Kings Forest Service Station

Tweed Coast Road, Kings Forest

Air Quality Impact Assessment

7872R01V01.docx
22/05/15

Prepared for

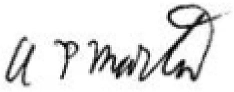
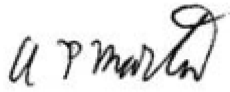
LEDA Group (Project 28 P/L)

ASK Consulting Engineers Pty Ltd

ABN: 55 622 586 522 - ACN: 128 491 967
PO Box 3901, South Brisbane. QLD. 4101.

P: 07-3255-3355 F: 07-3844-7180 W: www.askconsulting.com.au E: mail@askconsulting.com.au

Document Control				
\\nas-primary\projects\7800\7872 - Kings Forest Service Station\ASKout\7872R01V01.docx				
Document Ref	Date of Issue	Status	Author	Reviewer
7872R01V01_draft	07/05/15	Draft	AM	MR
7872R01V01	22/05/15	Final	AM	MR

Document Approval			
Author Signature		Approver Signature	
Name	Andrew Martin	Name	Andrew Martin
Title	Air Quality Manager	Title	Air Quality Manager

Disclaimer: This document and associated tasks were undertaken in accordance with the ASK Consulting Engineers Quality Assurance System, which is based on Australian Standard / NZS ISO 9001:2008. This document is issued subject to review, and authorisation by a Senior Consultant noted in the above table. If the table is incomplete, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

This document is prepared for our Client's particular requirements which are based on a specific brief with limitations as agreed to with the Client. It is not intended for and should not be relied upon by a third party and no responsibility is undertaken to any third party without prior consent provided by ASK Consulting Engineers. The information herein should not be reproduced, presented or reviewed except in full. Prior to passing on to a third party, the Client is to fully inform the third party of the specific brief and limitations associated with the commission.

The information contained herein is for the identified purpose of air quality assessment. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of air quality assessment including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing, safety design and the like. Supplementary professional advice should be sought in respect of these issues.

Copyright: This report and the copyright thereof are the property of ASK Consulting Engineers Pty Ltd (ABN 55 622 586 522). It must not be copied in whole or in part without the written permission of ASK Consulting Engineers Pty Ltd. This report has been produced specifically for the Client and project nominated herein and must not be used or retained for any other purpose. www.askconsulting.com.au

ACOUSTICS & AIR QUALITY

Contents

1 Introduction

ASK Consulting Engineers Pty Ltd (ASK) was commissioned by LEDA Group (Project 28 P/L) to provide air quality consultancy services for the Kings Forest Service Station, to be located on Lot 7 DP875447, Tweed Coast Road, Kings Forest.

NSW EPA has requested an "*air quality assessment of the air quality and odour impacts of the proposed development including impacts on any surrounding receivers*". The purpose of this report is to address these requirements based on the following tasks:

- Examine proposed operations to identify all air emission sources such as tank filling, breathing from tank vents, vehicle filling and spillage.
- Review the site, receptors, topography and land use based on Google Earth Pro aerial and street view photography.
- Identify coordinates of emission sources using Google Earth.
- Identify receptor locations for the nearby existing and proposed residences.
- Identify expected regional background concentrations of pollutants identified using monitoring data from existing Government air monitoring stations and other available sources.
- Calculate emissions based on activity information provided and using equations from the National Pollutant Inventory.
- Calculate cumulative odour emissions based on odour thresholds of individual compounds.
- Undertake meteorological modelling in the region and vicinity using TAPM and CALMET with assimilation of local meteorological data if suitable data is available.
- Undertake dispersion modelling of emissions from proposed operations. The Calpuff dispersion model has been used to estimate concentrations from the service station due to the low source height and consequent need to model near-calm conditions.
- Process results using Calpost and prepare tables of predicted concentrations and depositions at key receptors.
- Prepare figures showing contours of cumulative odour and key volatile organic compounds (VOCs).
- Determine ameliorative measures if required and practical.
- Provide report with input data, modelling methods and results, analysis and recommendations.

To aid in the understanding of the terms in this report a glossary is included in Appendix A.

2 Study Area Description

The site for the proposed service station is currently vacant and over the last 12 years has occasionally been used for material storage. The surrounding area is predominantly agricultural. The immediate surrounding land uses follow:

- To the north is cropland and a rural residence.
- To the east and south-east are wetlands and a stream draining the Cudgen Nature Reserve.
- To the west and south-west is the Tweed Coast Road with residences on Old Bogangar Road further to the west.

The addresses of nearby representative sensitive receptors are summarised in **Table 2.1** including their northing and easting locations and are shown in **Figure 2.1**.

Table 2.1 List of Sensitive Receptors with UTM Coordinates (WGS84 Z56)

ID	Address	Direction from Service Station	Easting (m)	Northing (m)	Elevation, AHD (m)
A	254 Old Bogangar Rd	south	555222	6870766	3
B	250 Old Bogangar Rd	south-west	555199	6870835	3
C	242 Old Bogangar Rd	west	555181	6870913	4
D	238 Old Bogangar Rd	west	555165	6870943	5
E	234 Old Bogangar Rd	west	555156	6870981	5
F	219 Tweed Coast Rd	north	555188	6871204	9
G	270 Casuarina Way	north-east	556247	6871489	9
H	17 Laceflower Pde	east	555982	6870796	7
I	41 Laceflower Pde	south-east	555941	6870561	6
J	89 Laceflower Pde	south-east	555913	6870282	6
K	9 Liriope St	south-east	555823	6869975	5

Figure 2.1 Location of Site and Sensitive Receptors (Image from Google Earth Pro)

3 Proposed Development

3.1 Overview

The proposed development entails the following elements:

- A building will contain the Service Station shop with toilets and storage, six retail tenancies and an eating area,
- Eight petrol/diesel bowsers for cars, a gas dispenser, and two diesel bowsers for trucks will be installed adjacent to the station shop.
- A canopy over the car bowsers will be joined to the building.
- Two drive throughs are planned for the rear of the building.
- 73 car parks are planned around the site along with a car wash and air/water fill point.
- The operating hours of the service station are not yet known but it is assumed to operate 24 hours.

The proposed site layout is presented in **Figure 3.1**.

