Huon Aquaculture Group Pty Ltd

Parramatta Creek Fish Processing Facility

APPENDIX D

PARTICULATE MODELLING

HUON AQUACULTURE – PARRAMATTA CREEK FISH PROCESSING FACILITY

SMOKER STACKS - PARTICULATE DISPERSION MODELLING

DOCUMENT CONTROL

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1. INTRODUCTION

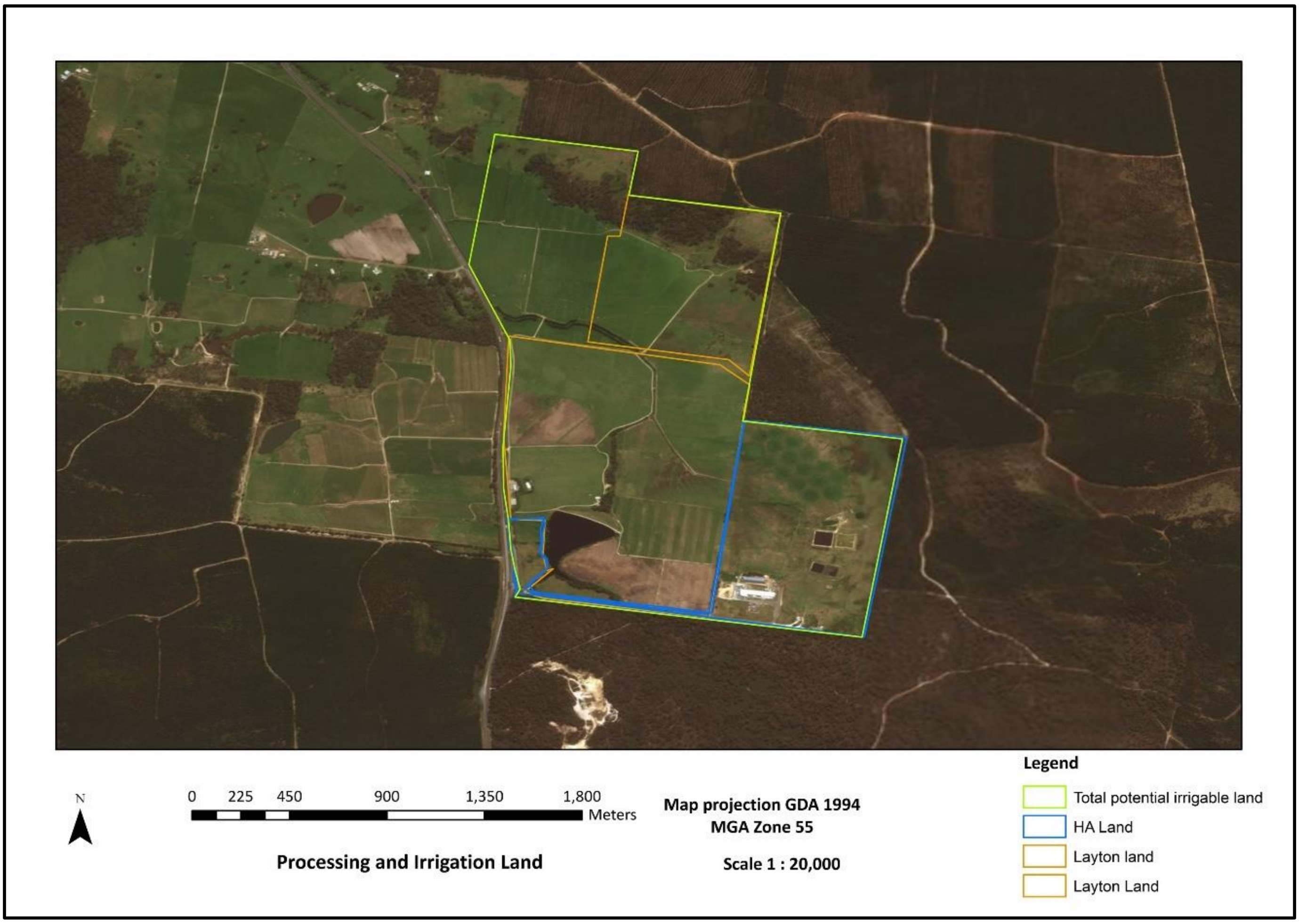
Airlabs Environmental was commissioned by Caloundra Environmental on behalf of HUON Aquaculture (HA) to undertake assessment of particulate matter emissions for smokehouse stacks ('particulate assessment') at HA's fish processing facility at Lot 1, 7218 Bass Highway, Sassafras, Tasmania 7307 (the facility).

The facility is located approximately 25km south-west of Devonport at Lot 1, 7216, Bass Highway, Sassafras, Tasmania. The processing site is located on 56 ha of land and is owned by HA.

In addition to the existing land, HA are planning to utilize land immediately adjacent to the facility being124-ha located at 7218 Bass Highway, Sassafras, which is owned by Mr. Troy Layton. Airlabs understand that HA has an agreement with Mr. Layton to irrigate treated wastewater on his land, once HA receives environmental approval.

Figure 1 shows the land owned by Mr. Layton (as indicated by brown color), adjacent to the HA owned land (blue color) and the total irrigable land (green color). The HA land (blue color) constitutes the boundary of the facility.

Figure 1: Facility Boundary



Ref: Caloundra Environmental, December 2017

2. ASSESSMENT OBJECTIVE

Commissioning tests were conducted by LEC Environmental in February 2016 (LEC, Feb 2016) to measure the particulates release from the smokehouses. The findings of the test were submitted in the *Smokehouse Construction and Commissioning Plan* prepared by LEC Environmental (LEC, April 2016).

In 2015, the EPA issued HA with Project Specific Guidelines for a Development Proposal and Environmental Management Plan for the Proposed Fish Processing Facility Production Increase. These included a requirement to undertake atmospheric dispersion modelling in relation to identified emissions sources where there is the potential for environmental harm to occur.

The objective of this assessment is to predict particulate impacts in the vicinity of the HA's fish processing facility. Particulate emissions measured during the commissioning tests were modelled using an appropriate air dispersion modelling package to predict the extent of particulate impacts from the facility's smokehouse operations on the surrounding environment. The predicted impacts are compared against relevant particulate assessment criteria specified in the Air Quality EPP.

3. DESCRIPTION OF SMOKEHOUSES OPERATIONS

3.1 Smokehouse Operations

The structure and operation of the smokehouses was described in the *Smokehouse Construction and Commissioning Plan* developed by LEC in April 2016 and submitted to the Tasmanian EPA by HA. Relevant sections from that plan are reproduced below.

There are three identical smokehouses installed at the Huon Aquaculture Parramatta Creek Processing Facility. These are Reich Airmaster® UKQ 10000 BE G 505 H units as described in LEC, 2016.

3.2 Smoking Cycles

There are two types of smoking processes in use at Huon Aquaculture, referred to as Hot Smoke and Cold Smoke. The cycles are different for each type.

- Hot Smoking

  The hot smoke cycle involves heating the core of the fish to 65°C for at least 10 minutes and heating the smokehouse chamber to up to 90°C using heaters mounted to the roof to achieve this. The hot smoke process usually runs for 6 to 7 hours and it has the following steps:

  1. Warming
  2. Drying
     - Intensive Smoke
     - Smoke Reduction
     - Drying

  (this repeats a further 3 times)

- Cold Smoking

  The cold smoke cycle involves heating the core of the fish to 12 - 14 °C using a chamber temperature of up to 26°C. The cold smoke process usually runs for approximately 11.5 hours and has the following steps:

  1. Warming
  2. Drying Cool

- Intensive Smoke Cool
- Smoke Reduction
- Drying FA1
- Drying FA1 Cool

(this repeats a further 6 times)

3.3 Smoker Emission Production

The smoke generator has a restricted oxygen supply and operates at a temperature between 600°C and 800°C so that the Redgum wood chips do not combust. The smoke is then released from the smoke generator into the smokehouse (the temperature of the smoke is controlled to be between 30°C and 100°C) where it circulates around the product, fresh air is then used to displace the smoke. The ratio of transport air and smouldering air must be kept at a ratio of 20:1 to ensure that explosive smoke densities are never reached (this is specified by German safety regulation BGR 138).

