BAIADA OAKBURN FACILITY

Windshear and Wake Turbulence Impacts

Prepared for:

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Baiada (Tamworth) Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report is for the exclusive use of the Client. No warranties or guarantees are expressed or should be inferred by any third parties. This report may not be relied upon by other parties without written consent from SLR.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
610.19171-R01-v1.0	25 June 2020	Dr Peter Georgiou	Dr Neihad Al-Khalidy	Dr Neihad Al-Khalidy

EXECUTIVE SUMMARY

SLR Consulting Australia Pty Ltd (SLR) has been engaged to assess Baiada's proposed Oakburn Poultry Processing Facility (Tamworth, NSW) in relation to potential building-induced windshear and wake turbulence effects according to the National Airports Safeguarding Framework (NASF) Guideline B, 2018 – Managing the Risk of Building Generated Windshear and Turbulence at Airports.

The assessment has been carried out in two stages:

- A Preliminary Qualitative Assessment investigating the potential for the proposed development to create downstream windshear and wake turbulence effects and the likely compliance of the same with respect to NASF-B (2018) criteria; and
- A Quantitative Assessment carried out via a 1:750 model-scale Environmental Wind Tunnel Study whereby hot-wire sensor measurements were made to investigate mean wind speeds and wind turbulence conditions along Tamworth Airport's main Runway 12L/30R and its northwest projection for aircraft landing flight path geometries potentially vulnerable to crosswinds from the northeast, passing firstly over the proposed Baiada Facility project domain, and then impacting landing flight paths on Runway 12L.

This study is required to assist in the preparation, lodgement and approval of a Major Development Plan for the proposed development.

The present study involved 1:750 scale model wind tunnel testing of two "built environment" scenarios:

- "Baseline" existing built environment at the airport and surrounds
- "Future" "Baseline" + proposed development

NASF-B (2018) Threshold "Triggers"

The study showed that the proposed development does not satisfy NASF-B (2018) with respect to the "1:35" rule - refer Section 2.

Accordingly, further quantitative assessment (ie via wind tunnel testing or CFD modelling) was undertaken as required for acceptance of the proposed concept design in relation to the NASF-B considerations covering mean wind speed deficit and wake turbulence.

Tamworth Airport BoM Station 55325 Wind Characteristics

The study analysed the exceedance characteristics of the long-term wind record (2008-2018) obtained at the Bureau of Meteorology (BoM) weather station located at Tamworth Airport, BoM 55325, in terms of both mean wind speed and turbulence. The site of the weather station is close to the project domain areas and shares similar upstream turbulence characteristics to Runway 12L positions (and its northwesterly projection) under crosswind (ie northeast) wind conditions. These statistics serve as a reference dataset to assess exceedance levels of interest in relation to NASF-B and the proposed development.

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Initial Tamworth Airport BoM 55325 1:750 Model Scale Wind Tunnel Test

An initial 1:750 model scale wind tunnel test was undertaken to directly measure the mean wind speed and turbulence level at the 10 m height anemometer location of Tamworth Airport BoM 55325. During this test a reference height wind speed (mean and gust) was also recorded at a location upstream of the model test area so as to be unaffected by any existing building wake effects.

This reference height wind speed was also used in the subsequent built environment scenarios and served as a "bridge" to relate wind speeds (mean and gust) measured along flight landing path positions back to the 10 m height mean wind speed at Tamworth Airport BoM 55325.

Built Scenarios 1:750 Model Scale Wind Tunnel Tests

As noted above, two built environment scenarios were tested to assess the impact of the proposal.

Hot-wire sensors were used to make wind speed measurements at positions located in a vertical plane centred on Runway 12L and its southern projection – refer Figure 9. The measurement grid had a horizontal spacing of 100 m and a vertical grid spacing of 5 m (ranging from 5 m up to 60 m above ground level).

Four wind directions were tested – 20.5°, 43°, 65.6° and 88° - noting that 43° is the wind direction perpendicular to Runway 12L (from the northeast).

NASF-B (2018) Mean Wind Speed Deficit Criteria

"Existing" Built Environment Scenario:

- Predicted exceedance of the mean wind speed deficit criteria at the "worst-case" grid measurement point are All greater than 100 years. This is not surprising given the scale of existing buildings at the site.

"Future" Built Environment Scenario:

- When comparing the results between the "Existing" and "Future" scenarios at any one individual measurement grid point, there were minor variances at particular locations (typically ±10%) both up and down;
- However, the minimum return period for each tested angle at the "worst-case" grid point, remained at or above 100 years.

NASF-B (2018) 4 kt Turbulence Criterion

"Existing" Built Environment Scenario:

- In the "Existing" built environment scenario, predicted 4 kt turbulence exceedance events have return periods ranging from once per year and upwards.

"Future" Built Environment Scenario:

- When comparing individual points along the flight path measurement grid between the "Existing" and "Future" scenario results, there are modest variances in terms of annual exceedance statistics at particular locations both up and down;

EXECUTIVE SUMMARY

- Predicted return periods are lowest (ie more frequently occurring) at locations in line with the highest RL section of the proposed development for the relevant wind direction; and
- 4 kt exceedances do not exceed one per year – essentially the same as the existing condition. This reflects both the low incidence of winds from the relevant crosswind directions of interest and the modest extent of the taller section of the proposed development.

Summary

In relation to wind conditions experienced by aircraft landing from the northwest on Runway 12L:

- The proposed development will have minimal/negligible impact in relation to the NASF-B mean wind speed deficit criteria, essentially no impact at wind speeds of practical interest.
- NASF-B 4 kt turbulence level event exceedances are of the order of once per year with the proposed development – essentially the same as for existing conditions at the airport. This is attributed to the low profile of the proposed development buildings and low probability of occurrence of crosswinds of interest to this study (ie from the NE). Again, the proposed development will have minimal/negligible impact at wind speeds of practical interest on runway turbulence levels.

Note Regarding Building Envelope Changes

It is understood that the final design of the proposed development is currently being reviewed.

Based on extensive studies undertaken by SLR and other Wind Engineering consultancies, the impacts identified in the present study would be an upper bound of expected changes to windshear and wake turbulence if any proposed changes to the development result in a decrease of bulk envelope (especially height-wise) in the main operational building.

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1 INTRODUCTION

SLR Consulting Australia Pty Ltd (SLR) has been engaged to assess Baiada's proposed Oakburn Poultry Processing Plant, located at 1154 Gunnedah Road, Westdale (Tamworth), in relation to potential building-induced windshear and wake turbulence effects according to the National Airports Safeguarding Framework (NASF) Guideline B, 2018 – Managing the Risk of Building Generated Windshear and Turbulence at Airports.

This assessment has been carried out in two stages:

- A Preliminary Qualitative Assessment investigating the potential for the proposed development to create downstream windshear and wake turbulence effects and the likely compliance of the same with respect to NASF-B (2018) criteria; and
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The wind tunnel testing examined two "built environment" scenarios:

- "Baseline" existing built environment at the airport and surrounds
- "Future" "Baseline" + proposed development

This assessment is required to assist in the preparation, lodgement and approval of a Major Development Plan for the Project.

1.1 Structure of Report

The remainder of this report is structured as follows:

Section 2 ...	describes the key criteria required to be assessed within NASF-B (2018)
Section 3 ...	describes the Project – location, project dimensions, etc
Section 4 ...	presents information covering mean wind speeds and turbulence levels at the Tamworth Airport Bureau of Meteorology BoM Station 55325 (BoM 55325)
Section 5 ...	presents the initial wind tunnel test results covering wind characteristics at BoM 55325
Section 6 ...	details the wind tunnel testing methodology used to assess mean wind speeds and turbulence levels along the flight paths of interest along Runway 12L/30R relevant to NASF-B (2018) – wind directions tested, built environment scenarios, measurement points, etc.
Section 7 ...	shows the wind tunnel test results for relevant to the NASF-B (2018) mean wind speed deficit criteria and 4 kt turbulence criterion.
Section 8 ...	provides the conclusions to this report

2 THE NASF-B 2018 GUIDELINE

National Airports Safeguarding Framework (NASF) Guideline B, 2018 – Managing the Risk of Building Generated Windshear and Turbulence at Airports contains benchmark assessment trigger points for a new building development or building expansion.

Which buildings should be assessed ?

The "Assessment Trigger Area" (ATA):

Buildings do NOT need to be assessed under NASF-B (2018) if they lie OUTSIDE the so-called ATA, as shown in NASF-B (2018) Figure 1:

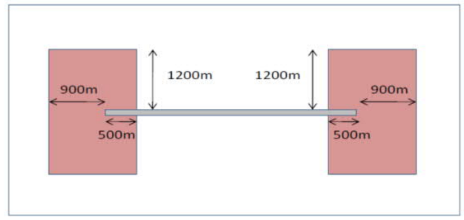


Figure 1: Assessment trigger area around runways, within which buildings should be assessed

If a building lies within the so-called "Assessment Trigger Area", apply the "1:35" Rule

- "1:35 Rule" – If the distance from the nearest runway centreline to the closest point of the new building is more than 35 times the height (above runway level) of the building, no further assessment is required as far as NASF-B (2018) is concerned;

If a building does not satisfy the "1:35" rule, assess the following criteria:

1. "7-knot alongwind criterion" – the variation in mean wind speed due to wind disturbing structures must remain below 7 kt (3.6 m/s) along the aircraft trajectory at heights below 200 ft. The speed deficit change of 7 kt must take place over a distance of at least 100 m;
2. "6-knot crosswind criterion" – the variation in mean wind speed due to wind disturbing structures must remain below 6 kt (3.1 m/s) across the aircraft trajectory at heights below 200 ft. The speed deficit change of 6 kt must take place over a distance of at least 100 m.
3. "4-knot turbulence criterion" – the standard deviation of wind speed must remain below 4 kt (2.06 m/s) at heights below 200 ft.

