AERONAUTICAL IMPACT ASSESSMENT

TALLAWARRA B
GAS PEAKING POWER STATION
WOLLONGONG, NSW.
OPEN CYCLE GAS TURBINE
REVISED PLUME INVESTIGATION

J0306

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Client

TRUenergy Tallawarra Pty Ltd

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1. EXECUTIVE SUMMARY

In November 2009 the Ambidji Group Pty Ltd (Ambidji) presented an aeronautical impact assessment to TRUenergy Tallawarra Pty Ltd (TRUenergy) for the proposed Tallawarra B Gas Peaking Power Station, near Wollongong, based on the plume rise results from the TAPM model used in the SKM Plume Rise Assessment in March 2008.

In February 2010 an additional plume rise investigation[1] (using TAPM version 4.0.3) was undertaken, by SKM for the two proposed Tallawarra Open Cycle Gas Turbines (OCGT). The Closed Cycle Gas Turbine (CCGT) is subject to a separate report.

This new analysis has resulted in a plume with vertical velocity for the OCGT falling below 4.3m/s at a lower altitude than the previous assessment. The revised plume assessment discusses the rationale.

The site of the proposed power plant (Tallawarra B) is located adjacent to the existing Tallawarra Power Station near Wollongong in NSW. The site coordinates, as advised by TRUenergy, are MGA Zone 56, 298,876E 6177714N. This location is approximately 3.8km north east of the RWY 19 Threshold at Illawarra Regional Airport (Wollongong Aerodrome). Figure 1-1 below shows the location of the development site and its proximity to Wollongong Aerodrome.

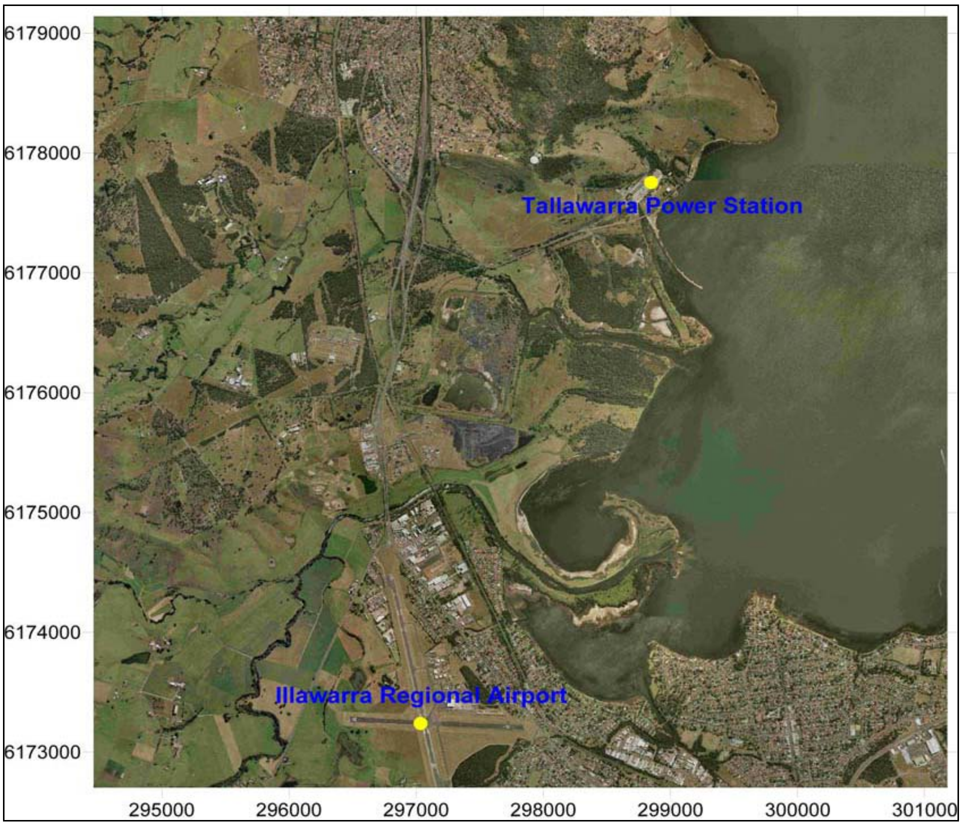

Fig 1-1 Power station location

[1] Tallawarra OCGT Plume Rise Draft 2 Gas EN02239

The proposed Tallawarra B power station Open Cycle Gas Turbine (OCGT) power station development being considered in this report is reported to consist of two 40 metre exhaust gas stacks at a maximum height of 43.1m AHD. Ground level at the site has been reported to be 3.1m AHD.

The Civil Aviation Safety Authority (CASA) is responsible for the safe conduct of all civilian aviation operations in Australia and they have established that an exhaust plume with a vertical velocity in excess of 4.3metres per second (m/s) may cause damage to an aircraft airframe, or upset an aircraft when flying at low level, typically when conducting the following phases of flight operations:

- Approach, landing and take-off;
- Specialist flying activities such as crop dusting, cattle mustering, pipeline or power-line inspections, fire fighting, etc;
- Search and rescue operations; and
- Military low-level manoeuvres.

The risk posed by an exhaust plume to an aircraft during low level flight can be managed or reduced if information is available to pilots so that they can avoid the area of likely air disturbance. As such CASA requires the proponent of a facility with an exhaust plume which has an average vertical velocity exceeding the limiting value of 4.3m/s at the aerodrome Obstacle Limitation Surface (OLS) or at 110m above ground level anywhere else, to be assessed for the potential hazard to aircraft operations. CASA Advisory Circular AC139-05(0) details the guidelines for conducting plume rise assessments.

The recently built Tallawarra A CCGT gas turbine power station exists on the site with one 60m exhaust stack. CASA was involved in the planning associated with this power station.

The revised plume rise analysis of the proposed power plant undertaken by SKM in accordance with AC139-05(0) indicates that the proposed power station will generate exhaust gas plumes that will reduce in vertical velocity to 4.3m/s at the altitudes shown in Table 1-1 below.

Site	Maximum Altitude (AHD) at which the Plume reduces to 4.3m/s	Average Altitude (AHD) at which the plume reduces to 4.3m/s	Theoretical 0.1% Exceedence Altitude (AHD) at which plume reduces to 4.3m/s
Tallawarra B OCGT	991.1m/3252ft	155m/509ft	735.1m/2412ft

Table 1-1: Altitudes at which the plume velocity reduces to 4.3m/s

The revised plume rise assessment has produced a reduction in the altitude that the plume reduces in vertical velocity to 4.3m/s for the maximum extent of the plume is 199m/653ft lower than the original assessment and the altitude that the plume reduces in vertical velocity to 4.3m/s for the 0.1% percentage exceedence is 145m/476ft.

Recent advice from CASA Office of Airspace Regulation (OAR) have confirmed that the assessment of the affect of the plume is only required to the theoretical height at which the velocity of a plume will be less than 4.3 m/sec for 99.9% of the duration of the plume.

As a result of this advice from CASA, the remainder of this report will only consider the theoretical 0.1% exceedence altitude for the OCGT proposal.

In its current form, the proposed power station development will have an impact upon:

- The Procedures for Air Navigation - Operations (PANS OPS) surfaces at Wollongong Aerodrome;
- The OLS surfaces at Wollongong Aerodrome;
- Take-off and Landing operations at Wollongong Aerodrome; and
- Visual Flight Rule (VFR) operations in the vicinity of the power station.

TRUenergy will need to undertake appropriate mitigation action acceptable to the aviation authorities to reduce the risk and hazard to aircraft and airport operations.

1.1 Summarised Results

1.1.1 Obstacle Limitation Surfaces

Protected airspace around airports includes Obstacle Limitation Surfaces that are defined by the International Civil Aviation Organization (ICAO). Their purpose is to protect aircraft conducting landing and take-off operations from obstacle and hazardous activity intrusions into defined airspace. ICAO Annex 14 defines the OLS.

The existing and the proposed power station plant are located within the Inner Horizontal Surface (IHS) of Wollongong Aerodrome's OLS. The elevation of the IHS is 52m/175ft AHD. The physical characteristics of the proposed OCGT power station (43.1M AHD) do not penetrate the OLS.

Examination of the revised plume rise analysis indicates that the proposed OCGT power plant will generate an exhaust plume that, at the specified benchmark velocity of 4.3m/s, discharges above the Inner Horizontal Surface by 683.1m (2242ft).

1.1.2 PANS OPS Surfaces

The physical heights of the proposed 40m OCGT exhaust stacks will not penetrate the PANS OPS Surfaces.

The proposed exhaust plume associated with the OCGT power stations will discharge above the Instrument Approach Procedure, Minimum Sector and Circling Altitudes at Wollongong, as published in Aeronautical Information Publications (AIP DAP East).

1.1.3 Siting and Clearance Areas for Airways Facilities

The existing and proposed development will not affect the performance of the Non-Directional Beacon (NDB) located on the eastern side of the aerodrome at Wollongong.

1.1.5 Overlying Air Routes

This development proposal lies beneath two air routes and their associated protection surfaces. Air routes H65 and W430 are used by airline traffic to fly into and out of Sydney. The air route

LSALT protection areas can be up to 50nm either side of the nominal track for the route. Air Route Q15 lies just to the east of these routes and is a high level air route that does not have a LSALT.

The theoretical 0.1% exceedence altitude of the hazardous portion of the exhaust plume for the proposed Tallawarra B OCGT power station is below the Lowest Safe Altitude (LSALT) for air routes H65 - 3400ft and W430 - 3600ft. The lowest LSALT for other routes in the vicinity of the development site is 4200ft. Figure 1-2 below shows these air routes.

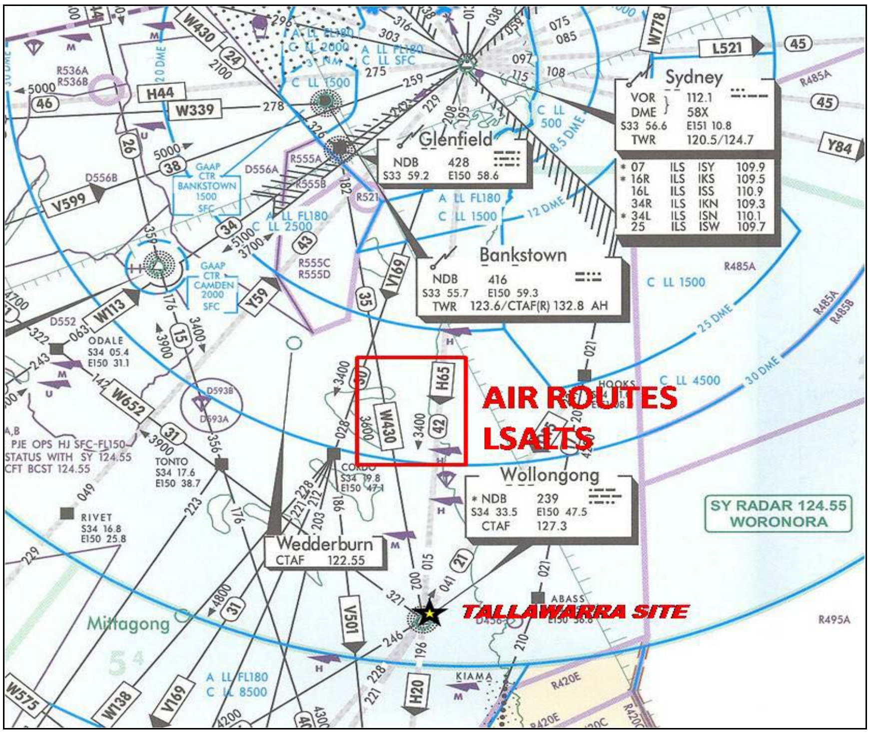

Fig 1-2 Air Routes overlying Wollongong

1.1.6 Local aviation activities

Illawarra Regional Airport (Wollongong Airport) is a security controlled, CASA Certified airport that is owned and operated by Shellharbour City Council. The airport is serviced by regular public transport aircraft operations and it is the base for a growing light aeronautics Industry, which provides maintenance and engineering services for aircraft ranging from ultra lights to medium size turbo prop and jet aircraft.

