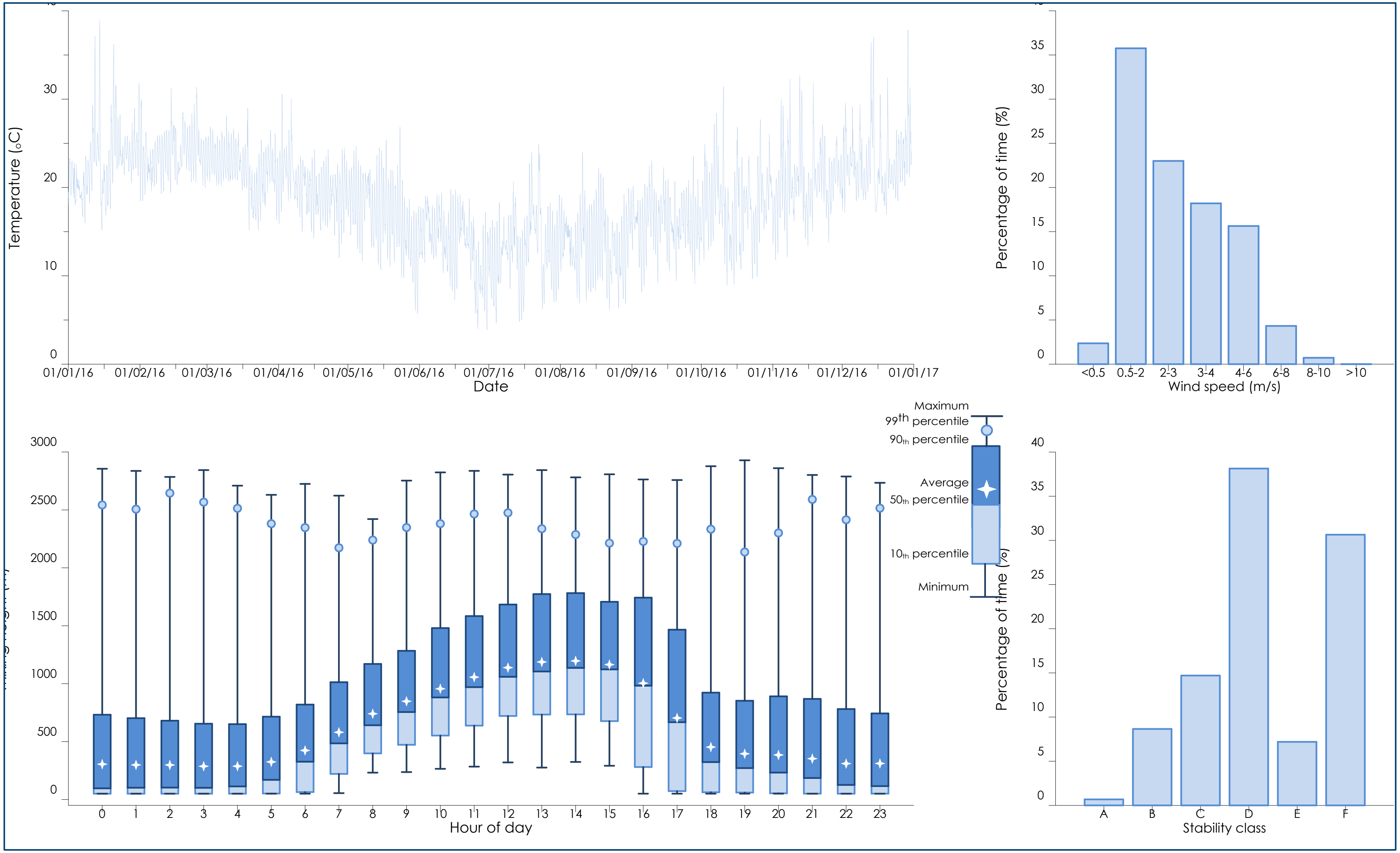

Figure 4-3: Meteorological analysis CALMET (cell ref 5520)

4.2.2 Dispersion modelling

Air dispersion modelling of the emission sources at the Caltex site was conducted to identify any potential for air quality impacts to arise at the Project site.

The same modelling scenarios used in the Air Modelling Report were followed in this assessment (however the Vapour Recovery Unit (VRU) is modelled at its licence limit in all cases). **Table 4-2** below presents a summary of throughput and fuel composition data used in determining each scenario.

Scenario 1 is representative of throughputs based on logistical peak flow with current infrastructure at a 100% capacity.

Scenarios 2-5 represent a potential increase in throughput based on up-scaled peak filling flow at a 100% capacity with varying fuel ratios.