To satisfy the above alongwind, crosswind and turbulence criteria, the following is noted:

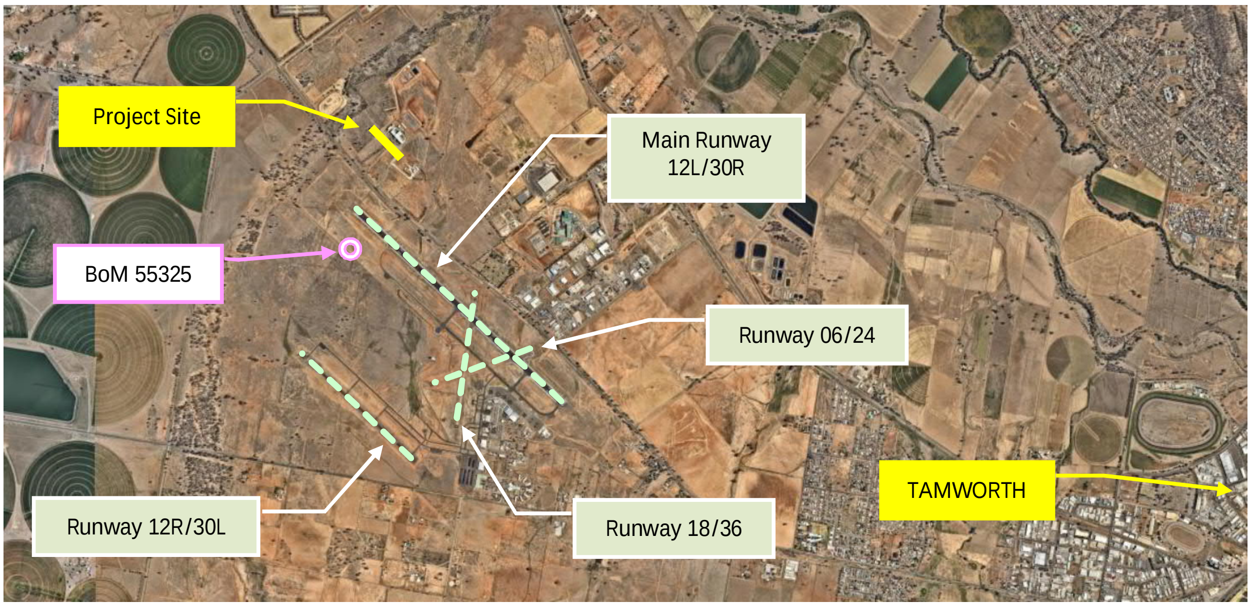
- In the absence of a simple (ie qualitative, expert opinion) safety case option, NASF-B requires a qualified wind engineer or other suitably qualified wind professional to assess the proposed development using Wind Tunnel Testing or Computational Fluid Dynamics (CFD) Simulation Modelling in order to satisfy the approval authority/decision maker (and CASA if their advice is sought) that the structure is acceptable.
- The Wind Tunnel Testing or CFD Simulation Modelling is to be used to assess when and in what circumstances the 6 kt (3.1 m/s) and 7 kt (3.6 m/s) wind speed deficit criteria and 4 kt (2.1 m/s) wake turbulence criterion (refer above) are likely to be exceeded. NASF-B (2018) Clause 34 states: "The assessment report should provide enough information (eg whether the criteria will be exceeded, what wind strength and direction would cause each criteria to be exceeded, how often this can be expected to happen) to allow planners to decide whether the proposed structure is acceptable, whether the risks can be mitigated through operational procedures at the airport, or whether the proposed structure should be refused."

3 THE PROJECT

3.1 Development Location

Baiada's proposed Poultry Processing Plant (the Project) is located at 1154 Gunnedah Road, Westdale, in Tamworth – refer Figure 1.

Figure 1 Project Site Location



3.2 Description of the Project

The development application for the Project includes the following elements:

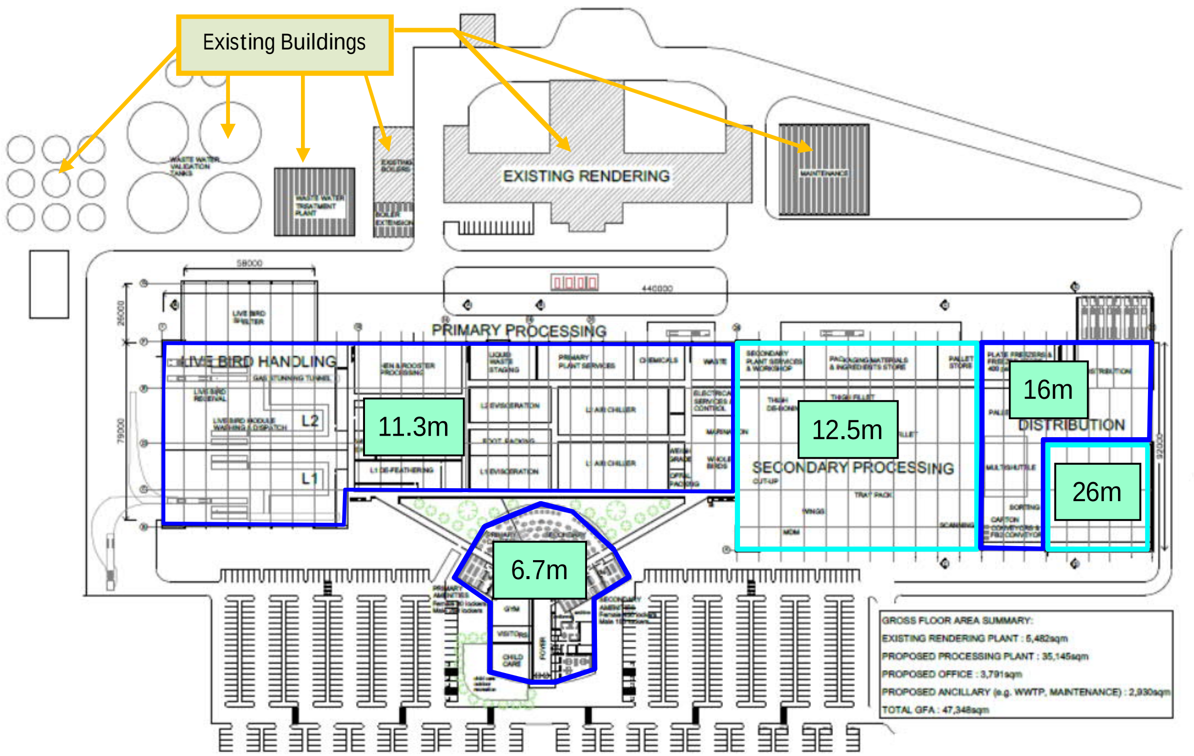
- Construction of a new poultry processing plant consisting of:
  - 38,936 m^2 of Gross Floor Area providing for live bird storage, processing, chilling, cold store and distribution facilities;
  - A 1,600 m^2 workshop and store building;
  - 3,791 m^2 of ancillary administration, staff amenities and childcare space; and
  - An expanded Waste Water Treatment Plant.
- Additional works, including:
  - New access roads, a new staff car parking area, site landscaping and screening vegetation.

Development Footprint

The proposed development footprint in relation to existing buildings on the site is shown in Figure 2.

- In terms of the overall building bulk envelope, the Project comprises a long, essentially rectangular building with four sections of variable height, ranging from 11.3 m (at the western end) to 26 m (at the eastern end) above ground.
- An Ancillary Services building located closer to the main runway at Tamworth Airport has a height of 6.7 m above ground.

Figure 2 Proposed Baiada Facility Footprint and Main Building Heights Above Ground

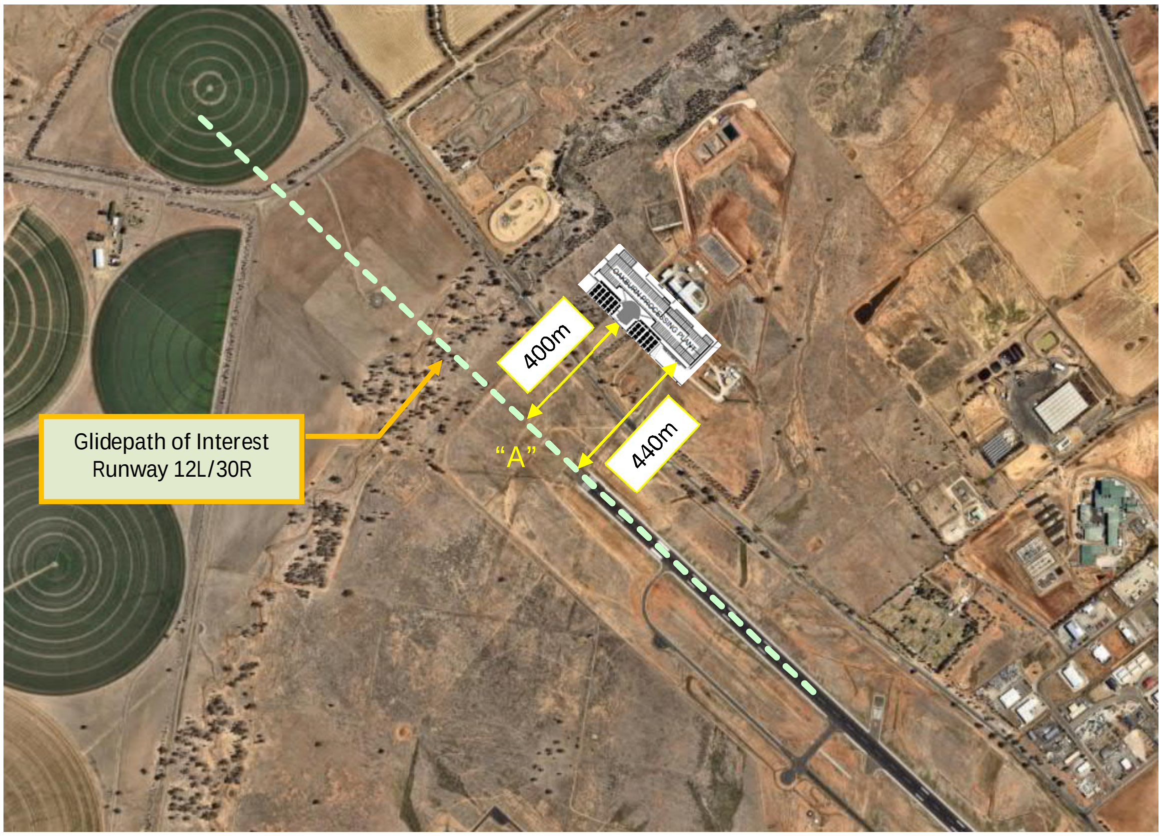


3.3 Development Siting Relative to Runway 12L/30R

The nearest runway to the proposed development is Runway 12L/30R (Tamworth Airport's main runway). The perpendicular distance from the Project to Runway 12L/30R is shown in Figure 3.

An aircraft landing from the northwest on Runway 12L would be at an approximate elevation of 10 m above ground level at point "A" (or higher if landing past the landing strips on the runway).

