

7. Airspace architecture and operation

7.1 Overview

Airservices Australia assessed airspace implications and air traffic management approaches for Sydney region airspace associated with the proposed Western Sydney airport. Airservices Australia's analysis indicates that there are no apparent physical impediments that would prevent safe and efficient operations for aircraft arriving at or departing from the proposed airport. On the basis of this analysis, Airservices Australia developed indicative flight paths to inform this draft EIS.

It is important to note that the formal flight path design for the proposed airport will be undertaken much closer to the commencement of operations. The formal design process will provide an opportunity to optimise flight paths on the basis of safety, efficiency, noise and environmental considerations, as well as minimising changes to existing regional airspace arrangements.

Decisions about airspace management arrangements, including the determination of flight paths, would be made by Airservices Australia and the CASA. These decisions may engage further environmental assessment processes, community and stakeholder engagement, and may be the subject of a future referral under the EPBC Act following detailed design.

7.1.1 Regulatory context

Airspace is the term used for the three dimensional space in which aircraft are able to fly. Elements of airspace include terminal airspace, controlled airspace and restricted airspace.


Terminal airspace generally encompasses the area within 55 to 90 kilometres (30 to 50 nautical miles) from a major airport. The height of terminal airspace extent varies depending on the operational parameters at an airport. In the case of Sydney Airport, terminal airspace extends from ground level up to about 6,000 metres (20,000 feet) close to the airport. As the distance from the airport increases, the lower boundary of this zone rises in steps, beginning at 300 metres (1,000 feet) and increasing to typically about 2,300 metres (7,500 feet) at the outer edges of the Sydney region.

Controlled airspace includes the terminal airspace area and also the airspace along the flight paths between airports.

Restricted airspace includes all airspace that has restrictions placed on its use. This is generally associated with military installations or other situations where safety is an issue, for example explosives storage facilities such as the Defence Establishment Orchard Hills.

Flight paths define the anticipated routes of aircraft arriving and departing from an airport when operating on standard instrument departures or conducting approaches under instrument guidance, or under visual meteorological conditions.

Ideally, aircraft would fly by the most direct route and at the optimum altitude for reasons of economy and efficiency of flight operations. However, it is not always possible for aircraft to fly optimum routes because of noise and safety considerations, and the competing demands of other airspace users.



When departing from an airport, an aircraft follows a predetermined flight path from the end of the runway until it is established on a route that leads ultimately to its destination. Because of the greater manoeuvring options available for aircraft after take-off, there is greater flexibility in determining flight paths for departing aircraft than for aircraft landing at an airport.

Australian airspace is largely available for civil aviation use, with overall responsibility for management of the airspace shared by Airservices Australia and the Department of Defence. CASA sets policies and standards governing the use of the non-military portion of the airspace. Airservices Australia manages the airspace and provides the necessary air traffic control services and equipment to maintain a safe and efficient flow of air traffic.

Day to day management of the airspace is achieved through air traffic controllers who direct the various phases of flight. Management procedures are published for each airport including standard instrument departures, standard arrival routes and noise management procedures.

The efficient use of airspace in the Sydney region is influenced by the geographic location of airport sites. The relatively close proximity in airspace terms, between the proposed airport, Sydney Airport and other existing facilities, such as Bankstown Airport means that operations would interact.

Runway orientation at the proposed airport is the major factor influencing the design of aircraft traffic flow patterns and flight path arrangements. Wherever operationally feasible, it is also desirable that aircraft traffic flow patterns are sufficiently flexible to minimise the effects of aircraft noise on surrounding residential and other noise sensitive areas.

7.2 Potential airspace parameters in the Sydney basin

7.2.1 Existing Sydney basin airspace

A review of the existing airspace arrangements in the Sydney basin was undertaken in March 2015 by CASA⁶. The review considered the airspace within 45 nautical miles of Sydney Airport. High levels of private operations, flight training activity, military operations and a wide range of other general and sports aviation activity combine to make the Sydney region one of the busiest and most complex volumes of Australian airspace, supporting Australia's busiest international airport and a number of satellite airports and aerodromes. The locations of prominent existing airports and aerodromes in the Sydney Region are shown in Figure 7–1. It is important to note that while operationalising the proposed airport is outside of CASA's current 2013-2018 study period this is likely to be considered in subsequent airspace reviews closer to the commencement of operations.