Table 4-2: Throughput and fuel composition data for modelling scenarios 5

Scenario	Potential throughput at 100% equipment utilisation (ML/p.a.)	Fuel composition (% of total)		
		ULP	Diesel	Jet
SCN1	3363.8	33.0	66.6	0.4
SCN2	5516.7	33.0	66.6	0.4
SCN3		59.2	40.6	0.2
SCN4		20.1	79.6	0.2
SCN5		20.1	40.6	39.3

The modelled emission rates for each of the assessed pollutants and emission sources at the Caltex site are identical to those applied in the Air Modelling Report with the exception of the VRU which is modelled at its licence limit of 10 milligrams per litre (mg/L). A summary of the estimated emission rates for the individual compounds emitted from the VRU, scaled up to account for an emission concentration of 10 mg/L is shown below in **Table 4-3**.

Table 4-3: VRU mass emission rates (scaled up to licence limit of 10mg/L)

Pollutant	Scenario 1 (kg/hr)	Scenario 2-5 (kg/hr)
Benzene	0.0147	0.0242
Cyclohexane	0.0110	0.0181
Ethylbenzene	0.0022	0.0036
N-hexane	0.0351	0.0576
Cumene	0.000077	0.00013
Toluene	0.0249	0.0409
Xylenes	0.0095	0.0156

5 DISPERSION MODELLING RESULTS

The dispersion modelling predictions for each of the assessed scenarios are presented in this section. The results include the 99.9th percentile ground level concentrations (GLC's) and predicted concentrations at various heights due to pollutant emissions from Caltex's operation.

Modelling receptors are categorised to include those positioned at the Caltex boundary and those positioned within the Project boundary. Modelling receptors within the Project boundary were assessed at ground level and varying building heights dependant on their proposed development plans.

Figure 5-1 below presents the maximum heights of the proposed Project buildings. These include the existing woolstore buildings that are proposed to be refurbished (shaded blue), two new buildings (shaded orange and red) and a community park (shaded green).

Modelled receptors were positioned at four metre (m) height intervals as relevant to represent the different residential storey levels for the proposed buildings. (We note that new buildings would normally have 3m height steps, but the existing high ceiling heights of the buildings apply here).