3.2 Description of Operations

The proposed development will have three underground fuel storage tanks, of which it is assumed that one will be diesel and 2 tanks will be petrol. For the purpose of this assessment the following has been assumed:

- Neither stage 1 vapour recovery nor stage 2 vapour recovery are assumed for the modelling.
- The maximum total volume of petrol stored at one time will be approximately 90,000 litres.
- Based on the number of dispensers (eight bowsers), the annual fuel throughput rates for the service station are anticipated to be no more than 12 ML/y.
- For the air dispersion modelling emission rates, it has been assumed that the peak rate of dispensing will be 3653 L/h in the daytime between 7am and 7pm, and 1826 L/h between 7pm and 7am.
- ASK has assumed that fuel deliveries will be restricted to between 7am to 7pm.
- Tank vent pipes typically have a diameter of 75 millimetres and this diameter has been assumed for the assessment.

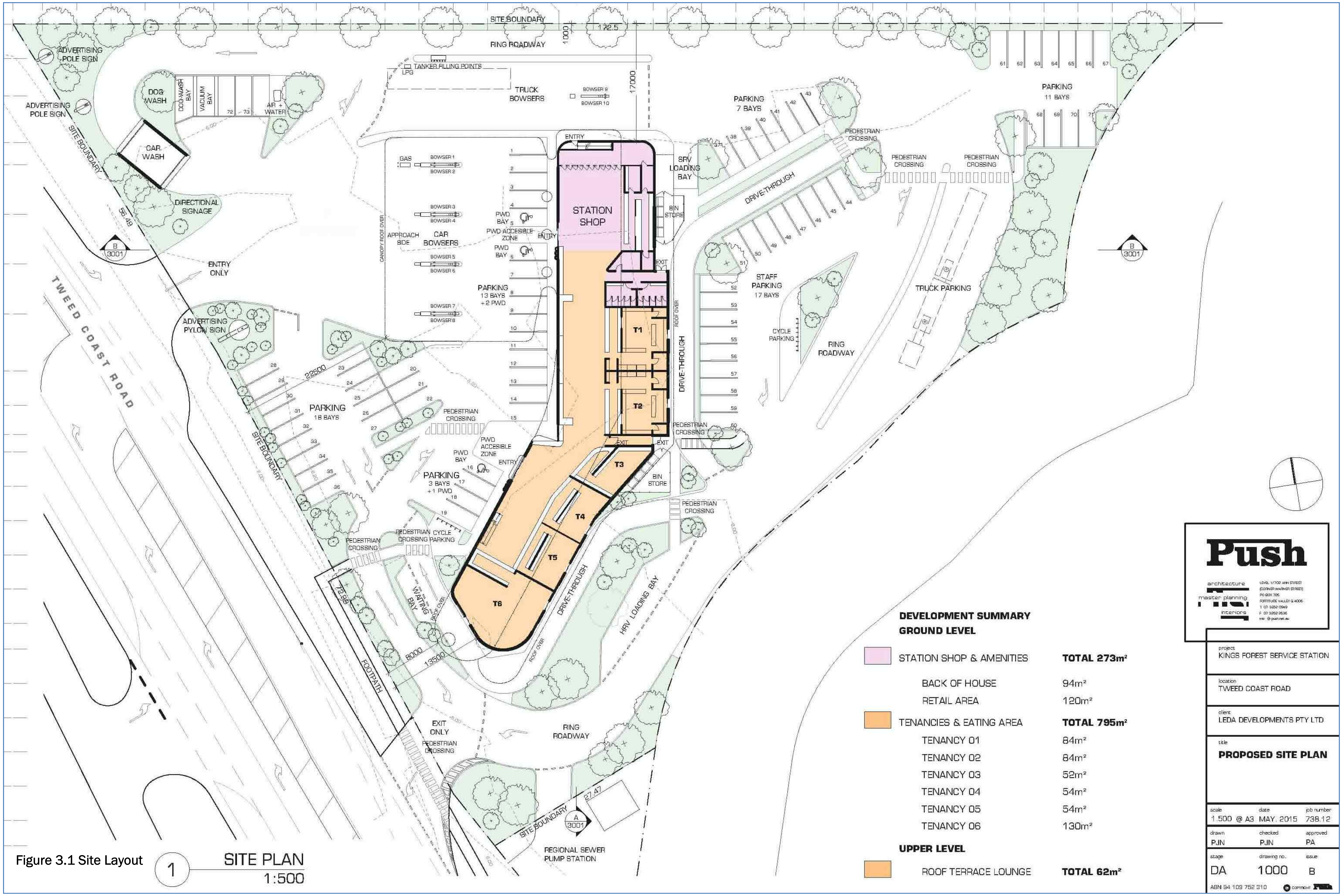


Figure 3.1 Site Layout

4 Air Quality Criteria

4.1 Anticipated Emissions

The operation of the service station would result in the emission of volatile organic compounds (VOCs) from the tank vents, bowsers and spillage. These emission sources are discussed further within Section 6.3.

4.2 Odour Criteria

The relevant criteria for assessment of the cumulative odour from a mixture of compounds are specified by Department of Environment and Conservation (DEC 2006) and reproduced in Table 4.1.

Table 4.1 Cumulative Odour Assessment Criteria (99%, 1 second)

Population of affected community	Criteria (ou)
1 or 2 (Single rural residence)	7.0
~10	6.0
~30	5.0
~125	4.0
~500	3.0
~2000 (urban area or schools or hospitals)	2.0

4.3 Criteria for Individual Pollutants

Impact assessment criteria for individual pollutants are specified by Department of Environment and Conservation (2005), and are based on a 1 hour averaging time and the 99.9 percentile (9th highest hour in one year) modelling prediction. The relevant pollutants are listed in Table 4.2.

Table 4.2 Relevant Air Quality Criteria (DEC 2005)

Pollutant	Criteria (µg/m^3)
benzene	29
cyclohexane	19,000
ethylbenzene	8,000
n-hexane	3,200
styrene	120
toluene	360
xylenes	190

5 Existing Air Quality

Monitoring data from similar locations have been used to represent the existing background. The estimated background concentrations have not been included in the modelling runs but are provided with the results so that the cumulative impact can be compared to criteria.

The nearest permanent monitoring location to the site with publicly available VOC data is the Springwood (in Queensland) monitoring station operated by Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA). VOC monitoring has also been undertaken at Runcorn (in Queensland).

