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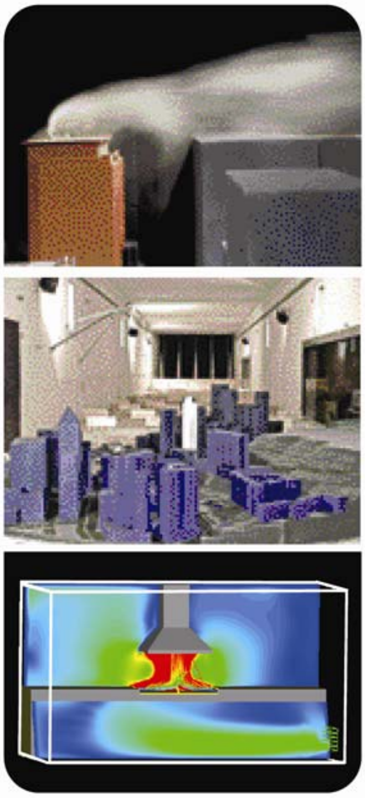
Final Report

REP-CW-W1-001



Wind assessment for

ROYAL NORTH SHORE HOSPITAL HELIPAD

QUALITATIVE TURBULENCE AND AIR QUALITY STUDY

St Leonards

Prepared for:

Thiess Pty Ltd Royal North Shore Hospital

RNSH Site Office

Herbert Street

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CPP Project 5319

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FINAL REPORT

WIND-TUNNEL TESTS — ROYAL NORTH SHORE HOSPITAL HELIPAD QUALITATIVE TURBULENCE AND AIR QUALITY STUDY
St Leonards

CPP Project 5319

April 2010

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EXECUTIVE SUMMARY

A qualitative wind assessment study of the proposed Royal North Shore Hospital Helipad, to be located on the proposed Acute building, was conducted to assess the effect of the development on the wind conditions for approaching helicopters and for transmission of exhaust fumes into the Acute building air intakes.

The helipad is located on the roof of a building of complex geometry, which has the potential to cause wind shear for strong winds from the north-west. These wind events occur for about 1.5% of the time. During such events the pilot will decide whether to use the helipad on the Acute building, or alternatively the helipad on the adjacent Douglas buildings, or the nearby oval.

Some outside air intakes on the Acute building are located such that potential odour complaints, and possibly exceedances of health limits for certain individual exhaust components, are likely for most wind directions. Passive and active mitigation measures will be used for those locations. Mitigation measures will be designed based on exhaust dispersion modelling to be conducted in a wind tunnel test.

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1. BACKGROUND

The aim of this report is to assess the proposed helipad located on the Acute building of the Royal North Shore Hospital, St Leonards, in terms of the influence of the expected local wind conditions on landing aircraft and the potential for helicopter exhaust contamination of the air intakes.

The proposed Royal North Shore Hospital Acute building rises to a maximum of 12 storeys above ground level, and is irregular in plan form, Figure 1. The proposed helipad is located to the south-east corner of the development on Level 11, Figure 2 and Figure 3.