Smoke is only emitted from the smokehouses during certain steps during the cycles. During the Intensive Smoke (Hot Smoke) and Intensive Smoke Cool (Cold Smoke) steps, the majority of the smoke is being recirculated inside the smokers. However, the ventilation system is arranged so that during this step there is a low velocity "overflow" of smoke that spills out of the stack. This step of the process has a maximum duration of 20 minutes.

During the Smoke Reduction step, the external ventilation is closed off so as to settle the remaining smoke on to the product by recirculating the smoke. There is no exhaust air flow during this time, however occasionally there can be a small amount of smoke already in the stack that can be sucked out by the wind giving the appearance of an emission during this stage.

At the start of the Drying (Hot Smoke) and Drying FA1 (Cold Smoke) steps that follow an Intensive Smoke, the ventilation system opens, and the air and smoke contained within the smoking chamber is emitted at higher velocity. The smoke is displaced quite quickly and is generally displaced by clean air within about 3 minutes.

3.4 Smoker Use

Smoking is carried out as a batch process in shifts. In the 2018/2019 financial year approximately 3% of total product produced was smoked. Smoking is value adding process which provides for fish which are not (A) sashimi grade or (B) whole fish grade, to be sold. The smokehouses currently operate 12–14 hours per day, 5 days per week with extra shifts in peak periods. Current smoked product production is 3.2 tonnes (2 batches at 1600 kg each) per smoking shift, for a total of 956 tonnes per financial year.

The smokehouses were built to cope with additional capacity and as a consequence can deliver sufficient product to meet the proposed production increase and proposed value-added sales forecasts. Smoker capacity can be increased by utilising additional smoker trays in the smokers above the current level because the smokers were installed with a design capacity of 2 tonnes per batch.
It is not predicted therefore that any additional smoking batches will occur under the proposed increased production of 33,000 tonnes per annum.

At full production capacity (33,000 tonnes per annum) each smoking shift lasting approximately 800 minutes and will involve either:

- 1 x hot smoke batch and 1 x cold smoke batch or
- 2 x hot smoked batches or
- 2 x cold smoked batches

With the smokers operating for 299 shifts per year (depending on demand) and producing 4 tonnes of smoked product per shift. This will equate to a total production of 1,196 tonnes per financial year. without the need to introduce increased smoking days and therefore without increasing emissions above current levels. This allows for some flexibility in the operation of the smokers with reductions in the number of smoking shifts a possibility.

Smoked product is predicted continue to account for approximately 3% of total processed product.

Table 1: Seasonal Smoker Use and Smoked Production Forecast

FY 2021/2022	Tonnes total production	Smoking tonnes at 3%	Total smoke shifts
Jul	2,330	69.9	22
Aug	2,592	77.76	24
Sep	2,555	76.5	24
Oct	2,760	82.8	25
Nov	2,863	85.89	26
Dec	2,959	88.77	27
Jan	2,866	85.93	26
Feb	2,887	86.61	27
Mar	2,874	86.22	27
Apr	2,366	70.98	22
May	2,798	83.94	26
Jun	2,515	75.45	23
Total	32,365	970.95	299

4. CHARACTERISATION OF PARTICULATE EMISSIONS

TAS EPA provided specific directions in terms of modelling particulate emissions, where in the particulate component as well as the measured fish oil component from the smoker stacks needed to be considered for determination of the particulate emission rate.

The methodology to characterise the particulate emissions as provided by the EPA is presented below in italics:

"Calculate a total particulate matter emission rate comprising solid/liquid and volatile (condensable) particles to be used as representative emission rate for each of the stacks. The result is to be used as a PM_{10} *emission rate for modelling purposes, acknowledging that it would represent a conservative approach. From our discussions last week it is understood that the total particulate emission matter rate could be calculated using existing data without the requirement for further testing."*

"Undertake air dispersion modelling to determine whether the PM_{10} *design criteria listed in Schedule 2 of the Environment Protection Policy (air quality), 2004 can be satisfied."*

In response to the above comments from TAS EPA, Airlabs have developed particulate matter emission inventory from the stack sampling conducted by LEC in February 2016.

4.1 Particulate Emission Rates from Smokehouse

Airlabs have calculated the mass emission rates for particulate matter, which are presented in **Table 2.**

Other stack parameters (e.g. temperature and exit velocity) are also collated from the LEC report and presented **Table 2**. The approach employed was to calculate the in-stack volumetric flow rate based on measured exit velocity and cross-sectional area of stack; and then multiplying it with measured concentrations at stack conditions to calculate the mass emission rates.

Table 2: Summary of LEC Environmental Test Report (LEC, February 2016)

Parameter	Units	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
Smoker number hot/cold		Smoker 1 - Hot	Smoker 1 - Hot	Smoker 2 - Cold	Smoker 3 - Cold	Smoker 1 - Hot	Smoker 1 - Hot	Smoker 2 - Hot	Smoker 3 -Hot	Smoker 3 -Hot	Smoker 3 -Hot
Test details		intensive smoke cycle only, low velocity	intensive smoke, smoke reduction and start of drying cycle	intensive smoke, smoke reduction and start of drying cycle	intensive smoke, smoke reduction and start of drying cycle	intensive smoke, smoke reduction and start of drying cycle	smoke reduction and start of drying	smoke reduction and start of drying	intensive smoke, smoke reduction and start of drying cycle	intensive smoke, smoke reduction and start of drying cycle	intensive smoke, smoke reduction and start of drying cycle
Reported particulate matter concentration	mg/m^3 (STP dry)	712	1461	980	1041	1215	354	1141.7	996	1436.1	1245.9
Stack diameter	m	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345	0.345
Average traverse velocity (exit velocity)	m/sec	0.4	9.4	9.1	9.5	8.4	8.4	8.4	8.4	8.4	8.4
Actual volumetric flow rate	m^3/sec	0.037	0.879	0.851	0.888	0.785	0.785	0.785	0.785	0.785	0.785
Average flue temperature	^0C	36.5	40.6	21.7	22.4	29.6	37.6	34.7	39	40.4	40.4
Moisture percentage	%	3.6	3.9	2	1.9	1.9	2.4	2.5	2.9	3.3	3.6
Calculated particulate matter concentrations	mg/m^3 (calculated to stack conditions)	605	1222	890	944	1075	304	988	846	1210	1046
Calculated particulate matter emission rates	g/sec	0.023	1.07	0.76	0.84	0.84	0.24	0.78	0.66	0.95	0.82

To estimate hourly emissions of particulates (required for input in CALPUFF model), the following methodology was employed by Airlabs.

Hot Smoke

Each hot smoke shift lasts for 13.3 hours. Break down of one Hot smoke shift is as shown below in **Table 3**.

Table 3: Break-down of Hot Smoke Shift

Process Description	Minutes	Expected emissions
Warming	10	No emissions
Intensive smoke	20	Low velocity emissions
Smoke reduction	3	High velocity emissions
Drying	67	No emissions
One cycle	100 (10+20+3+67)	23 minutes of emissions
One batch	400 (4 cycles per batch)	23*4 = 92 minutes of emissions
One smoke shift	800 (2 batches per shift)	92*2 = 184 minutes of emissions
One day of operations	One 800 min smoke shift per day	184 minutes of emissions per day

Based on the analysis of data presented in **Table 2**, Airlabs propose the use of Test 2 and Test 5 data for hot smoke operations.

Test 2 was conducted for 25 minutes of operations and captured all the cycles with potential to emit emissions, namely:

- Intensive smoke (20 min),
- smoke reduction (3 min), and
- start of drying (2 min out of 67 min of drying) of operations

Test 5, Test 8, Test 9 and Test 10 also captured the operations of interest, however the highest emission rates (1.07 g/s) was measured for Test 2. The lowest exit velocity (8.4 m/s) and temperature (29.6 0C) were recorded by Test 5.

Airlabs propose the use of 1.07 g/s of emission rates for 23 minutes of emissions. For the remaining 77 minutes (i.e. 100 – 23) in cycle, it is assumed that there are no emissions released.