The aerodrome is capable of handling jet aircraft of Boeing 737 size and military jets including F/A-18 Hornets although both these type of aircraft are occasional visitors.

The area surrounding Wollongong contains many scenic areas that attract light aircraft, helicopter and tourist activities. Such scenic flights are conducted in fair weather which allows pilots to navigate by visual reference to the ground and water.

The Historical Aircraft Restoration Society (HARS) museum, a flying training and charter operation, a business jet charter operation, a Search and Rescue/Aerial Surveillance operation, a Skydiving operation, the NSW Ambulance Helicopter Service, an ultralight flying training and club operation and a helicopter charter operation all currently share the aviation facilities at Wollongong Aerodrome with itinerant visiting aircraft.

As Tallawarra B plume rise and physical characteristics result in a penetration of the OLS and PANS OPS surfaces, these local aviation activities are likely to be impacted by Tallawarra B operations.

1.1.7 Mitigation of the adverse impact of the exhaust plume

In accordance with AC139-05(0), penetrations of the OLS and PANS OPS surfaces requires the proponent to consult with the aviation authorities in regard to the potential hazards to aircraft safety and to consider mitigation strategies that would enable the development of Tallawarra B to proceed.

Individual and/or combined impact mitigation strategies or options, which are detailed later in this report, include:

- Risk analysis and management of the likelihood of aircraft being affected by the plume, considering the limited amount of time that this plume will penetrate the prescribed airspace;
- Reduction of the theoretical 0.1% exceedence altitude of the 4.3m/s velocity plume;
- Redesign of affected Instrument Approach procedures (PANS OPS) to avoid the proposed development;
- Creation of a Danger Area by CASA;
- Installation of high or medium intensity obstacle lighting to allow VFR aircraft, both civil and military to identify and avoid the site; and
- Consideration of precedents in relation to similar and existing high velocity gas plumes.

1.1.8 Other Approvals

If the proposed power station development is to proceed at the nominated site, cranes and other construction equipment used during the construction phase, that penetrate the OLS or PANS OPS surfaces will be considered temporary obstructions and will require separate approval from the aviation agencies.

Cranes used during the construction phase (temporary obstructions) which operate above 52m AHD will penetrate the OLS but could be approved under condition of the developer providing timely advice to the Aerodrome operator prior to the construction commencing so that appropriate Notice to Airman (NOTAM) action can be promulgated.

2. METHODOLOGY

The methodology employed for the preparation of this report focuses on the consideration and assessment of civil and military aviation protection of airspace and airport operations as outlined in the following:

- Civil Aviation Safety Authority (CASA) Advisory Circular AC139-05(0) - Guidelines for Conducting Plume Rise Assessments;
- Written advice from CASA's Office of Airspace Regulation referring to the assessment of the theoretical 0.1% exceedence altitude;
- The Obstacle Limitation Surfaces (OLS);
- The Procedures for Air Navigation Services - Operations (PANS OPS) surfaces at Wollongong Aerodrome in conjunction with Civil Aviation Safety Regulations (CASR) Part 173 Manual of Standards (MOS);
- The instrument approach procedures contained in the Australian Aeronautical Information Publication (AIP), Departure and Approach Procedures (DAP) East effective 11 March 2010, and current NOTAMS;
- Civil Aviation Safety Regulations (CASR) Part 139 Manual of Standards (MOS), Chapter 7 Obstacle Restriction and Limitation and Chapter 11 Standards for Other Aerodrome Facilities; and
- Consideration of possible mitigation strategies to reduce the potential impacts of the proposed power station on aviation and airport activities with a view to making the proposed development acceptable to the aviation authorities.

The client has provided a revised plume rise assessment (refer Appendix A) which provides the necessary data relating to plume height rise, velocity and dispersal that is necessary to undertake the aeronautical impact assessment.

The following aviation assessments and examinations were undertaken:

- Obstacle Limitation Surface infringements were determined accurately, based on the siting information provided by the client;
- Relevant instrument approach procedures were examined in detail to determine whether the development would impose any restriction on those procedures. The Instrument Approach Procedures considered in the original report were amended by Airservices after the completion of that report. The new procedures which will be available for aircraft use on and after 11 March 2010 were assessed for this report;
- Existing flight paths were examined, in relation to the proposed development, to determine any impacts on those procedures;
- Civil Aviation Order (CAO) 20.7.1B relates to the minimum requirements for clearance of obstacles by an aircraft that has suffered a failure of a critical engine during take-off (Contingency Procedures). The contingency procedures analyse the minimum safe altitudes (and therefore relate to maximum allowable obstacle heights) required in such a circumstance. The influence that development on the site would have on contingency

(CAO 20.7.1B) procedures was considered. The consideration was extended to include any impediment to these procedures as a result of existing obstacles and possible and feasible flight paths from the airport over the power station development site;

- A preliminary assessment of potential impacts on navigational aids and air traffic control radar coverage; and
- A concise summary of findings and conclusion as to whether the proposal should be approved.

Subject to the findings of this assessment and consideration of mitigation options, this aeronautical impact assessment may form part of an application to CASA, for assessment as to whether or not the plume rise and physical characteristics of Tallawarra B could be deemed acceptable to the aviation authorities, including, if appropriate, classification of the power station and associated plume rise as a hazardous object to civil aviation activities under CASR Part 139. Consideration was also given to development of possible mitigation strategies to reduce the potential impacts with a view to making the proposed development acceptable to the aviation authorities.

3. ANALYSIS OF OBSTACLE LIMITATION SURFACES (OLS)

Protected airspace around airports includes Obstacle Limitation Surfaces that are defined by the International Civil Aviation Organization (ICAO). Their purpose is to protect aircraft conducting landing and take-off operations from obstacle and hazardous activity intrusions into a defined airspace considered essential for aircraft manoeuvres to ensure safe take-off and landing operations are not compromised.

ICAO Annex 14 defines the OLS.

The existing and the proposed power stations are located within the Inner Horizontal Surface (IHS) of Wollongong Aerodrome's OLS.

The elevation of the IHS is 52m/175ft AHD.

The physical characteristics of the proposed OCGT power station 40m exhaust stack does not penetrate the OLS.

Examination of the plume rise analysis indicates that the proposed OCGT plants will generate a theoretical 0.1% exceedence exhaust plume to 735.1m/2412ft, at the specified benchmark velocity of 4.3m/s, which is above the Inner Horizontal Surface of the OLS.

Cranes used during the construction phase that penetrate the OLS (temporary obstructions) will require separate approval from the aviation agencies.

4. ANALYSIS OF PANS OPS SURFACES

Assessment of the impact by the proposed development was undertaken with respect to the Instrument Approach Procedures for Wollongong aerodrome and Wollongong Hospital Helipad.

There are no other airfields with PANS OPS surfaces located above the proposed development site.

This assessment considered Minimum Descent Altitudes (MDA), Circling Minima and Minimum Sector Altitudes (MSA) and the Obstacle Infringement Surfaces (protection surfaces) as published in:

- Australian Aeronautical Information Publication, Departures and Approach Procedures (AIP DAP) effective 11 March 2010;and
- Aeronautical Information Circulars (AIC), Aeronautical Information Supplements and NOTAMS relevant to Wollongong Airfield, Wollongong Hospital Helipad and the associated Instrument Approach Procedures.

The CASR Part 173 Manual of Standards (MOS), Chapter 8, details the segregation required for safe approach, landing and take-off procedures associated with instrument approach procedures to airfields in the vicinity of high velocity gas efflux plumes.

The plumes are assessed in relation to the approach procedure's published altitudes, known as procedure altitudes, and obstacles are considered in relation to a buffer beneath the procedure altitude, known as the Minimum Obstacle Clearance (MOC) buffer, except in the final approach segment and the missed approach segment where the approach procedure protection surfaces must be clear of the plume.

A full and detailed PANS OPS assessment considering all operational procedures was undertaken and the results are summarised in the following Tables 4-1 to 4-3 for Wollongong Airport and Tables 4-4 and 4-5 for the Wollongong Hospital Helipad procedures.

WOLLONGONG AERODROME

APPROACH PROCEDURE	IMPACT/COMMENTS
GPS ARRIVAL SECTOR A	The proposed OCGT is located beneath the last step of the Final Approach Segment. The 99.9% extent of the revised OCGT exhaust plume at 2412ft will discharge above the Minimum Descent Altitude (1730ft).
GPS ARRIVAL SECTOR B	The proposed OCGT is located beneath the last step of the Final Approach Segment. The 99.9% extent of the revised OCGT exhaust plume at 2412ft will discharge above the Minimum Descent Altitude (1730ft).
RNAV (GNSS) RWY 16	The exhaust plume is located outside of all of the segments for this approach.
RNAV(GNSS) RWY 34	The 99.9% extent of the revised OCGT exhaust plume at 2412ft will discharge into the final missed approach surface (1445ft). (Missed Approach PANS OPS surface above the stack = 1445ft)
NDB -A	The proposed OCGT is located beneath the Initial Approach Segment. The 99.9% extent of the revised OCGT exhaust plume at 2412ft will discharge above the minimum initial approach altitude of 2200ft. Holding at 4300ft is not affected. The exhaust stack is located outside of the protection area for Final Approach.

Table 4-1 Approach Procedures

CIRCLING PROCEDURE	IMPACT/COMMENTS
CAT A/B	The development site is within the CAT A/B Circling Area. The 99.9% extent of the revised OCGT plume discharges above the procedure altitude of 1730ft.
CAT C	The development site is within the CAT A/B Circling Area. The 99.9% extent of the revised OCGT plume discharges above the procedure altitude of 1830ft.

Table 4-2 Circling Areas

Aircraft are in an approach configuration during the Initial Approach phase of an NDB approach and would be considered at risk to turbulence from a high velocity gas efflux plume.

The CAT A/B area encompasses an area of 4.9km radius from each THR. The CAT C circling area encompasses the CAT A/B circling area and beyond out to a distance of 7.8km.

CAT A/B aircraft are typically light single engine and twin engine aircraft generally operating with less than 15 people on board.

CAT C aircraft are generally of the Boeing 737, or Airbus A320 size as operated by domestic airlines.

MSA PROCEDURE	IMPACT/COMMENTS
25NM MSA	The 99.9% extent of the revised OCGT exhaust plume at 2412ft will NOT discharge into the 25nm MSA altitude (3700ft).
10NM MSA	The worst case plume will not discharge into the procedure altitude of 4300ft.

Table 4-3 Minimum Sector Altitudes

Aircraft using the 25nm MSA altitude of 3700ft can maintain this altitude up to the WOL NDB. They do not have to climb up to 4300ft once inside 10nm.

WOLLONGONG HOSPITAL HELIPAD

APPROACH PROCEDURE	IMPACT/COMMENTS
RNAV(GNSS) – 212 (HELICOPTER)	The development site is 6nm from the Hospital Helipad and does not infringe upon the approach splays.

Table 4-4 Approach Procedure

MSA PROCEDURE	IMPACT/COMMENTS
25NM MSA	None of the plumes penetrate the southern sector 4200ft 25NM MSA.
10NM MSA	The 99.9% extent of the OCGT plume at 2412ft will NOT discharge into the 10NM MSA Altitude of 4000ft.

Table 4-5 Minimum Sector Altitudes

Circling Areas do not exist for helicopter instrument approaches of this type.

The following figures Fig. 4-1 to 4-4 indicate the proximity of the power station to the various PANS OPS surfaces.

