THE AUSTRAL BRICK CO PTY LTD

PROPOSED PLANT 2 UPGRADE – SSD 9601

780 WALLGROVE ROAD, HORSLEY PARK, NSW

PLUME RISE ASSESSMENT

DOCUMENT CONTROL

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

KEY ACRONYMS

AGL	Above Ground Level
AHD	Australian Height Datum
Airlabs	Airlabs Environmental Pty Ltd
BEF	Buoyancy Enhancement Factor
BoM	Bureau of Meteorology
CASA	Civil Aviation Safety Authority
CPH	Critical Plume Height
CPV	Critical Plume Velocity
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPI&E	NSW Department of Planning, Industry and Environment
GAPS	Global Analysis and Prediction System
LAPS	Local Area Prediction System
OLS	Obstacle Limitation Surface
RAAF	Royal Australian Air Force
SSD	State Significant Development
TAPM	The Air Pollution Model
USGS	United States Geological Survey
UTM	Universal Transverse Mercator

1. INTRODUCTION

Airlabs Environmental Pty Ltd (Airlabs) have been commissioned by Willowtree Planning on behalf of The Austral Brick Co Pty Ltd to undertake a plume rise assessment associated with the proposed upgrade to the existing brickmaking plant (known as Plant 2) located at 780 Wallgrove Road, Horsley Park, NSW.

State Significant Development SSD 9601 concerning the proposed upgrade has been lodged by The Austral Brick Co Pty Ltd. As the facility is in proximity to the Western Sydney Airport and Bankstown Airport, the NSW Department of Planning, Industry and Environment has requested a Plume Rise Assessment, which is addressed in this report (MAR20052.1).

The objectives of the assessment are:

- Conduct a plume rise assessment adhering to guidelines published by the Australian Civil Aviation Safety Authority (CASA).
- Estimation of Critical Plume Velocity (CPV) based on type of operations at the proposed facility and any associated risks identified by CASA.
- Estimation of the critical plume height (vertical) and the critical plume extent (horizontal) at which the average plume vertical velocities achieve the threshold velocity of 4.3 m/sec.

It is to be noted that the impacts concerning the plume rise with the proposed expansion could be independently assessed by CASA and, as-such, this report (MAR20052.1) presents a background assessment as well as provides the necessary information for undertaking an independent assessment.

The statistics presented in this report have been generated in accordance with the CASA Advisory Circular Guidelines for conducting Plume Rise Assessments (CASA, 2003).

The Air Pollution Model (TAPM) was used to calculate plume rise trajectories resulting from the proposed stack operations at the facility. The TAPM Plume Rise Module was used to account for plume momentum and buoyancy effects for the proposed stack source.

It is to be noted that the assessment was conducted in accordance with the following:

- Advisory Circular, AC 139-5(1) – Plume Rise Assessments, Civil Aviation Safety Authority, November 2012.
- Advisory Circular, AC 139-05(0) – Guidelines for Plume Rise Assessments, Civil Aviation Safety Authority, June 2004.

2. BACKGROUND

It is important to assess the hazards related to exhaust plumes in the context of aircraft safety, as they have the potential to cause airframe damage to an aircraft as well as affect the handling of the aircraft in flight. This is particularly sensitive during take-off and landing, and as the facility is close to the Western Sydney base, the exhaust plumes from the proposed expansion are to be assessed.

Aviation authorities have established that an exhaust plume with a vertical gust in excess of 4.3 m/sec may cause damage to an aircraft airframe or upset an aircraft when flying at low levels.

As a result, CASA requires the proponent of the facility with an exhaust plume, which has an average vertical velocity exceeding the limiting value (4.3 m/sec at the Aerodrome Obstacle Limitation Surface (OLS) or at 110 metres above ground level anywhere else) to be assessed for the potential hazard to aircraft operations (CASA, 2003).

Revision of the advisory circular relating to conducting plume rise assessments was issued in November 2012 (CASA, 2012) which has been simplified and refers to the use of "Screening Tool" to assist in the assessment process.

The screening tool is based on TAPM methodology which includes a buoyancy enhancement factor for multiple plumes. The revised CASA guidelines require that plume rise assessments determine the height at which a plume could exceed the average in-plume vertical velocity thresholds of 4.3 m/sec and 10.6 m/sec, which are also known as the Critical Plume Velocity (CPV).