To translate 23 minutes of emissions per 100 minutes into modelling inputs, the following approach is proposed:

- 23 minutes of emissions are released every 100 min of operations per cycle.
- 92 minutes of emissions are released every 400 minutes of operations per batch.
- 184 minutes of emissions are released every 800 minutes of operations per shift.
- 800 minutes of operations = approximately 13 hours of operations.
- Assuming that operating hours for the hot smoke operations are 7 AM to 8 PM (13 hours a day), Airlabs proposes to distribute the 184 minutes of emissions across 13 hours of operations.
- Hence, emissions per hour will be 184/13 = 14.15 minutes of emissions.

- Hence for each modelled hour, emission rate of 1.07 g/s will be applied to 14.15 minutes and zero emissions for 45.85 minutes.
- Equivalent hourly emission rate, across the modelled hour = 1.07 g/s * 14.15/60 = 0.252 g/s.

Cold Smoke

For cold smoke shift, a similar approach will be employed.

Each cold smoke shift lasts for 13.3 hours. Break down of one cold smoke shift is as shown below in **Table 4**.

Table 4: Break-down of Cold Smoke Shift

Process Description	Minutes	Expected emissions
Warming	10	No emissions
Drying cool	10	No emissions
Intensive smoke cool	20	Low velocity emissions
Smoke reduction	3	High velocity emissions
Drying FA1	35.5	No emissions
Drying FA1 cool	35.5	No emissions
One Cycle	114 (10+10+20+3+35.5+35.5)	23 minutes of emissions per cycle
One Batch	800 (7 cycles per batch)	23*7 = 161 minutes of emissions per batch
One smoke shift	800 (1 batch per shift)	161 minutes of emissions per batch
One day of operations	One 800 min smoke shift per day	161 minutes of emissions per day

Based on the analysis of data presented in **Table 2**, two tests (Test 3 and Test 4) were conducted for cold smoke operations. Airlabs propose the use of Test 4 data for estimating emission rates for cold smoke operations as it has the highest emission rates. The stack characteristics will be used from Test 3 as it recorded lower exit velocity and temperature.

Using same approach as hot smoke, 161 minutes of emissions per 800 minutes translates to roughly 12.38 minutes of emissions for each of the 13 modelled hours per day.

The equivalent hourly emission rate, across the modelled hour = 0.84 g/s * 12.38/60 = 0.173 g/s.

4.2 Operating Hours of Smokers

At maximum production in 2020, HA forecasts 299 smoking shifts per annum. Each smoking shift lasting approximately 800 minutes. For the sake of simplicity in modelling, Airlabs have assumed 365 days of operations per year i.e. 365 smoking shifts per annum and shift occurring between 7 AM to 8 PM. It is noted that such approach, although may seem conservative, is necessary to ensure that the worst meteorological day is captured by the model.

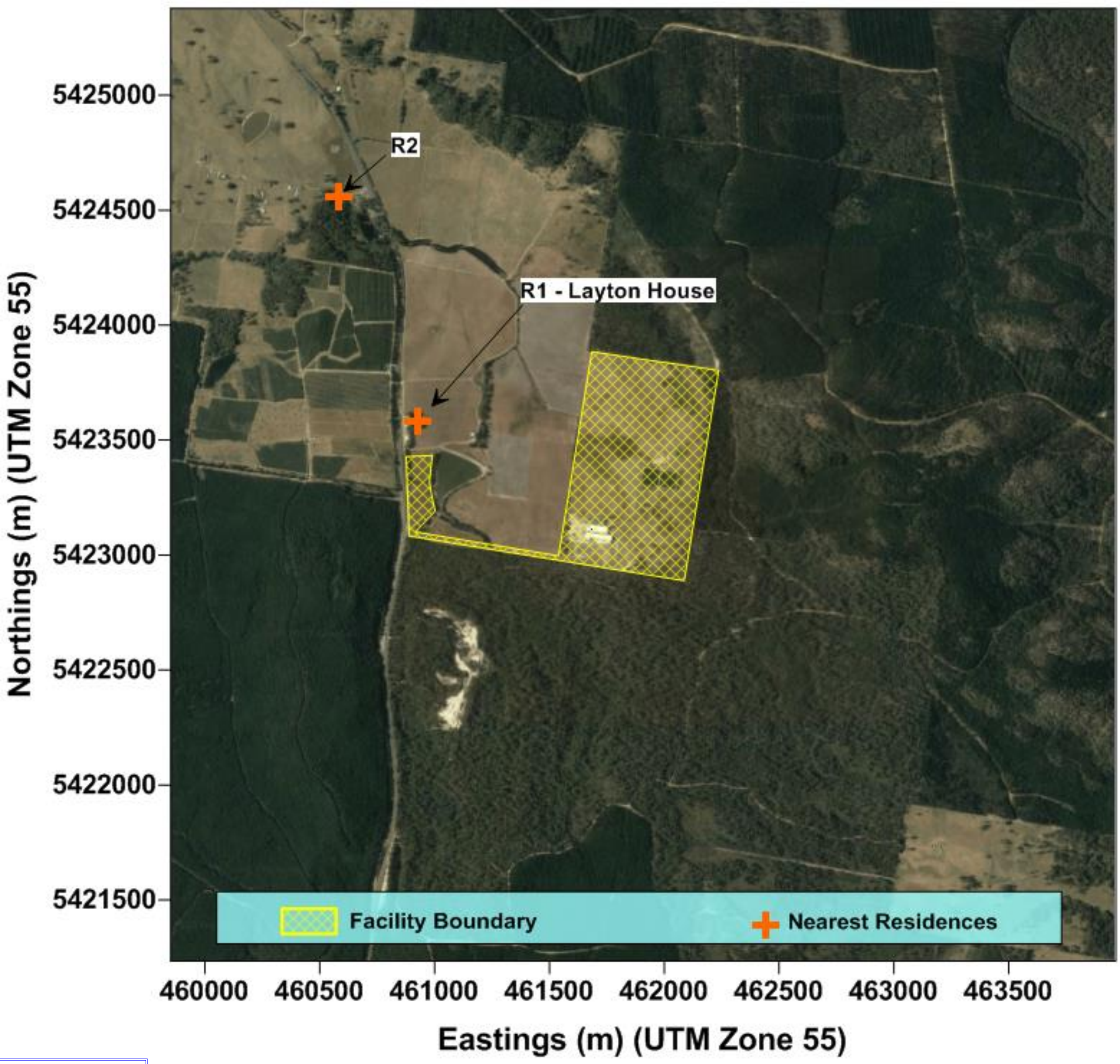
5. STUDY AREA AND SURROUNDS

The HA facility is located approximately 25km southeast of Devonport in Sassafras, Tasmania. Through aerial imagery and observations made during the site inspection, it is noted that there are two existing dwellings, in the nearby vicinity of the HA facility.

The nearest existing residential receptor (R1) is land owned by Mr. Layton. Second receptor (R2) is located more than 1 km northwest of the HA facility. The identified sensitive receptors (as shown in **Figure 2**) are the closest receptor to the facility amongst a set of scattered and sparse residential dwellings.

Based on discussions with Mr. Stephen Kent from Caloundra Environmental, it is very unlikely that there would be any future residential or commercial / industrial developments in the immediate surrounds, as the land-use is predominantly identified as either timber production or timber reserves. Consequently, no additional sensitive receptors have been identified for this assessment.

Figure 2: Identified Sensitive Receptors Closest to the Huon Parramatta Creek Facility



6. REGULATORY FRAMEWORK

The particulate dispersion modelling impact assessment is based on the Tasmanian legislative framework.

TASMANIA - Atmospheric Dispersion Modelling Guidelines Nov 2018

These guidelines provide the Environment Protection Authority (EPA), Tasmania's requirements for atmospheric dispersion modelling of emissions from existing and proposed industrial activities within the state of Tasmania.