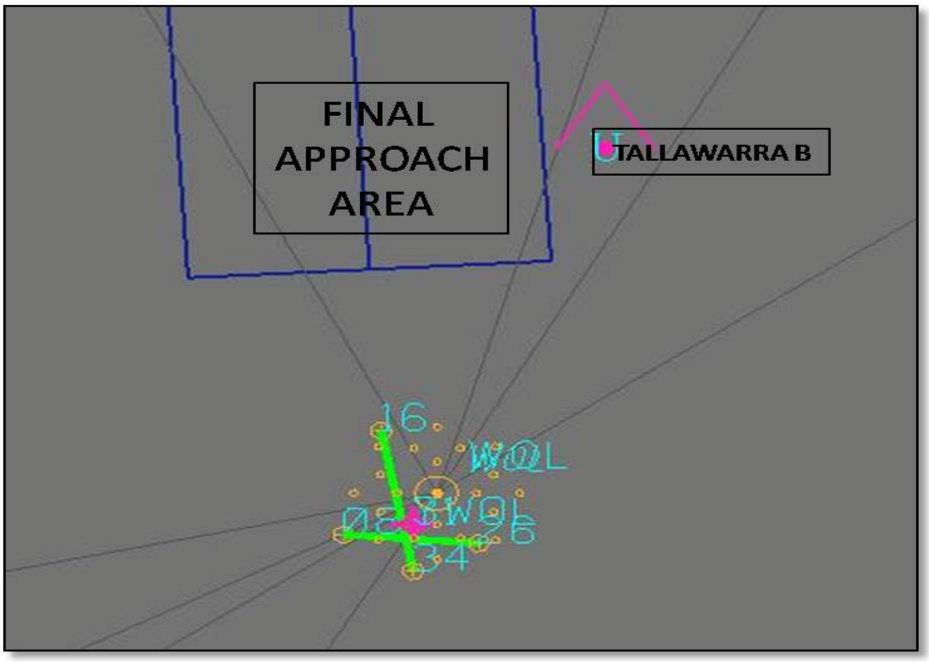

Fig4-1 Power station location outside of the RWY 16 RNAV final approach PANS OPS protection area

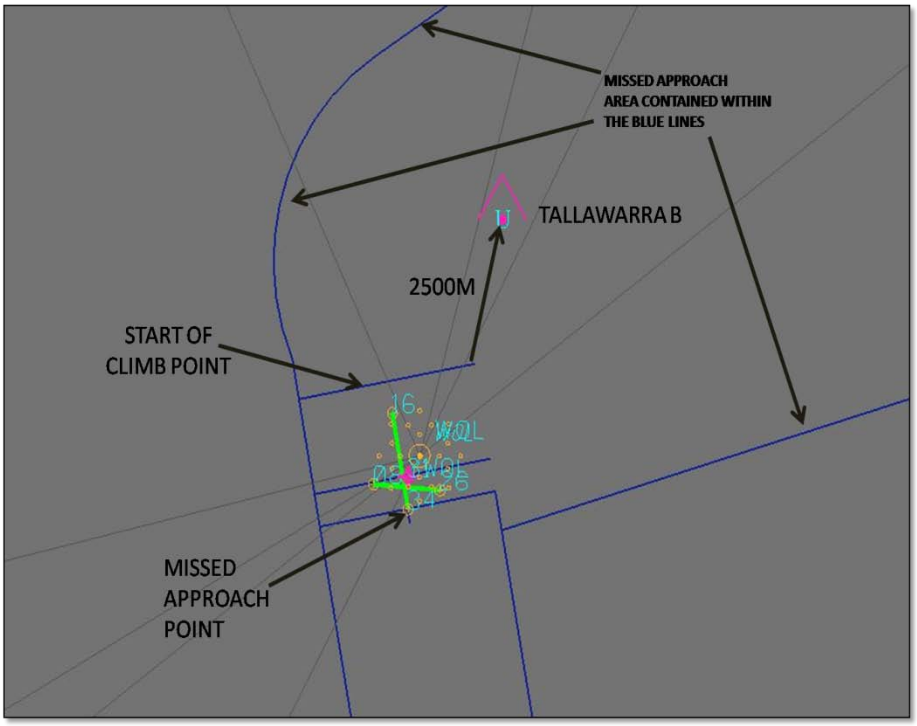

Fig 4-2 Power station location in relation to RWY 34 RNAV Missed Approach PANS OPS protection area

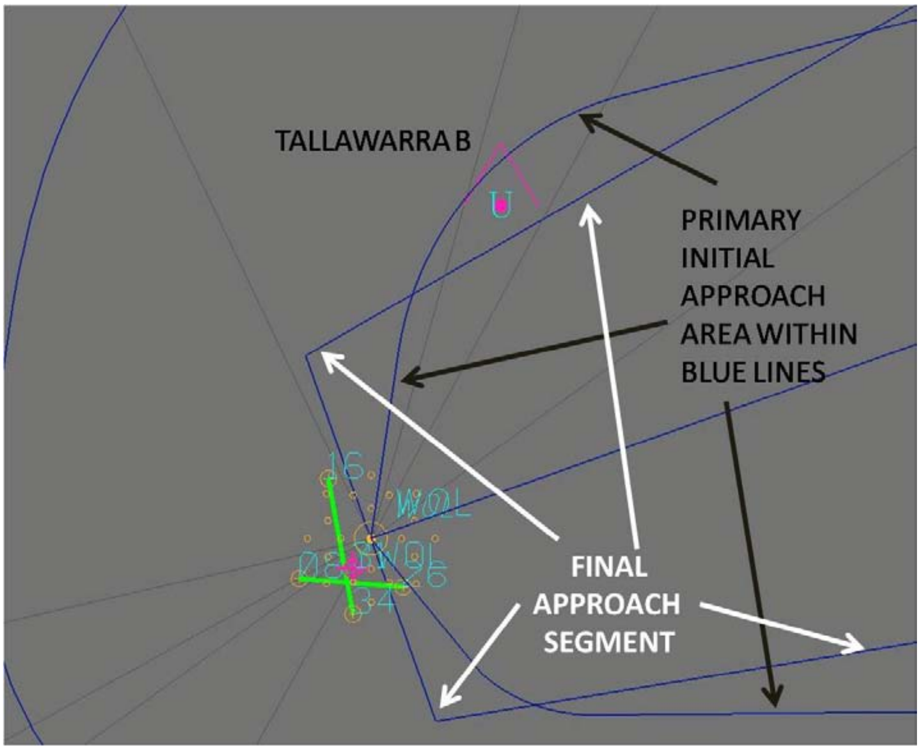

Fig 4-3 Power station development location in relation to NDB A PANS OPS protection areas

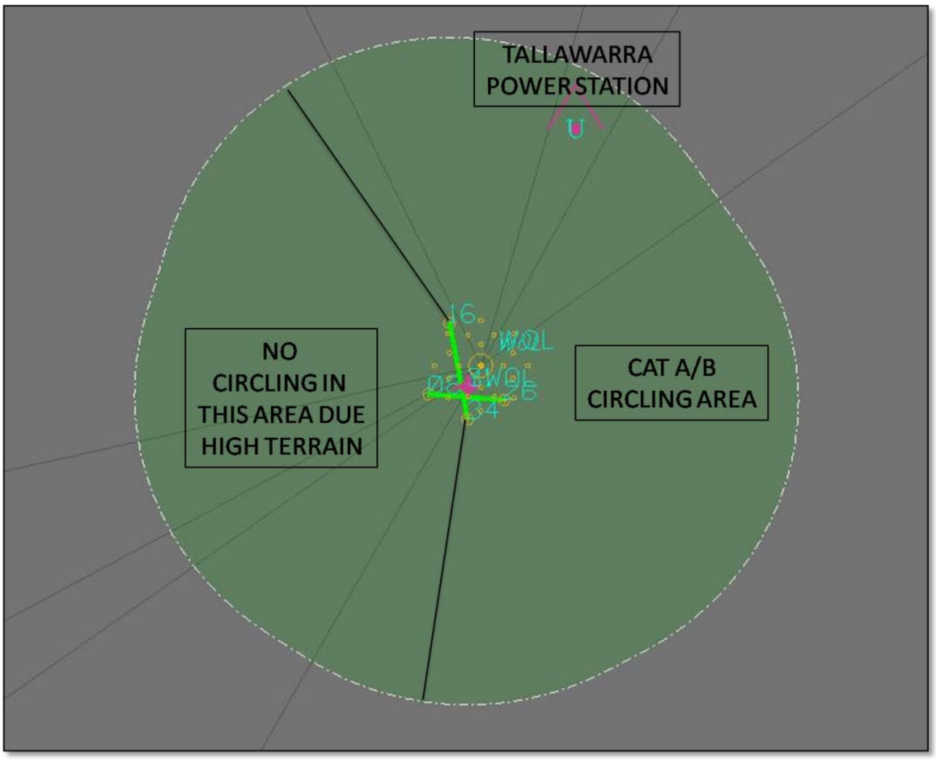

Fig 4-4 Power station location in relation to CAT A/B Circling Area

5. CONTINGENCY PROCEDURES - ENGINE INOPERATIVE FLIGHT PATHS

Multi-engine aircraft suffering from the loss of a critical engine during take-off or climb and those conducting an instrument approach with a critical engine inoperative cannot manoeuvre to the same extent as when all engines are operating normally. Aircraft operating agencies, including military units, plan and implement contingency procedures in relation to the aircraft that they operate.

In the case of Tallawarra B and operations from Wollongong aerodrome, the worst case plume rise at the proposed development would need to be considered by local aircraft operating companies.

Twin engine aircraft suffering an engine failure shortly after take-off are likely to remain within the published circling area while attempting to return to the runway for an emergency landing. This is likely to bring such aircraft into close proximity with the power station and its high velocity exhaust plume. This aspect will need further consideration by the operators at Wollongong Airport.

6. OTHER ISSUES

6.1 Radar Interference and Shadowing

The physical building development for the Tallawarra B Power Station does not infringe upon any ATC Radar signal clearance planes.

6.2 Potential Impact on Airport Navigation Aids

The building and the exhaust plume do not impact upon Radio Navigation Aid performance at Wollongong Airport.

There are no other Radio Navigation aids in the vicinity.

6.3 Future Developments

The increasing population and building development in the Illawarra region is likely to limit any physical expansion of the runways. However, it is known that expansion of the existing commercial aviation activities at Wollongong is being actively sought by the airport owner.

Any future plans for additional Instrument Approach Procedures will need to take account of the exhaust plume, should the development be approved.

However, given the complexity of the terrain and housing developments in the Illawarra region, it is unlikely that other procedures that encompass different flight paths than those in existence today would meet the design criteria required.

6.4 Lighting of Buildings

The proposed OCGT power station exhaust stack is planned at a height (43.1m AHD) that does not penetrate the OLS. However, should CASA recommend establishment of a Danger or Restricted Area to identify the existence of the high rise plume, they may also recommend obstacle lighting of the power station stack to enable pilots to identify the centre of the Danger or Restricted Area.

7. POSSIBLE MITIGATION STRATEGIES OR OPTIONS

The above assessment indicates that the proposed power plant is likely to impact upon the safety of aircraft operations and the project may be unacceptable to the aviation authorities unless appropriate mitigation action can be taken. This section proposes various mitigation strategies or options for consideration by the power plant proponent and for possible discussion with the aviation authorities.

This proposed power station generates an exhaust plume defined as high velocity by CASA.

An extract from the CASA Advisory Circular – AC 139-05(0) of June 2004 states:

" ***4.2*** *Aviation authorities have established that an exhaust plume with a vertical gust in excess of 4.3 metres/second (m/s) may cause damage to an aircraft airframe, or upset an aircraft when flying at low levels.*

4.3 *Low level flying operations are typically conducted during:*

- *approach, landing and take-off*
- *specialist flying activities such as, crop dusting, cattle mustering, pipeline inspection, power line inspections, fire-fighting, etc*
- *search and rescue operations*
- *military low-level manoeuvres*

4.4 *While approach, landing and take-off are normally conducted in the vicinity of an aerodrome, the other low level operations can be conducted anywhere across the country.*

4.5 *The risk posed by an exhaust plume to an aircraft during low level flight can be managed or reduced if information is available to pilots so that they can avoid the area of likely air disturbance.*

4.6 *As a result of this, CASA requires the proponent of a facility with an exhaust plume, which has an average vertical velocity exceeding the limiting value (4.3 m/s 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."*

The theoretical 0.1% exceedence level at which the revised OCGT exhaust plume reduces to a velocity of 4.3m/s occurs at 735.1m/2412ft AHD which is above the OLS and some PANS OPS surfaces and procedure altitudes.