As per CASA, 2012, the CPV is the velocity at which the vertical plume rise may affect the handling characteristics of an aircraft in flight such that there may be a momentary loss of control. Following determination of the CPV, the Critical Plume Height (CPH) and the critical plume extent (horizontal) for the CPV under scrutiny is determined using The Air Pollution Model (TAPM). The CPH, as per CASA, 2012 is the height up to which the plume of critical velocity may impact the handling characteristics of an aircraft in flight such that there may be a momentary loss of control.

3. PROJECT DESCRIPTION

The Plant 2 upgrade site ('the subject site') is identified as 780 Wallgrove Road, Horsley Park, NSW (Lot 7 in Deposited Plan 1059698). The entire site is 82 hectares (ha) in area and is considered to be the main brick manufacturing site for the Austral Brick Company.

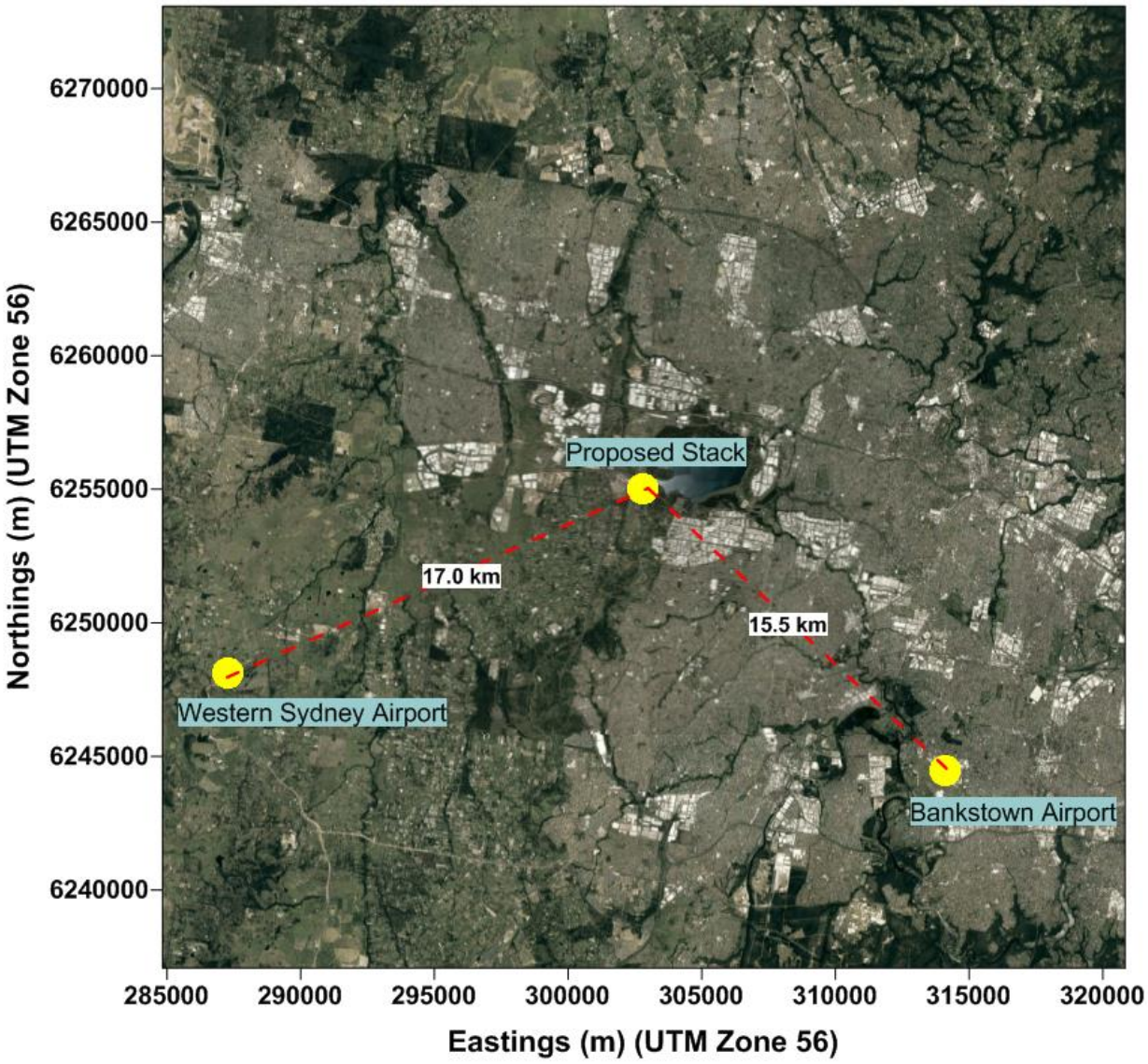
The subject site is located within the Fairfield City Council Local Government Area (LGA) and forms part of the Western Sydney Parklands (WSP), which is a 27km urban park corridor running north from Quakers Hill, south to Leppington accounting for approximately 5,280 hectares of land and as per the WSP Plan of Management 2030, the site is clearly delineated as 'Austral Bricks'.