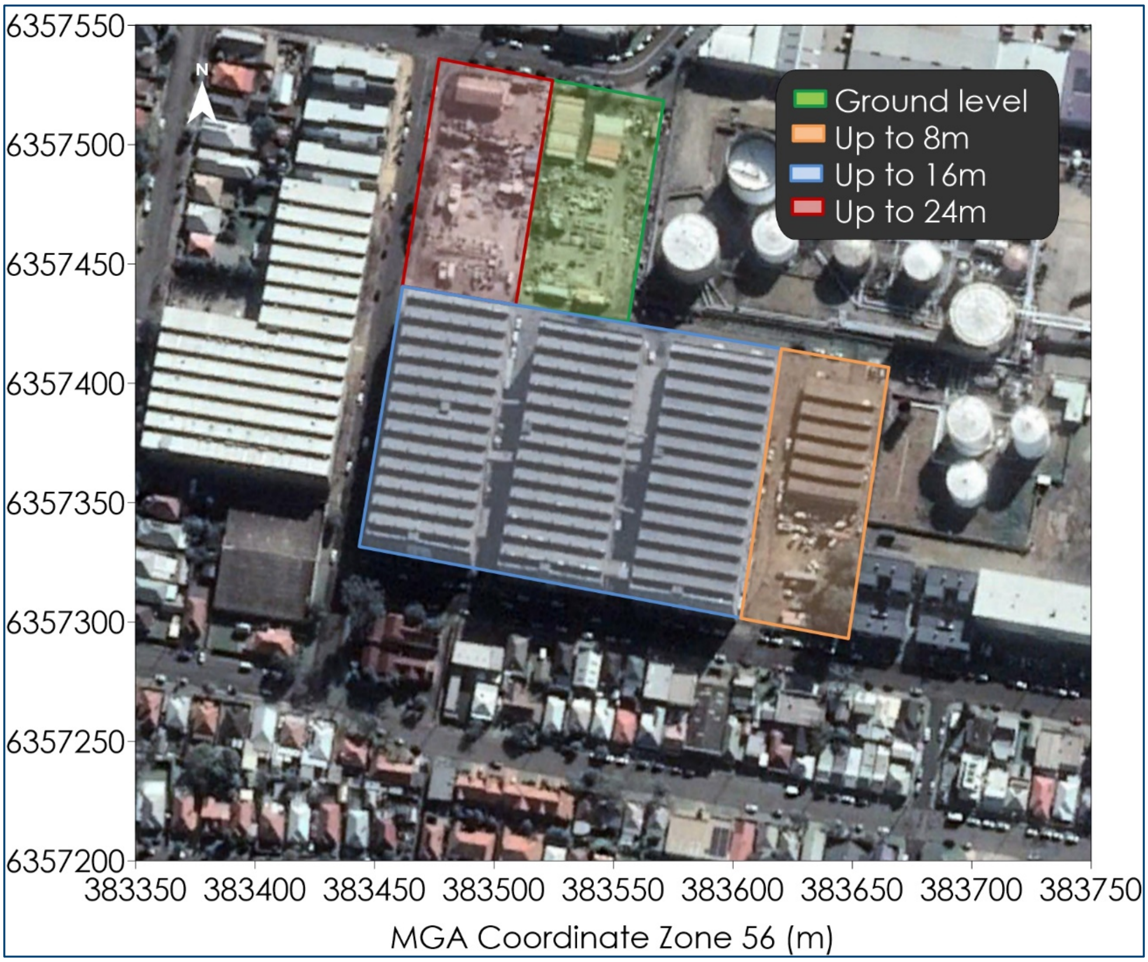

Figure 5-1: Building heights included at the Project boundary

Table 5-1 presents the maximum predicted pollutant dispersion modelling results for each of the modelled scenarios at the Caltex boundary and within the Project boundary at varying heights.

The results indicate that for all Scenarios the predicted levels are well below the relevant criteria for the assessed pollutants at every receptor at every height.

Figure 5-2 to **Figure 5-6** present isopleths of the predicted ground level benzene concentrations for Scenarios 1 to 5, respectively. These figures indicate a significant margin of compliance for the predicted ground level benzene concentrations at the Project site for all scenarios.

Additional isopleths of the predicted benzene concentrations over the Project site for various heights are provided in **Appendix A**. The isopleths indicate the predicted levels at any height would be well below criteria for any scenario.

5.1 Odour results

Individual odorous air pollutants pertinent to fuel storage facilities, i.e. cumene, toluene and xylene have been assessed at the Project boundary. The modelled results for these odorous compounds are shown in **Table 5-1** with green shading. Where compliance with the odorous air pollutant criteria is achieved, it is unlikely that any offensive odour impacts would arise in practice.

The results in **Table 5-1** indicate that all such pollutants are well within criteria, even for the maximum potential future throughput scenarios with higher emission rates.

Given that odorous pollutants for all scenarios are well below the applicable criteria there would be no tangible risk of offensive odours from the facility at the proposed development.

Table 5-1: Particulate pollutant modelling results, maximum predicted concentrations (µg/m³)

Scenario	Pollutant	Receptor Category								EPA Criteria
		Caltex GLC	Project boundary GLC	Project boundary 4m	Project boundary 8m	Project boundary 12m	Project boundary 16m	Project boundary 20m	Project boundary 24m	
SCN1	Benzene	4.2	1.6	1.9	3.4	3.3	3.1	1.7	0.9	29
	Cyclohexane	5.6	4.7	3.4	4.8	13.0	13.4	5.2	2.5	19,000
	Ethylbenzene	0.6	0.4	0.4	0.9	0.7	0.5	0.2	0.1	8,000
	Hexane	10.0	6.3	5.3	8.2	20.2	18.8	7.1	3.4	3,200
	Cumene	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0	21
	Toluene	11.0	7.7	8.5	20.4	12.4	10.1	4.8	2.7	360
	Xylene	10.2	7.1	7.8	20.0	9.8	5.3	2.4	1.4	190
SCN2	Benzene	7.9	2.6	3.2	6.1	5.2	5.0	2.7	1.8	29
	Cyclohexane	9.1	7.7	5.5	7.8	21.2	22.1	8.4	4.0	19,000
	Ethylbenzene	1.2	0.7	0.7	1.5	1.2	0.8	0.3	0.3	8,000
	Hexane	18.9	10.3	8.8	14.2	33.1	30.8	11.4	5.5	3,200
	Cumene	0.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	21
	Toluene	18.2	12.7	14.0	34.1	20.2	16.3	7.8	4.3	360
	Xylene	16.7	11.6	12.7	32.8	16.0	8.7	4.0	2.3	190
SCN3	Benzene	7.9	4.1	4.4	8.8	8.7	8.9	4.1	2.2	29
	Cyclohexane	16.3	13.1	9.0	12.5	31.2	35.3	14.3	6.9	19,000
	Ethylbenzene	1.4	1.0	1.1	2.7	1.4	0.8	0.4	0.3	8,000
	Hexane	19.5	16.4	11.8	18.4	41.8	44.3	17.8	8.9	3,200
	Cumene	0.1	0.1	0.1	0.3	0.1	0.1	0.0	0.0	21
	Toluene	31.0	21.9	23.8	59.7	34.4	27.6	13.3	7.1	360
	Xylene	29.5	20.3	22.3	58.3	26.9	13.9	6.4	3.8	190
SCN4	Benzene	7.8	2.2	2.6	5.1	4.2	3.3	2.0	1.7	29
	Cyclohexane	6.1	5.2	4.2	6.1	16.9	15.8	5.6	2.6	19,000
	Ethylbenzene	1.2	0.5	0.5	1.0	1.2	0.8	0.3	0.3	8,000
	Hexane	18.9	8.3	7.5	12.2	29.5	24.3	8.6	4.6	3,200
	Cumene	0.1	0.0	0.0	0.1	0.2	0.1	0.0	0.0	21
	Toluene	13.4	8.5	9.4	21.1	13.5	11.0	5.4	3.2	360
	Xylene	10.4	7.4	8.0	20.1	10.6	6.7	2.8	1.6	190