The average height at which the plume vertical velocity reduces to 4.3m/s or below is 155m, which is also above the OLS but beneath all PANS OPS surfaces and procedure altitudes.

It is likely that the aerodrome operator and CASA will determine that this exhaust plume will have an "adverse impact on flight procedures" at this location and height as the exhaust plume will discharge into both the OLS and PANS OPS procedure altitudes.

The following mitigation strategies or options have been considered. Some will reduce or eliminate the hazard to flight procedures and airport operations. All will need further consideration by the proponent and discussion with the aviation authorities as to reasonableness, acceptability and cost-effectiveness. It is not part of this study to undertake mitigation studies, but to identify options available to the proponent that may make the proposed power station development more acceptable to the aviation authorities.

7.1 Risk based assessment of the impact of the exhaust plume

Advisory Circular AC 139-05(0) allows for a probability based risk assessment approach by proponents and it is understood that other power plant proponents have undertaken such assessments, taking into account the infrequent operation of the plant, the relatively low duration of operation, the infrequency of the plume achieving the 99.9% height, the probability of aircraft being in the vicinity of the worst-case plume rise and other factors that may reduce the risk to an acceptable level.

7.2 Reduction of the maximum height that the plume exceeds 4.3m/s

Control of the exhaust plume to limit the velocity of the plume as it exits the stack will reduce the height that the plume exceeds the critical velocity of 4.3m/s. (It is understood that reduction of plume height may be a limited option for peaking power plant operations.)

The major impact to PANS OPS surfaces is to the missed approach protection surfaces for the RWY 34 RNAV approach and the Initial Approach Segment of the NDB (A) approach. The missed approach procedure is similar to a take-off procedure in that the aircraft is climbing at prescribed rate to ensure obstacle clearance is achieved efficiently. It is reasonable for CASA to presume that the AC 139-05 (0) applies to a missed approach.

Aircraft on the RNAV (GNSS) approach to RWY 34 that reach the MDA of 1240ft but who cannot see the runway environment at that point due to cloud or rain, etc, must carry out the Missed Approach published on the procedure chart. The distance from the “Start of Climb Point” to the nearest point of the reported plume is 2500m. At the minimum prescribed climb rate during a missed approach, aircraft will reach 1445ft overhead the stack. The MOC for this portion of the missed approach could be reduced to 91ft, giving a PANS OPS altitude of 1354ft.

If the theoretical 0.1% exceedence altitude of the exhaust plume can be reduced to 410m AHD then penetration of the missed approach will be eliminated, along with the penetration of the Initial approach segment of the NDB-A approach.

If the critical PANS OPS surfaces are not infringed then the Wollongong OLS infringement may be acceptable to the aerodrome operator and to CASA.

7.3 Redesign of the affected Instrument Approach procedures at Wollongong to avoid the proposed development.

The proposed development exhaust plume will discharge above the missed approach procedure for the RWY 34 RNAV (GNSS) approach.

Redesign of the missed approach track is not considered viable as nearby high terrain precludes a left hand turn or straight missed approach which means that the proposed power plant site will still remain within the protected area for the missed approach path.

Redesign of the missed approach to increase the climb gradient, to increase the MDA or to change the location of the missed approach waypoint to a position further away from the Runway threshold and therefore provide more climb distance prior to overflying the exhaust stack is possible. However, these changes are rarely applied as they then limit the ability of the pilot to land at the airport when the weather is as bad as it can possibly be but still allow the pilot to maintain visual contact with the runway environment and then be able to land safely. The missed approach procedures must also cater for the full range of aircraft likely to use the airport and some aircraft have limited climb performance in some laden or emergency situations.

Reduction of the height of the plume as indicated in 7.2 above would eliminate the need to modify existing approach procedures.

In regard to the NDB procedure, it is unlikely that a revision to the procedure is possible that would eliminate the horizontal extent of the plume at its proposed location due to several factors:

- The area of the initial segment for a reversal procedure is large;
- The proximity and location of the populated areas;
- The proximity and location of the steeply rising terrain to the north, south and west of Wollongong; and
- The proximity and location of the proposed power station.

The cost of modifying Instrument Approach Procedures to accommodate new developments such as Tallawarra B is usually borne by the developer. An indication of the likely cost of such modifications was provided in an e-mail from AsA to NSW Planning in late 2009.

7.4 Consideration of precedent in relation to similar gas peaking power stations

There are insufficient numbers of these types of power stations operating in close proximity to airfields with OLS and PANS OPS surfaces to provide precedent determinations in respect of the approval of operating requirements for such plants.

7.5 Display of the location on Aeronautical Charts (Declaration or a 'Danger Area')

Regardless of the approved height for the operation of this proposed power station, display of the location of the power station on Aeronautical Charts (e.g. as a Danger Area) provides advice to pilots of an "obstacle" and assists pilots to avoid the area.

Providing the "as constructed" details of the power station to CASA will ensure that the location is published on relevant aeronautical charts.

7.6 Mitigation conclusions

The mitigation options considered in this report will not completely eliminate the penetrations of OLS and PANS OPS surfaces.

Reduction of the vertical extent of the exhaust plume where the velocity reduces to 4.3m/s to an altitude of 1354ft may allow CASA to approve the operation as it will remove all PANS OPS penetrations.

CASA have indicated that a risk based analysis and report of the real impact of the vertical extent of the hazardous component of an exhaust plume, taking into consideration the extremely low likelihood of an aircraft entering the plume at a time when worst-case plume height velocities prevail, may provide support for the approval of the operation of the proposed power station at the nominated site and altitudes.

8. CONCLUSION

The extent of the high velocity exhaust plume associated with the proposed revised Tallawarra B OCGT development is considered to create a potential hazard to the safety of aviation procedures and activities at Wollongong Airport.

The major findings of this assessment are:

- The theoretical 0.1% exceedence height of the exhaust plume for the revised OCGT plant option will exist above some PANS OPS surfaces and procedure altitudes at Wollongong Airport;
- The theoretical 0.1% exceedence height of the exhaust plume for the revised OCGT plant option will exist above the Obstacle Limitation Surfaces of Wollongong Airport; and
- The exhaust plume for the revised OCGT plant option will not exist above air routes to the north of Wollongong airport.

The reduction to the extent of the plume in the revised SKM report for the OCGT plant does not eliminate all of the OLS or PANS OPS intrusions.

Some of the mitigations explored will reduce or eliminate the hazard to flight procedures and airport operations. All will need further investigation by the proponent and discussion with the aviation authorities as to their reasonableness, acceptability and cost-effectiveness.

A risk based analysis and report of the real impact of the vertical extent of the hazardous component of the exhaust plume, taking into consideration the extremely low likelihood of an aircraft entering the plume at a time when the theoretical 0.1% exceedence plume height velocities prevail, may provide support for the approval of the operation of the proposed power station at the nominated site.

To meet the requirements of CASA AC 139-05(0), the Tallawarra B power station proposal requires consultation and discussion with the aviation authorities to consider the potential hazards to aircraft safety and to agree on an acceptable mitigation strategy.

APPENDIX A

TALLAWARRA A and B GAS PEAKING POWER STATION DEVELOPMENT

REVISED PLUME RISE ASSESSMENT

SKM

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TRUEnergy
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2 February 2010

Tallawarra OCGT_Plume rise_Draft2_Gas
EN02239

Dear Nicola

Additional Plume Rise Investigations for Tallawarra OCGT

This letter has been prepared by Sinclair Knight Merz (SKM) for TRUenergy following recent discussions on the potential impacts of the proposed open cycle gas turbine (OCGT) at the Tallawarra Power Station. The purpose of the letter is to provide results and analysis from additional plume rise modelling, to further understand the likely hazards to aviation in the area.

In 2008, SKM carried out dispersion modelling for the proposed Tallawarra CCGT and OCGT plants to determine plume rise statistics (SKM, 2008). The assessment was carried out in accordance with the Civil Aviation Safety Authority (CASA) guidelines (CASA, 2004) and results have been used to inform an aviation hazard assessment, conducted by the Ambidji group. One of the findings from the Ambidji study was that the OCGT proposal has the potential to cause adverse impacts on aviation due to higher plume rise.

It has been noted in recent discussions between SKM and TRUenergy that additional investigations on plume rise from the OCGT plant will be useful, due to recent upgrades to the dispersion model (TAPM) and changes to the way in which results are processed and presented. SKM has also been involved in recent discussions with CSIRO on the effect of merged plumes from multiple sources and the way in which this process is incorporated into the dispersion modelling – that is, the derivation of the buoyancy enhancement factor (BEF).

The modelling results presented in this letter seek to provide the most up-to-date estimates on the plume rise statistics for the OCGT proposal. In particular, the following tasks have been undertaken:

- Checking the OCGT machine that was originally modelled in the SKM 2008 study. This is to ensure that originally forecast plume rise statistics were not over-stated because of conservative assumptions on the exit velocity, temperature and flow conditions of the stack sources;

- Re-calculation and analysis of the BEF to confirm whether the originally calculated value of 1.82 is appropriate, given recent discussions and debate in the scientific community; and
- Updating and re-running the plume rise simulations, based on the most recent version of "The Air Pollution Model" (TAPM). Improvements to the science behind TAPM will, theoretically, lead to more reliable meteorology and plume rise statistics.

In summary, the updated plume rise modelling suggests that the maximum height at which the OCGT plumes fall below the critical vertical velocity of 4.3 metres per second (m/s) is 988 m. This value is lower than the originally forecast maximum height of 1,179 m.

Details of the additional plume rise investigations are provided in **Sections 1** to **4** below.

Yours sincerely

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1. Introduction

1.1 Plume Rise Assessment

TRUenergy is proposing to build a CCGT or OCGT plant next to their existing Tallawarra Power Station. This assessment focuses on the OCGT proposal and provides results and analysis from plume rise modelling. The Civil Aviation Safety Authority (CASA) requires the results of plume rise modelling in order to assess the potential impact that stack exhaust plumes may have on aircraft in the vicinity of the plant. The assessment was carried out in accordance with guidelines published by CASA (2004).

The location of Tallawarra Power Station is shown in **Figure 1** below. Illawarra Regional Airport is located approximately five kilometres (km) to the south of the power station.

- **Figure 1 Location of Tallawarra Power Station**

1.2 Background

Aviation authorities have established that wind gusts with vertical velocity exceeding 4.3 metres per second (m/s) may cause damage to an aircraft airframe or otherwise upset an aircraft flying at low levels. CASA has subsequently required that proponents of a facility where the vertical velocity of exhaust plumes exceed 4.3 m/s at an aerodrome Obstacle Limitation Surface (OLS), or at 110 metres above ground level anywhere else, must undertake plume rise modelling to assess the potential hazard to aircraft operations. Requirements of the plume rise modelling are outlined in CASA's Advisory Circular titled *Guidelines for Conducting Plume Rise Assessment* (CASA, 2004).

2. Assessment Methodology

2.1 Study Requirements

Plume rise assessments are typically based around the use of the CSIRO's prognostic model known as TAPM (The Air Pollution Model). TAPM is a prognostic model which has the ability to generate meteorological data for any location in Australia (from 1997 onwards) based on synoptic information determined from the six hourly Limited Area Prediction System (LAPS). TAPM is further discussed in the model's user manual (Hurley, 2008).