Figure 3 Location of Project Relative to Runway 12L



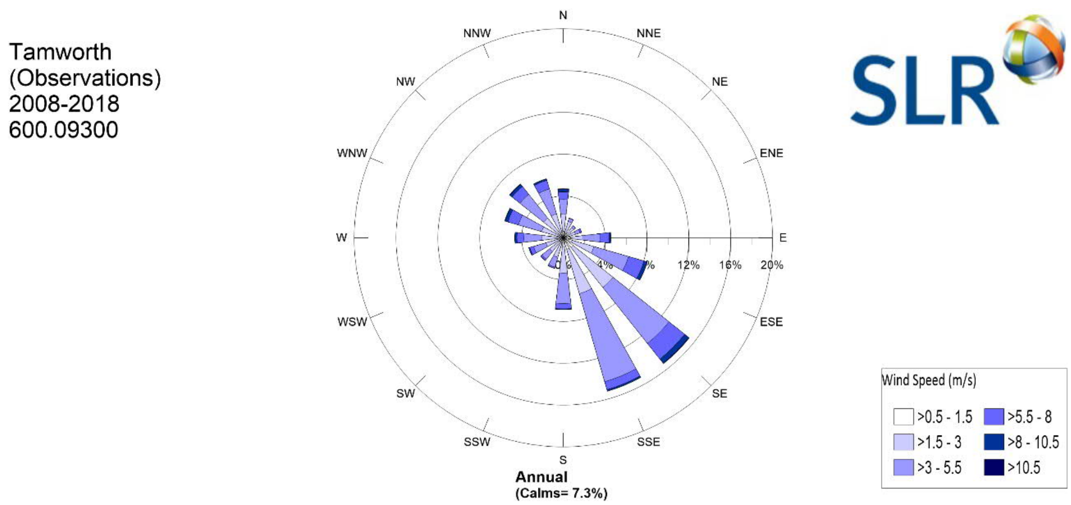
4 TAMWORTH AIRPORT WIND CLIMATE

4.1 Tamworth Airport Bureau of Meteorology (BoM) Station 55325

SLR has analysed wind records from the Bureau of Meteorology's (BoM's) automated weather station located at Tamworth Airport, recorded over the period 2008-2018.

The annual wind rose determined from this data is shown in Figure 4. The corresponding seasonal wind roses are shown in Appendix A.

Figure 4 BoM Station 55325 – Annual Wind Rose (2008-2018)



Two prevailing wind "lobes" are present in the Tamworth Airport data:

Southeast (SE) Winds

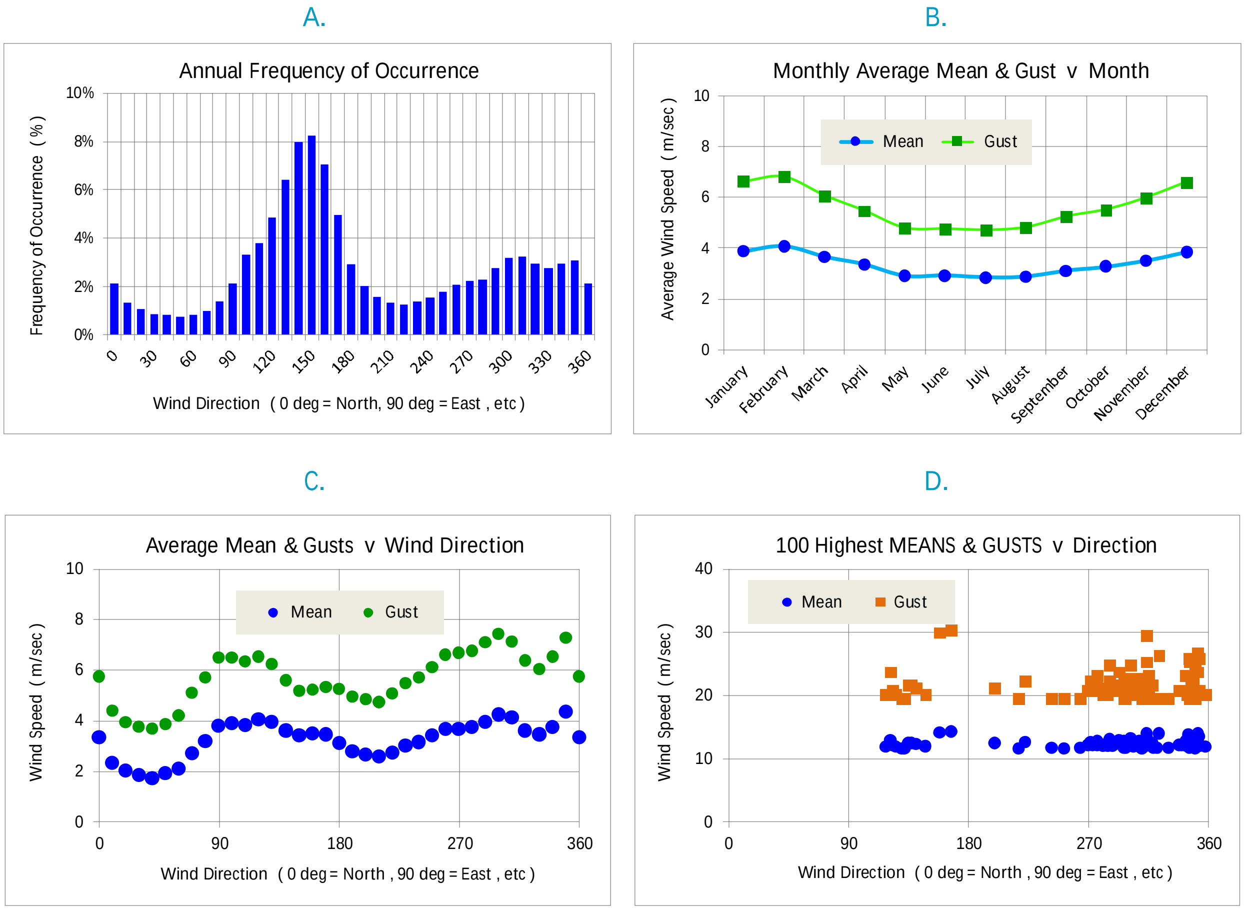
- Appendix A shows that these winds occur all-year round and are strongest and most frequent Late Spring to Early Autumn.

Northwest (NW) Winds

- Appendix A shows that these winds are most frequent Late Winter to Early Summer and are strongest during the months of Spring.

Figure 5 shows key characteristics of the BoM 55325 wind data.

Figure 5 BoM Station 55325 – Representative Wind Characteristics



A. shows the annual frequency of occurrence of all mean winds by wind direction: the two prevailing wind lobes at SE and NW are clearly evident. Note that this figure is simply a reflection of the frequency of occurrence of all winds by wind direction and not necessarily correlated with wind strength.

B. shows the variation of average monthly mean wind speeds and average monthly gusts by month throughout the year: average winds (means and gusts) are highest in the Summer months.

C. shows the average magnitude of mean wind speed and gust with wind direction, determined in 10° increments: interestingly, while SE winds provide by far the most common wind direction, the average wind speed from this direction is not as high as from the NW quadrant.

D. shows the 100 highest mean wind speeds and gusts recorded during the period 2008-2018: the highest winds recorded at Tamworth Airport in this period occurred mostly from the northwest with a secondary group of maxima occurring from the SE.

4.2 BoM Station55325 – Mean Wind Occurrence

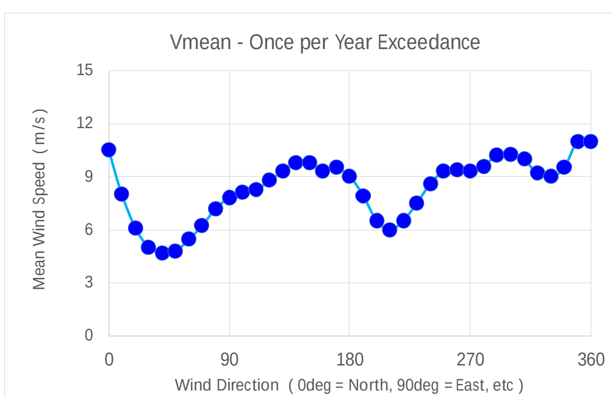
The mean hourly wind speed data recorded at BoM Station 55325 was used to generate Table 1 and Figure 6:

- Table 1 shows the number of hours per year that mean wind speeds are exceeded at BoM 55325 from the crosswind directions of interest in relation to the Project, in 10° increments from 10° to 80°, as well as from all directions combined (0° to 360°). For example, mean winds of 7 m/s or more occur less than once per year from 40°±5°, compared to over 500 times per year for all wind directions.
- Figure 7 shows the variation with wind direction of the mean wind speed which is exceeded, on average, once per year, ie the one-year return period mean wind speed. The 1-yr return period mean wind speed taking into account all wind directions at BoM 55325 is 13 m/s.
- The above data shows that, at the crosswind directions of interest to this study (namely NE), mean wind speeds have a relatively low probability of occurrence.

Table 1 Mean Wind Speed Exceedances (Hours per Year) versus Wind Direction at BoM 55325

Mean Wind (m/s)	Wind Direction (±5° bands)								
	10°	20°	30°	40°	50°	60°	70°	80°	ALL
1	118	94	76	70	65	71	83	117	8144
2	100.9	77.0	61.4	51.9	48.4	54.0	68.6	101.5	6822
3	66.5	43.8	28.7	24.2	24.5	31.1	45.9	72.5	4831
4	29.8	14.2	9.5	7.3	11.3	15.6	28.9	51.9	3034
5	13.8	5.7	3.0	2.8	5.5	7.8	18.6	37.8	1662
6	6.0	2.5	1.6	1.2	1.7	3.6	11.3	23.6	956
7	2.7	1.0	0.52	0.57	0.52	1.2	6.0	13.5	529
8	1.0	0.48	0.24	0.38	0.19	0.86	2.0	6.8	264
9	0.33	0.24	0.24	0.29		0.24	0.67	3.1	124
10	0.14		0.10	0.10		0.14	0.24	0.48	55
11	0.05		0.10					0.19	19
12									6
13									1

Figure 6 Once-per-Year Occurrence Mean Wind Speeds at BoM Station 55325 versus Wind Direction



4.3 BoM Station 55325 – Turbulence Occurrence

The BoM wind record at Station 55325 (Tamworth Airport) comprises mean hourly winds and peak (3-second) gusts as well as the mean (hourly average) wind direction. The turbulence, ie the standard deviation or "RMS" value, of the wind speed, which is relevant to the NASF-B (2018) 4 kt turbulence criterion, is not recorded directly at BoM 55325. Instead, it has to be inferred from the recorded mean and gust wind speeds.