Scenario	Pollutant	Receptor Category								EPA Criteria
		Caltex GLC	Project boundary GLC	Project boundary 4m	Project boundary 8m	Project boundary 12m	Project boundary 16m	Project boundary 20m	Project boundary 24m	
SCN5	Benzene	7.8	2.2	2.6	5.1	4.2	3.3	2.0	1.7	29
	Cyclohexane	6.0	4.8	3.5	5.4	13.0	13.5	5.3	2.6	19,000
	Ethylbenzene	1.2	0.5	0.5	1.0	0.8	0.5	0.3	0.3	8,000
	Hexane	18.9	7.3	8.8	16.0	20.7	18.9	8.2	4.5	3,200
	Cumene	0.3	0.2	0.2	0.5	0.4	0.2	0.1	0.0	21
	Toluene	13.4	10.1	12.3	29.5	22.2	13.0	6.1	3.4	360
	Xylene	11.7	8.7	10.3	26.5	17.9	9.4	3.5	2.0	190

Figure 5-2: Benzene ground level concentration isopleth – Scenario 1 (µg/m³)

Figure 5-3: Benzene ground level concentration isopleth – Scenario 2 (µg/m³)

Figure 5-4: Benzene ground level concentration isopleth – Scenario 3 (µg/m³)

Figure 5-5: Benzene ground level concentration isopleth – Scenario 4 (µg/m³)

Figure 5-6: Benzene ground level concentration isopleth – Scenario 5 (µg/m³)

6 DISCUSSION

The original Air Modelling Report (**AECOM, 2018**) used the GRAL model, which was questioned by EPA. AECOM also provided a revised Air Modelling Report (**AECOM, 2019**) which also used the GRAL model and provided clarifications. Whilst we consider that GRAL can be used in cases like this, and may offer some advantages over other models, to respond to the EPA we applied the CALPUFF model in this study.

Both the GRAL and CALPUFF modelling show that concentrations of odorous compounds are below their respective odour threshold criteria, which is consistent with our understanding of there being no recent odour complaints in regard to the operation of the Caltex facility.

There are residential receptors in the general area that would be exposed to odour from the Caltex site at similar levels to that predicted for the majority of the proposed development site. Also, there are many commercial receptors much closer to the key sources of emissions from the Caltex site than the proposed development. However, we understand that there have been no complaints regarding odour from the Caltex site, which is consistent with the modelling results.

Given that odorous pollutants for even the highest impacting future scenarios are well below the applicable criteria, and the modelling reflects the actual case reliably, the results show that is no tangible risk of any significant offensive odours to occur from the facility.

It should be noted that there is a significant margin of conservatism (overestimation) in the modelling also, as it is based on higher than actual fuel throughput capacities. Fuel throughputs approximately 165% of the maximum possible plant handling capacity have been modelled. Nevertheless, both the GRAL and CALPUFF modelling indicates no tangible scope for the existing or future operations of the Caltex facility to cause odour impacts at unacceptable levels.

The CALPUFF and GRAL modelling both show that the VRU is the dominant odour source in regard to potential impacts. Whilst the CALPUFF model indicates lower ground level impacts than the GRAL model, ultimately, both models demonstrate that potential impacts would be below acceptable criteria, and the trends shown by both models are consistent.

Examination of the emissions rates used in the GRAL modelling shows that the emission rates for the VRU are based on the measured emission rates, which are below the licence limit. In this regard there does not appear to be any issue as it normal, and required to operate within licence limits. However, as EPA questioned this aspect of the GRAL modelling, the CALPUFF modelling used in this study applied an emission rate for the VRU consistent per the maximum licenced level of emissions (10mg/L), which is higher than the actual measured emissions and those modelled previously.

In terms of total site emissions, examination of the reported NPI data for the last 15 years shows an approximate ten-fold reduction in VOC emissions from the site occurred in 2008/9. Whilst we do not know exactly what changed, this change would be consistent with introducing modern pollution controls, and indeed the data shows that the site must have good emissions controls in place. It is therefore reasonable to expect that only be relatively low levels of emissions from all major sources.