The requirements of CASA, when conducting plume rise modelling and assessment, can be summarised as follows:

- Modelling using the TAPM version 2.0 or higher;
- At least five years of continuous meteorological data modelled;
- Horizontal displacement of the plume centreline evaluated as a function of height;
- Plume spread about the centreline evaluated as a function of height;
- Consideration of "average" and "peak" vertical plume velocities for each height;
- Wind speed evaluated as a function of height; and
- Probability of vertical velocity exceeding 4.3 m/s.

The approach to the assessment was to follow the CASA requirements.

2.2 Plume Rise Modelling

TAPM (version 4.0.3) modelling was undertaken in accordance with the CASA requirements. The simulation period was 2004 to 2008 inclusive. **Table 1** provides a summary of TAPM user inputs and settings for this assessment.

- **Table 1 Summary of TAPM modelling parameters**

TAPM version	4.0.3
Number of grids (spacing)	3 (30 km, 10 km, 3 km)
Number of grid points	25 x 25 x 25
Simulation period	Jan 2004 to Dec 2008 inclusive
Terrain information	AUSLIG 9 second DEM data
Centre of analysis	34^{o}31.5'S, 150^{o}48.5'E (MGA 298840 mE, 6177449 mN)
Local data assimilation	none
Mode	Meteorology and pollution mode

The stack air emissions characteristics provided by TRUenergy are shown in **Table 2**, where the CCGT is the existing stack and the two OCGT sources are proposed. The OCGT data relate to a gas-fired 2 x 13E2 configuration as it results in higher NO_x emissions than other units and configurations.

- **Table 2 Stack emissions characteristics**

ID	Stack name	Easting	Northing	Height (m)	Stack tip radius (m)	Exhaust velocity (m/s)	Exhaust temperature (K)
1	CCGT	298826	6177714	60	2.75	26.0	351
2	OCGT1	298876	6177792	40	3.00	40.6	806
3	OCGT2	298892	6177777	40	3.00	40.6	806

For emissions from multiple stacks there is the possibility that merged, overlapping hot plumes may interact with one another, resulting in a single, higher buoyancy plume. This process is referred to as buoyancy enhancement.

The buoyancy enhancement factor (N_E) is defined (Hibberd *et al*, 2005) as follows:

Equation 1

$$N_E = \left[\frac{n+S}{1+S}\right]$$

Where *n* is the number of stacks and *S* is a dimensionless separation factor, defined as:

Equation 2

$$S = 6 \times \left[\frac{(n-1).\Delta s}{n^{\frac{1}{3}}.\Delta z}\right]^{\frac{3}{2}}$$

Where Δs is the stack separation and Δz is the rise of an individual plume. It should be noted that this approach is relevant to stack emissions of similar physical and emission characteristics, such as a group of gas turbine stacks separated by equal distances.

To determine relevant buoyancy enhancement factors, TAPM was run twice in pollution mode. The first model run was used to predict the final rise of an individual plume. The second model run included groups of “like” stack emissions, with the calculated buoyancy enhancement, and was used for the final analysis. The “like” stack emissions, or groups were determined by examination of the physical and emission characteristics from **Table 2**.

Statistics on the final rise of individual plumes, after modelling all stack emissions with no buoyancy enhancement, are shown below in **Table 3**. Two (2) groups of like stack emissions have been derived from the three original stacks and the buoyancy enhancement from these stack groups has been determined.

The data from **Table 3** show that, as expected, the proposed OCGT units are predicted to have higher final plume rise than the existing CCGT plume, at 1,231 m above ground-level. The final rise is the height above ground at which the vertical velocity falls to zero. The buoyancy enhancement factor (BEF) of 1.99 was determined from the maximum final rise of individual plumes, which is a conservative approach.

- **Table 3 Final rise of individual plumes and buoyancy enhancement factors**

ID	Stack name	Statistics for final rise of individual plumes (all units in metres)			Group	Buoyancy enhancement of stack group
		Minimum	Maximum	Average		
1	CCGT	96	779	273	1	1.00
2	OCGT1	150	1,295	456	2	1.99
3	OCGT2	150	1,295	456		

TAPM has a limitation in that only one value of the BEF can be used for the entire model simulation. In reality, the BEF will vary from hour to hour, due to variations in meteorology. The BEF for every hour of the simulation has been determined to range between 1.81 and 1.99.

3. Model Results

The TAPM output from the five year simulation period included a file with gradual plume rise data for every hour and for each stack. Gradual plume rise data included vertical velocity, plume height and plume dimensions from the time of release to the time of final plume height. Statistics were generated from this data file by interpolating to selected heights above ground.

An analysis of plume rise data was undertaken to determine the maximum, minimum and average heights at which the plume vertical velocity exceeded the critical velocity of 4.3 m/s. Results of this analysis are shown in **Table 4**.

- **Table 4 Summary of height at which plume vertical velocity falls below 4.3 m/s**

IDs	Group	Stack name	Height at which plume vertical velocity falls below 4.3 m/s (m)		
			Minimum	Maximum	Average
2,3	2	OCGT plant	63	988	155

Over the five year modelling period the proposed OCGT plant was predicted to result in a maximum height at which the plume vertical velocity falls below 4.3 m/s of 988 m. The average height at which the plume vertical velocity reduced to 4.3 m/s or below was 155 m.

Table 5 shows the height at which the plume vertical velocity was predicted to fall below 4.3 m/s for various percentile bands, consistent with CASA requirements. It can be seen from these data that there is a large difference between the height exceeding 0% of the time (that is, the maximum at 988 m), and the height of 0.05% exceedance (811 m).

- **Table 5 Height at which plume vertical velocity falls below 4.3 m/s**

Percentage exceedance	Height above ground-level for proposed OCGT plant (m)
0%	988
0.05%	811
0.1%	732
0.2%	664
0.3%	624
0.5%	561
1%	478
2%	397
3%	355
4%	327
5%	303
6%	285
7%	270
8%	257
9%	246
10%	236
20%	184
30%	160
40%	146
50%	134
60%	123
70%	114
80%	104
90%	93
100%	63

Table 6 shows the frequency of time that the plume vertical velocity was predicted to fall below 4.3 m/s for a range of heights above local ground-level. These data are required by CASA.

- **Table 6: Frequency of plume vertical velocity exceeding 4.3 m/s in height bands**

Height above ground (m)	Frequency of plume vertical velocity exceeding 4.3 m/s at each height (%)
60	100.000
70	99.802
80	97.421
90	94.073
100	83.571
110	73.670
120	63.476
150	36.168
200	15.567
300	5.106
400	1.948
600	0.353
800	0.059
1000	0.000

Time-series graphs of hourly plume vertical velocity, lateral plume radius, time since release, wind speed and horizontal displacement from the proposed OCGT plant are shown in **Figure 2** to **Figure 5**, for four selected heights above local ground-level. These graphs have been generated to show the hourly trend over the entire simulation period.

The region of space where the vertical velocity of the plume centreline exceeds 4.3 m/s, for all hours in the model simulation, is shown in **Figure 6**. This shows that the maximum height of the plume vertical velocity exceeding 4.3 m/s is located approximately above the proposed OCGT plant location. In this instance the simulated winds were very light (0.3 m/s at 800 m), and the horizontal displacement was 105 m from the stack location.

Figure 7 shows the regions of space in which the vertical velocity of the plume centreline exceeds 4.3 m/s from the OCGT plant. These figures have been created to help the CASA define a restricted area.

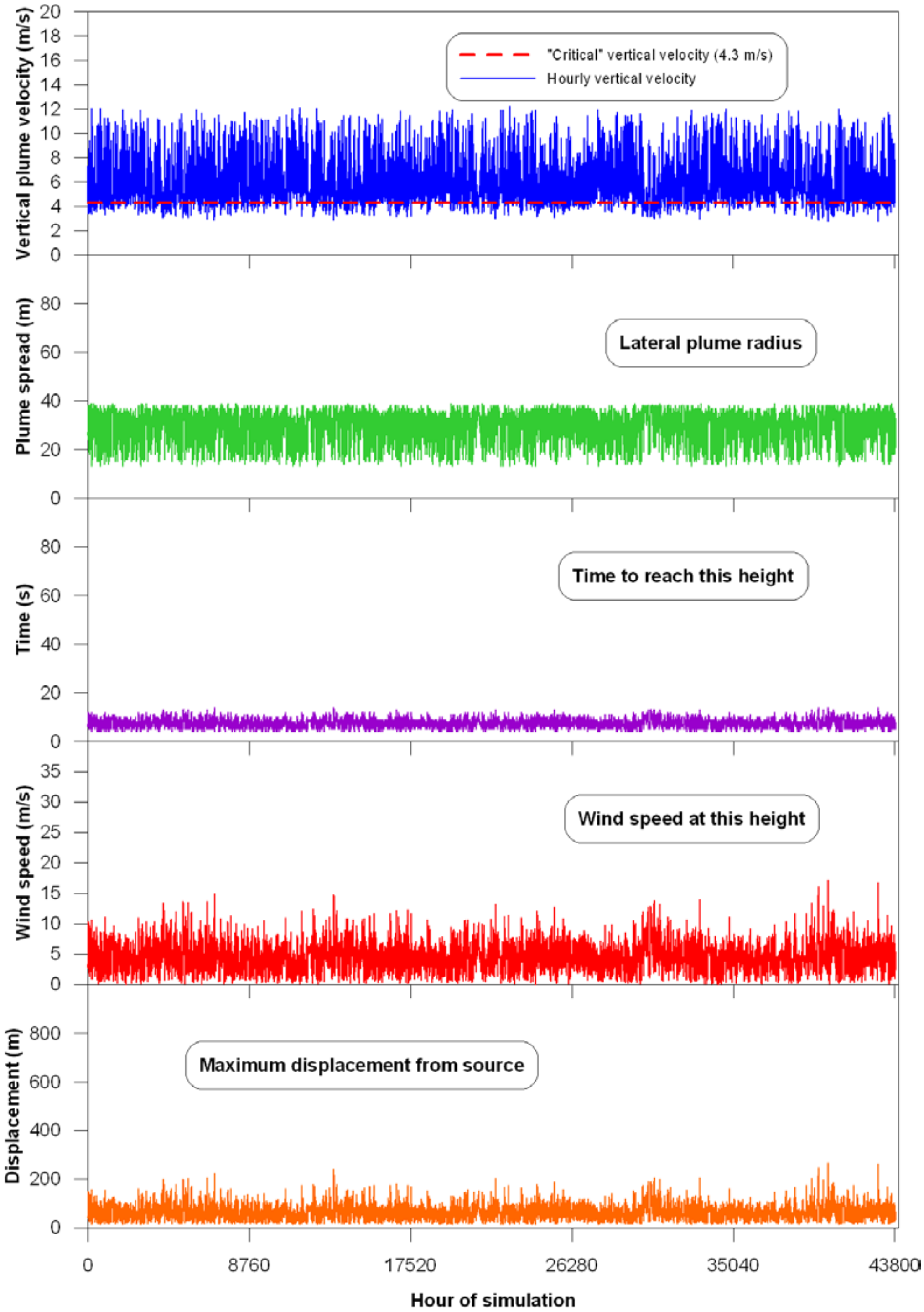
Figure 8 to **Figure 11** provide further analysis of the plume vertical velocity results, including:

- An hourly time-series of heights at which the plume vertical velocity falls below 4.3 m/s (**Figure 8**);
- A histogram of heights at which the plume vertical velocity falls below 4.3 m/s (**Figure 9**);
- Analysis of the results by hour of day (**Figure 10**); and