Figure 1: Level 9 floor plan, Acute building

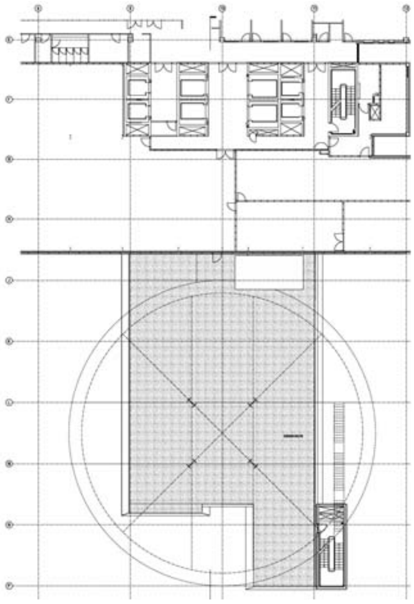

Figure 2: Location of helipad in south-east corner of the development

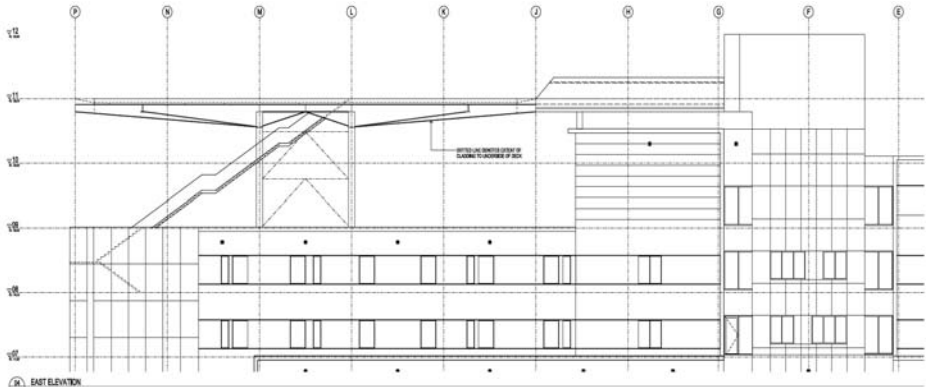

Figure 3: East elevation of the proposed helipad

The helicopter approach plan to the hospital is presented in Figure 4. The largest design helicopter to use the facility is the Agusta AW139.

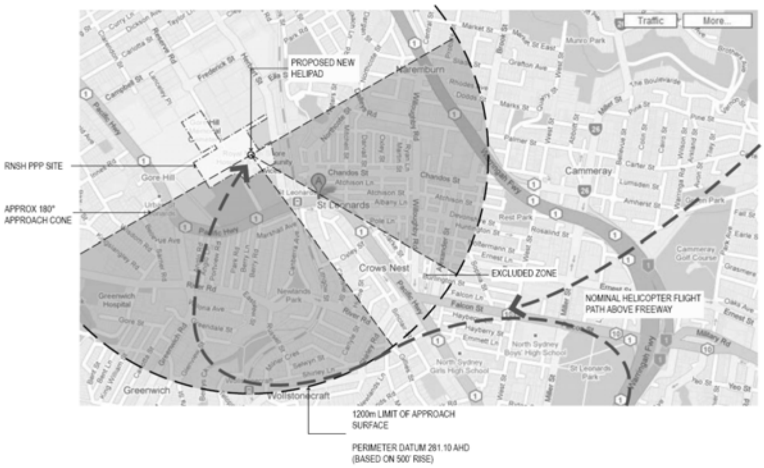

Figure 4: Acute hospital helipad approach plan

Aircraft landing are generally decelerating and moving slower than aircraft taking off, and are therefore more susceptible to changes in the relative wind speed between the aircraft and the wind. Departing aircraft generally ascend more rapidly than landing aircraft and again would be less susceptible to changes in wind conditions. The point of most interest for helicopter operations is on the immediate approach to the touchdown point.

2. WIND EFFECTS ON HELICOPTER OPERATION

It is important to appreciate the difference between wind shear and turbulence to enable a reasonable interpretation of the wind tunnel testing results conducted on the proposed development. It is also important to appreciate the potential influence of convection, and therefore some discussion on these events is included.

2.1 DISCUSSION ON WIND SHEAR AND TURBULENCE

Paragraph 2.2.1 from International Civil Aviation Organisation (ICAO) (2005) states:

‘In the explanation of wind shear given in Chapter 1, the changes in wind speed and/or direction concern changes in the mean (or prevailing) wind from one reference point in space to another. Short-term fluctuations of the wind about a mean direction and/or speed are normally referred to as “variations” from the prevailing wind. Such variations of the wind, individually at least, are temporary, like eddies; while eddies clearly involve wind shear; because they are on a much smaller scale than an aircraft, they tend to affect the aircraft as bumpiness or turbulence. The scale on which the wind shear operates, in relation to the overall size of the aircraft concerned, is therefore of fundamental importance.’

From the above it can be appreciated that wind shear is based on a difference in mean wind speed between two locations, whereas turbulence is the natural variation in the wind speed and direction due to the flow over the ground.

The “variations” mentioned above are generally called turbulence in the wind engineering community and will be used in this document. Turbulence intensity is a term used to quantify turbulence and is calculated as the standard deviation of wind speed divided by the mean wind speed. This does not give an indication of the size, or distribution, of the gusts. A spectral analysis would be required to extract the frequency structure of the gusts from which a measure of the size could be inferred. This is considered beyond the scope of the current discussion, and would be impractical to monitor full-scale.

To emphasise the difference between wind shear and turbulence, a brief discussion on the driving mechanisms involved in generating turbulence and low level wind shear in the form of a thunderstorm downburst is included. Low level in wind engineering terms is defined as below about 500 m.