Land-use surrounding the facility is predominantly rural-residential along with grazing / pastoral lands, predominantly to the south of the subject site. Existing residential development in the immediate surrounds is quite spread out and scattered, which is typically indicative of low-medium density rural residential developments.

Two airports (Western Sydney and Bankstown) are located within 20 km radius of the subject site.

An aerial overview of the facility with an approximate distance to nearest airports is illustrated in **Figure 1**.

Figure 1: Location of Proposed Stack with reference to Nearby Airports



4. MODELLING METHODOLOGY

4.1 Emission Sources and Characteristics

Exhaust stack characteristics used in the assessment are based on information provided in the Revised Air Quality Impact Assessment Report (Airlabs, 2019).

The proposal will include a 35m above ground stack.

Based on information provided in Airlabs, 2019, the design velocity of the stack is 15 m/sec.

Parameters corresponding to the proposed stacks are summarised in **Table 1**.

Table 1: Boiler Stack Parameters

Parameter	Upgraded Plant 2 Kiln Stack
Stack Location (Easting, Northing) (UTM 56)	302801, 6255028
Base ground elevation (m AHD) at stack	64.6
Stack height above ground level (m AGL)	35.0
Stack diameter (m)	2
Stack temperature (°K)	467
Exit velocity (m/s)	15.0

4.2 TAPM Model Configuration

The plume rise assessment was conducted using The Air Pollution Model (TAPM) version 4.0.5.

TAPM is a combined predictive meteorological module, and plume dispersion module, which provides a better alternative for realistic estimates of plume rise and lateral dispersion. This combination provides a three-dimensional (3-D) grid type simulation model which is most suited in estimating the frequencies of occurrences (CASA, 2004).

TAPM solves approximations of the fundamental equations of the atmosphere to predict meteorology and pollutant concentrations, eliminating the need to have site-specific meteorological observations. The Plume Rise Module in TAPM is used to account for plume momentum and buoyancy effects for point sources. This has been validated against the most commonly used mathematical equations for hot buoyant plumes in both calm and windy conditions. Plume rise is terminated when the plume dissipation rate decreases to ambient levels.

TAPM model was set to produce gradual plume rise output at every second (up to 900 seconds) until the plume dissipation rate decreases to ambient levels and the plume is terminated. The output from the TAPM gradual plume rise module allows to determine the dimensions of the plume at the point at which it reaches 4.3 m/s.

TAPM configuration details for this assessment was based on *Guidelines for Conducting Plume Rise Assessments* (AC139-05(0)) (CASA, 2004) and are presented in **Table 2** below.

Table 2: TAPM Configuration Details

Parameter	Value
TAPM version	v4.0.5
Number of years modelled	5
Modelled years	2013, 2014, 2015, 2016 & 2017
Meteorological Module	
TAPM grid centre coordinates	-33^0 49.5' Latitude & 150^0 42' Longitude
Local values (MGA94) of grid centre	302571 m Easting, 6255201 m Northing
Number of grid points (nx, ny)	25, 25
Number of vertical grid levels	25 (10 m through to 8000m)
Number of nested grids (grid domains)	4 (30 km, 10 km, 3 km & 1 km)
Terrain database	Default TAPM v4.0.5 database (270 m resolution from Geoscience Australia)
Land use database	Default TAPM v4.0.5 database (1 km resolution dataset from the United States Geological Survey - USGS)
Synoptic analyses database	Default TAPM v4.0.5 database (six hourly synoptic scale analyses derived from Bureau of Meteorology LAPS or GAPS)
Plume Rise Module	
Number of stacks Modelled	1
Source type for modelled stack	Point source
Stack location (MGA Zone 56)	302801 m Easting, 6255028 m Northing
Stack height above ground (m)	35
Stack diameter (m)	2.0
Exit velocity (m/s)	15.0
Exit temperature (k)	467
Mode of dispersion	Eulerian for outer grids and Lagrangian for innermost grid