5.1 DSITIA Springwood Monitoring Station

The Springwood DSITIA monitoring station has been located on the grounds of Springwood State High School since 1999. It is relevant to this project as the station undertakes monitoring of VOCs (benzene, toluene and xylene). The Springwood site would be expected to be affected by nearby road traffic sources and petroleum distribution activities and thus would represent a conservatively high background concentration. **Table 5.1** shows the maximum 24-hour average concentrations at Springwood over the period 2001 – 2013. The DSITIA reports state that p-xylene typically makes up approximately 20% of total xylenes. Hence when only p-xylene was monitored, the results have been scaled up by a factor of 5 to enable comparison between years.

Table 5.1 Concentrations Recorded by Queensland DSITIA Air Quality Monitoring Station at Springwood

Year	Maximum 24h benzene (ppb)	Maximum 24h toluene (ppb)	Maximum 24h xylene (ppb)
2001	1.7	17.6 [1]	1.8
2002	1.4	7.1	2.1
2003	1.6	4.7	1.6
2004	1.3	5.9	1.9
2005	1.5	4.9	1.6
2006	1.2	2.5	2.1
2007	1.5	3.8	2.4
2008	1.9	3.5	1.7
2009	0.9	2.3	1.6
2010	1.5	3.8	-
2011	1.9	4.4	8.1
2012	1.3	11.8	11.8
2013	1.2	9.0	13.0
Average	**1.5**	**6.3**	**9.7**
Average (μg/m³)	**4.8**	**24**	**42**

Note: 1. This value was during a bushfire.

5.2 DERM Runcorn Monitoring

VOCs were monitored from September 2009 to March 2010 near the Bradken Resources Foundry at Runcorn (Department of Environment and Resource Management (DERM) 2010). Sampling was completed at three sites. The data summarised in **Table 5.2** includes VOC concentrations averaged across the three sites.

Table 5.2 Summary of DERM Runcorn Monitoring Results Most Relevant to Background

Pollutant	Concentration (µg/m³)
ethylbenzene	0.5
n-hexane	1
styrene	0.6

5.3 Odour

The only regional sources of odour are occasional vegetation fires. Unlike other air quality criteria, odour criterion relate to the source under assessment and any associated odours. Odours from other sources are not considered a cumulative impact unless associated with the same type of source.

For the purpose of comparison with criterion, regional background odour is normally assumed to be zero.

5.4 Other Pollutants

Background concentrations of cyclohexane are not routinely monitored and are expected to be negligible.

6 Assessment Methodology

The methodology of this assessment follows that of a Level 3 odour assessment as stipulated by Department of Environment and Conservation (2006) and the modelling method is according to a Level 2 modelling assessment (Department of Environment and Conservation, 2005), except that local background data was not available so representative statistics were used from another location.

In order to predict what happens to the pollutants after they are emitted to air, a mathematical model is used to simulate their dispersion and deposition. This modelling has large uncertainty associated with it, but is useful in estimating statistical averages over long simulation times.

With sources close to ground level, the critical wind conditions tend to be near-calm i.e. low wind speeds. Gaussian plume models such as Ausplume and Aermod cannot model calm conditions and have low accuracy in light winds, especially in valleys where katabatic flows are present and where drainage flows turn to follow the valley. CALPUFF, being a non-steady-state Lagrangian puff model, is able to simulate stagnation over time, which is critical in calm conditions.

Due to the low source height for emissions sources associated with the Project, the worst conditions may be calm conditions. Thus CALPUFF (Version 6.4.2) was chosen as the most appropriate model. The predictions undertaken for this assessment are based on the following method:

- The activity scenario selected for modelling was chosen based on the highest potential to cause impact to nearby sensitive receivers.
- Emission estimates were based on accepted methods and data consolidated by the National Pollutant Inventory (NPI). The main emission calculation methods utilised are included in Section 6.2.
- Prediction of input meteorology was completed using TAPM developed by the CSIRO Division of Atmospheric Research. TAPM has a prognostic 3 dimensional meteorological component which can be used to generate hourly meteorological data for input into dispersion models.
- Prediction of gas concentrations was undertaken using CALPUFF.

6.1 TAPM

6.1.1 TAPM Fundamentals

The meteorological component of The Air Pollution Model (TAPM) was used to provide wind fields over the region. No site specific meteorological data is available within the vicinity of the subject site.

The databases required to run TAPM are provided by CSIRO and include global and Australian terrain height data, vegetation and soil type datasets, sea surface temperature datasets and synoptic scale meteorological datasets.

The Australian terrain data is in the form of 9-second grid spacing (approximately 0.3 kilometres) and is based on data available from Geosciences Australia. Australian vegetation and soil type data is on a longitude/latitude grid at 3-minute grid spacing (approximately 5 kilometres) and is public domain data provided by CSIRO Wildlife and Ecology.

The synoptic scale meteorology datasets used are a six-hourly synoptic scale analyses on a longitude/latitude grid at 0.75 or 1.0-degree grid spacing (approximately 75 kilometres or 100 kilometres). The database is derived from US NCEP reanalysis synoptic product.

TAPM dynamically fits the gridded data for the selected region to finer grids taking into account terrain, surface type and surface moisture conditions. It produces detailed fields of hourly estimated temperature, winds, pressure, turbulence, cloud cover and humidity at various levels in the atmosphere as well as surface solar radiation and rainfall.

6.1.2 TAPM Configuration

The year 2007 has been used for the meteorological simulation as it experienced typical weather conditions. A run was also performed for 2014, another typical year for the purpose of ensuring consistency of the wind distribution. **Figure 6.1** and **Figure 6.2** illustrate that the frequencies of different wind speeds and directions are similar for the two years.

TAPM was setup using four nested 30 x 30 grids centred on latitude 28°17.0' south, longitude 153°33.5' east, which are coordinates at the nearby property, 194 Tweed Coast Road. The four nested grids were as follows:

- 750 km x 750 km with 30 km resolution
- 250 km x 250 km with 10 km resolution
- 75 km x 75 km with 3 km resolution
- 22.5 km x 22.5 km with 900 m resolution

30 vertical levels were used with lower level steps at 10, 25, 50, 75 and 100 metres up to 8 kilometres in altitude. Boundary conditions on the outer grid were derived from the synoptic analysis. Non-hydrostatic pressures were included.

TAPM land use data was updated using the latest aerial photography available being November 2014 from the Queensland Globe overlay for Google Earth from the Department of Natural Resources & Mines.