Turbulence (relevant to the NASF-B (2018) 4 kt criterion)

The turbulence level (m/s or knots) can be inferred from the following relationship:

$$\text{Gust} = \text{Mean} + \phi \times \text{Turbulence}$$

where … ϕ = "peak" factor

The peak factor, "ϕ", depends on the averaging times of the recorded mean and gust speeds. For a mean wind averaged over an hour and a 3-second gust, ϕ would be close to 3.7. ϕ also depends on the "response" characteristics of the wind recording instrument, with older instruments exhibiting ϕ values less than 3.7.

Turbulence Intensity & Gust Factor

The Turbulence Intensity and Gust Factor are dimensionless quantities and are defined as follows:

$$\text{Turbulence Intensity} = \text{Turbulence} / \text{Mean}$$

$$\text{Gust Factor} = \text{Gust} / \text{Mean}$$

The above was used to analyse the BoM 55325 wind record of mean wind speed and gust speed to determine associated turbulence levels.

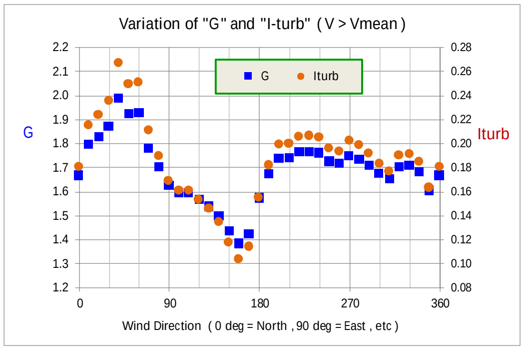
Figure 7 presents the resulting data for Gust Factor, Turbulence Intensity and Turbulence level.

A. shows the variation of Gust Factor ("G") and implied Turbulence Intensity ("i_{TURB}") with wind direction: the data presented are for the higher winds recorded at the site, ie when the wind speed was higher than the average mean wind speed for that particular direction. A relatively low Gust Factor and corresponding low Turbulence Intensity imply that the upstream built environment in that direction is largely free of obstacles such as buildings, trees, etc. A relatively high Gust Factor and corresponding Turbulence Intensity implies that there are buildings, trees, etc, upstream and in close proximity of the site in that direction.

B. shows the variation of 4 kt turbulence level exceedances with wind direction; the data suggest that, on average, turbulence levels are greater than 4 kt at the BoM 55325 site on approximately 42 occasions per year (ie 42 hours per year), with the highest incidence occurring from the northwest (270° to 330°). Note that this data is influenced by both the wind climate characteristics impacting the airport area in general and the local built environment and vegetation, trees, etc, immediately surrounding the site of the BoM 55325 anemometer. The incidence of 4 kt turbulence exceedances from the crosswind direction of interest to this study (NE) is seen to be very low.

Figure 7 Turbulence Occurrence Characteristics at BoM 55325

A.



B.

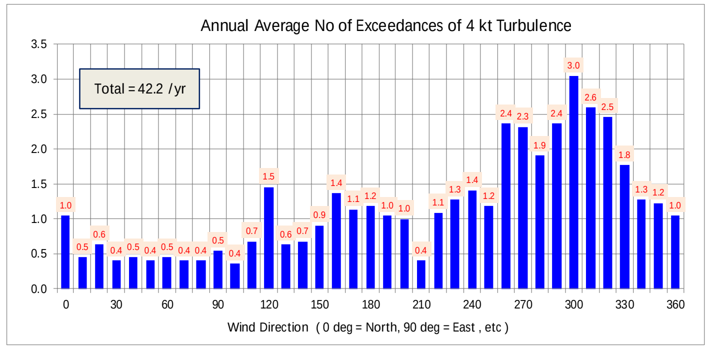


Figure 7-B and Table 1 show that the annual average turbulence exceedance of 4 kt at BoM 55325 (42 hours per year) coincides with a 1-yr return period mean wind speed of 10.3 m/s.

This implies an average turbulence intensity at the airport close to 20%, which aligns well with the average of the turbulence intensity points shown in Figure 7-A.

The above comparison provides confidence in the statistical exceedance probabilities of turbulence levels at the Tamworth Airport BoM 55325 site. Accordingly, confidence can be relied upon with the statistical exceedance probabilities of turbulence predicted for the landing flight paths of interest for Runway 12L/30R for the built environment scenarios of interest to the Project – of particular relevance to assessment of the NASF-B (2018) 4 kt turbulence criterion.

5 NASF-B ASSESSMENT: STAGE 1 - QUALITATIVE

National Airports Safeguarding Framework (NASF) Guideline B, 2018 – Managing the Risk of Building Generated Windshear and Turbulence at Airports contains benchmark assessment trigger points for a new building development or building expansion.

5.1 NASF-B (2018) "Assessment Trigger Area"

As can be seen in Figure 3, the Project would lie within the 1,400 m x 2,400 m NASF-B (2018) "Assessment Trigger Area" (refer Section 2) at the northwest end of Runway 12L/30R.

- Accordingly, further assessment is required as far as NASF-B (2018) is concerned;

5.2 NASF-B (2018) 1:35 Rule

The NASF-B (2018) "1:35 Rule" states that:

- If the distance from the nearest runway centreline to the closest point of the new building is more than 35 times the height (above runway level) of the building, no further assessment is required as far as NASF-B is concerned.

The two new Project building envelopes (Ancillary Service Building and new Operational Building) would lie 400 m and 440 m respectively from the nearest perpendicular point of Runway 12L/30R and its NW projection – refer Figure 3.

To satisfy the 1:35 rule, and hence avoid the necessity for further NASF-B (2018) analysis:

- The Ancillary Services Building would have to have a maximum height of 11.4 m; and
- The main Operational Building would have to have a maximum height of 12.6 m.

The Ancillary Services Building easily satisfies the NASF-B (2018) "1:35 Rule".

The two sections of higher roof height in the new Operational Building (at 16 m and 26 m above ground level) do not satisfy the NASF-B (2018) "1:35 Rule".

On this basis, the proposed development does not satisfy NASF-B (2018) with respect to the "1:35" rule and further assessment is required for acceptance of the proposed design in relation to all NASF-B considerations, ie the two mean wind speed deficit criteria and the 4 kt wake turbulence criterion.

6 WIND TUNNEL TEST PARAMETERS

6.1 Preliminary Test: Wind Profile at BoM 55325

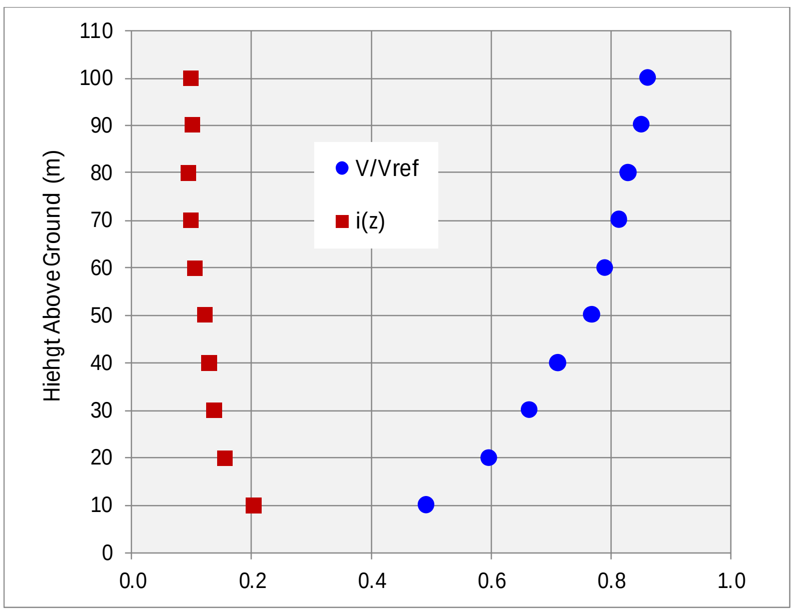
An initial test was undertaken in the wind tunnel with the "existing:" built environment – refer Figure 8 – to measure the change in mean wind speed and turbulence level with height at the location of the Bureau of Meteorology's Station 55325 site.

Concurrent measurements were made at a "Reference" position located upstream of the model (and free of any "obstruction" effects from existing buildings, etc).

Figure 8 shows the variation with height above ground of mean wind speed (ratio relative to the upstream reference mean wind speed) and local turbulence intensity, for a wind direction of 43°, which is the perpendicular wind direction from the northeast to Runway 12L.

- The ratio of the 10 m height BoM 55325 mean wind speed (ie recording height of the BoM wind monitor) to the upstream reference height wind speed at a wind direction of 43° is approximately 0.5.
- The measured turbulence intensity of wind speed at the BoM 55325 10 m recording position is 20%.

Figure 8 BoM 55325 Site Wind Profiles (Wind Direction = 43°)



6.2 Assessment of the Proposed Development

To assess the impact of the Project on Tamworth Airport's Runway 12L/30R operations in terms of windshear and wake turbulence, SLR undertook wind tunnel testing of two built environment scenarios, with the following test parameter combinations.

Built Environment Scenarios

Two built environment scenarios were tested:

- "Baseline" existing built environment at the airport and surrounds; and
- "Future" "Baseline" + proposed development.

Figure 9 shows the 1:750 scale Site Area models discussed above. The 2.5 m diameter "Proximity Model" corresponds to a circular area just under 1.9 km in diameter full-scale.

A reference height wind speed (mean and gust) was also recorded for each test. This was located upstream of the model test area (Proximity Model) and therefore unaffected by building wake effects for any model. The reference height wind speed data was used to relate Runway 12L/19L landing flight path wind speeds to BoM 55325 wind speeds.