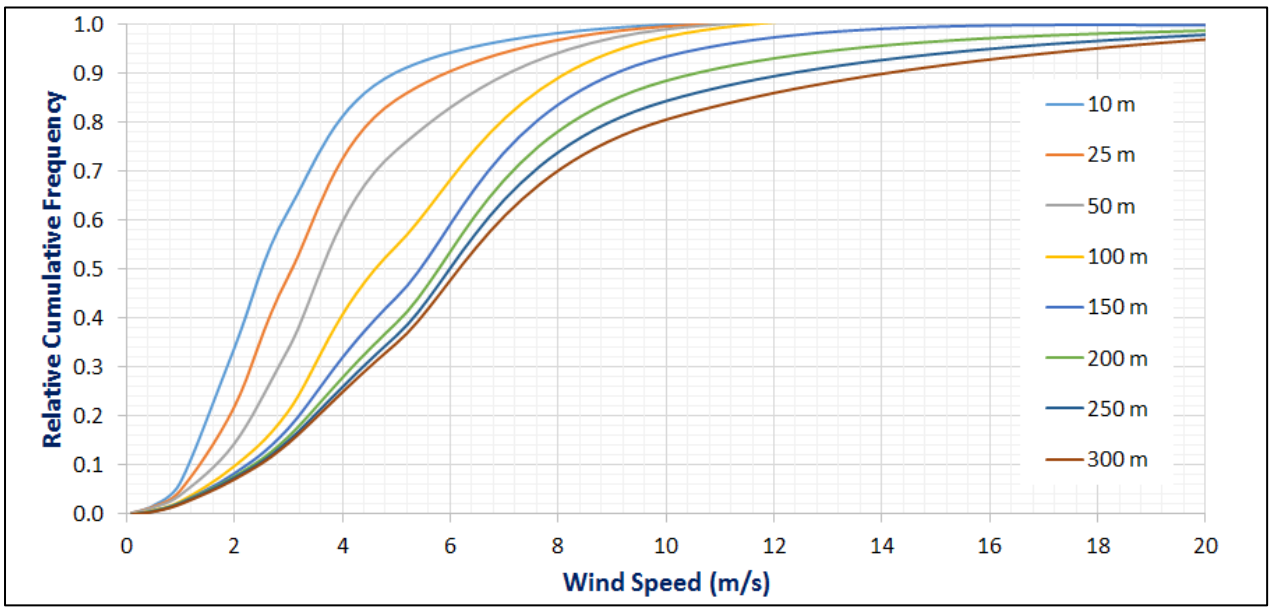
5. RESULTS AND DISCUSSION

5.1 Local Meteorology

As mentioned earlier, TAPM v4.0.5 was used to predict meteorological conditions in the vicinity of the facility.

CASA guidelines require the generation and presentation of wind speed cumulative frequency plots for at least 8 well-spaced heights ranging from the height of the point source to the maximum height at which the peak vertical velocity reduces to the CPV of 4.3 m/s. Wind speed cumulative frequency plots have been presented for the 8 lowest TAPM vertical levels ranging from 10 m to 300 m above ground as illustrated in **Figure 2.**

Figure 2: Wind Speed Cumulative Relative Frequency Plots at Varying Heights (Note: Heights are Above Ground Level)



The percentage of time that wind speeds are less than 0.1 m/sec, 0.2 m/sec, 0.3 m/sec, 0.4 m/sec and 0.5 m/sec generated from TAPM upper air meteorological data are presented in (as percentage frequency) in **Table 3.**

Results show that wind speeds are less than 0.5 m/sec for 1.7 % of the hours at 10 m elevation above ground level, whereas, wind speeds are less 0.5 m/sec for approximately 0.8 % of the time at highest elevation (150 m in **Table 3**) at which plume velocity depreciates below 4.3 m/sec.

Table 3: Frequency Distribution for Wind Speeds < 0.5 m/sec for Varying Heights (Above Ground Level)

Height (m) / Wind Speed (m/s)	10 m	25 m	50 m	100 m	150 m	200 m	250 m	300 m
<= 0.1 m/s	0.2%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
<= 0.2 m/s	0.5%	0.4%	0.3%	0.2%	0.2%	0.2%	0.2%	0.1%
<= 0.3 m/s	0.8%	0.7%	0.6%	0.4%	0.4%	0.3%	0.3%	0.3%
<= 0.4 m/s	1.2%	1.0%	0.8%	0.6%	0.6%	0.5%	0.5%	0.4%
<= 0.5 m/s	1.7%	1.5%	1.2%	0.9%	0.8%	0.7%	0.7%	0.6%

5.2 Plume Rise Statistics

Analysis of five (5) years of TAPM model results from 2013-2017 have been undertaken to generate plume rise statistics associated with proposed expansion of the facility.