⁶ *The Sydney Basin Aeronautical Study (CASA 2015)*

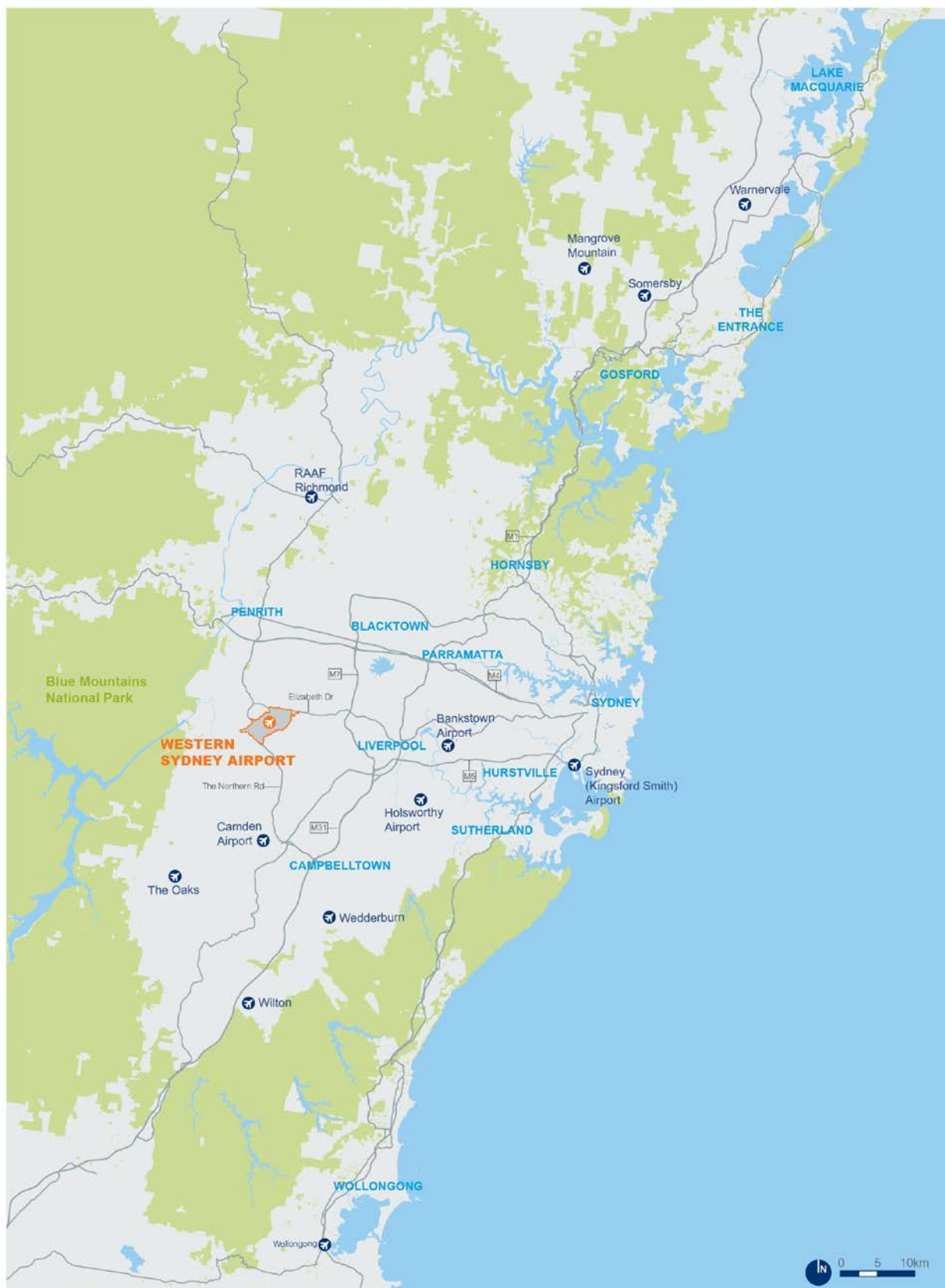


Figure 7-1 – Airports and aerodromes in the Sydney basin

7.2.2 Existing Sydney region airspace controls

The Sydney region airspace comprises a number of zones that are set to control the safe and efficient function of the airspace. These include:

- Class C control zone;
- Class C control areas;
- Class G uncontrolled airspace;
- Restricted areas; and
- Danger areas.