Figure 9 Built Environment Scenario 1:750 Scale Models in the Wind Tunnel

"Baseline"

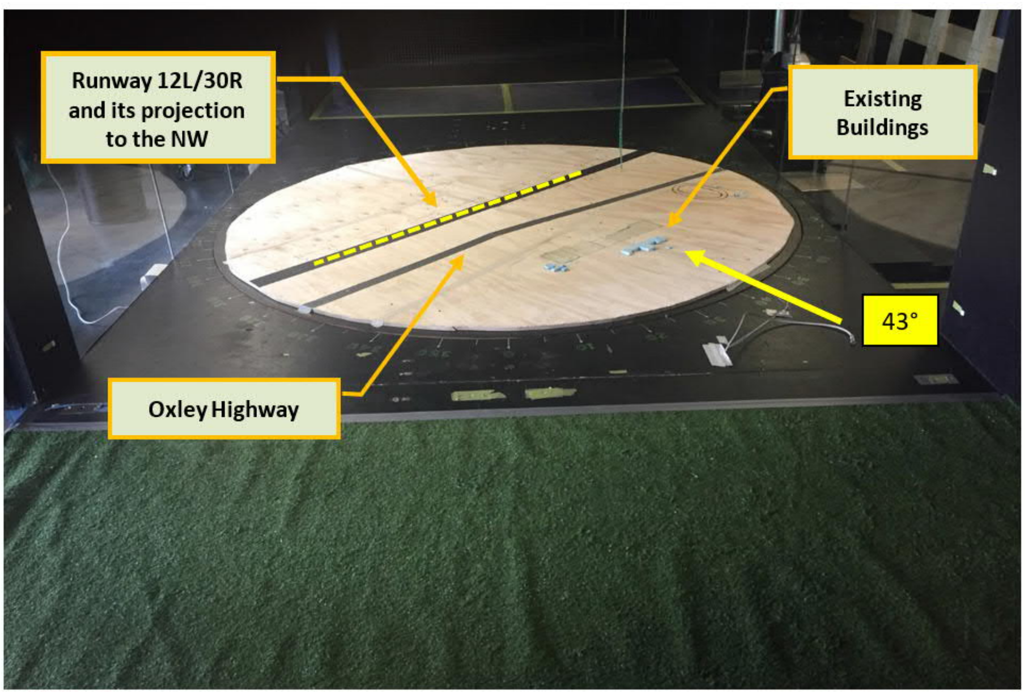
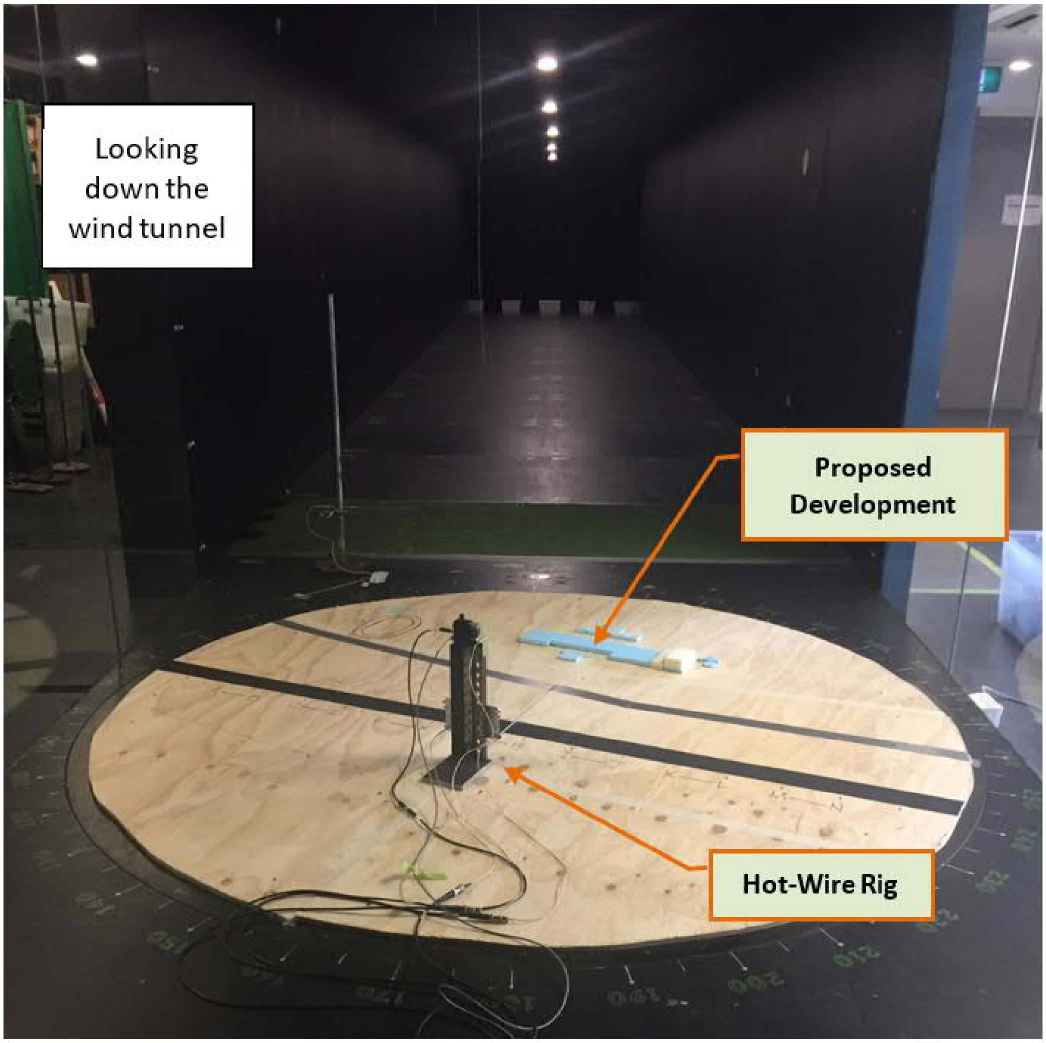


Fig.9 (cont'd)

"Future"



Measurement Probes

Measurements of wind speed were made using calibrated hot-wire probes, configured in a special purpose hot-wire test rig. These are capable of "fast-response" measurements of wind speed, and hence capable of capturing 3-second gusts in the modelled airflow.

- Data sampling rate was 1,024 Hz;
- Measurement sampling time was 30 seconds per sample.

Wind Directions – refer Figure 10

4 wind directions were tested: 20.5°, 43°, 65.5° and 88°.

Note that 43° is the wind direction perpendicular to Runway 12L/30R (from the northeast). A fifth potential wind direction of interest (-2°) was not tested, given it would constitute a significant and non-permissible tailwind for planes landing from the NW. Furthermore, for wind direction of -2°, the proposed development's wake would lie on the runway at a point where planes would already be on the ground.

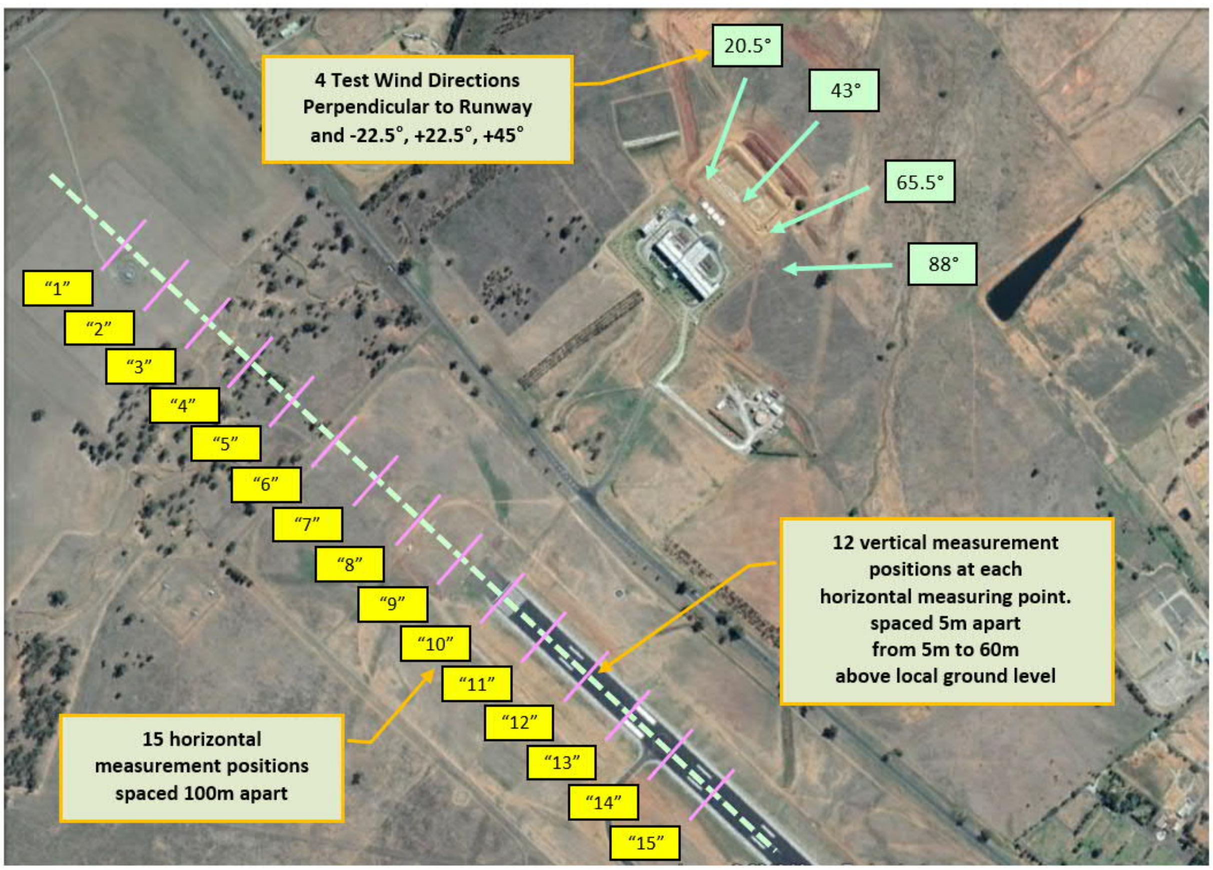
Measurement Grid Points – refer Figure 10

A 15 by 12 measurement grid was used for each of the test combinations:

- 15 Horizontal Positions: 100 m apart along Runway 12L/30R, with the midpoint between locations "8" and "9" being perpendicular to the site along the runway.
- 12 Vertical Positions: 5 m apart from 5 m above ground level to 60 m above ground level.

Figure 10 shows the measurement point locations along Runway 12L/30R and its projection to the northwest as well as the 4 test wind directions.

Figure 10 Runway Horizontal Measurement Positions and Test Wind Directions



7 WIND TUNNEL TEST RESULTS

7.1 NASF-B (2018) Mean Wind Speed Deficit Criteria

The NASF-B (2018) criteria related to mean wind speed deficit for the assessment of building development proposals at airports are:

- "7-knot alongwind criterion" – the variation in mean wind speed due to wind disturbing structures must remain below 7 kt (3.6 m/s) along the aircraft trajectory at heights below 200 ft. The speed deficit change of 7 kt must take place over a distance of at least 100 m;
- "6-knot crosswind criterion" – the variation in mean wind speed due to wind disturbing structures must remain below 6 kt (3.1 m/s) across the aircraft trajectory at heights below 200 ft. The speed deficit change of 6 kt must take place over a distance of at least 100 m.