With the nearest BoM weather station being Coolangatta airport, which is in a different airshed to the north, there is no data to allow comparison of the TAPM output. However the wind rose (**Figure 6.1**) demonstrates that a high proportion (5%) of the winds are adverse with respect to potential impacts from the the development. Adverse wind is considered to be light wind (0.5-1.5m/s) from the five segments of the windrose from north to east.

Although comparison was unable to be undertaken, the TAPM data was expected to be adequately representative of this location. The TAPM GIS visualisation tool was used to examine the final windfields generated by the model. The last few hours of the year were checked to ensure the model completed the run correctly.

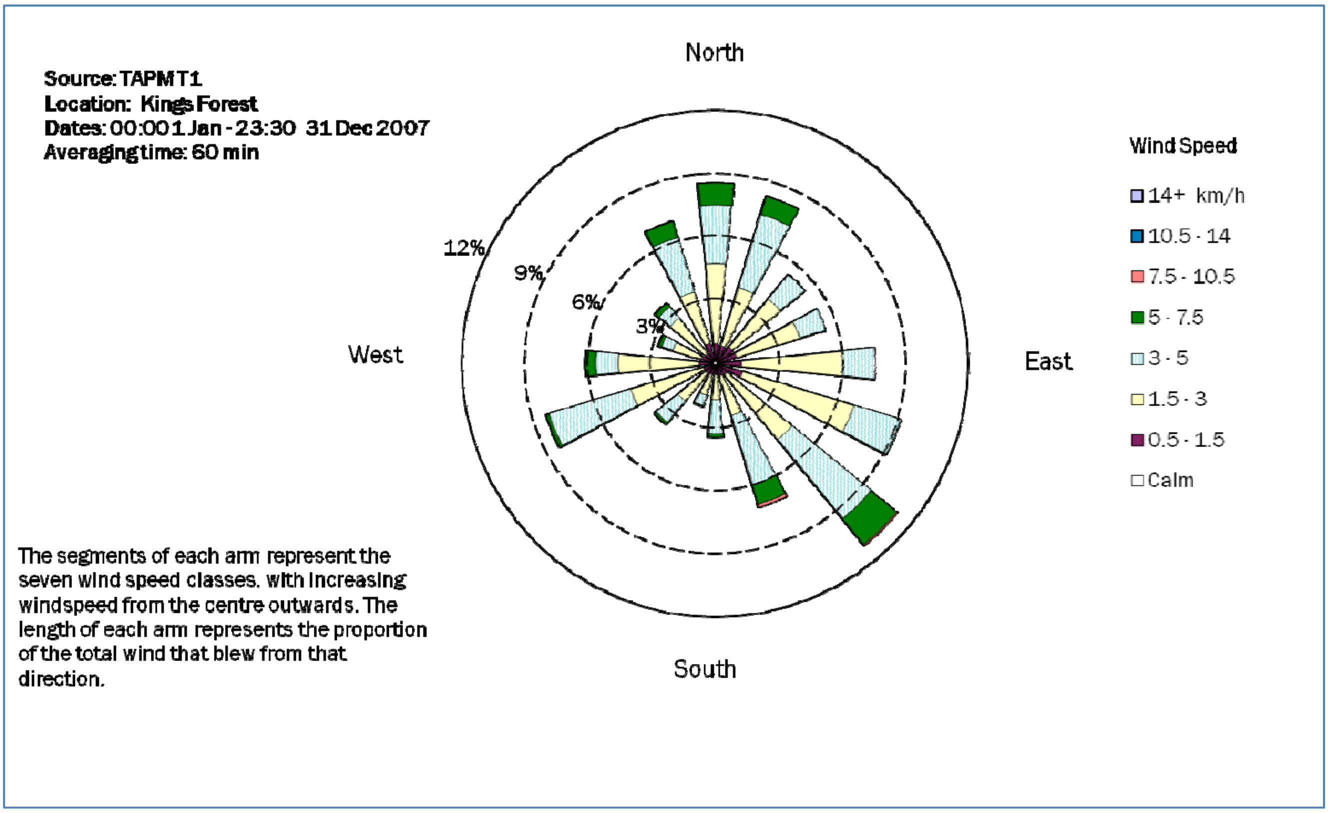


Figure 6.1 Wind Rose of TAPM Data for 2007 Modelling Year Near the Site

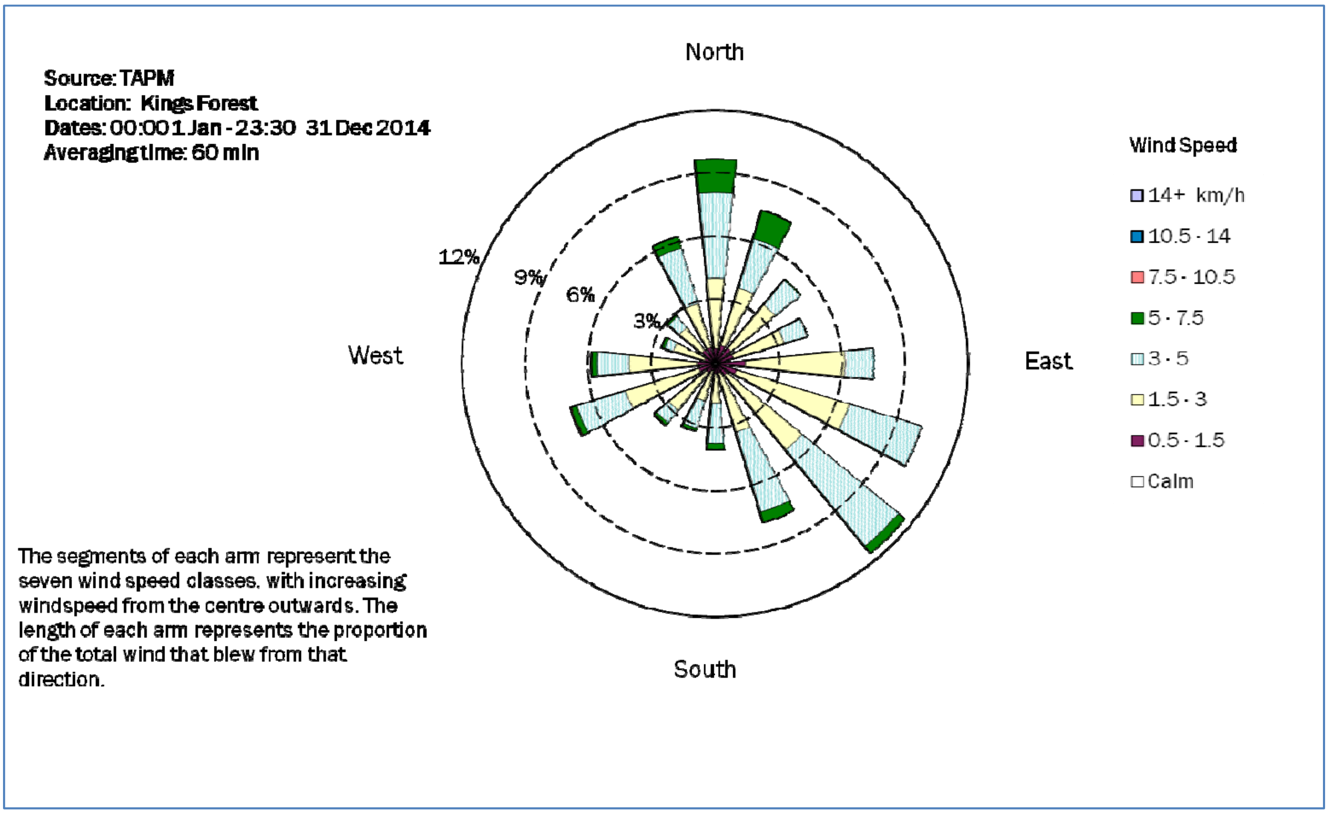


Figure 6.2 Wind Rose of TAPM Data for 2014 Near the Site (not used in modelling)

6.2 Calmet Modelling Configuration

The model was run over the full year of 2007 based on a 3-dimensional grid produced using the Caltapm utility program to convert TAPM data to MM5 format suitable for Calmet to read. The Calmet grid was set to grid spacing of 100 metres and 50 by 50 grid points.

Gridded topographic data for Calmet was created using Global Mapper to process data from Geosciences Australia using the Kriging method. The Geosciences Australia data used was Shuttle Radar Topography Mission (SRTM) elevations on a 1-second grid (approximately 30 metre spacing). There are three versions of this data available to the public:

- Digital Elevation Model (DEM) 1.0 is the raw data.
- DEM-S is smoothed to remove artefact like trees, has better vertical accuracy and should be the best version for most applications.
- DEM-H is smoothed with overlayed hydrological channels to ensure flow connectivity and may be better in steep terrain. However it may have horizontal errors up to 200 metres in flat terrain.

The three data sets were all loaded into the Calpuff View software to determine which was best for this location. The DEM-S was chosen as it included the main topographic features.

Mixing height calculation parameters were set to default values except that the depth of the inversion layer was set to 200 metres above the mixing height and the maximum mixing height was set to 1500 metres to accommodate limitations in the number of layers exported from TAPM. The latter setting will tend to reduce vertical velocity and hence mixing on turbulent days, which is a conservative approach for low sources.

Kinematic effects of terrain on vertical velocity were included with the empirical factor set to the default value of 0.1. Divergence minimisation was used. The critical Froude number was set to 1. The radius of influence of terrain features was set to 3 kilometres.

The output from Calmet was a three dimensional grid of wind-field data for incorporation into Calpuff.

6.3 Emission Inventory Calculations

Emissions from service stations occur due to:

- the loading (refilling) of underground tanks