The modelling (GRAL or CALPUFF) shows no tangible impacts for any toxic or odorous pollutant within the project boundary at any height (note that detailed modelling at various heights in set out in Appendix A).

Thus we are of the opinion that both the GRAL modelling conducted independently by Caltex, and CALPUFF modelling for this study show that no likely air pollution impacts or odour impacts would occur at the Project presently or in the future.

7 SUMMARY AND CONCLUSIONS

This report has assessed the potential air quality impacts associated with the proposed mixed use including residential development of the Woolstore facility at Wickham adjacent to the Caltex fuel storage and distribution facility.

Air dispersion modelling using the CALPUFF model was applied to predict the potential for off-site air pollutant and odour impacts in the surrounding area due to the development of the Project.

The estimated emissions of pollutants applied in the modelling have been taken from the Air Modelling Report (**AECOM, 2019**) except for the VRU which was modelled at a higher emission rate of 10mg/L, as per the Caltex Licence limit. The modelling uses fuel throughputs that are approximately 165% of the maximum possible fuel throughput capacity of the current equipment, which factors in any future increase in fuel throughputs.

Predicted modelling results for the assessed air pollutants are well below the relevant criteria for all scenarios modelled at each receptor.

Individual odorous air pollutants of cumene, toluene and xylene were assessed at the Caltex boundary and within the Project boundary. The results are also well below their respective criteria in every scenario and indicate that no unacceptable level of odour impact would arise at the Project due to Caltex activity now and in future.

Overall, we consider that both the GRAL modelling conducted independently by Caltex, and the CALPUFF modelling for this study show that no likely air pollution impacts or odour impacts would occur at the Project presently or in the future.

8 REFERENCES

AECOM (2018)

"Air Quality Impact Assessment – Caltex, Wickham Facility", prepared for Caltex Australia Petroleum Pty Ltd by AECOM Australia, September 2018.

AECOM (2019)

"Air Quality Impact Assessment – Caltex, Wickham Facility", prepared for Caltex Australia Petroleum Pty Ltd by AECOM Australia, October 2019.

NSW EPA (2017)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales", January 2017

TRC (2011)

"Generic Guidance and Optimum Model Settings for the CALPUFF Modeling System for Inclusion into the Approved Methods for the Modeling and Assessments of Air Pollutants in NSW, Australia", Prepared for the NSW Office of Environment and Heritage by TRC Environmental Corporation.