TASMANIA - Environmental Management and Pollution Control Act 1994

The Environmental Management and Pollution Control Act 1994 (EMPCA) is the primary environment protection and pollution control legislation in Tasmania. The EMPCA was developed in the early 1990s to replace the Environment Protection Act 1973. There are a number of regulations made under EMPCA for environmental management and pollution control. Environmental Protection Policies (EPPs) have been developed to give effect to the objectives of the EMPCA. The EPP for air quality – Environment Protection Policy (Air Quality) 2004 (hereafter 'Air Quality EPP') was commenced on 01 June 2005.

TASMANIA - Environment Protection Policy (Air Quality) 2004

The Air Quality EPP provides a framework for the management and regulation of both point and diffuse sources of emissions to air for pollutants with the potential to cause environmental harm.

According to the policy, the environmental values to be protected are:

(a) the life, health and well-being of other forms of life, including the present and future health, wellbeing and integrity of ecosystems and ecological processes;

(b) visual amenity; and

(c) the useful life and aesthetic appearance of buildings, structures, property and materials.

Schedule 2 – Design Criteria of the Air Quality EPP (2004) specifies the design criteria. For the purpose of this Schedule, the maximum predicted ground level concentration of particulate matter at each receptor location is defined as the 100 percentile peak concentrations for 24 hour averaging periods.

Table 5: Schedule 2 – Design criteria of the Tasmania Air Quality EPP (2004)

Pollutant	Concentration	Percentile	Reported at
Particulate matter (as PM_{10}, 24-hour average)	150 µg/m^3	100th percentile	At or beyond facility boundary

7. METEOROLOGICAL MODELLING

7.1 Assessment Methodology

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. The local meteorology at the site plays a significant role in understanding the pollutant transport and dispersion mechanisms, and in order to adequately characterise the local meteorological conditions, information is needed on key parameters such as prevailing wind regime, mixing depth, atmospheric stability, ambient temperatures, rainfall and relative humidity. The following sections outline the methodology for characterising the meteorological conditions at the facility.

Meteorological modelling was conducted using a combination of 'The Air Pollution Model (TAPM) (Version 4) and CALMET meteorological models. Meteorological modelling was conducted for year 2014 as per TAS EPA recommendations.

7.2 TAPM

For this modelling assessment, the meteorological model 'The Air Pollution Model (TAPM) (Version 4.0.5)' was used to generate the prognostic output. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which is used to predict three-dimensional meteorological data and air pollution concentrations. TAPM allows users to generate synthetic observations by referencing in-built databases (e.g. terrain information, synoptic scale meteorological observations, vegetation and soil type etc.) which are subsequently used in generating site-specific hourly meteorological data (Hurley P.J., 2008).

No local observations of wind speed and wind direction were assimilated into TAPM as the nearest available stations were located at a distance of more than 20 km from the facility.

Technical details of the model equations, parameterisations and numerical methods are described in the Hurley (2008)

Details of the TAPM model configuration are outlined in **Table 6**.

Table 6: TAPM Model Configuration

Parameter	Value
TAPM version	V4.0.5
Run dates	01/01/2014 to 31/12/2014
Number of grids	5 (30 km, 10km, 3 km, 1 km, 300m)
Grid Centre Coordinates (latitude, Longitude) (degree)	-41deg -20.5min, 146deg 32.5min
Grid Centre (cx, cy)	461653, 5423212 (m)
Grid Dimensions (nx, ny, nz)	31, 31, 30
Terrain and land use data	Default TAPM dataset
Data assimilation	No, as nearest met station is approximately 20km from the Project site
Additional run details extracted from TAPM list file	LOCAL HOUR IS GMT+ 9.800000 TIMESTEP SCALING FACTOR = 1.000000 VARY SYNOPTIC WITH 3-D SPACE AND TIME V4 LAND SURFACE SCHEME EXCLUDE NON-HYDROSTATIC EFFECTS INCLUDE PROGNOSTIC RAIN EQUATION EXCLUDE PROGNOSTIC SNOW EQUATION

7.3 CALMET

CALMET (version 6.4.0) was used to derive higher resolution meteorological fields at 200 m resolution over a 20km x 20km modelling domain centred over the facility. CALMET was run in no-observations (NOOBS=2) mode with prognostic output from TAPM (1 km Grid) used as an input to the CALMET model.

The CALMET model settings were in general accordance with the NSW - Environment Protection Agency (NSW-EPA) (formerly Office of Environment and Heritage – OEH) '*Generic Guidance and Optimum Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia*' (OEH, 2011).

Details of the CALMET model configuration are outlined in **Table 7**.

Table 7: CALMET Model Configuration

Parameter	Value
CALMET version	Version: 6.4.0
Run dates	01/1/2014 to 31/12/2014
Number of grids cells (NX, NY)	101, 101
Grid spacing (DGRIDKM)	0.2 km
Southwest corner of grid cell (1,1)	XORIGKM = 451.808, YORIGKM = 5413.206
Number of vertical layers	NZ = 12
Height of cell face (m)	*ZFACE = 0, 20, 40, 70, 100, 150, 200, 300, 450, 640, 1200, 2000, 3000*
No Observation Mode	NOOBS = 2 (No surface, overwater, or upper air observations Use MM4/MM5/3D for surface, overwater, and upper air data)
M3D dataset source	TAPM output (1 km grid) converted to M3D dataset using CALTAPM version 7.0.0
Other critical parameters	MCLOUD = 4 ICALM = 0 IPROG = 14 TERRAD = 5 km ZIMIN = ZIMINW = 50 m, ZIMAX = ZIMAXW = 3000 m
GEO.DAT file	Terrain data sourced from SRTM1 (30 m resolution) Land use data: USGS default land use

The geophysical dataset for CALMET contains terrain and land use information for the modelling domain. For this assessment, terrain data for the CALMET grid was extracted from 1- arc second (30m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000 (downloaded from USGS website). The land use or land cover data for the modelling domain was derived from USGS Global Land Cover Classification (GLCC). The geotechnical parameters for the land use classification were adopted from the default CALMET corresponding land use categories.

A 3-dimensional representation of the topographical features surrounding the facility over a 20-km x 20-km domain is illustrated in **Figure 3**. Terrain contours covering the CALMET modelling domain are presented in **Figure 4**.