- tank breathing due to temperature and pressure changes
- the refuelling of vehicles
- fuel spillage associated with the refuelling of vehicles.

Emission factors for the nominated sources have been obtained from:

- National Pollutant Inventory (NPI) "Emission Estimation Technique Manual for Fuel and Organic Liquid Storage" version 3.3 (Environment Australia, 2012)
- National Pollutant Inventory (NPI) "Emission Estimation Technique Manual for Aggregated Emissions from Service Stations" (Environment Australia, 1999).

Emission rates for pollutant species have been calculated based on the following data and information listed in **Section 3.2**:

- Underground tank loading consists of loading 30,000 litres of petrol in a 30 minute period, based on an average fill rate of 1000 L/minute. It is assumed that one tank truck will unload each hour between 7am and 7pm.
- Breathing due to temperature and pressure change will occur for 6 hours every day (6am until 12pm), due to the temperature increase during the day.

- During peak hours (7am to 7pm) the fuel throughput is 3,653 L/hour whilst in off peak hours (7pm – 7am) the fuel throughput is 1,826 L/hour. This assumption results in an annual throughput of approximately 12 ML/year. Department of Environment & Climate Change (2007) states that 82% of service stations in NSW have a throughput of less than 12 ML/year and therefore this assumption is considered appropriate, considering the number of dispensers (eight bowsers).

Emission rates have been calculated based on the following fuel vapour emission factors for petrol from Table 2 of the NPI "Emissions Estimation Technique Manual for Aggregated Emissions from Service Stations" which have been re-presented in **Table 6.1**.

Table 6.1 NPI Emission Factors

Emission Source	Emission Factor (g/throughput (L))
Underground tank filling without vapour recovery	0.88
Underground tank breathing/emptying	0.12
Vehicle refuelling (uncontrolled)	1.32
Spillage	0.08

Using the emission factors presented in **Table 6.1** and the assumptions nominated, the estimated fuel vapour emission rates for underground tank loading, tank breathing, refuelling and spillage at bowsers have been calculated and are shown in **Table 6.2**.

Table 6.2 Fuel Vapour Emission Rates

Activity	Fuel Vapour Emission Rates (g/s)
Underground Tank Loading	7.3
Breathing (6am to 12pm)	0.17
Refuelling – Peak Period (7am to 7pm)	1.34
Refuelling – Off Peak (7am to 7pm)	0.67
Spillage – Peak (7pm to 7am)	0.08
Spillage – Off Peak (7pm to 7am)	0.04

The individual pollutant emission rates have been calculated on the basis of the liquid and vapour species weight percentages presented in **Table 6.3**. The liquid weight percentages in **Table 6.3** have been obtained from Table 2 of DEWHA (2012) with the vapour weight percentages obtained from Appendix F5 of DEWHA (2012). The weight percentages of the pollutants have been taken for Unleaded Petrol (ULP) as this type is anticipated to have the largest quantity used. Styrene data has been taken from Environment Australia (1999) as this information is not presented in DEWHA (2012).