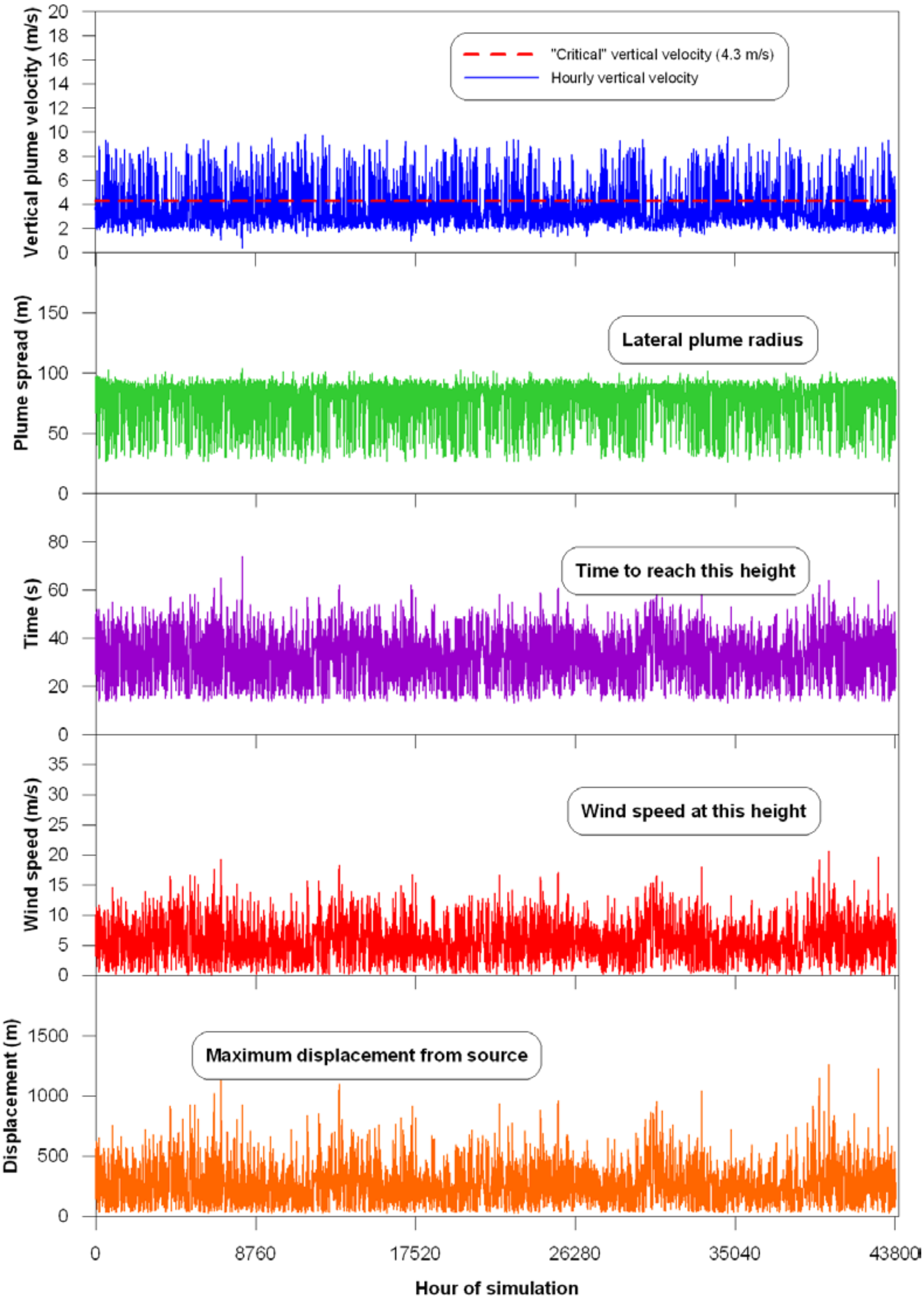
- Analysis of the results by month (**Figure 11**).

The results from **Figure 8** to **Figure 11** suggest that the height at which the plume velocity is above 4.3 m/s tends to be lower in the warmer months of the year, and lower over-night and in the morning.

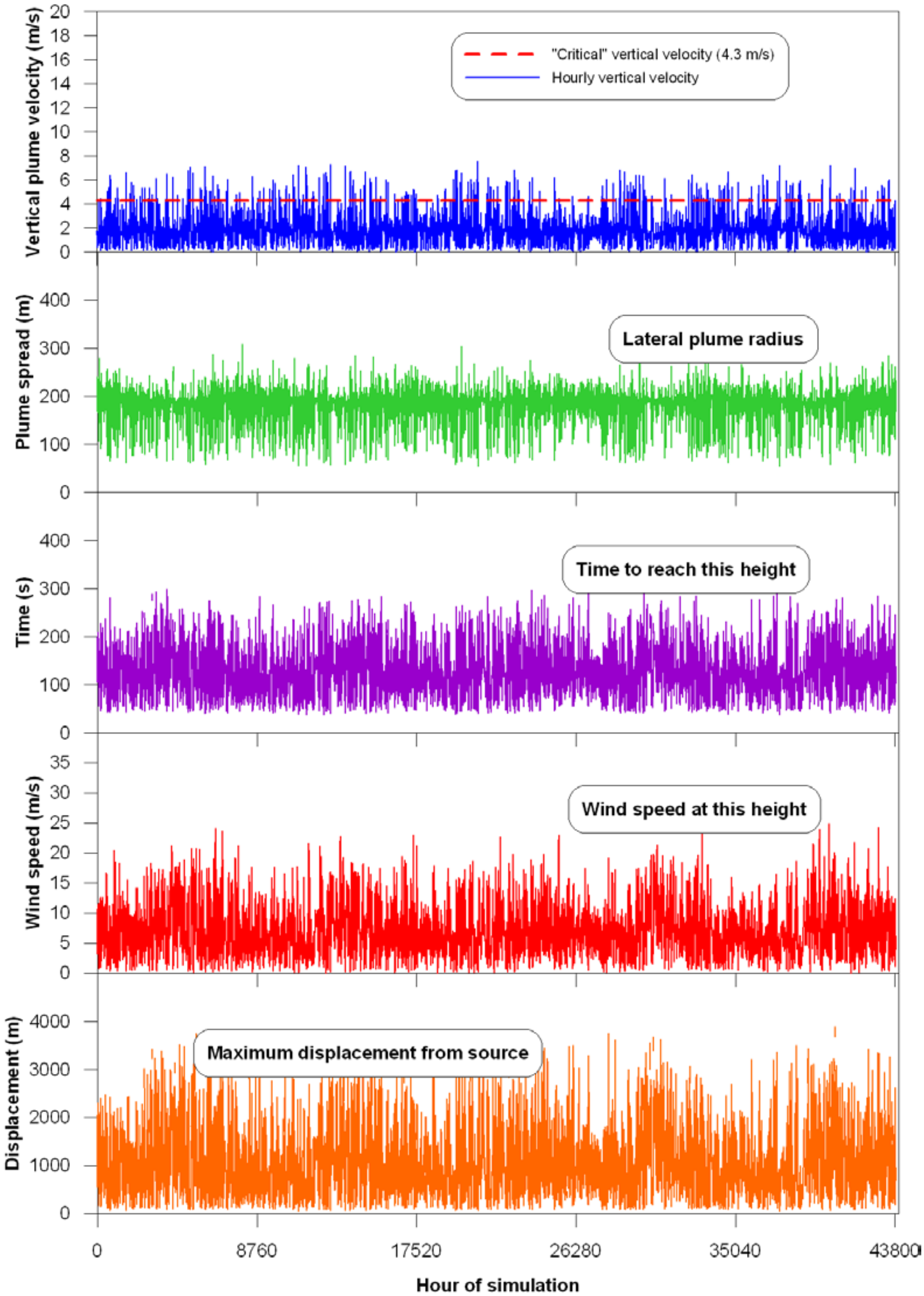
Figure 2 Plume and wind analysis for 100 m above ground-level



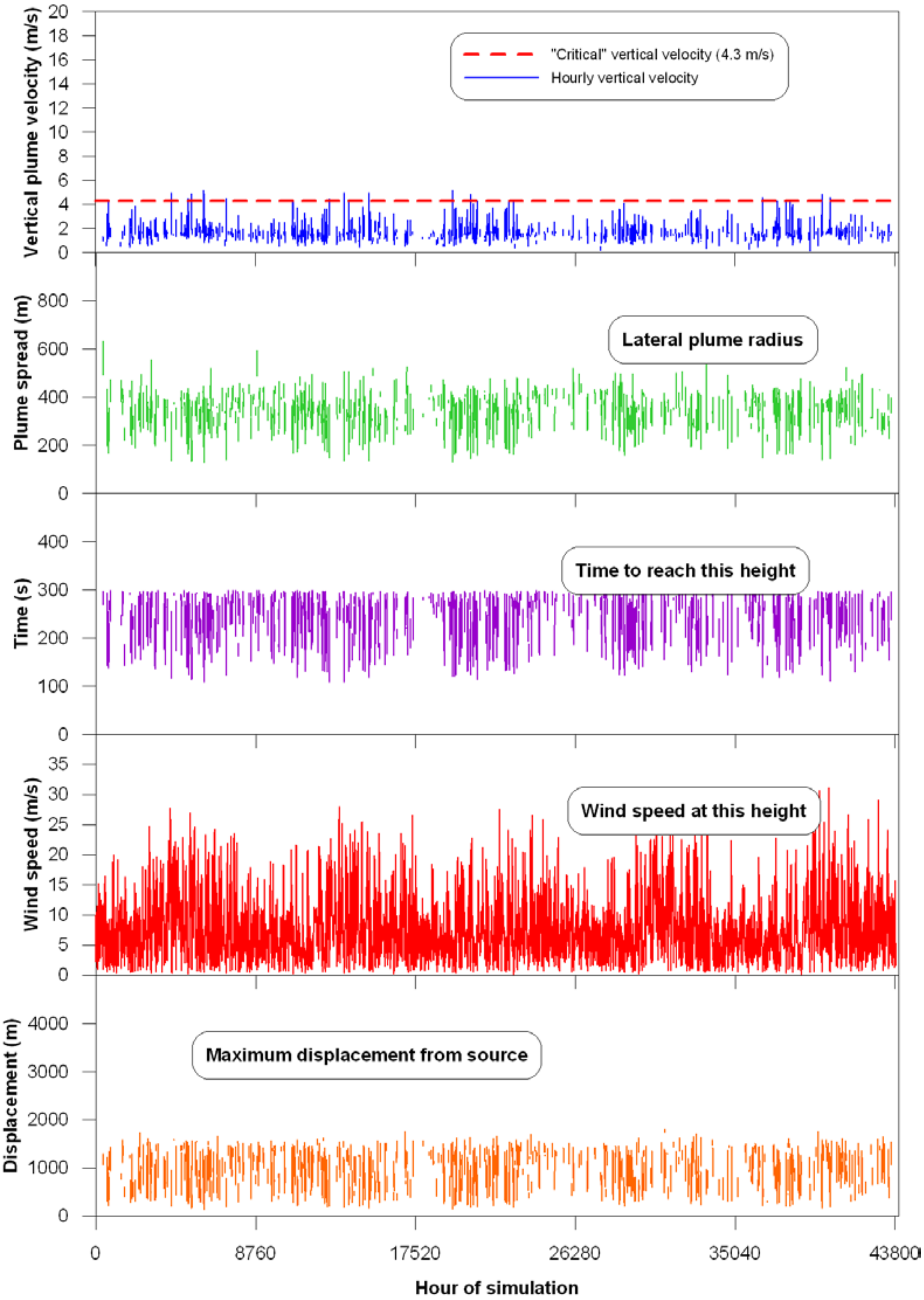
- **Figure 3 Plume and wind analysis for 200 m above ground-level**