Appendix A

Additional Isopleth Diagrams

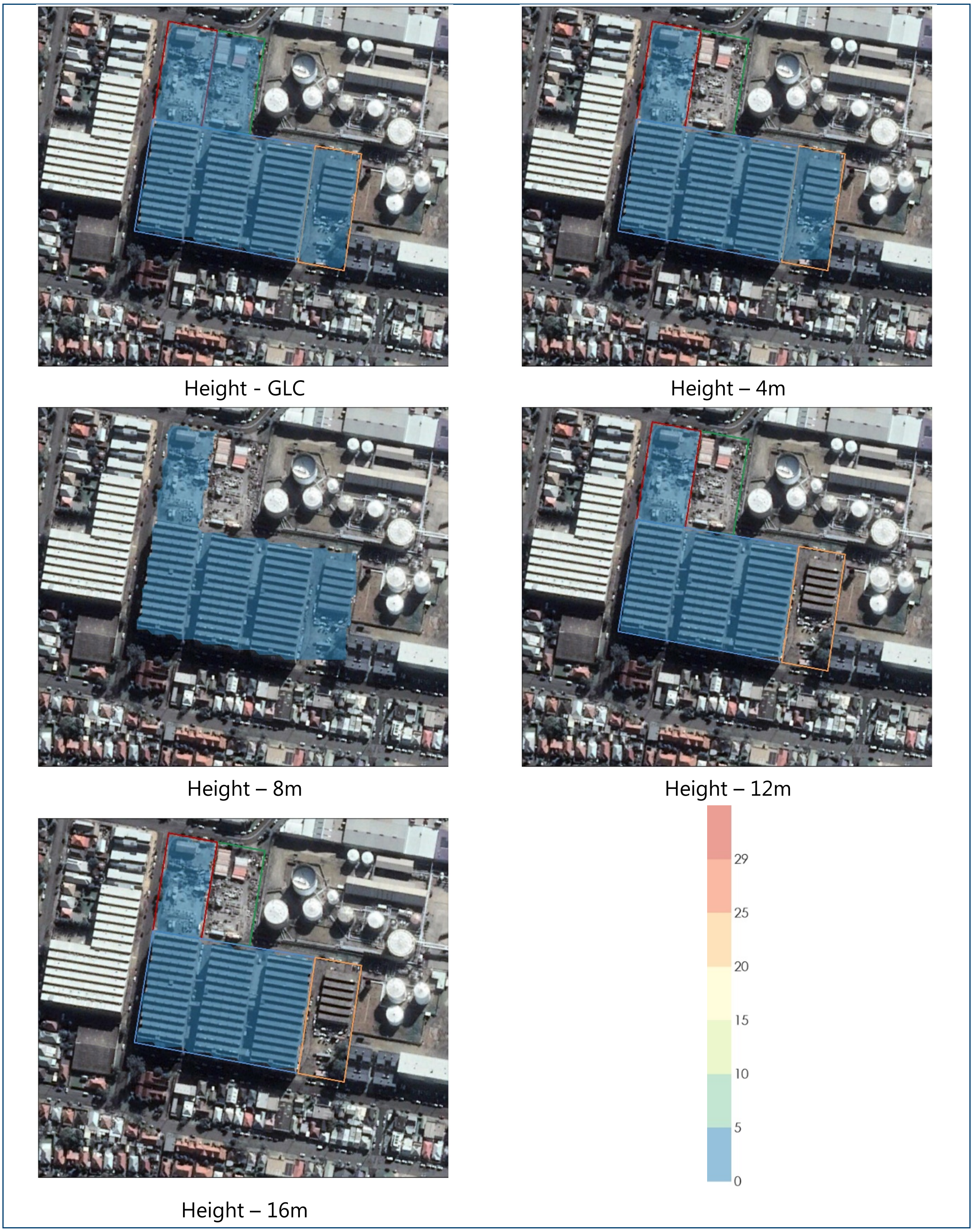

Figure A-1: Predicted benzene concentrations within Project boundary for Scenario 1 (µg/m³)