Table 6.3 Liquid and Vapour Weight Percentages (for PULP)

Pollutant Species	Liquid Weight Percentage (%)	Vapour Weight Percentage (%)
benzene	2.9	0.41
cyclohexane	0.2	0.35
ethylbenzene	2.0	0.06
n-hexane	3.5	1.3
styrene	0.1	0.003
toluene	10.4	0.70
xylenes	12.2	0.27

Based on the liquid and vapour percentages presented in **Table 6.3** the calculated emission rates for each species are shown in **Table 6.4**.

Table 6.4 Pollutant Emission Rates (g/s)

Activity	benzene	cyclohexane	ethyl benzene	n - hexane	styrene	toluene	xylene
Breathing	0.001	0.001	0.0001	0.00	0.00000	0.00	0.000
Underground Tank Loading	0.060	0.051	0.0094	0.19	0.00041	0.10	0.040
Refuelling – Peak Period	0.005	0.005	0.0009	0.02	0.00004	0.01	0.004
Refuelling – Off Peak	0.003	0.002	0.0004	0.01	0.00002	0.00	0.002
Spillage – Peak Period	0.002	0.000	0.0016	0.00	0.00008	0.01	0.010
Spillage – Off Peak	0.001	0.000	0.0008	0.00	0.00004	0.00	0.005

6.4 Cumulative Odour

The impact of odour from fuel vapour emissions has been assessed based on the published odour thresholds of the individual compounds identified. The odour detection thresholds shown in **Table 6.5** are the geometric mean of those quoted by AIHA (2013), Amoore and Hautala (1983) and Devos et al (1990). Odour concentrations are defined as the number of dilutions required for a sample to reach the odour threshold. Thus the odour emission rate is the compound's emission rate divided by the odour threshold. The emission concentrations of all compounds have been converted to odour concentrations and summed to give the cumulative odour emission rate shown in **Table 6.6.**

Table 6.5 Odour Thresholds

Compound	Odour Threshold (mg/m3)
benzene	24
cyclohexane	117
ethylbenzene	4.6
n - hexane	58
styrene	0.67
toluene	7.6
xylene	2.5

Table 6.6 Cumulative Odour Emissions from Each Source

Source	Cumulative Odour Emission Rate (ou m3/s)
Underground Tank Loading	38
Breathing	0.4
Refuelling & Spillage– Peak Period (7am-7pm)	9.1
Refuelling & Spillage – Off Peak (7pm-7am)	4.6

6.5 Other Source Parameters

Other source parameters used in modelling are provided in **Table 6.7**. In the model, the tank vent was located in the garden bed adjacent to the air and water fill point. This location is approximately 35 metres from the kerb of the Tweed Coast Road.

Table 6.7 Other Source Parameters

Source	**Easting (m) WGS84**	**Northing (m) WGS84**	**Horizontal spread / Diameter (m)**	**Vertical spread (m)**	**Mid Height (m)**	**Velocity (m/s)**	**Temperature (°C)**
Tank Loading & Breathing	555234	6871003	0.075	-	4.5	14.7	20
Refuelling & Spillage	555261	6870984	6.98	3.26	3.5	-	20

Building downwash using BPIP and Prime was included for the service station store with one tier (7 metres high) included in the model.

6.6 Calpuff Configuration

A 3D meteorological file generated by Calmet was entered into Calpuff for the full year 2007. Calpuff was run over the full meteorological grid (5 kilometres x 5 kilometres) with spacing of 100 metres, and with receptors gridded over a smaller domain (1.6 kilometres x 1.4 kilometres with a nesting factor of 4 to achieve a resolution of 25 metres. Chemical transformation was not included in the modelling which causes an over-prediction of airborne concentrations.

Transitional plume rise and vertical wind shear (abrupt changes in direction with height) were included. Puff-splitting was turned on.

Dispersion coefficients used were calculated using turbulence from local meteorology. The Heffter curve was used to compute time-dependent dispersion beyond 550 metres. The partial plume height adjustment method was used to allow winds to approach hills as terrain increases. Coefficients were set to 0.5 for unstable and neutral conditions, and 0.35 for stable conditions allowing the plume to approach the ground faster in stable conditions.

7 Dispersion Modelling Results

7.1 Limitations

The uncertainties associated with this type of assessment are normally only dealt with in a qualitative manner, but include:

- emission factor techniques
- source strength variability
- meteorological data variability
- inherent uncertainty in dispersion modelling.

Typically 95% confidence intervals are estimated to require a multiplicative factor of 2 or 3. In this case, the uncertainty is high due to assumptions regarding the details of emission sources and operating information. Hence the results should be interpreted as providing an indication of impacts.

In addition to these uncertainties, the modelling has many conservative assumptions that will over-predict the ambient concentrations including the following:

- Because the actual times of tank filling are unknown, the model assumes that one tank truck will undertake tank filling every hour between 7am and 7pm. In reality there will only be a tank truck loading for one or two hours during the day.
- The scenario modelled assumes high volumes of fuel usage and consequent high emission rates.
- The model assumes that the high emission rates coincide with most adverse meteorological conditions, which is unlikely.

7.2 Gas Concentration Results

The predicted concentrations (not including background concentrations) at sensitive receptors are shown in **Table 7.1** and **Table 7.2** along with the criteria and estimated background levels.

The cumulative (including background) 99.9 percentile 1-hour benzene concentrations at the most affected receptor (E) is 20 µg/m^3, within the criterion of 29 µg/m^3. Predicted concentrations of other compounds and cumulative odour are orders of magnitude within the criteria.

The predicted 99.9 percentile 1-hour benzene ground level concentrations are illustrated in **Figure 7.1.** Other gases are not shown since the concentrations are more than an order of magnitude within the criteria. The concentrations illustrated in **Figure 7.1** include the assumed background concentrations.