7.1.1 NASF-B (2018) Mean Wind Speed Deficit Exceedance Calculation Procedure

The procedure for assessment of the two NASF-B (2018) mean wind speed deficit criteria for the two built environment scenarios tested is as follows:

Step 1: Measure the mean wind speed for each built environment scenario and each wind direction examined at each measurement grid point (refer Figure 9);

Step 2: Simultaneously record the upstream reference height mean wind speed for each test;

Step 3: Use the BoM 55325 wind tunnel test profile data to relate the upstream reference height mean wind speed to the mean wind speed which would be occurring at the BoM 55325 weather station location; and

Step 4 Use the statistical occurrence of mean wind speeds at the BoM 55325 site (refer Table 1) to develop tables of the statistical occurrence of mean wind speed deficit exceedances along Runway 12L landing flight paths.

The process is illustrated for the following test configuration: EXISTING / 43°

Table 2 is the ratio of the mean wind speed occurring at each measurement grid position to the BoM 55325 10 m height mean wind speed - "Existing" scenario, wind direction 43°. Lines (ochre-coloured) have been superimposed on Table 2 illustrating potential aircraft landing 3° glide paths on approach to Runway 12L. Data points at locations not physically possible for landing aircraft (ie implying an aircraft landing on the ground before the end of Runway 12L) have been excluded from the table (as well as Table 3).

Table 3 gives the return period of the BoM 55325 10 m height mean wind speed which would produce an exceedance of the NASF-B (2018) deficit criteria.

- Table 2 shows that an aircraft landing on Runway 12L would experience mean wind speeds along potential flight paths varying from 175% (at 60 m height) to 90% (at 5 m height) measured as a ratio of the BoM 55325 10 m height mean wind speed.
- Table 3 (using data from Table 1) shows that the lowest BoM 10 m height mean wind speed able to create an exceedance of the NASF-B (2018) deficit criteria has a return period greater than 10 years. This is not surprising given the low height of the existing buildings on the site.

Table 2 Glide Path Mean Wind Speed Ratios to BoM 55325 10m Mean Wind Speed - EXISTING, 43°

Height (m)	Horizontal Grid Position (refer Figure 9)									
	4	5	6	7	8	9	10	11	12	13
60	1.73	1.72	1.73	1.75	1.75	1.75	1.73	1.70	1.72	1.74
55	1.71	1.70	1.71	1.72	1.71	1.70	1.68	1.67	1.70	1.73
50	1.69	1.69	1.69	1.70	1.67	1.65	1.64	1.64	1.68	1.73
45	1.66	1.66	1.67	1.68	1.64	1.60	1.61	1.62	1.67	1.71
40	1.64	1.63	1.64	1.66	1.61	1.56	1.59	1.61	1.65	1.70
35	1.58	1.56	1.58	1.61	1.56	1.51	1.53	1.56	1.58	1.60
30	1.52	1.49	1.53	1.56	1.51	1.45	1.48	1.50	1.50	1.50
25		1.45	1.47	1.49	1.44	1.40	1.41	1.42	1.44	1.46
20			1.41	1.42	1.38	1.34	1.35	1.35	1.38	1.41
15				1.27	1.25	1.23	1.22	1.21	1.23	1.24
10					1.12	1.12	1.09	1.07	1.07	1.07
5						1.01	0.97	0.93	0.91	0.90

Table 3 BoM 55325 Return Period for NASF-B (2018) Deficit Criteria Exceedance: EXISTING, 43°

Height (m)	Horizontal Grid Position (refer Figure 9)									
	4	5	6	7	8	9	10	11	12	13
60	>100	>100	>100	>100	>100					
55	>100	>100	>100	>100	>100	>100				
50	>100	>100	>100	>100	>100	>100	>100			
45	>100	>100	>100	>100	>100	>100	>100	>100		
40	>100	>100	>100	>100	>100	>100	>100	>100	>100	
35	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
30	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
25		>100	>100	>100	>100	>100	>100	>100	>100	>100
20			>100	>100	>100	>100	>100	>100	>100	>100
15				>100	>100	>100	>100	>100	>100	>100
10					>100	>100	>100	>100	>100	>100
5						>100	>100	>100	>100	>100

7.1.2 NASF-B (2018) Mean Wind Speed Deficit Criteria Exceedance - Scenario Comparison

The results shown in Tables 4 and 5 give the BoM 55325 10 m height mean wind speed which would produce an exceedance of the NASF-B (2018) deficit criteria for the two tested built environment scenarios.

"EXISTING" Built Environment Scenario - refer Table 4

Wind Direction 20.5°

- The return period of NASF-B (2018) mean wind speed deficit criteria exceedance ranges exceeds 100 years for all grid measurement points.

Wind Direction 43°

- The return period of NASF-B (2018) mean wind speed deficit criteria exceedance ranges exceeds 100 years for all grid measurement points.

Wind Direction 65.5°

- The return period of NASF-B (2018) mean wind speed deficit criteria exceedance ranges exceeds 100 years for all grid measurement points.

Wind Direction 88°

- The return period of NASF-B (2018) mean wind speed deficit criteria exceedance ranges exceeds 100 years for all grid measurement points.

"FUTURE" Built Environment Scenario - refer Table 5

A review of the mean wind speeds in Table 5 causing an exceedance of the NASF-B (2018) mean wind speed criteria shows the following:

- When comparing the results between the "Existing" and "Future" scenarios at any one individual measurement grid point, there were minor variances at particular locations (typically ±10%) both up and down;
- However, the minimum return period for each tested angle at the "worst-case" grid point, remained at or above 100 years.

Summary:

> Exceedances of the NASF-B (2018) mean wind speed criteria are essentially non-existent for both the "Existing" and "Future" scenarios at practical wind speeds, ie winds occurring with a return period of less than one per hundred years.

Table 4 BoM 55325 Mean Wind Speed for NASF-B (2018) Deficit Criteria Exceedance: EXISTING

	Wind Direction = 20.5°									
	6	7	8	9	10	11	12	13	14	15
60	>100	>100	>100							
55	>100	>100	>100	>100						
50	>100	>100	>100	>100	>100					
45	>100	>100	>100	>100	>100	>100				
40	>100	>100	>100	>100	>100	>100	>100			
35	>100	>100	>100	>100	>100	>100	>100	>100		
30	>100	>100	>100	>100	>100	>100	>100	>100	>100	
25	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
20	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
15		>100	>100	>100	>100	>100	>100	>100	>100	>100
10			>100	>100	>100	>100	>100	>100	>100	>100
5				>100	>100	>100	>100	>100	>100	>100

	Wind Direction = 43°									
	4	5	6	7	8	9	10	11	12	13
60	>100	>100	>100	>100	>100					
55	>100	>100	>100	>100	>100	>100				
50	>100	>100	>100	>100	>100	>100	>100			
45	>100	>100	>100	>100	>100	>100	>100	>100		
40	>100	>100	>100	>100	>100	>100	>100	>100	>100	
35	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
30	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
25		>100	>100	>100	>100	>100	>100	>100	>100	>100
20			>100	>100	>100	>100	>100	>100	>100	>100
15				>100	>100	>100	>100	>100	>100	>100
10					>100	>100	>100	>100	>100	>100
5						>100	>100	>100	>100	>100

	Wind Direction = 65.5°									
	2	3	4	5	6	7	8	9	10	11
60	>100	>100	>100	>100	>100	>100	>100			
55	>100	>100	>100	>100	>100	>100	>100	>100		
50	>100	>100	>100	>100	>100	>100	>100	>100	>100	
45	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
40	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
35		>100	>100	>100	>100	>100	>100	>100	>100	>100
30			>100	>100	>100	>100	>100	>100	>100	>100
25				>100	>100	>100	>100	>100	>100	>100
20					>100	>100	>100	>100	>100	>100
15						>100	>100	>100	>100	>100
10							>100	>100	>100	>100
5								>100	>100	>100

	Wind Direction = 88°								
	1	2	3	4	5	6	7	8	9
60	>100	>100	>100	>100	>100	>100	>100		
55	>100	>100	>100	>100	>100	>100	>100	>100	
50	>100	>100	>100	>100	>100	>100	>100	>100	>100
45	>100	>100	>100	>100	>100	>100	>100	>100	>100
40		>100	>100	>100	>100	>100	>100	>100	>100
35			>100	>100	>100	>100	>100	>100	>100
30				>100	>100	>100	>100	>100	>100
25					>100	>100	>100	>100	>100
20						>100	>100	>100	>100
15							>100	>100	>100
10								>100	>100
5									>100

Table 5 BoM 55325 Mean Wind Speed for NASF-B (2018) Deficit Criteria Exceedance: FUTURE

	Wind Direction = 20.5°									
	6	7	8	9	10	11	12	13	14	15
60	>100	>100	>100							
55	>100	>100	>100	>100						
50	>100	>100	>100	>100	>100					
45	>100	>100	>100	>100	>100	>100				
40	>100	>100	>100	>100	>100	>100	>100			
35	>100	>100	>100	>100	>100	>100	>100	>100		
30	>100	>100	>100	>100	>100	>100	>100	>100	>100	
25	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
20	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
15		>100	>100	>100	>100	>100	>100	>100	>100	>100
10			>100	>100	>100	>100	>100	>100	>100	>100
5				>100	>100	>100	>100	>100	>100	>100

	Wind Direction = 43°									
	4	5	6	7	8	9	10	11	12	13
60	>100	>100	>100	>100	>100					
55	>100	>100	>100	>100	>100	>100				
50	>100	>100	>100	>100	>100	>100	>100			
45	>100	>100	>100	>100	>100	>100	>100	>100		
40	>100	>100	>100	>100	>100	>100	>100	>100	>100	
35	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
30	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
25		>100	>100	>100	>100	>100	>100	>100	>100	>100
20			>100	>100	>100	>100	>100	>100	>100	>100
15				>100	>100	>100	>100	>100	>100	>100
10					>100	>100	>100	>100	>100	>100
5						>100	>100	>100	>100	>100

	Wind Direction = 65.5°									
	2	3	4	5	6	7	8	9	10	11
60	>100	>100	>100	>100	>100	>100	>100			
55	>100	>100	>100	>100	>100	>100	>100	>100		
50	>100	>100	>100	>100	>100	>100	>100	>100	>100	
45	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
40	>100	>100	>100	>100	>100	>100	>100	>100	>100	>100
35		>100	>100	>100	>100	>100	>100	>100	>100	>100
30			>100	>100	>100	>100	>100	>100	>100	>100
25				>100	>100	>100	>100	>100	>100	>100
20					>100	>100	>100	>100	>100	>100
15						>100	>100	>100	>100	>100
10							>100	>100	100	>100
5								>100	>100	100

	Wind Direction = 88°								
	1	2	3	4	5	6	7	8	9
60	>100	>100	>100	>100	>100	>100	>100		
55	>100	>100	>100	>100	>100	>100	>100	>100	
50	>100	>100	>100	>100	>100	>100	>100	>100	>100
45	>100	>100	>100	>100	>100	>100	>100	>100	>100
40		>100	>100	>100	>100	>100	>100	>100	>100
35			>100	>100	>100	>100	>100	>100	>100
30				>100	>100	>100	>100	>100	>100
25					>100	>100	>100	>100	>100
20						>100	>100	>100	>100
15							>100	>100	>100
10								>100	>100
5									>100

7.2 NASF-B (2018) 4 kt Turbulence Criterion

The remaining NASF-B (2018) criterion for assessment of building development proposals at airports is the so-called 4 kt turbulence criterion, which requires that:

- The standard deviation ("RMS") of wind speed (ie the turbulence level) must remain below 4 kt (2.06 m/s) at heights below 200 ft.