There are no prohibited areas (no-fly zones) in the Sydney region airspace.

Control zones

Control zones extend from surface level to a specified altitude in airspace surrounding major airports. There are three control zones within the Sydney region located at Sydney Airport, Bankstown Airport and Camden Airport. These control zones, labelled as 'CTR' are illustrated in Figure 7–2.

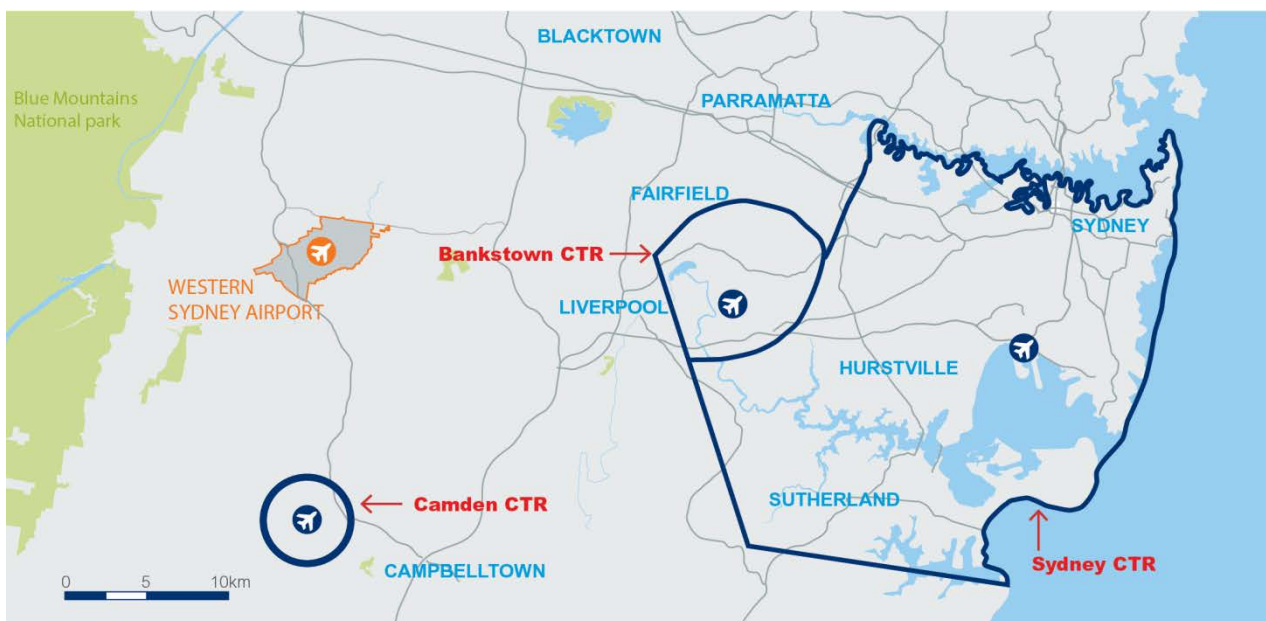



Figure 7–2 – Control zones in the Sydney region

The Sydney control zone is Class C airspace from the surface to 2,500 feet Above Mean Sea Level (AMSL). It has an irregular boundary design extending four nautical miles to the north and up to 11 nautical miles to the south west of the airport. Sydney has a large number of published terminal instrument flight procedures that allow aircraft to safely navigate to and from the airport at times of low visibility. The Bankstown control zone is Class D airspace (controlled airspace that surrounds general aviation and regional airports equipped with a control tower) the surface to 1,500 feet AMSL and abuts the Sydney control zone.



The Bankstown control zone extends three nautical miles north and two nautical miles south of the aerodrome. The control zone at Bankstown also has terminal instrument flight procedures published to allow safe navigation during low visibility conditions.

The Camden control zone is also Class D airspace from the surface to 2,000 feet AMSL. Centred on Camden airport, the control zone has a radius of two nautical miles and includes published terminal instrument flight procedures to allow safe navigation during low visibility conditions.

Control areas

Control areas extend upwards from a specified altitude. The control areas within the Sydney region are Class C airspace. The control areas within 45 nautical miles of Sydney make up the Sydney terminal control area, which has a number of different control area steps at different altitudes. The Sydney terminal control area is controlled by Airservices Australia.