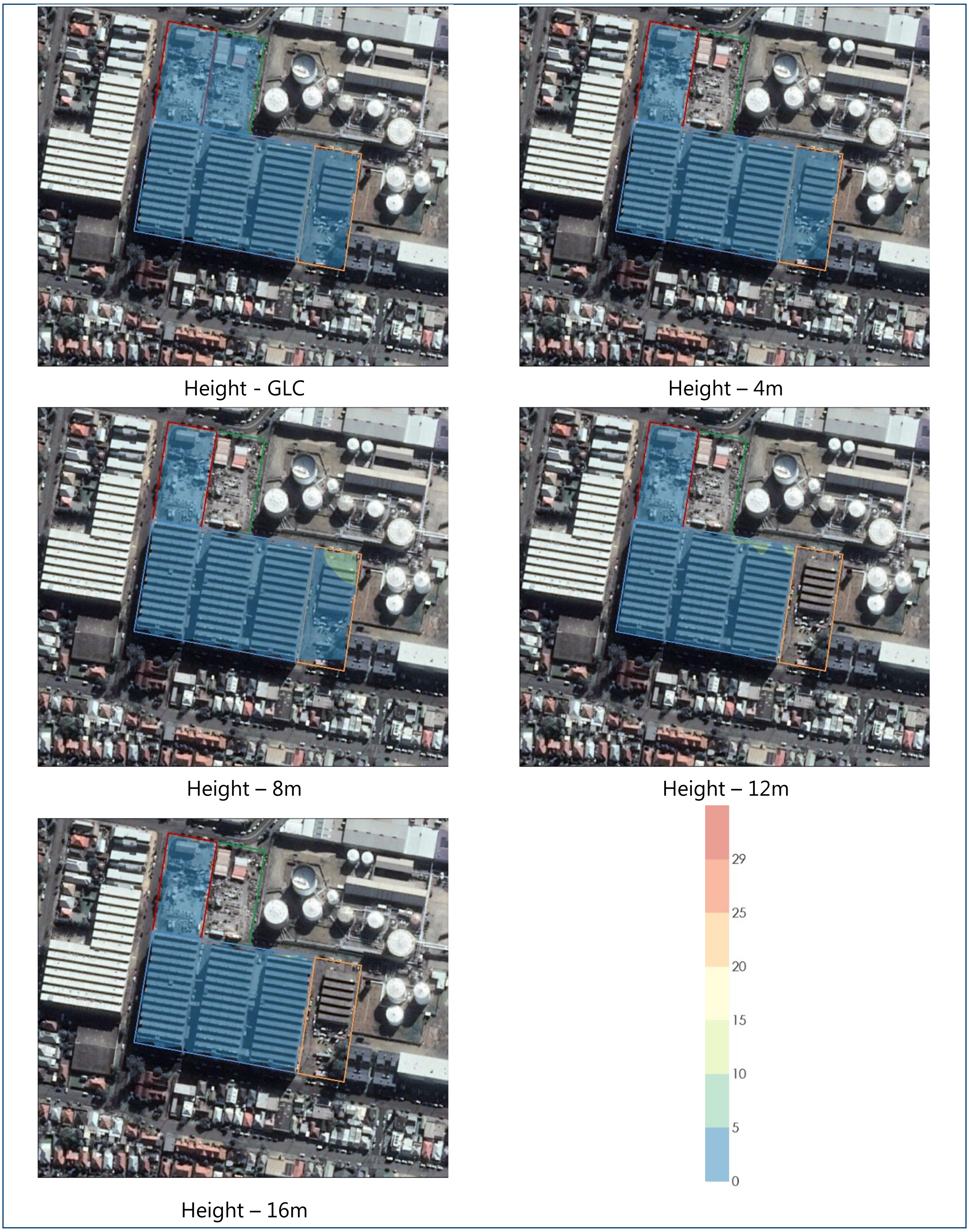

Figure A-2: Predicted benzene concentrations within Project boundary for Scenario 2 (µg/m³)

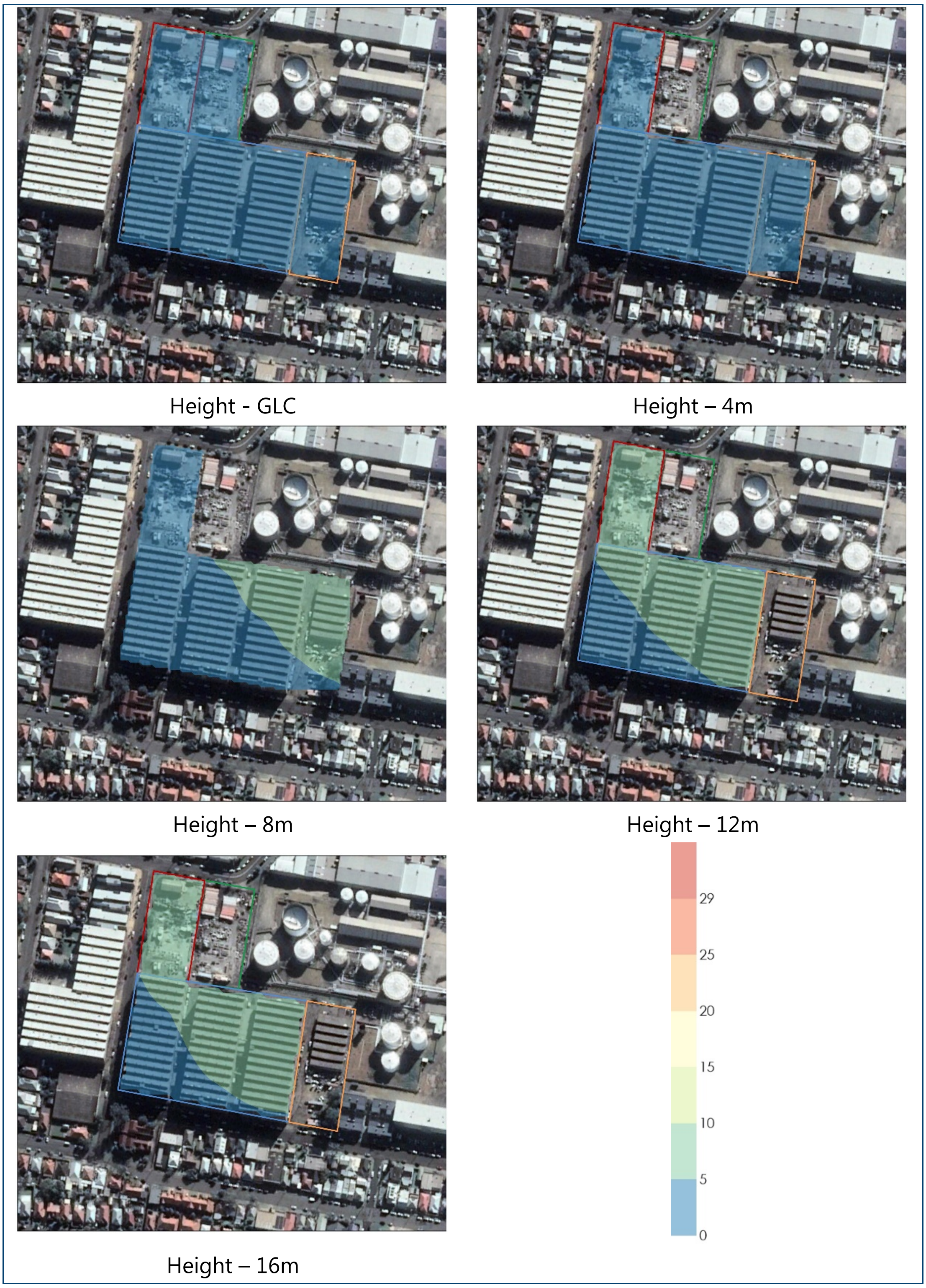

Figure A-3: Predicted benzene concentrations within Project boundary for Scenario 3 (µg/m³)