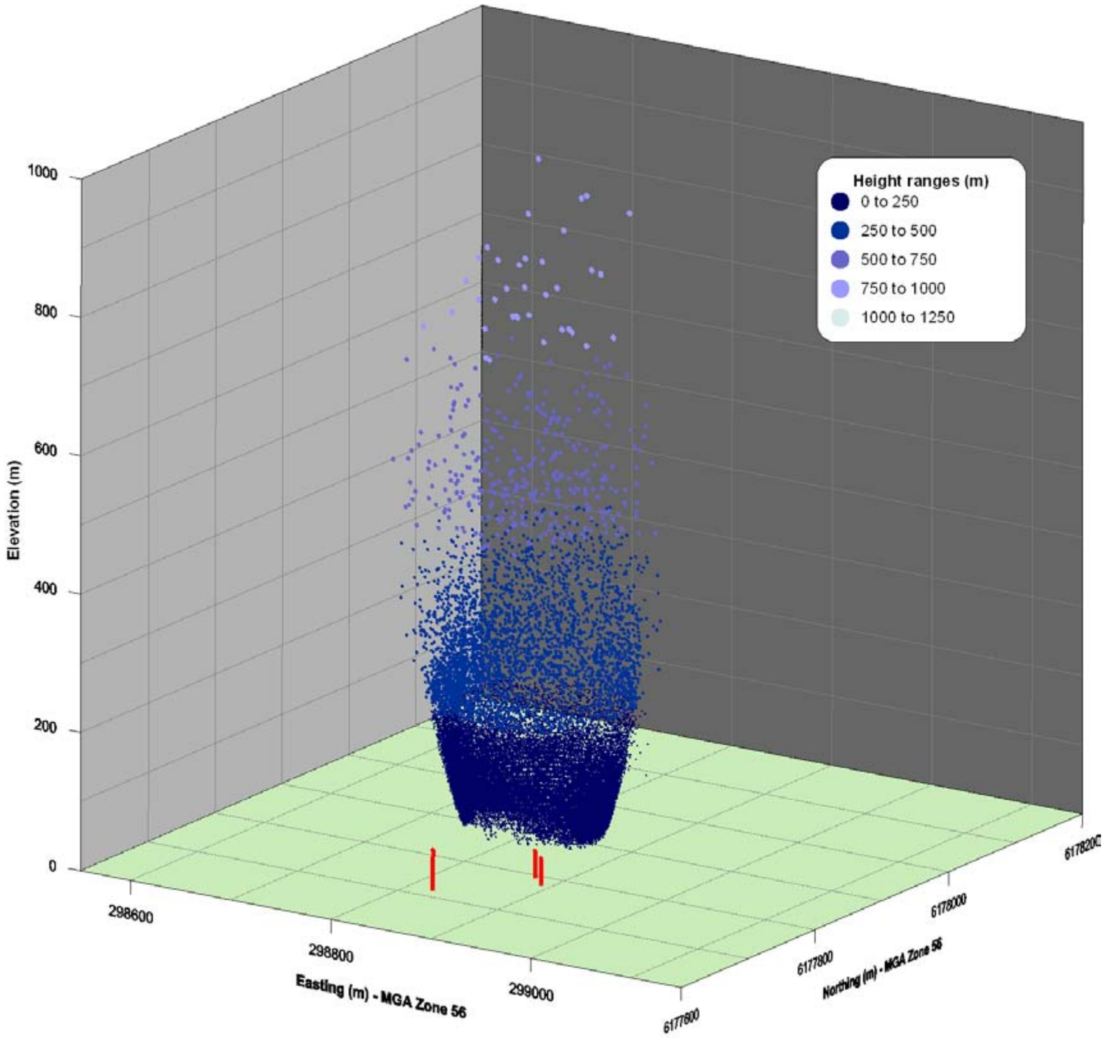
- **Figure 4 Plume and wind analysis for 400 m above ground-level**



- **Figure 5 Plume and wind analysis for 800 m above ground-level**



- **Figure 6 3D space in which plume vertical velocity falls below 4.3 m/s**



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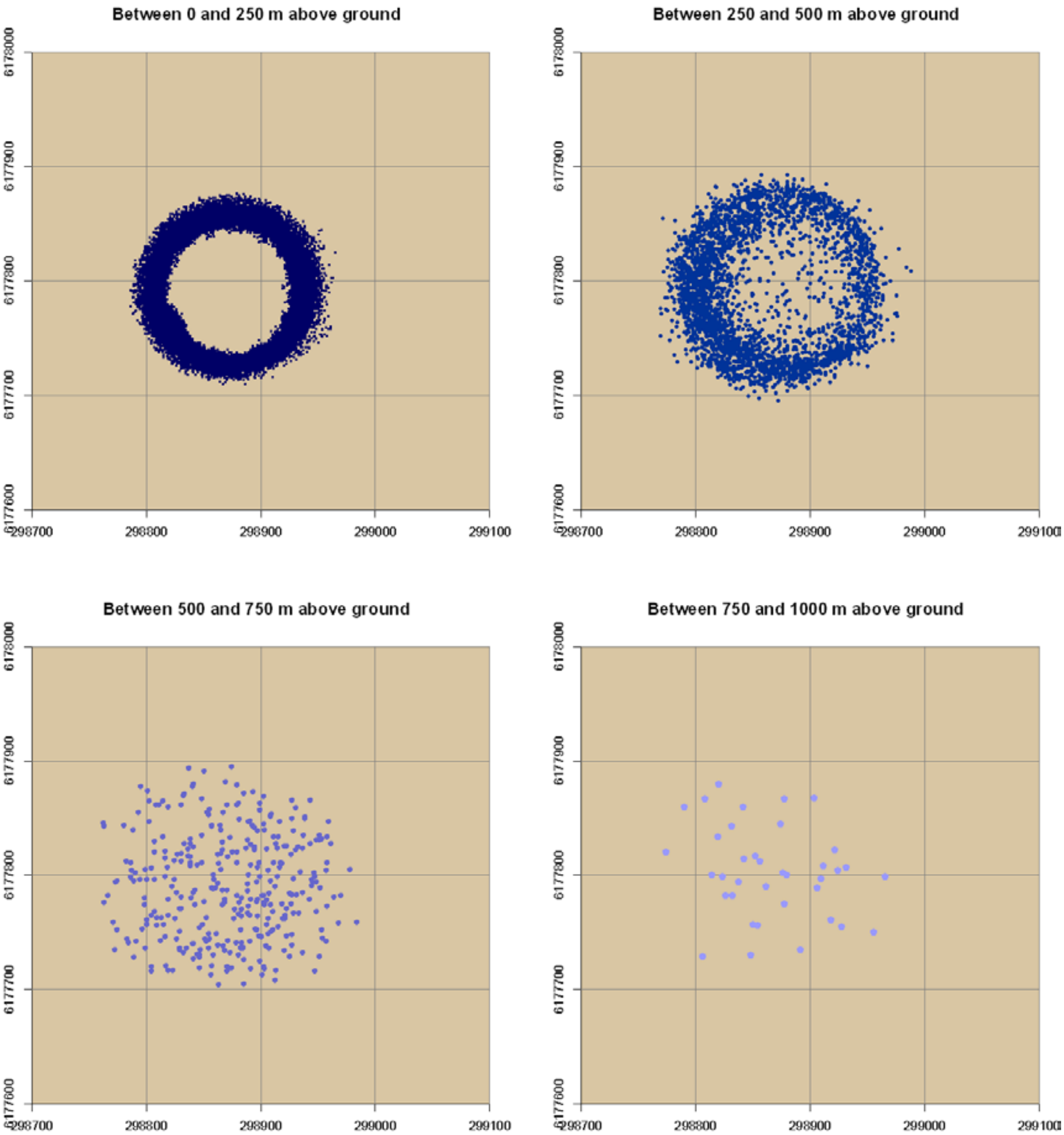
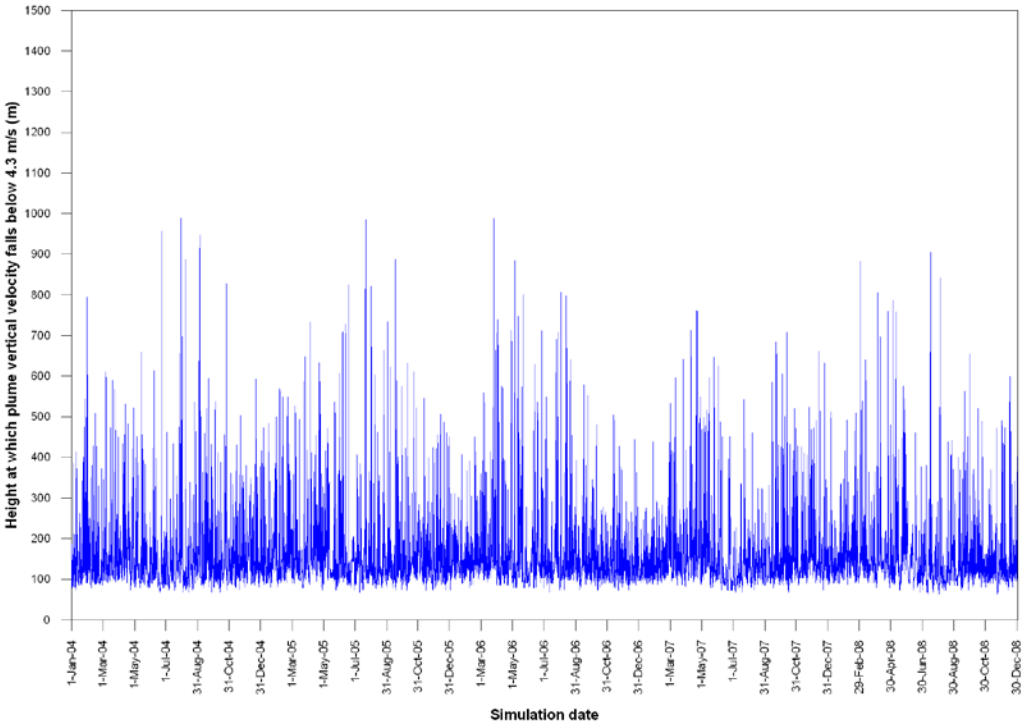
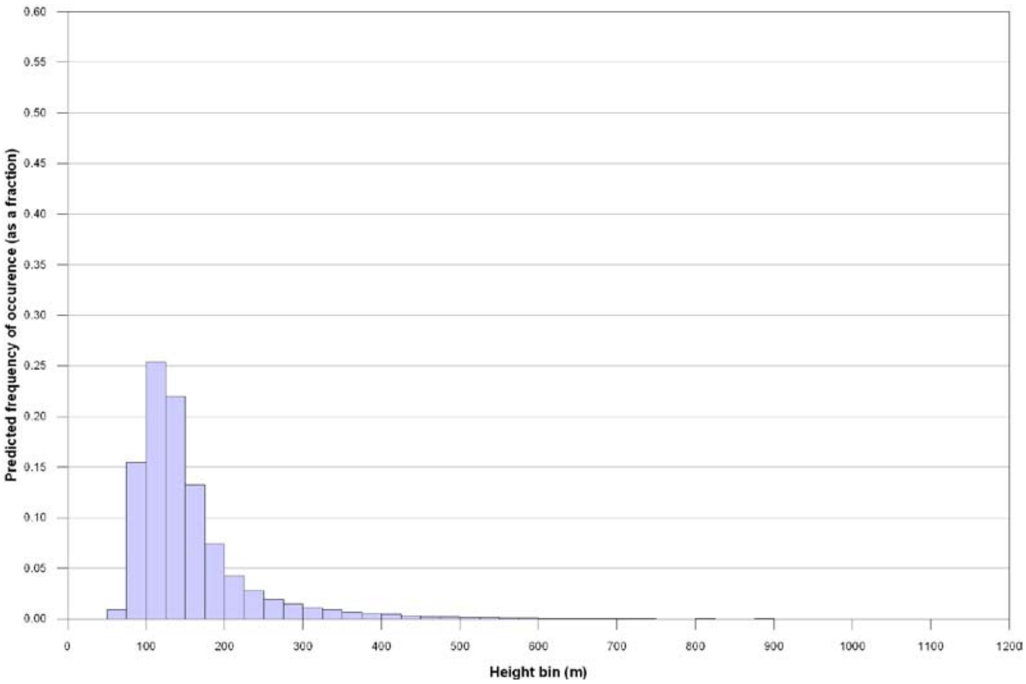
- **Figure 7 2D space in which plume vertical velocity falls below 4.3 m/s**