Class G airspace

Class G (uncontrolled) airspace exists below the control areas and extends from the surface to the control area lower limits. The total volume of Class G airspace within 45 nautical miles of Sydney varies depending on the activation of various restricted areas and control zones.

The Sydney basin Class G airspace supports a range of typically smaller aircraft operations including flight training (fixed wing and helicopters), parachute operations, emergency services and sports and private general aviation.

A clearance from air traffic control to enter Class G airspace is not required. Aircraft equipped with instrument flight rule equipment receive a flight information service from air traffic control including movement information on other instrument flight rule aircraft.

To aid visual flying in the Sydney region, CASA, in consultation with Airservices Australia, publishes a Sydney Basin Visual Pilot Guide 20, Sydney General Flying Guide 21, visual flight rule Flight Guide 22 and the On Track 23 website.

In order to support light aircraft and helicopter flights between the control zones and operating over the Sydney Central Business District and along the coast, visual flight rules routes rules of entry have been established in Class G airspace.

Restricted areas

The declaration of a restricted area in most cases creates airspace of defined dimensions within which the flight of aircraft is restricted, in accordance with specified conditions. Restricted areas are also allocated a conditional status (restricted area 1, restricted area 2 or restricted area 3) which provides an indication as to the likelihood of obtaining a clearance to fly through the airspace (restricted area 1 being the most likely to obtain a clearance from air traffic control).

In accordance with the Airspace Regulations 2007, CASA must not declare an area to be a restricted area unless in the opinion of CASA, it is necessary in the interests of public safety or the protection of the environment to restrict the flight of aircraft over the area to aircraft flown in accordance with specified conditions.

Twenty restricted areas are located within 45 nautical miles of Sydney. The main restricted areas can be grouped as follows:

- RAAF Base Richmond;
- Army Range Holsworthy/Lucas Heights; and
- Tasman Sea Military Flying Training.

Other restricted areas within 45 nautical miles of Sydney are located in the vicinity of Sydney Harbour, Defence Establishment Orchard Hills and the Tasman Sea, to the north east of Sydney. Indicative locations of these restricted areas are identified as red in Figure 7–3. Outside of the 45 nautical mile radius, there are also restricted areas associated with RAAF Base Williamtown at Newcastle.