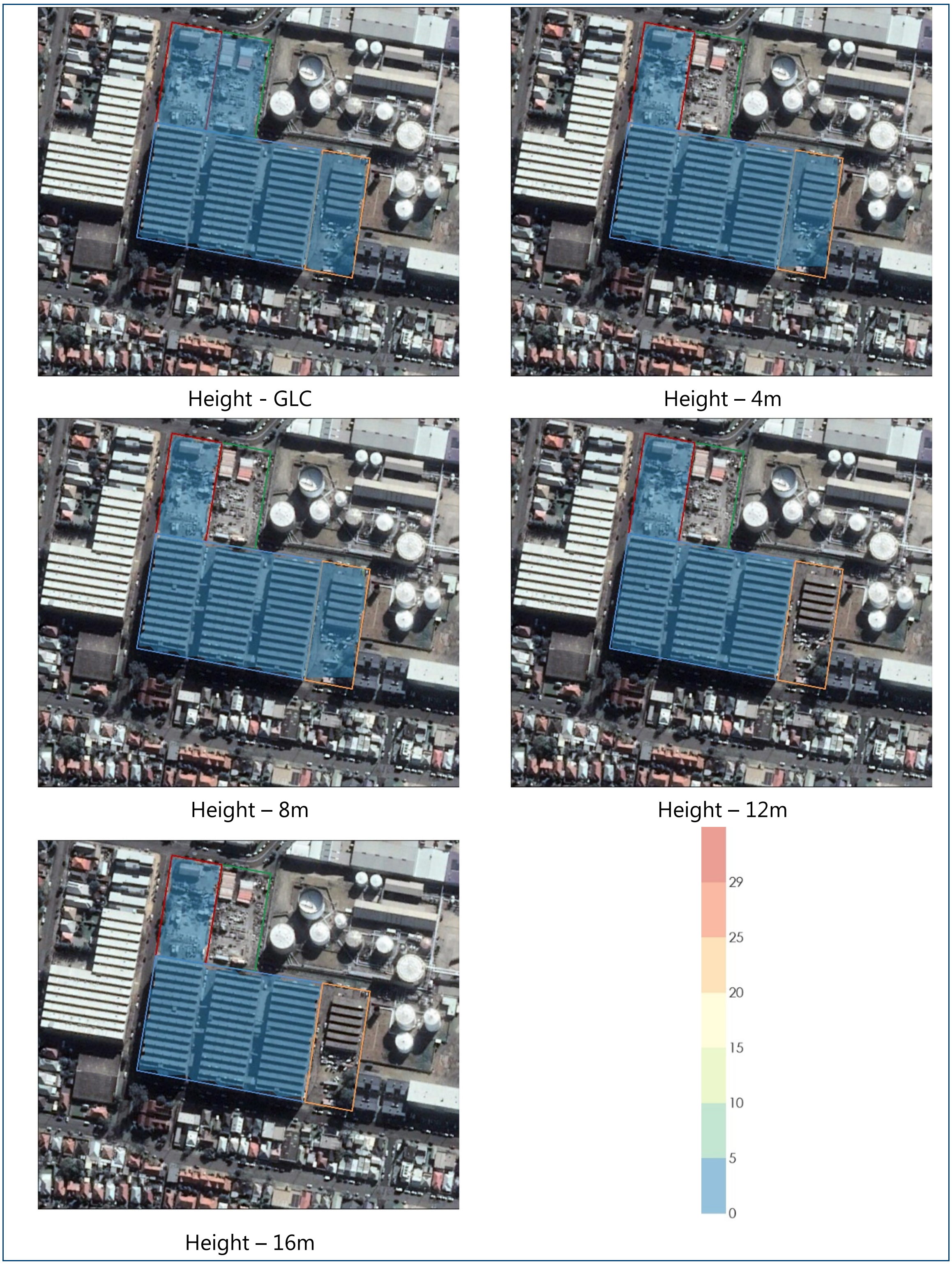

Figure A-4: Predicted benzene concentrations within Project boundary for Scenario 4 (µg/m³)

Height - GLC

Height – 4m

Height – 8m

Height – 12m

Height – 16m

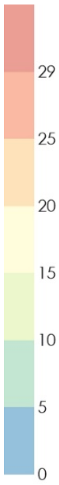

Figure A-5: Predicted benzene concentrations within Project boundary for Scenario 5 (µg/m³)