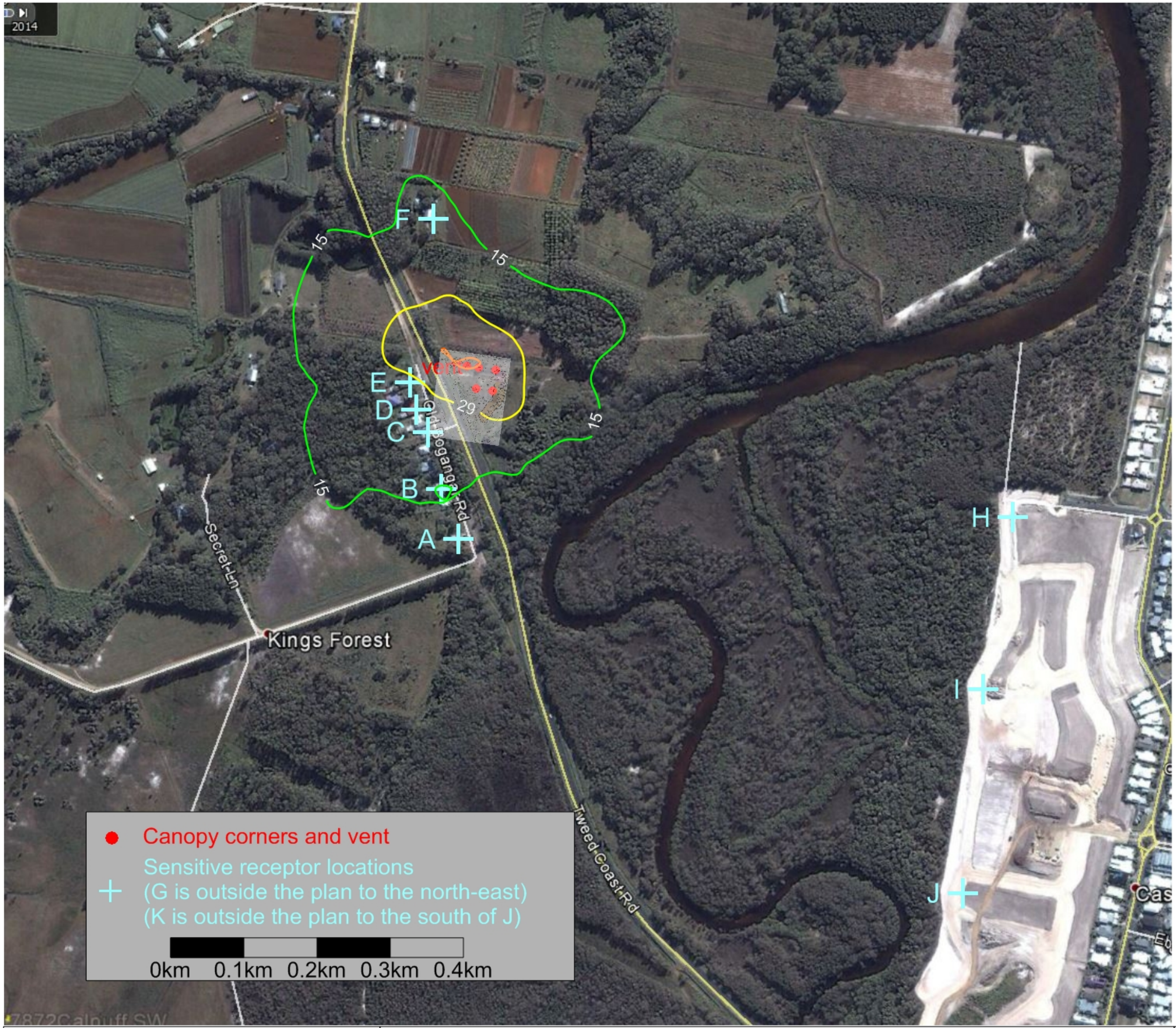
Table 7.1 Predicted 99.9 Percentile Gaseous Concentration Levels at 1.5 Metre Height

Receptor ID#	benzene (µg/m3)	cyclohexane (µg/m3)	ethylbenzene (µg/m3)	n-hexane (µg/m3)	styrene (µg/m3)
Background	5	0	1	1	1
Period	1 hour	1 hour	1 hour	1 hour	1 hour
Criterion	29	19,000	8,000	3,200	120
A	6	5	1	19	0.1
B	9	7	2	28	0.1
C	12	10	2	41	0.1
D	14	11	2	44	0.1
E	15	12	3	50	0.1
F	10	7	2	30	0.1
G	1	1	0	4	0.0
H	1	1	0	4	0.0
I	1	1	0	4	0.0
J	1	1	0	2	0.0
K	1	1	0	2	0.0

Table 7.2 Predicted Gaseous Concentration Levels (cont)

Receptor ID#	toluene (µg/m3)	xylene (µg/m3)	odour (OU.m3/s)
Background	24	42	0
Period	1 hour	1 hour	99.9 percentile 1 second [1]
Criterion	360	190	2 to 7
A	11	6	0.01
B	16	8	0.01
C	21	10	0.02
D	24	11	0.02
E	27	14	0.03
F	19	10	0.02
G	3	1	0.00
H	2	1	0.00
I	2	1	0.00
J	1	1	0.00
K	1	1	0.00

Note: 1. Odour criterion is based on the 99th percentile, which is not a standard parameter from Calpost. The higher 99.9th percentile concentrations are shown here.



ask ACOUSTICS & AIR QUALITY

ASK Consulting Engineers Pty Ltd
Level 2, 43 Peel Street
PO Box 3901
South Brisbane. QLD 4101
P 07 32553355 F 07 38447180
www.askconsulting.com.au
mail@askconsulting.com.au

Drawing Ref 7872R01V01

Kings Forest Service Station
99.9 percentile 1-hour benzene concentrations (ug/m3)

Client
Project 28
(Image from Google Earth Pro)

Figure 7.1

Drawn by AM

Revision Date 07/05/2015

N

MGA94 Z56

This figure should be read in conjunction with the data disclaimer at the front of this report.

8 Discussion

8.1 Summary of Results

Predicted concentrations and levels of all indicators are within the relevant criteria as summarised in **Table 8.1**.

Predicted concentrations of all pollutants are within the criteria.

The highest predicted concentration of benzene at a sensitive receptor is 20 µg/m³ (including background), within the criterion of 29 µg/m³. As discussed in **Section 7.1**, there are substantial conservative assumptions, so the chance of benzene exceeding the criterion is considered to be low. It is very unlikely that exceedances of any other pollutant criteria would occur.