Figure 3: CALMET Terrain – 3D

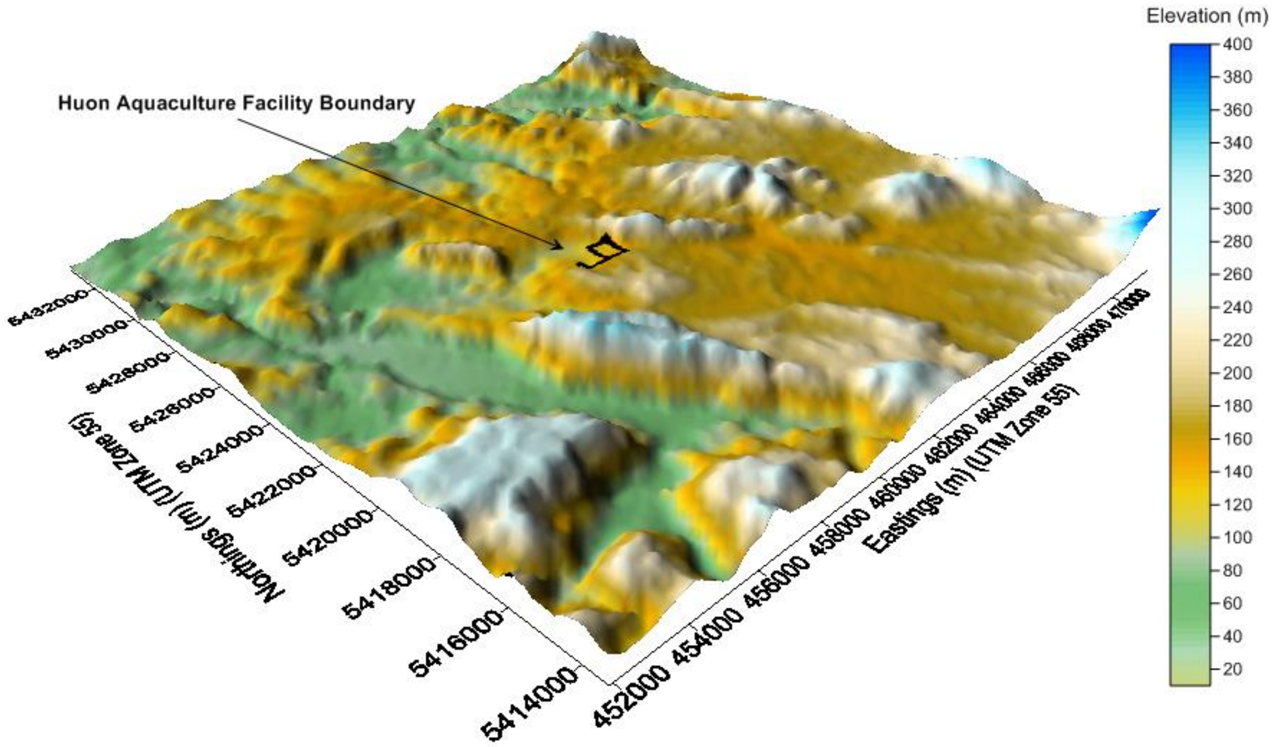
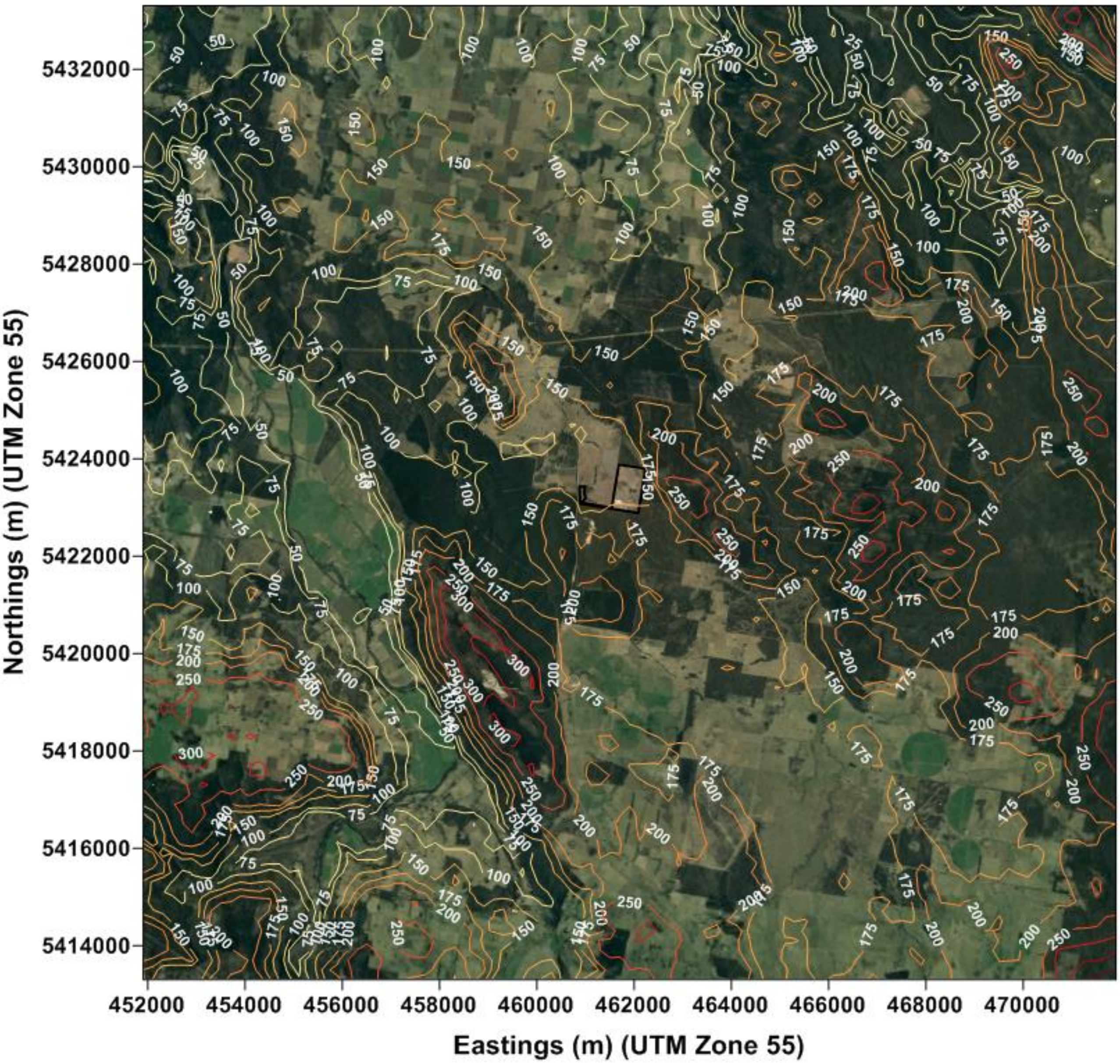


Figure 4: CALMET Terrain – Contours (elevation in meters)

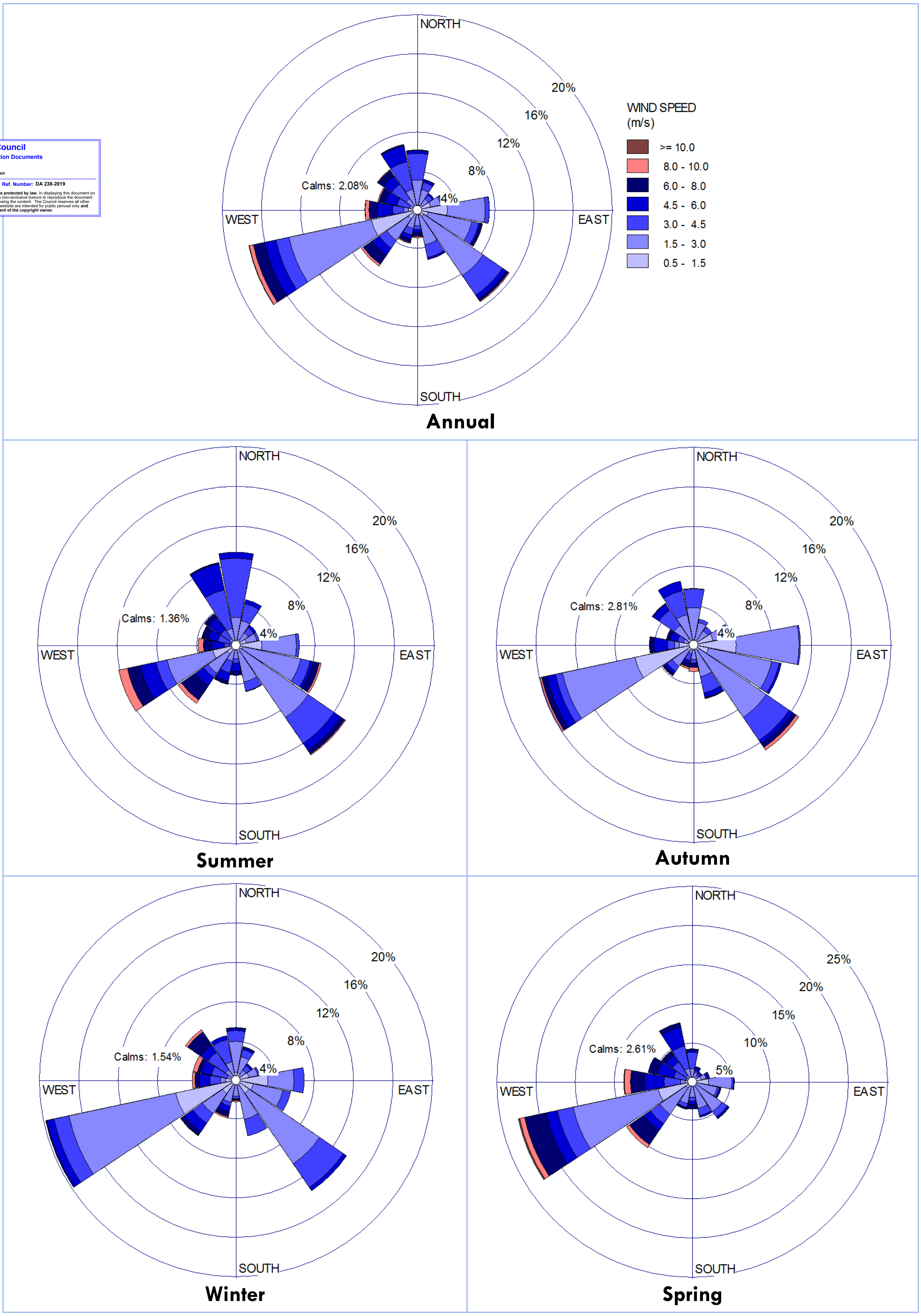


7.4 Modelled Meteorology

Hourly wind speeds and direction for calendar year 2014 were extracted from the CALMET output at the centre of the facility and are visually presented in the form of wind roses in **Figure 5**.