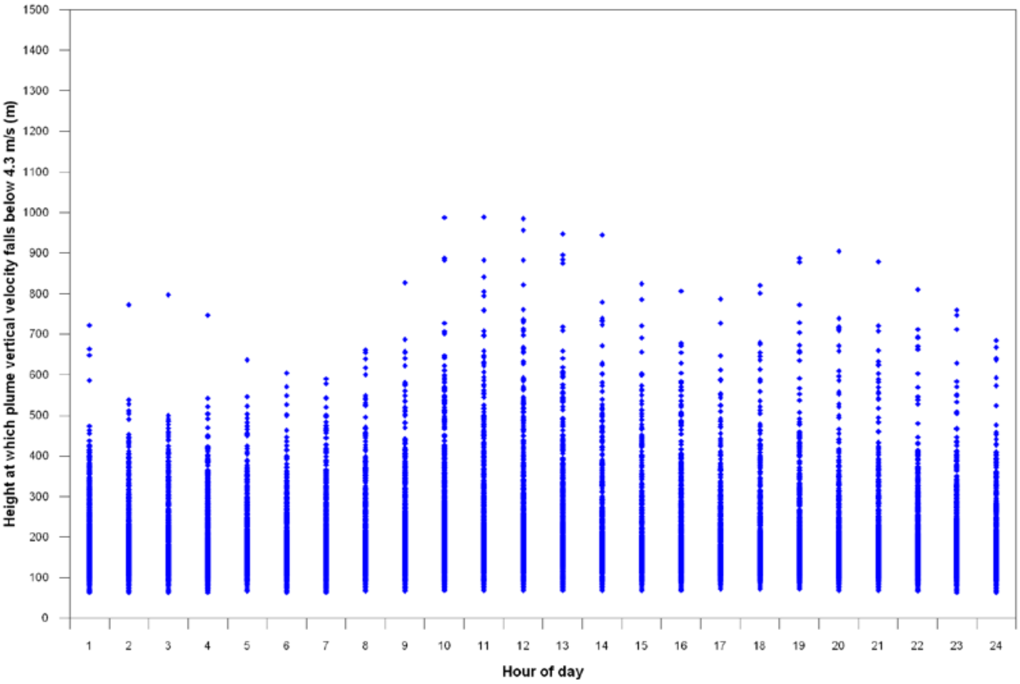
- **Figure 8 Time series of height at which plume vertical velocity falls below 4.3 m/s**



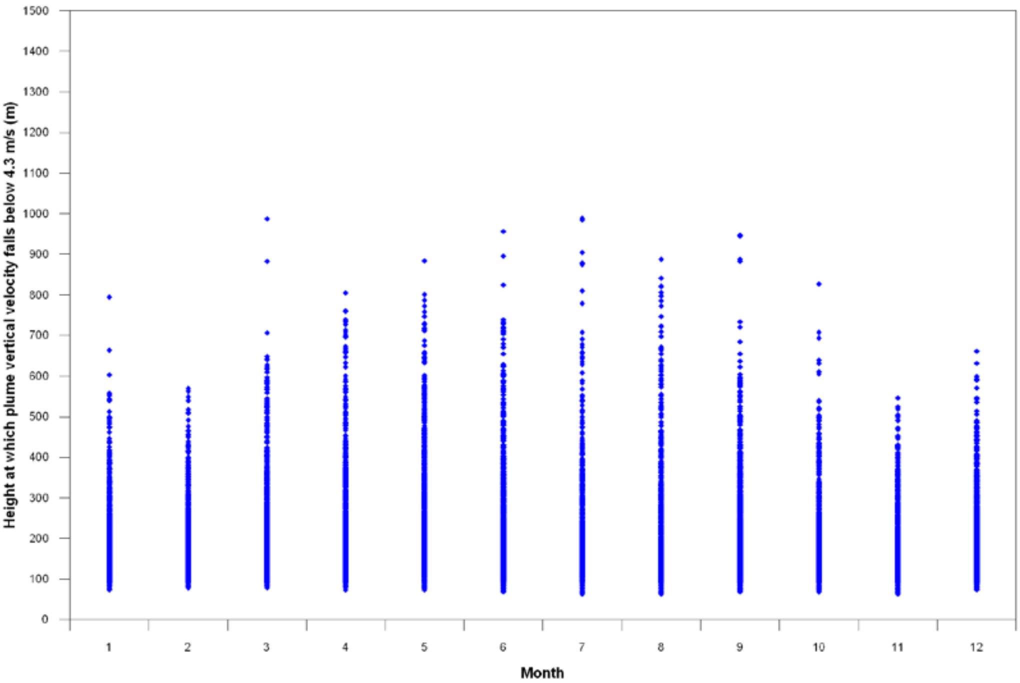
- **Figure 9 Histogram of height at which plume vertical velocity falls below 4.3 m/s**



- **Figure 10 Height at which plume vertical velocity falls below 4.3 m/s by hour of day**



- **Figure 11 Height at which plume vertical velocity falls below 4.3 m/s by month**



4. Conclusions

This report has presented results from plume rise modelling for the proposed Tallawarra OCGT plant. Plume rise modelling was conducted using TAPM in accordance with the requirements of CASA and results were presented such that the regions of space where the vertical plume velocity exceeded 4.3 m/s could be determined.

The key outcomes from the modelling are as follows:

- The maximum height at which the plume vertical velocity falls below 4.3 m/s is predicted to be 988 m. This is lower than the previously forecast maximum height of 1,179 m (SKM, 2008).
- The average height at which the plume vertical velocity falls below 4.3 m/s is predicted to be 155 m.
- The difference between the maximum height of exceedance and the 0.05 percentile exceedance is predicted to be 177 m (that is, 988 m down to 811 m).
- The height at which the plume velocity is above 4.3 m/s tends to be lower in the warmer (summer) months of the year than in the cooler months.
- The height at which the plume velocity is above 4.3 m/s tends to be lower over-night and in the morning.

As for the earlier assessment (SKM, 2008), these results suggest that the OCGT plant could, on occasions, produce exhaust plumes with vertical velocities greater than 4.3 m/s at altitudes greater than 110 m above ground level.

Model input data and results can be provided to TRUenergy, Ambidji or CASA for further analysis, as required.

5. References

Civil Aviation Safety Authority (2004), *Guidelines for Conducting plume Rise Assessment*, Advisory Circular, AC 139-05(0), Civil Aviation Safety Authority, Australian Government, June 2004.

Hibberd M, Hurley P, Edwards M, Luhar A, Galbally I and Bentley S (2005) *Meteorological and Dispersion Modelling using TAPM for Wagerup*, Phase 3A: HRA Concentration Modelling – Current Emission Scenario", CSIRO Atmospheric Research Final Report.

Hurley (2008) *TAPM v.4. User Manual*. CSIRO Marine and Atmospheric Research Internal Report No. 5. October 2008.

SKM (2008) *Tallawarra Power Station: Tallawarra CCGT and OCGT Plume Rise Assessment*. Prepared by SKM for TRUenergy, 7 March 2008.

LIMITATION: The sole purpose of this report and the associated services performed by Sinclair Knight Merz Pty Ltd (SKM) is to provide information on the Tallawarra OCGT plume rise impacts in accordance with the scope of services set out in the contract between SKM and TRUenergy. That scope of services, as described in this report, was developed with TRUenergy.

In preparing this report, SKM has relied upon, and presumed accurate, certain information (or absence thereof) provided by the Client and other sources. Except as otherwise stated in the report, SKM has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

SKM derived the data in this report from a variety of sources. The sources are identified at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. SKM has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose of the project and by reference to applicable standards, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by SKM for use of any part of this report in any other context.

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APPENDIX B

GLOSSARY OF TERMS and ABBREVIATIONS

APPENDIX B

GLOSSARY OF TERMS and ABBREVIATIONS

Abbreviations used in this report, and the meanings assigned to them for the purposes of this report are detailed in the following table:

Abbreviation	Meaning
AC	Advisory Circular (document support CAR 1998)
ACFT	Aircraft
AD	Aerodrome
ADF	Australian Defence Force
AHD	Australian Height Datum
AHT	Aircraft height
AIP	Aeronautical Information Publication
AIRPORTS ACT	Airports Act 1996, as amended
AIS	Aeronautical Information Service
ALT	Altitude
AMSL	Above Minimum Sea Level
A(POFA)R	Airports (Protection of Airspace) Regulations, 1996 as amended
APARs	Airports (Protection of Airspace) Regulations, 1996 as amended
ARP	Aerodrome Reference Point
AsA	Airservices Australia
ATC	Air Traffic Control(ler)
ATM	Air Traffic Management
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CAT	Category
DACR	Defence (Area Control) Regulations
DAP	Departure and Approach Procedures (charts published by AsA)
DER	Departure End of (the) Runway
DEVELMT	Development
DME	Distance Measuring Equipment
Doc nn	ICAO Document Number nn
DITRDLG	Department of Infrastructure, Transport, Regional Development and Local Government. Also called “Infrastructure”. (Formerly Department of Transport and Regional Services (DoTARS))
DOTARS	See DITRDLG above
ELEV	Elevation (above mean sea level)
ENE	East North East
ERSA	Enroute Supplement Australia

Abbreviation	Meaning
FAF	Final Approach Fix
FAP	Final Approach Point
FT/ft	feet
GA	General Aviation
GNSS	Global Navigation Satellite System
GP	Glide Path
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IHS	Inner Horizontal Surface, an Obstacle Limitation Surface
ILS	Instrument Landing System
ISA	International Standard Atmosphere
KM/km	kilometres
kt	Knot (one nautical mile per hour)
LAT	Latitude
LLZ	Localizer
LONG	Longitude
LSALT	Lowest Safe Altitude
m	metres
MAPt	Missed Approach Point
MDA	Minimum Descent Altitude
MGA94	Map Grid Australia 1994
MOC	Minimum Obstacle Clearance
MOS	Manual of Standards, published by CASA
MSA	Minimum Sector Altitude
MVA	Minimum Vector Altitude
NDB	Non Directional Beacon
NE	North East
NM	Nautical Mile (= 1.852 km)
nnDME	Distance from the DME (in nautical miles)
NNE	North North East
NOTAM	NOtice To AirMen
OAS	Obstacle Assessment Surface
OCA	Obstacle Clearance Altitude
OCS	Obstacle Clearance Surface
OCH	Obstacle Clearance Height
OHS	Outer Horizontal Surface
OIS	Obstacle Identification Surface
OLS	Obstacle Limitation Surface
PANS-OPS	Procedures for Air Navigation Services – Operations, ICAO Doc 8168
PRM	Precision Runway Monitor

Abbreviation	Meaning
PROC	Procedure
QNH	An altimeter setting relative to height above mean sea level
REF	Reference
RL	Relative Level
RNAV	aRea NAVigation
RNP	Required Navigation Performance
RPA	Rules and Practices for Aerodromes — replaced by the MOS Part 139 — Aerodromes
RPT	Regular Public Transport
RWY	Runway
SACL	Sydney Airport Corporation Limited
SFC	Surface
SID	Standard Instrument Departure
SOC	Start Of Climb
STAR	Standard ARrival
TACAN	UHF Tactical Air Navigation Aid
TAPM	The Air Pollution Model (A CSIRO model for the assessment of exhaust plumes.)
TAR	Terminal Approach Radar
TAS	True AirSpeed
THR	Threshold (Runway)
TNA	Turn Altitude
TODA	Take-Off Distance Available
VFR	Visual Flight Rules
V_n	aircraft critical Velocity reference
VOR	Very high frequency Omni directional Range