Table 8.1 Summary of Results

Indicator & Averaging Period	Worst Affected Receptor	Prediction from Model (µg/m³)	Cumulative Prediction with Background (µg/m³)	Criterion (µg/m³)
1 hour benzene	E	15	20	29
1 hour cyclohexane	E	12	12	19,000
1 hour ethylbenzene	E	3	4	8,000
1 hour n-hexane	E	50	51	3,200
1 hour styrene	A to F	0.1	1.1	120
1 hour toluene	E	27	51	360
1 hour xylene	E	14	56	190
99.9 percentile 1 second odour	E	0.03 (ou)	0.03 (ou)	2 to 7 (ou)

8.2 Recommendation

1. The location of the vent pipes for the tanks were modelled adjacent to the air and water fill point. The shape of contours in **Figure 7.1** indicates that locating the vent pipes to the west or directly to the south may result in predicted levels higher than the criterion. Thus it is recommended that the vent pipes be located either adjacent to the air and water fill point, or to the north or east of the station shop, as shown in **Figure 8.1**. This recommendation may not be required if Stage 1 vapour recovery were installed.

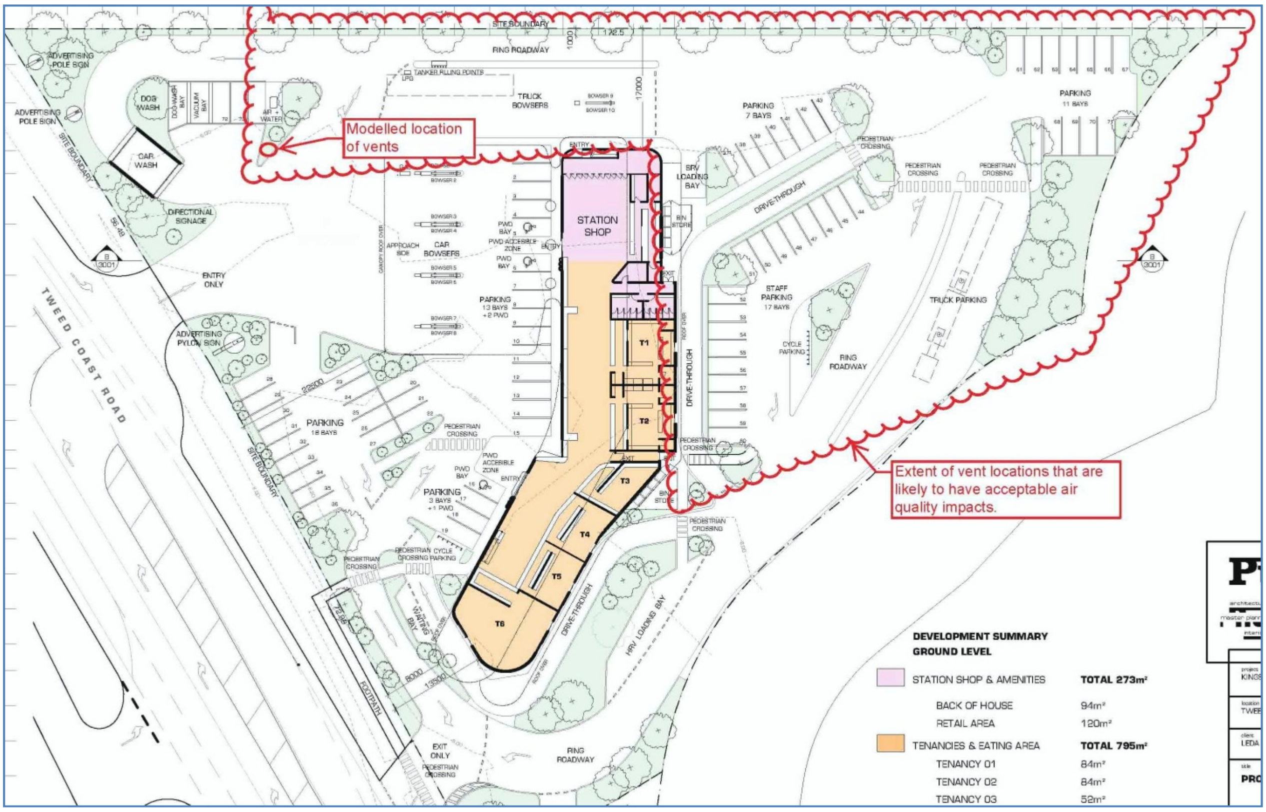


Figure 8.1 Vent Locations

8.3 Conclusion

An air quality assessment has been conducted for the proposed service station development to be located on Lot 7 DP875447, Tweed Coast Road, Kings Forest. The results of the assessment are summarised as follows:

- The location of the vent pipes should be as recommended in Section 8.2.
- Based on the methodology used, and the locations assumed, concentrations of specific VOCs and odour are predicted by the dispersion model to be within the relevant criteria at nearby sensitive receptors. It is considered unlikely that exceedances would occur.

References

AIHA 2013, *Odor Thresholds for Chemicals with Established Occupational Health Standards*, 2nd Ed, American Industrial Hygiene Association.

Amoore J. and E. Hautala (1983), *Odor as an Aid to Chemical Safety*, Journal of Applied Toxicology, pp272 – 290.

Department of Environment and Conservation (2005), *Approved Methods for the Modeling and Assessment of Air Pollutants in New South Wales*.

Department of Environment and Conservation (2006), *Technical Framework: Assessment and management of odour from stationary sources in NSW*.

DEWHA (2012), National Pollutant Inventory *Manual for Fuel and organic liquid storage* version 3.3.

Devos M., F.Patte, J.Rouault, P.Laffort, L.J.Van Gemert 1990, *Standarized Human Olfactory Thresholds*, Oxford University Press.

Environment Australia (1999), National Pollutant Inventory *Manual for Aggregated Emissions from Service Stations.*

United States Environmental Protection Agency (1999), *Compilation of Air Pollutant Emission Factors, EPA AP-42*, Emission Factor and Inventory Group, 7th Ed, USEPA.

Vershueren K. (1996), *Handbook of Environmental Data on Organic Chemicals* 3rd Edition, Van Nostrand Reinhold.

Appendix A Glossary

Parameter or Term	Description
ASK	ASK Consulting Engineers Pty Ltd
DEC	New South Wales Department of Environment and Conservation
DSITIA	Queensland Department of Science, Information Technology, Innovation and the Arts
m/s	Metres per second
mg/m^3	Milligrams per cubic metre
ppm	Parts per million by volume
TAPM	The Air Pollution Model developed by CSIRO and used by ASK for meteorological modelling
µg/m^3	Micrograms per cubic metre
USEPA	United States Environmental Protection Agency
VOCs	Volatile organic compounds