Annual wind rose shows winds predominantly from west-southwest and southeast. Winds are usually in low (< 3m/s) to medium speed (3 to 6 m/s). Percentage of hourly calms over the year averages to 2.1%. Seasonal breakdown of wind shows that similarities are observed for the summer, autumn and winter season. Spring shows unusually low frequency of winds from southeast sector.

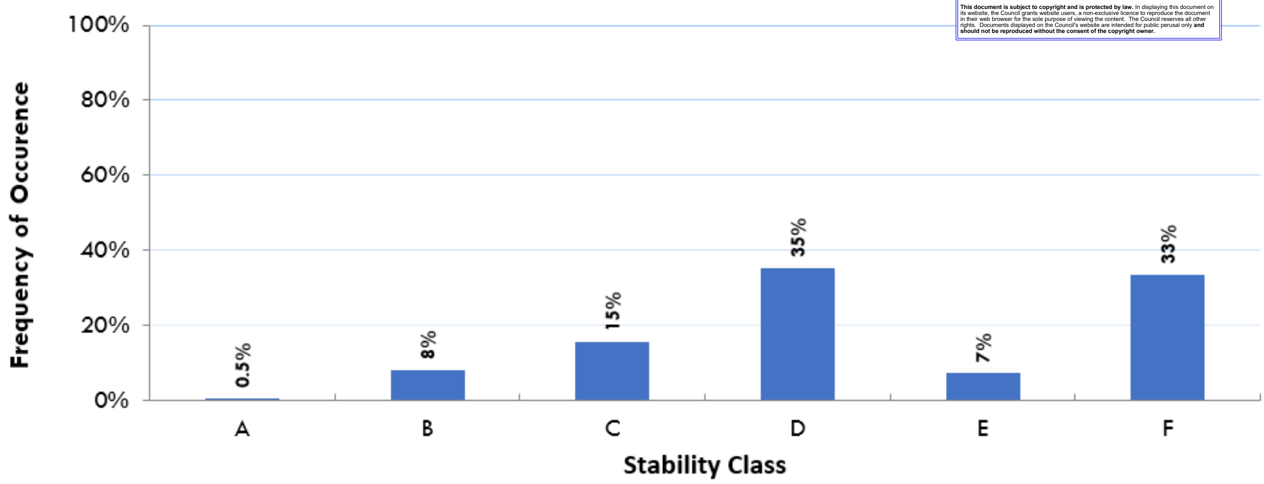
Figure 5: CALMET Predicted Wind Rose –2014



Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead, it must be inferred from available data, either measured or numerically simulated. The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed, the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data using CALMET for calendar year 2014 is presented in **Figure 6**. A higher frequency of stability class D (35%) and stability class F (33%) was predicted by CALMET at the facility location.

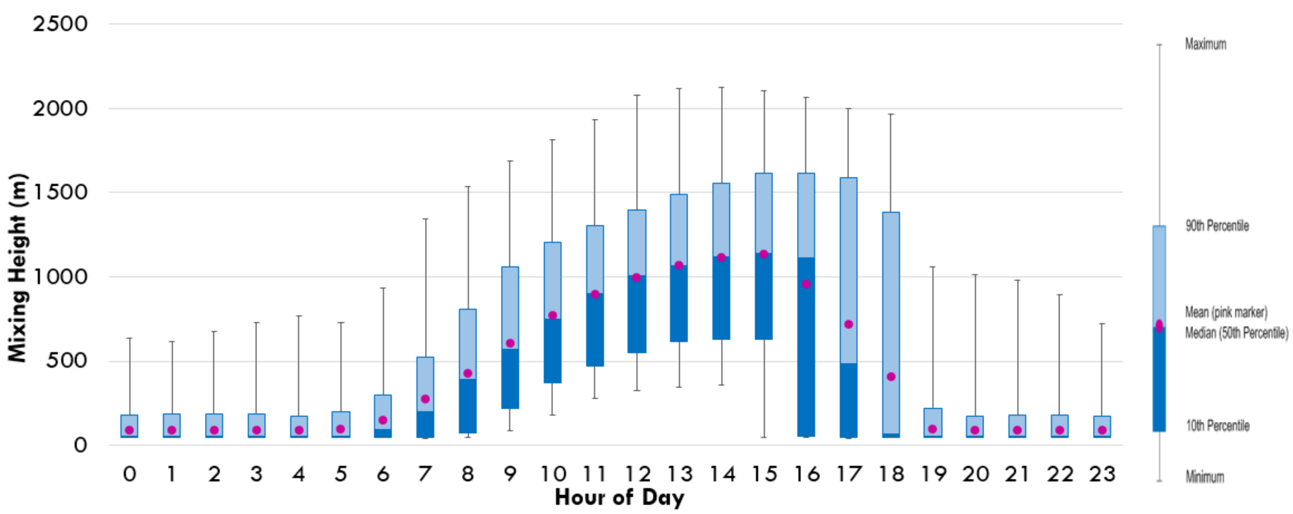
Figure 6: CALMET Predicted Frequency of Stability Class – 2014



The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low mixing heights typically translate to stagnant air with little vertical motion, while high mixing heights allow vertical mixing and good dispersion of pollutants.

CALMET simulated hourly mixing height data are presented in **Figure 7** showing the mixing height as a function of the hour. The graph represents the typical growth of the boundary layer, whereby the mixing height is generally lowest during the night and into the early morning and highest during the late afternoon

Figure 7: CALMET Predicted Diurnal Variation in Mixing Heights –2014



8. PARTICULATE DISPERSION MODELLING

To model the particulate emissions from the smokehouses at HA facility, dispersion modelling was undertaken for the calendar year 2014 using the US-EPA CALPUFF dispersion model.

CALPUFF is the dispersion model that calculates the dispersion of plumes within the three-dimensional (3D) meteorological field calculated by CALMET. CALPUFF is a non-steady state US-EPA approved dispersion model, which "advects" puffs of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the wind fields generated by CALMET. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period (SRC, 2011).

8.1 CALPUFF Configuration

CALPUFF computational domain was set to 20 km by 20 km (full CALMET domain), while the sampling domain was set to be a 6 km x 6 km subset of the computational domain. It is expected that the predicted particulate impacts will be contained within the sampling domain of 6 km x 6 km. To increase the accuracy of concentration isopleths, a nesting factor of 4 was used in CALPUFF to predict the particulate impacts at 50 m resolution.