7.2.1 NASF-B (2018) 4 kt Turbulence Exceedance Calculation Procedure

The procedure for assessment of the 4 kt turbulence criterion for the two built environment scenarios tested is as follows:

Step 1: Measure the turbulence level for each built environment scenario and each wind direction examined at each measurement grid point (refer Figure 9);

Step 2: Simultaneously record the upstream reference height mean wind speed for each test;

Step 3: Use the BoM 55325 location wind tunnel test data to relate the upstream reference height mean wind speed to the mean wind speed which would be occurring at the BoM 55325 weather station location; and

Step 4 Use the statistical occurrence of mean wind speeds at the BoM 55325 site (refer Table 1) to develop tables of the return period of 4 kt turbulence exceedances along Runway 12L landing flight paths.

The process is illustrated for the following test configuration: EXISTING / 436°

Table 6 gives the 10 m height mean wind speed which would be occurring at the BoM 55325 weather station location when a 4 kt turbulence level would be occurring at each measurement grid position - "Existing" scenario, wind direction 43°. Lines (ochre-coloured) have been superimposed on Table 6 illustrating potential aircraft landing 3° glide paths on approach to Runway 12L.

Table 7 gives the return period corresponding to the mean wind speed values shown in Table 6 – this is the recurrence interval of a 4 kt event for the "Existing" built environment scenario and for a wind direction of 43°±5°.

Sample Tables 6/7 Data Point: Horizontal Position "11", Height above Ground = 15 m

- Table 6 shows that an aircraft landing on Runway 12L would experience a turbulence level of 4 kt at this location (directly perpendicular to the Project) with the BoM 55325 site recording a 10 m height mean wind speed of 11 m/sec.
- Table 7 shows that the above event is predicted to about once every 6 years.

Table 6 BoM 10m Height Mean Wind Speed for 4 kt Turbulence at Glide Path Location – EXISTING, 296°

Height (m)	Horizontal Grid Position (refer Figure 9)									
	4	5	6	7	8	9	10	11	12	13
60	13.0	13.0	13.0	12.5	13.0	13.5	12.5	12.0	13.0	14.0
55	13.0	13.0	13.0	13.0	13.0	13.0	12.5	12.0	12.5	13.5
50	13.0	13.0	13.0	13.0	13.0	12.5	12.0	12.0	12.0	12.5
45	13.0	13.0	13.0	13.0	13.0	12.5	12.0	11.5	12.0	12.0
40	13.0	13.0	13.0	13.0	12.5	12.0	12.0	11.5	11.5	11.5
35	13.0	13.0	13.0	13.0	12.5	12.5	12.0	12.0	11.5	11.5
30	12.5	12.5	12.5	12.5	13.0	13.0	12.5	12.0	12.0	11.5
25		12.5	12.0	12.0	12.0	12.5	12.0	11.5	11.5	11.5
20			11.5	11.5	12.0	12.0	11.5	11.0	11.0	11.5
15				11.5	11.5	12.0	11.5	11.0	11.5	11.5
10					11.5	12.0	11.5	11.5	11.5	12.0
5						12.0	11.5	11.5	12.0	12.5

Table 7 Return Period for a Flight Path 4 kt Turbulence Exceedance: EXISTING, 296° (±7.5°)

Height (m)	Horizontal Grid Position (refer Figure 9)									
	4	5	6	7	8	9	10	11	12	13
60	>100	>100	>100	65	>100	>100	65	25	>100	>100
55	>100	>100	>100	>100	>100	>100	65	25	65	>100
50	>100	>100	>100	>100	>100	65	25	25	25	65
45	>100	>100	>100	>100	>100	65	25	15	25	25
40	>100	>100	>100	>100	65	25	25	15	15	15
35	>100	>100	>100	>100	65	65	25	25	15	15
30	65	65	65	65	>100	>100	65	25	25	15
25		65	25	25	25	65	25	15	15	15
20			15	15	25	25	15	6	6	15
15				15	15	25	15	6	15	15
10					15	25	15	15	15	25
5						25	15	15	25	65

7.2.2 NASF-B (2018) 4 kt Turbulence Exceedance – Built Scenario Comparison

The results shown in Tables 8 and 9 give the return period of a 4 kt event occurring at the flight landing path grid measurement points for the two tested built environment scenarios.

"EXISTING" Built Environment Scenario - refer Table 8

Wind Direction 20.5°

- Predicted 4 kt Turbulence Exceedance return periods range from 4 years and up. The most affected areas are at locations 13 and 14, directly downstream of the existing buildings for this wind direction.

Wind Direction 43°

- Predicted 4 kt Turbulence Exceedance return periods range from 2 years (at just one location) and up for this "perpendicular" wind direction.

Wind Direction 65.5°

- Predicted 4 kt Turbulence Exceedance return periods range from once per year and upwards.
- Predicted 4 kt Turbulence Exceedance return periods range from 4 years (one location) and upwards.

"FUTURE" Built Environment Scenario - refer Table 9

Wind Direction 20.5°

- Predicted 4 kt Turbulence Exceedance return periods range reduce at several locations and range from 2 years and up. Again, the most affected areas are at locations 13 and 14, directly downstream of the existing buildings and proposed development for this wind direction.

Wind Direction 43°

- Predicted 44 kt Turbulence Exceedance return periods range reduce, most noticeably at location 11 which is in line with the wake behind the highest RL section of the proposed development (at the eastern end). Return periods range from 1 year and up.

Wind Direction 65.5°

- Predicted 4 kt Turbulence Exceedance return periods also range from once per year and upwards with the largest impact seen at locations 7 and 8, in line with the highest RL section of the proposed development (at the eastern end).

Wind Direction 88°

- Predicted 4 kt Turbulence Exceedance return periods are modified depending upon location – again ranging from 4 years and up.

Summary:

Exceedances of the NASF-B (2018) 4 kt turbulence criterion are minimal (ie no more than once per year from wind directions of interest) and essentially the same for both the "Existing" and "Future" scenarios.

Table 8 4 kt Turbulence Exceedance Statistics for all "EXISTING" Scenarios (Hours per Year)

	Wind Direction = 20.5°									
Ht	6	7	8	9	10	11	12	13	14	15
60	45	25	45	>100	>100					
55	>100	>100	>100	>100	>100	>100				
50	>100	>100	>100	>100	>100	>100	45			
45	>100	>100	>100	>100	>100	>100	25	7		
40	>100	>100	>100	>100	>100	>100	25	4	25	
35	>100	>100	>100	>100	>100	45	45	25	45	>100
30	>100	>100	>100	>100	>100	45	45	45	>100	>100
25	>100	>100	>100	>100	>100	25	25	25	45	>100
20	>100	45	>100	>100	>100	25	25	7	45	>100
15		>100	>100	>100	>100	45	25	25	25	45
10			>100	>100	>100	45	45	25	25	7
5				>100	>100	>100	45	25	7	4

	Wind Direction = 43°									
Ht	4	5	6	7	8	9	10	11	12	13
60	25	25	25	15	25					
55	25	25	25	25	25	25				
50	25	25	25	25	25	15	6			
45	25	25	25	25	15	15	6	6		
40	25	25	25	25	15	6	6	4	4	
35	25	25	25	25	15	15	6	6	4	4
30	15	15	15	15	25	25	15	6	6	4
25		15	6	6	15	15	6	4	4	4
20			6	4	6	6	4	2	4	4
15				4	6	6	4	4	4	6
10					6	6	4	4	6	6
5						6	4	4	6	15

	Wind Direction = 65.5°									
Ht	2	3	4	5	6	7	8	9	10	11
60	>100	>100	>100	>100	11	3	11			
55	>100	>100	>100	30	7	2	7	68		
50	>100	>100	>100	11	3	1	3	30	68	
45	>100	>100	>100	11	3	1	3	11	30	68
40	>100	>100	68	11	3	1	2	3	11	30
35		>100	68	7	3	2	3	7	11	68
30			68	7	3	2	3	7	30	68
25				3	3	3	3	7	11	30
20					3	3	7	7	7	7
15						3	3	3	7	11
10							3	2	7	30
5								2	7	30

	Wind Direction = 88°								
Ht	1	2	3	4	5	6	7	8	9
60	>100	>100	>100	50	7	7	20		
55	>100	>100	>100	>100	20	20	20	>100	
50	>100	>100	>100	>100	>100	50	20	>100	>100
45	>100	>100	>100	>100	20	20	50	>100	>100
40		>100	>100	50	7	20	50	50	50
35			>100	>100	20	20	20	50	50
30				>100	>100	50	20	50	50
25					50	50	50	20	7
20						50	>100	20	4
15							50	20	20
10								50	>100
5									>100

Table 9 4 kt Turbulence Exceedance Statistics for all "FUTURE" Scenarios (Hours per Year)

	Wind Direction = 20.5°									
Ht	6	7	8	9	10	11	12	13	14	15
60	>100	>100	>100	>100	>100					
55	>100	>100	>100	>100	>100	>100				
50	>100	>100	>100	>100	>100	>100	25			
45	>100	>100	>100	>100	>100	>100	45	2		
40	>100	>100	>100	>100	>100	>100	45	4	45	
35	>100	>100	>100	>100	>100	>100	45	4	25	>100
30	>100	>100	>100	>100	>100	>100	25	2	7	45
25	>100	>100	>100	>100	>100	>100	45	4	25	>100
20	>100	>100	>100	>100	>100	>100	45	4	25	>100
15		>100	>100	>100	>100	>100	45	2	7	>100
10			>100	>100	>100	>100	25	2	7	45
5				>100	>100	>100	25	2	4	25