The typical atmospheric boundary layer created by synoptic wind events is created by friction at the ground surface, and therefore changes from the ground up. The boundary layer typically extends about 500 to 1000 m above ground level. Increasing friction caused by ground objects causes a decrease in the near ground mean wind speed and an increase in turbulence intensity. The ratio of mean wind speed at 500 m to that at 10 m is typically about 1.6 for winds over open terrain, and 2.1 times for winds over suburbia. The mean wind speed at 500 m over open terrain is about 10% higher than that over suburbia. Turbulence intensity ratios between 500 m and 10 m are typically about 0.4, with winds over suburbia having about 1.3 times the turbulence intensity of those created over open land.

To develop ICAO defined ‘moderate’ and ‘strong’ wind shear in the lowest 30 m of the boundary layer, the mean wind speed at 10 m would have to be in excess of 11 m/s (22 kt), and 20 m/s (40 kt) respectively.

Turbulence intensity is wind speed dependent and the lower the mean wind speed the higher the turbulence intensity. However, once the mean wind speed exceeds about 10 m/s (20 kt) the turbulence statistics become relatively less sensitive to wind speed. At the lower wind speeds turbulence intensity is not a significant issue to aircraft as the change in relative air speed between the aircraft and the wind is negligible. Turbulence is also a function of the meteorological event; local pressure driven winds such as summer onshore winds contain much smoother flow than winds associated with a large frontal system, even if they come from the same direction.

It is evident from the above that the existing wind conditions at the Royal North Shore Hospital are diverse depending on wind speed, direction, and meteorological event.

The most likely cause of wind shear at this site would be for winds from the north-west passing over the raised roof to the immediate north of the helipad. The wind flow patterns over a generic building, Figure 5, create recirculation zones near the windward wall and roof edge, and in the immediate lee of the building. These are highly dependent on the geometry of the building. The typical maximum extent of these recirculation zones relative to the total height of the structure, h, is illustrated in Figure 5; for instance Peterka et al. 1985 describe the downstream recirculation zone extending 2 to 6 times the height of the structure. These regions are not fixed but fluctuate in time thereby increasing downstream turbulence, but significant wind shear would only be experienced in the recirculation zones. For an isolated building, as the distance increases from the structure the flow pattern will revert to the undisturbed state. This distance is a function of the geometry of the building, and the roughness of the surrounding terrain, but the mean velocity and turbulence intensity at roof height would be expected to approach the free stream conditions at 10 times the height of the structure down wind from the building. The building may influence the wind pattern to a distance larger than this, but the magnitude of any change is expected to be slight. The frequency of turbulence shed from the building would be expected to be fairly high and the spatial extent of a similar size to a large aircraft, therefore any effect would be expected to be of a short duration.

Given the location of the helipad relative to the raised roof, it is likely that the helicopter will pass through the recirculating region on the top of the building for winds from the north-west. The wind conditions in this region of the roof are expected to be highly varied, and the location of the windsock will be paramount to predicting the local wind speed and direction. Wind flows around taller buildings remote from the immediate landing site tend to create mechanical turbulence rather than wind shear on the approach.

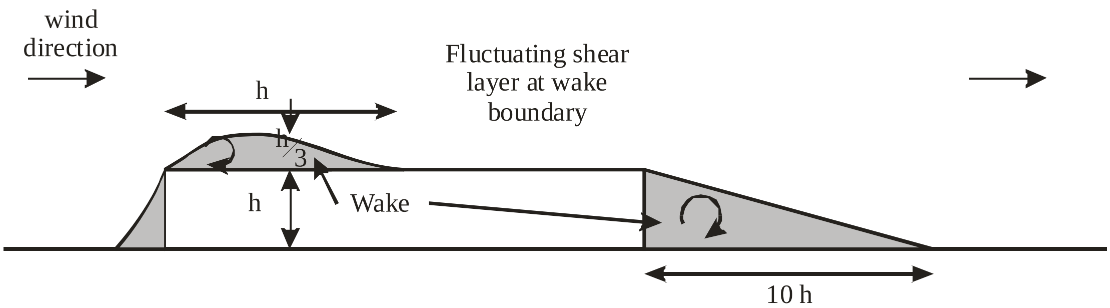

Figure 5: Sketch of the flow pattern over a building

This discussion is in agreement with the ICAO Manual which in section 3.2.2 states: '…This means that while the buildings are comparatively low, they present a wide and solid barrier to the prevailing surface wind flow. The wind flow is diverted around and over the buildings causing the surface wind to vary along the runway. Such horizontal wind shear, which is normally very localised, shallow and turbulent, is of particular concern to light aircraft operating into smaller aerodromes, but has also been known to affect larger aircraft.'