CPV should be determined based on the type of operations at the location and any associated risks identified by CASA.

The following parameters are to be considered in determining the CPV under scrutiny:

- Phase of flight affected.
- Size of aircraft affected.
- Geographical factors such as high terrain.
- Frequently used flight paths.
- Navigation method in use (visual vs instrument).
- Presence of Air Traffic Control.
- Human factors considerations; and
- Proximity to a regulated aerodrome.

The CPH is the height up to which the plume average vertical velocity exceeds the CPV (4.3 m/s).

Gradual plume rise statistics obtained from TAPM plume rise module indicates that plume velocity drops below 4.3 m/sec within 20 second of release from stack.

For the proposed stack the predicted minimum, average and the maximum critical plume height ranges from 37 m above ground to 141 m above ground (refer **Table 4**).

Table 4: Predicted Critical Plume Height (m, above ground level) for CPV of 4.3 m/sec

Percentile	Critical Plume Height (m above ground level)
Maximum	141
Average	45
Minimum	37

The critical plume extent is horizontal distance (sum of the total downwind translation of the plume centreline and plume radius) at which the average plume vertical velocity drops below CPV.

For the proposed stack the predicted minimum, average and the maximum critical plume extent ranges from 9 m to 19 m from the centre of modelled stack source (refer **Table 5**).

Table 5: Predicted Critical Plume Extent (horizontal distance) for CPV of 4.3 m/sec

Percentile	Critical Plume Extent (horizontal distance in m)
Maximum	19
Average	12
Minimum	9

The heights (above ground level) below which the average vertical velocity of plume exceeds the critical velocity (4.3 m/s) expressed in percentiles ranging from 0.01% to 100% are presented in **Table 6**.

Based on the modelling results for five (5) years (43835 hours), statistics in **Table 6** indicate the following:

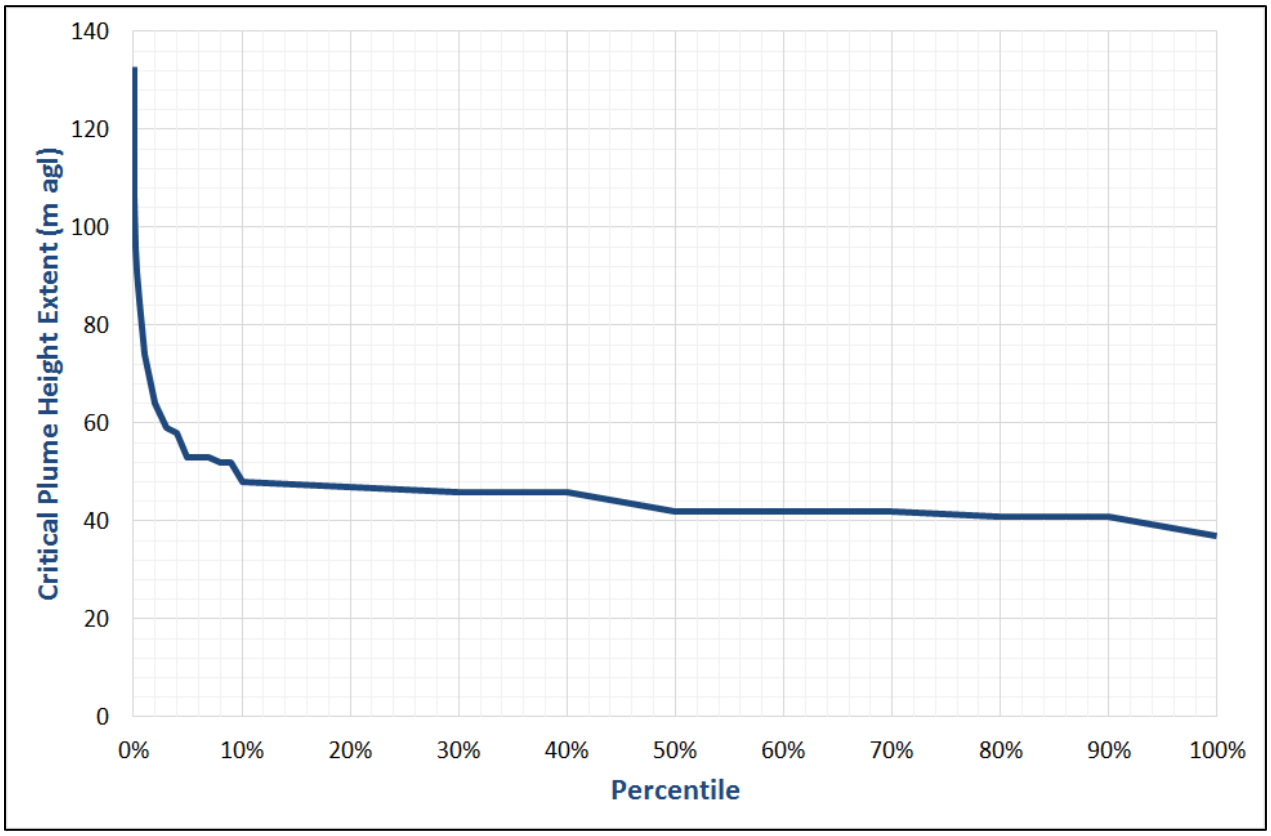
- For 1 in every 10000 hours (0.01 percentile) the plume velocity exceeds 4.3 m/sec at a height of 133 m above ground level.
- For 1 in every 2000 hours (0.05 percentile) the plume velocity exceeds 4.3 m/sec at a height of 118 m above ground level.
- For every 1 in 2 hours (50 percentile) the plume velocity exceeds 4.3 m/sec at height of 42 m above ground level; and
- For all the hours (100 percentile) the plume velocity exceeds 4.3 m/s at height of 37 m above ground level.