	Wind Direction = 43°									
Ht	4	5	6	7	8	9	10	11	12	13
60	>100	65	>100	>100	15	2	2			
55	>100	>100	>100	>100	15	2	2	2		
50	>100	>100	>100	>100	15	4	2	1	6	
45	>100	>100	>100	>100	25	4	4	2	15	>100
40	65	65	>100	>100	25	6	4	4	25	>100
35	>100	>100	>100	>100	25	6	4	4	15	65
30	>100	>100	>100	>100	25	6	4	4	6	25
25		>100	>100	25	15	6	4	2	6	65
20			65	15	15	15	4	1	6	>100
15				25	15	6	4	2	15	>100
10					15	6	4	2	15	>100
5						4	4	4	15	>100

	Wind Direction = 65.5°									
Ht	2	3	4	5	6	7	8	9	10	11
60	>100	>100	>100	68	11	7	11	11		
55	>100	>100	>100	68	11	3	7	11	68	
50	>100	>100	>100	30	7	2	3	7	30	>100
45	>100	>100	>100	68	7	1	3	7	30	>100
40	>100	>100	>100	>100	7	1	2	7	30	>100
35		>100	>100	>100	3	1	2	7	68	>100
30			>100	68	2	1	1	11	>100	>100
25				30	3	1	3	30	>100	>100
20					3	2	7	68	>100	>100
15						2	11	>100	>100	>100
10							11	>100	>100	>100
5								>100	>100	>100

	Wind Direction = 88°								
Ht	1	2	3	4	5	6	7	8	9
60	>100	>100	50	20	20	7	4		
55	>100	>100	20	20	20	7	4	20	
50	50	>100	20	20	20	7	7	20	>100
45	>100	>100	20	20	20	7	7	20	>100
40		>100	50	50	50	20	7	20	>100
35			50	20	20	20	7	50	>100
30				20	7	7	20	50	50
25					20	20	20	50	50
20						50	50	50	50
15							50	50	>100
10								>100	>100
5									>100

8 CONCLUSIONS AND SUMMARY

The present study involved 1:750 scale model wind tunnel testing of two "built environment" scenarios"

- "Baseline" existing built environment at the airport and surrounds
- "Future" "Baseline" + proposed development

NASF-B (2018) Threshold "Triggers"

The study showed that the proposed development does not satisfy NASF-B (2018) with respect to the "1:35" rule - refer Section 2.

Accordingly, further quantitative assessment (ie via wind tunnel testing or CFD modelling) was undertaken as required for acceptance of the proposed concept design in relation to the NASF-B considerations covering mean wind speed deficit and wake turbulence.

Tamworth Airport BoM Station 55325 Wind Characteristics

The study analysed the exceedance characteristics of the long-term wind record (2008-2018) obtained at the Bureau of Meteorology (BoM) weather station located at Tamworth Airport, BoM 55325, in terms of both mean wind speed and turbulence. The site of the weather station is close to the project domain areas and shares similar upstream turbulence characteristics to Runway 12L positions (and its northwesterly projection) under crosswind (ie northeast) wind conditions. These statistics serve as a reference dataset to assess exceedance levels of interest in relation to NASF-B and the proposed development.

Initial Tamworth Airport BoM 55325 1:750 Model Scale Wind Tunnel Test

An initial 1:750 model scale wind tunnel test was undertaken to directly measure the mean wind speed and turbulence level at the 10 m height anemometer location of Tamworth Airport BoM 55325. During this test a reference height wind speed (mean and gust) was also recorded at a location upstream of the model test area so as to be unaffected by any existing building wake effects.

This reference height wind speed was also used in the subsequent built environment scenarios and served as a "bridge" to relate wind speeds (mean and gust) measured along flight landing path positions back to the 10 m height mean wind speed at Tamworth Airport BoM 55325.

Built Scenarios 1:750 Model Scale Wind Tunnel Tests

As noted above, two built environment scenarios were tested to assess the impact of the proposal.

Hot-wire sensors were used to make wind speed measurements at positions located in a vertical plane centred on Runway 12L and its southern projection – refer Figure 9. The measurement grid had a horizontal spacing of 100 m and a vertical grid spacing of 5 m (ranging from 5 m up to 60 m above ground level).

Four wind directions were tested – 20.5°, 43°, 65.6° and 88° - noting that 43° is the wind direction perpendicular to Runway 12L (from the northeast).

NASF-B (2018) Mean Wind Speed Deficit Criteria

"Existing" Built Environment Scenario:

- Predicted exceedance of the mean wind speed deficit criteria at the "worst-case" grid measurement point are All greater than 100 years. This is not surprising given the scale of existing buildings at the site.

"Future" Built Environment Scenario:

- When comparing the results between the "Existing" and "Future" scenarios at any one individual measurement grid point, there were minor variances at particular locations (typically ±10%) both up and down. However, the minimum return period for each tested angle at the "worst-case" grid point, remained at or above 100 years.

NASF-B (2018) 4 kt Turbulence Criterion

"Existing" Built Environment Scenario:

- In the "Existing" built environment scenario, predicted 4 kt turbulence exceedance events have return periods ranging from once per year and upwards.

"Future" Built Environment Scenario:

- When comparing individual points along the flight path measurement grid between the "Existing" and "Future" scenario results, there are variances in terms of annual exceedance statistics at particular locations both up and down. As expected, predicted return periods are lowest (ie more frequently occurring) at locations in line with the highest RL section of the proposed development for the relevant wind direction.
- 4 kt exceedances do not exceed one per year. This reflects both the low incidence of winds from the relevant cross-wind directions of interest and the modest extent of the taller section of the proposed development.

Summary

In relation to wind conditions experienced by aircraft landing from the northwest on Runway 12L:

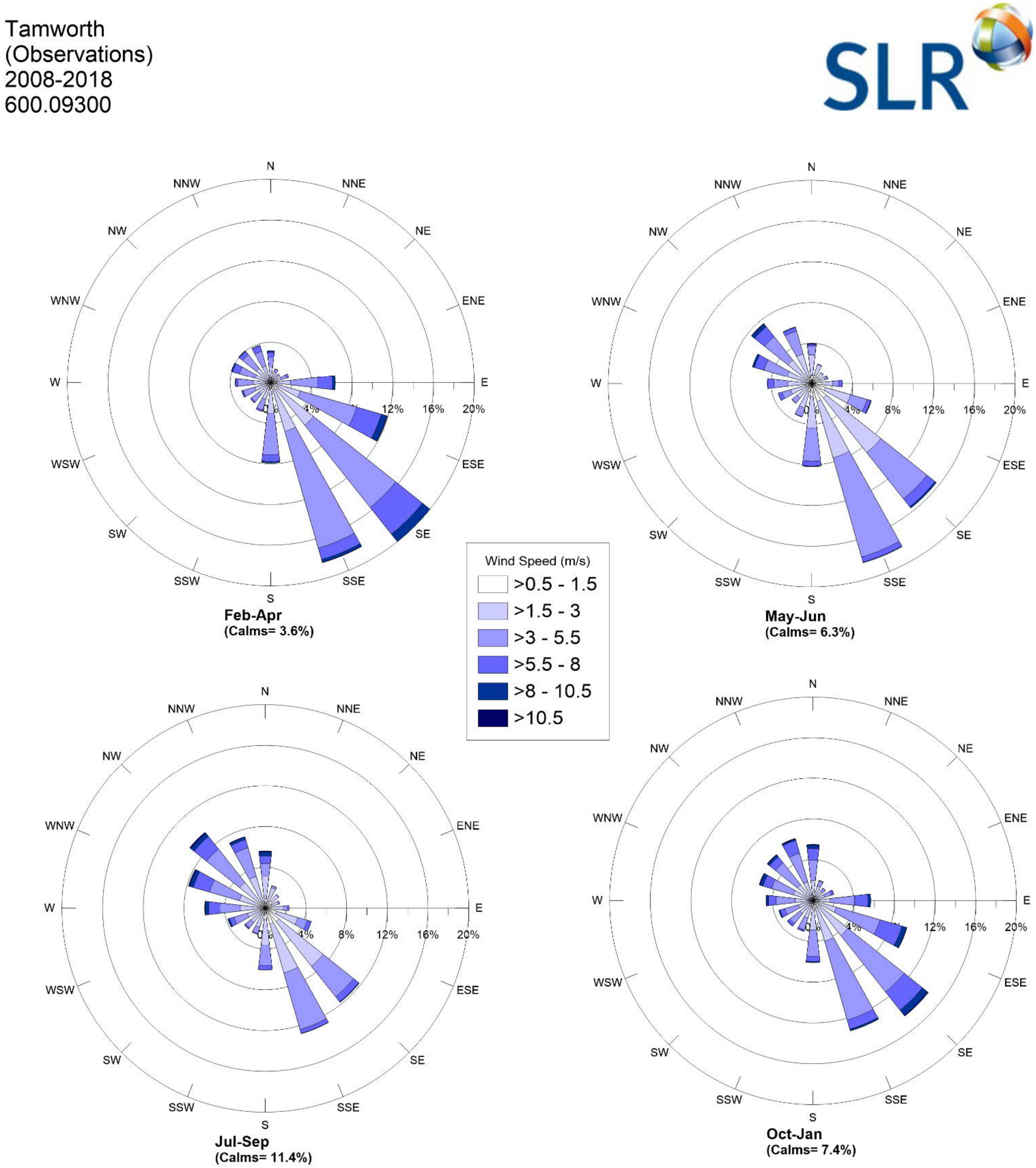
- The proposed development will have minimal/negligible impact in relation to the NASF-B mean wind speed deficit criteria, essentially no impact at wind speeds of practical interest.
- NASF-B 4 kt turbulence level event exceedances are of the order of once per year with the proposed development – essentially the same as for existing conditions at the airport. This is attributed to the low profile of the proposed development buildings and low probability of occurrence of crosswinds of interest to this study (ie from the NE). Again, the proposed development will have minimal/negligible impact at wind speeds of practical interest on runway turbulence levels.

Note Regarding Building Envelope Changes

It is understood that the final design of the proposed development is currently being reviewed. Based on extensive studies undertaken by SLR and other Wind Engineering consultancies, the impacts identified in the present study would be an upper bound of expected changes to windshear and wake turbulence if any proposed changes to the development result in a decrease of bulk envelope (especially height-wise) in the main operational building.

APPENDIX A

Tamworth Airport Seasonal Wind Roses



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