2.2 DISCUSSION ON WIND EFFECTS ON HELIPAD

Before discussing specifics about the Royal North Shore Hospital site, it should be appreciated that only strong wind events (gusting to over 10 m/s (20 kt)) are considered here. Wind events with a lower wind speed would not be expected to appreciably influence the flight characteristics of a landing aircraft.

Prevailing strong wind speeds in Sydney tend to come from the north-east, south, and west quadrants, Figure 6. Winds from the north-east and south sectors are not expected to cause wind shear, however there may be requirements for helicopter pilots to land into a strong head wind rather than a tail wind. Provisional guidance for the siting of helicopter landing sites is given in US Department of Transport (1984); for roof top helipads in variable wind conditions, a suggested height of 15 m above the centre of the roof is suggested, but caveats are given relating to complex building geometry.

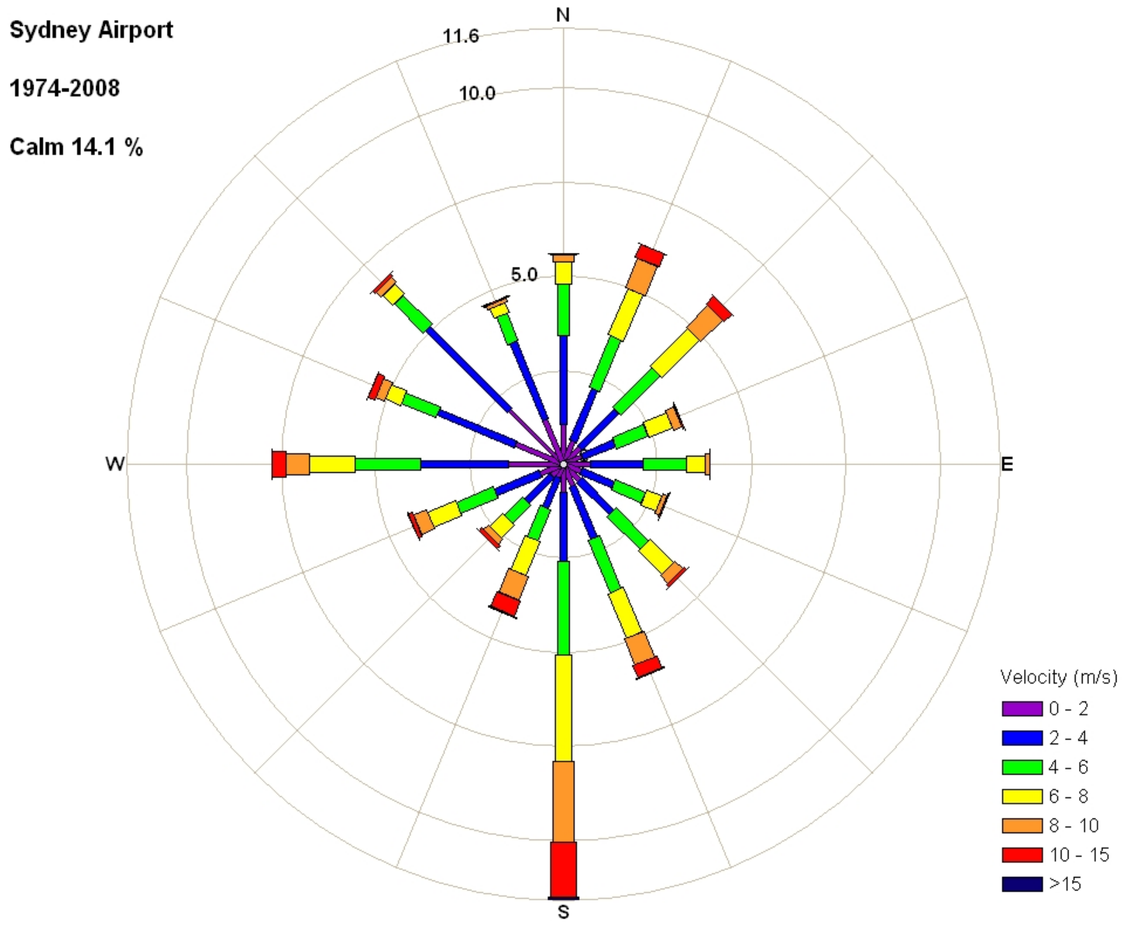

Figure 6: Wind rose for Sydney International Airport

During light winds with a mean speed less than 10 m/s, wind shear is unlikely to cause any operational issues to helicopter pilots as the magnitude of wind shear will be 'moderate' based on the ICAO criteria. Above this wind speed, which occurs for less than 1.5% of the time in Sydney for winds from the north-west quadrant, landing helicopters would be advised to use the nearby oval to avoid wind shear.