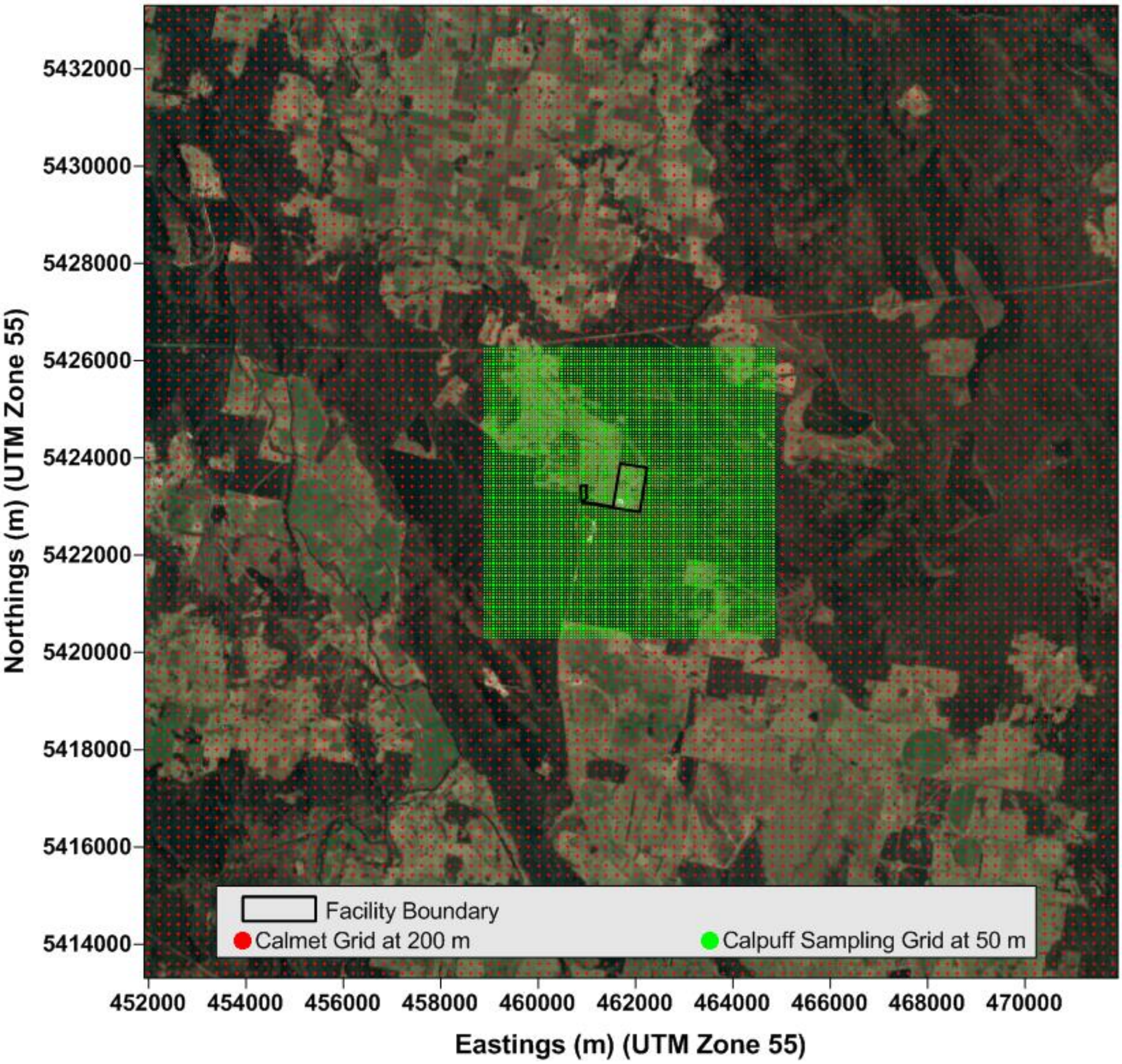
General run control parameters and technical options that were selected in the CALPUFF model are summarised in **Table 8.**

Table 8: CALPUFF Dispersion Model Configuration

Parameter	Value
Calpuff version	Version 6.42
Run dates	01/1/2014 to 01/01/2015
Met grid definition	See CALMET configuration
Computational grid	Full size of meteorological grid (IBCOMP & JBCOMP = 1, IECOMP & JECOMP = 101)
Sampling grid	A subset of computational grid, 6 km x 6 km, centred over Huon facility.
Nesting factor for sampling grid	4 (Sampling grid spacing set at 50 m)
Number of vertical layers	NZ = 12
Height of cell face (m)	*ZFACE = 0, 20, 40, 70, 100, 150, 200, 300, 450, 640, 1200, 2000, 3000*
Dry deposition	No (MDRY = 0)
Wet deposition	No (MWET = 0)
Method used to compute dispersion coefficients	Dispersion coefficients from internally calculated sigma v, sigma w using micrometeorological variables (MDISP = 2)
PDF used for dispersion under convective conditions	Yes (MPDF = 1)
Particulate sources modelled as	Point sources
Number of smoker stacks included	All three smokers (1 x hot and 2 x cold), running concurrently

The extents of the CALPUFF computational domain (same as CALMET domain) and the CALPUFF sampling domain in reference to the facility boundary are illustrated in **Figure 8.** The red dot represents 200 m grid resolution, whereas the finer green dots represents 50 m sampling resolution.

Figure 8: CALPUFF Computational and Sampling Domain



Modelled stack characteristics for each of the three modelled smoker stacks are presented the below table.

Table 9: CALPUFF Dispersion Model – Smoker Stack Characteristics

Parameter	Value		
Stack Number	1	2	3
Smoker Type	Hot	Cold	Cold
Stack Location	461682E, 5423111N	461683E, 5423113N	461683E, 5423115N
Stack Height (above ground) (m)	11	11	11
Stack Temperature (^{0}C)	29.6	21.7	21.7
Stack diameter (m)	0.345	0.345	0.345
Exit velocity (m/s)	8.4	9.1	9.1
Emission Rates	7AM – 8PM (0.252 g/s) 8PM – 7AM (No emissions)	7AM – 8PM (0.173 g/s) 8PM – 7AM (No emissions)	7AM – 8PM (0.173 g/s) 8PM – 7AM (No emissions)
Operating Days	365 days a year	365 days a year	365 days a year
Building Wake	Included	Included	Included

8.2 Smokehouse Stack Location

The map coordinates (MGA55) for each stack exhaust point are listed below and **Figure 9** illustrates the location of these stacks with reference to the Huon processing facility building.

- Smokehouse 1 Stack: 461682E, 5423111N
- Smokehouse 2 Stack: 461683E, 5423113N
- Smokehouse 3 Stack: 461683E, 5423115N

Figure 9: Location of Three Smoker Stacks (Blue markers)

8.3 Building Wake Effect

The impact of building wake effects on plume dispersion has been included in the modelling for buildings and structures located around the smoker stacks. The heights and locations of these structures were entered into the Building Profile Input Program (BPIP) utility using PRIME algorithm. The wind direction-specific building dimensions calculated by BPIP for the stack at their corresponding heights were then entered into the CALPUFF model.

The location and heights of three smoker stacks (red markers) and buildings included (Blue outlines) in the BPIP calculations are illustrated in **Figure 10**.

Figure 10: BPIP Configuration

8.4 Particulate Fraction (PM_{10})

The LEC report presented particulate matter results as TSP. It has been conservatively assumed in the dispersion model that 100% of measured TSP is PM_{10} size fraction.

9. MODELLING RESULTS AND DISCUSSION

The mass emission rates were calculated for particulate matter from the sampling data (LEC, Feb 2016) and modelled using the CALPUFF dispersion model.

Dispersion modelling scenario corresponding to concurrent operations of all three smokers was modelled using CALPUFF modelling system. The stack characteristics and mass emission rates of these three smoker stacks are presented in **Table 9**. CALPUFF run configuration is presented in **Table 8**.

The maximum (reported as 100th percentile) 24-hour average particulate concentrations from the facility were predicted for particulate matter. It is to be noted that no background particulate sources were considered for this assessment, as there were no nearby sources identified outside the facility site boundary that released particulate emissions.

The comparison of predicted particulate results with Tasmania Air Quality EPP (2004) is presented in **Table 10**.