Percentile statistics for the critical plume height are presented graphically in **Figure 3**.

Table 6: Percentiles of Heights (m, above ground level) below which vertical plume velocity exceeds 4.3 m/sec

Percentile	Height (m above ground level)
0.01%	133
0.05%	118
0.1%	106
0.2%	96
0.3%	91
0.5%	85
1%	74
2%	64
3%	59
4%	58
5%	53
6%	53
7%	53
8%	52
9%	52
10%	48
20%	47
30%	46
40%	46
50%	42
60%	42
70%	42
80%	41
90%	41
100%	37

Figure 3: CPH (above ground level) by Percentile for CPV of 4.3 m/sec



6. DISCUSSION OF RESULTS AND CONCLUSION

Airlabs were commissioned to undertake a plume rise assessment for the Plant 2 upgrade (SSD 9601) application at 780 Wallgrove Road, Horsley Park, NSW (Lot 7 in Deposited Plan 1059698).

As the facility is in proximity to the two airports (Western Sydney airport and Bankstown airport), a Plume Rise Assessment has been conducted. It is to be noted that the assessment was conducted in accordance with the following:

- Advisory Circular, AC 139-5(1) – Plume Rise Assessments, Civil Aviation Safety Authority, November 2012; and
- Advisory Circular, AC 139-05(0) – Guidelines for Plume Rise Assessments, Civil Aviation Safety Authority, June 2004.

The critical plume height (CPH) is the height at which the plume average vertical velocity exceeds the Critical Plume Velocity (CPV) of 4.3 m/sec. Gradual plume rise statistics obtained from TAPM modelling indicates that plume velocity drops below 4.3 m/sec within 20 second of release from stack. Modelling also indicates that the CPH at CPV of 4.3 m/sec is 141 m above ground level.

Ground elevation at the subject site is 64.6 m AHD. In terms of m AHD, CPH is 141+64.6 = 205.6 m AHD.

For the Western Sydney Airport, OLS tool is available on the Western Sydney Airport website to estimate the OLS at the subject site. It was determined that OLS height relative to ground level at proposed stack location is 157.6 m. Hence the determined CPH of 141 m above ground level from the proposed stack is below the threshold.

For Bankstown Airport, OLS tool is not readily available but based on the relative distance to the subject site, it is can be assumed that the OLS height relative to ground level is also 157.6 m (typical Outer Horizontal Surface).

It is however recommended to verify the exact OLS height by consultation with the Bankstown Airport. It is to be noted that this report contains enough information for the Bankstown Airport officials to assess the plume rise from the proposed stack.

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