3. HELICOPTER EXHAUST

Plan locations for the air intakes at the upper floors of the Acute building are shown in Figure 7 and Figure 8. The primary intakes of concern, those serving most of the normally occupied spaces, are those shown in on the south building elevation in Figure 8. These intakes are in relatively close proximity to the landing pad as shown in Figure 9.

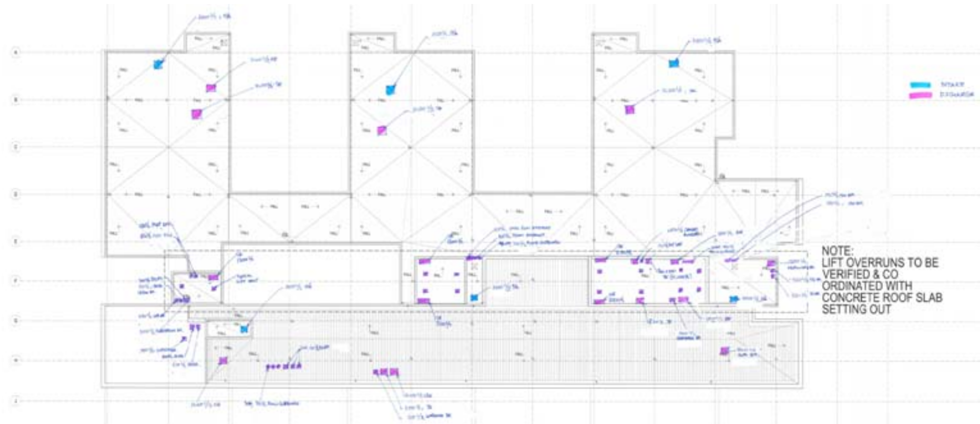

Figure 7: Level 10 floor plan, Acute building with intakes highlighted in blue

Figure 8: Level 9 floor plan, Acute building with intakes highlighted in blue

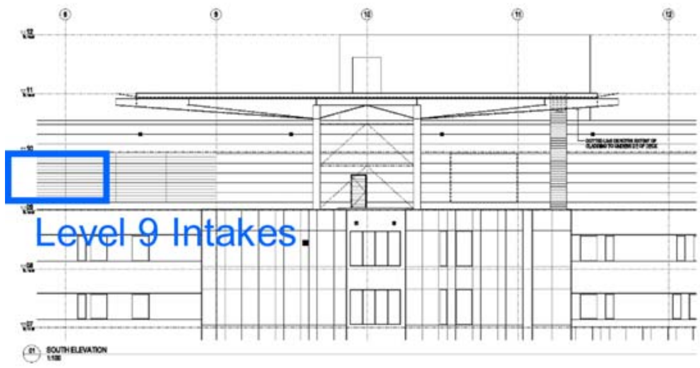

Figure 9: South elevation view near landing pad with east end of intakes outlined in blue

It is likely that odour thresholds for helicopter exhaust will be exceeded at the air intakes on the south side of the building, particularly on the upper floors. Under certain conditions, helicopter odours may be noticeable even at the lower set of primary intakes, at level 5, shown in Figure 10.

Figure 10: Level 5 floor plan, Acute building with intakes highlighted in blue

Under most landing scenarios, it is anticipated that the helicopter exhaust will be oriented towards the south-west, Figure 4 and Figure 11. With this orientation, moderate to strong winds from the south and south-west will tend to drive the exhaust towards the intakes; light to moderate winds are likely to trap the exhaust plume in the building wake cavity, discussed above; all south-easterly winds will tend to drive the exhaust plume along the south building elevation, affecting the upper level intakes.

Since most wind directions are likely to result in significant exhaust levels at the intakes, passive and/or active systems will be implemented to minimize odour complaints and potential exceedances of health limits, particularly to Nitrogen Dioxide (NO_2), as per applicable standards. The extent of any active or passive measures will be determined from wind tunnel test results. It should be noted that the most common passive measures include activated carbon filters to adsorb the odorous hydrocarbons in the exhaust. If NO_2 is an issue, special catalytic filters may be warranted. One active method that may be employed is to shift the air handling systems into an alternate, temporary, mode where outside air is blocked (or at least minimized) from entering the system. Such a system could be activated by an operator at the hospital or be tied into the Pilot Activated Lighting (PAL) system discussed in the Helicopter Landing Site Guidelines report (AviPro, 2009).