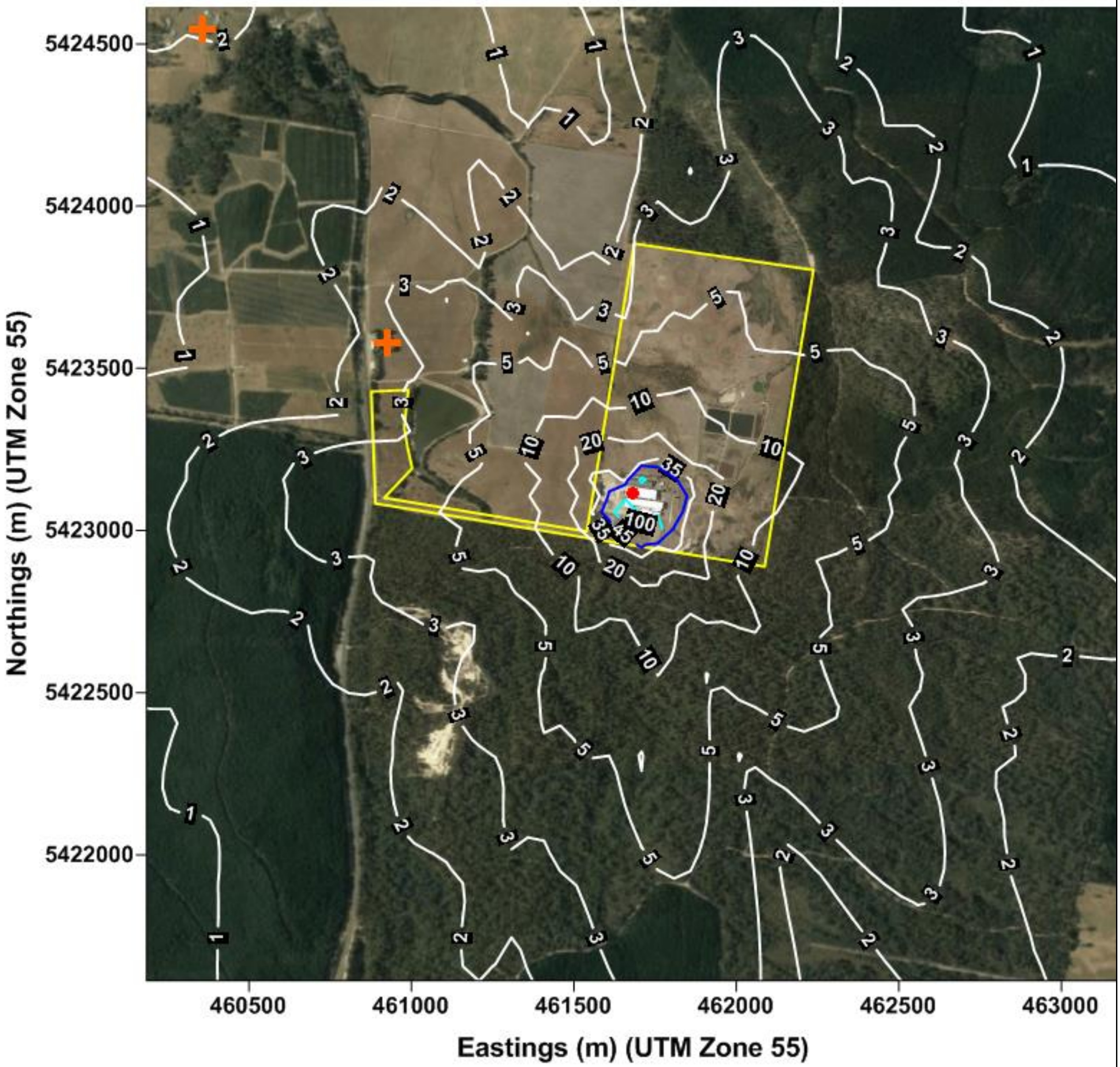
Table 10: Comparison of Predicted Particulate Concentrations with TAS – Air Quality EPP (2004)

Pollutant	Design Criteria of the TAS -Air Quality EPP (2004)	Predicted Maximum Concentrations - At or Beyond Boundary
PM_{10} (24-Hour)	150 µg/m^3	45 µg/m^3

From the particulate dispersion modelling results, it is observed that the maximum predicted PM_{10} 24-hour average concentrations of 45 µg/m^3 at or beyond the facility boundary, as a result of particulate emissions from HA's smoker stacks is below the Tasmanian Air Quality EPP (2004) assessment criterion of 150 µg/m^3. Maximum predicted PM_{10} 24-hour average particulate concentrations at Layton house is approximately 3 µg/m^3.

The predicted concentrations are visually presented in the form of a concentration isopleth in **Figure 11**.

Figure 11: Predicted Maximum PM_{10} 24-Hour Average Concentrations



Scenario: Normal Operations	Site Boundary: Yellow Outline
Included Sources: 1 x Hot smoker, 2 x Cold smoker (operating 7 am to 8 pm, 365 days a year) (All three stacks shown as one red marker)	Included Receptor: 1, Orange Marker (top left of map)
Model used: TAPM V4.0.5, CALMET 6.4.0, CALPUFF 6.42	Modelling Run Dates: 01/01/2014 to 31/12/2014
Computational Grid Resolution: 200 m	Sampling Grid Resolution: 50 m
Pollutant: PM_{10}	Units: µg/m³
Percentile Level: 100th Percentile	Averaging Period: 24- Hour
TAS Air Quality EPP (2004) Criterion Contour: 150 µg/m³ (Not shown in map as all levels are below 150)	Other Contours: white (1, 2, 3, 5, 10, 20 & 35 µg/m³) Blue (45 µg/m³), Red (100 µg/m³)
Maximum At or Beyond site Boundary: 45 µg/m³	

10. CONCLUSION

Airlabs Environmental was commissioned by Caloundra Environmental on behalf of HUON Aquaculture (HA) to undertake particulate assessment for smokehouse stacks at HA's fish processing facility at Lot 1, 7218 Bass Highway, Sassafras, Tasmania 7307 (the facility).

The commissioning tests were conducted by LEC Environmental in February 2016 (LEC, Feb 2016) to measure the particulates release from the smokehouses. The findings of the test were submitted in the *Smokehouse Construction and Commissioning Plan* prepared by LEC Environmental (LEC, April 2016).

To model the particulate emissions from the smokehouses at HA facility, dispersion modelling was undertaken for the calendar year 2014 using the US-EPA CALPUFF dispersion model. The mass emission rates were calculated for particulate matter from the sampling data (LEC, Feb 2016). Dispersion modelling scenario corresponding to concurrent operations of all three smokers was modelled using CALPUFF modelling system.

The maximum (reported as 100th percentile) 24-hour average particulate concentrations from the facility were predicted for PM_{10} fractions. It is to be noted that no background particulate sources were considered for this assessment, as there were no nearby sources identified outside the facility site boundary that released particulate emissions.

From the particulate dispersion modelling results, it is observed that the maximum predicted PM_{10} 24-hour average concentrations of 45 $\mu g/m^3$ at or beyond the facility boundary, as a result of particulate emissions from HA's smoker stacks is below the Tasmanian Air Quality EPP (2004) assessment criterion of 150 $\mu g/m^3$.

Based on the modelling conducted by Airlabs, it can be concluded that the operation of the smoker stacks is not expected to have an adverse impact on the surrounding environment with regards to particulate emissions.

11. REFERENCES

Caloundra Environmental (2017): Draft Development Proposal & Environmental Management Plan (DPEMP), HUON Aquaculture Company Pty. Ltd., December 2017

Draft Atmospheric Dispersion Modelling Guidelines, Environment Protection Authority – Tasmania, 2017

Environment Protection Policy (Air Quality) 2004, Environment Protection Authority – Tasmania

Hurley P.J. (2008): TAPM V4. Part 1: Technical Description, CSIRO Marine and Atmospheric Research Paper No. 25

LEC Environmental (Feb 2016): Report on Atmospheric Emissions No.5 Boiler Stack, Huon Aquaculture Parramatta Creek, Tasmania, Sampling conducted 17th & 18th February 2016, Report issued 29th April 2016

LEC Environmental (April 2016): Smokehouse Construction and Commissioning Plan, Huon Aquaculture Parramatta Creek, Tasmania, Report issued 29th April 2016

NSW – OEH (2011) Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia, Office of Environment and Heritage

PAE Holmes (2009): Air Quality Assessment for a Smokehouse at Parramatta Creek, HUON Aquaculture Group Pty. Ltd., October 2009

SRC (2000): A User's Guide for the CALMET Meteorological Model

SRC (2011): CALPUFF Modeling System Version 6 User Instructions, April 2011

SRTM (2000): NASA's Shuttle Radar Topography Mission (SRTM), Downloaded from USGS website http://dds.cr.usgs.gov/srtm/version2_1/SRTM3/Australia/