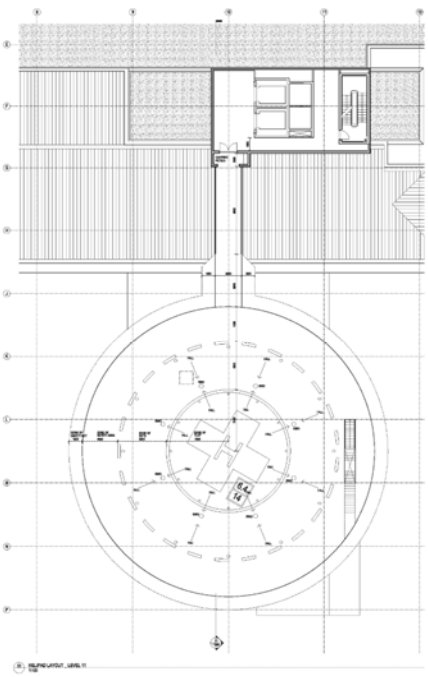

Figure 11: Helipad plan view

Similar conditions are anticipated at the upper level intakes for the planned Community Hospital Building, particularly those on the north and west side nearest the helipad, Figure 12. Passive measures will likely be recommended for this building unless the building control systems are linked.

Exhaust dispersion testing, conducted using physical modelling in a wind tunnel, will be conducted to quantify pollutants and determine which air intakes may require these special measures.

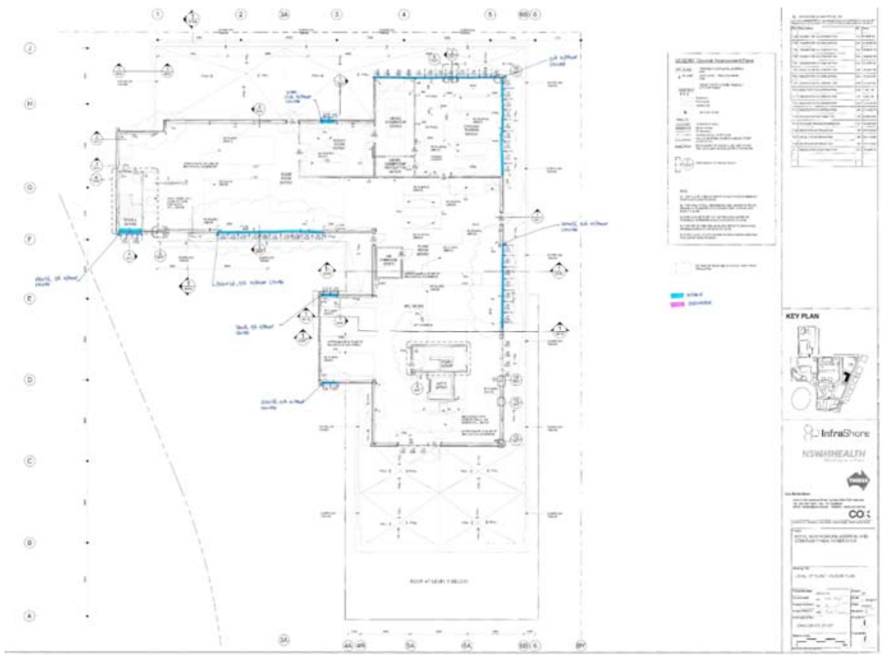

Figure 12: Level 7 floor plan, Community Hospital with air intakes noted in blue

REFERENCES

AviPro, (2009), Helicopter Landing Site Guidelines: Royal North Shore Hospital Redevelopment, Proposed Roof Top HLS, September, 2009.

ICAO (International Civil Aviation Organisation), (2005), *Manual on low-level wind shear*.

Peterka, J.A., R.N. Meroney & K.M. Kothari, (1985), Wind Flow Patterns About Buildings, *Journal of Wind Engineering and Industrial Aerodynamics*, Vol. 21, pp.21-38.

US Department of Transport, Federal Aviation Authority (1984), *Evaluating wind flow around buildings on heliport placement*, DOT/FAA/PM-84/25October 1984.