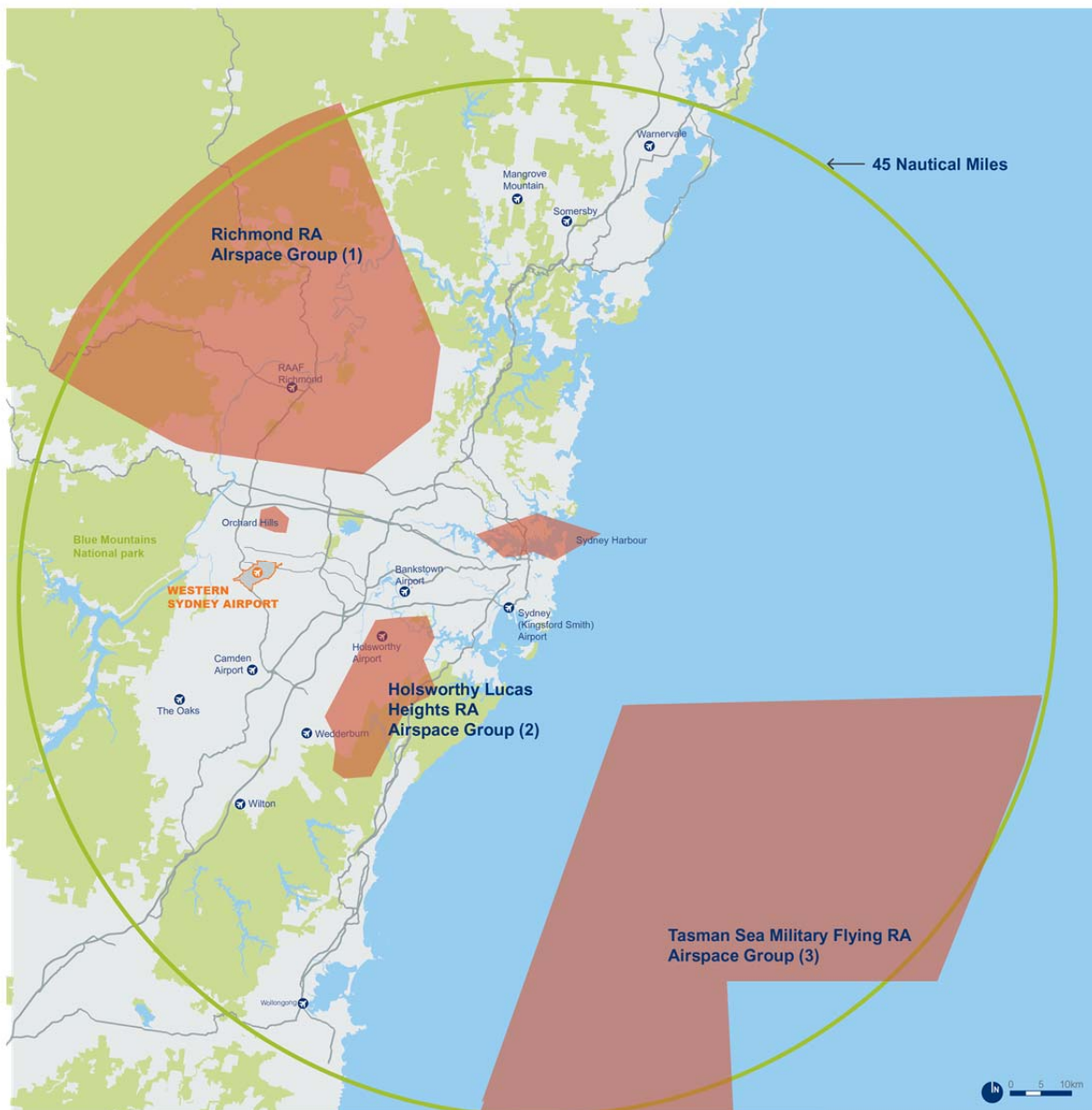



Figure 7–3 – Sydney region restricted areas



The hours of operation of restricted areas can vary to accommodate a range of activities. Most restricted areas are activated by the issue of a Notice to Airmen and some can be activated at standard times or based on defined conditions. Two restricted areas in the Sydney region are active 24-hours per day, these are R521 (Lucas Heights) and R555A (Military flying area, Holsworthy).

Danger areas

CASA may declare a danger area where, in its opinion, there exists an activity that is a potential danger to overflights. Danger areas generally relate to airspace over hazardous areas such as mining or quarrying sites, or in areas of special use such as hang-gliding, parachuting and unmanned aerial vehicle testing. Approval for flight through a danger area outside controlled airspace is not required. However, pilots are expected to maintain a high level of vigilance when transiting a danger area.

There are 10 danger areas located within 45 nautical miles of Sydney. Five of these encompass visual flight rule flying training areas and lanes of entry supporting operations to and from Bankstown and Camden. Other danger areas support parachuting and unmanned aerial vehicle testing activities. Indicative locations of the danger areas within 45 nautical miles of Sydney are identified as red in Figure 7-4.

7.2.3 Defence airspace operations

RAAF Base Richmond is the home of Air Mobility Group and supports locally based C130J and C27J aircraft as well as visiting aircraft. The airspace architecture consists of three main restricted areas.

R470 is the terminal area airspace and also supports two parachute zones which are active several times a week. Other flying operations include circuit and low flying training. R469 lies outside R470 and supports low flying and additional training areas. It is activated in conjunction with R470. Both of these are RA1 which allows civilian traffic to use these areas for instrument training and transit, if a clearance is available.

R494 is the upper air airspace overlying RAAF Base Richmond and is primarily used as air-test airspace. Activation is by Notice to Airmen only. RAAF Base Richmond also serves as an alternate aerodrome for military fast jet operations at RAAF Base Williamtown. R469 and R470 are generally activated 15-hours per day, seven days a week.

A visual flight rule lane exists to the west of Richmond to provide support to civilian operations. It is designed to provide separation from drop zones and circuit traffic in the RAAF Base Richmond terminal area however, a clearance through the terminal areas may be available subject to traffic. Defence is conducting a scoping study to identify whether the restricted areas can be reduced in volume to better support civilian operations while not compromising Defence activities.

The Orchard Hills restricted areas exist to prevent aircraft overflying an explosive risk area. The status is RA3 due to the explosive risk and activation times may vary. The Orchard Hills restricted areas are two nautical miles in diameter and are not expected to change from the present design.

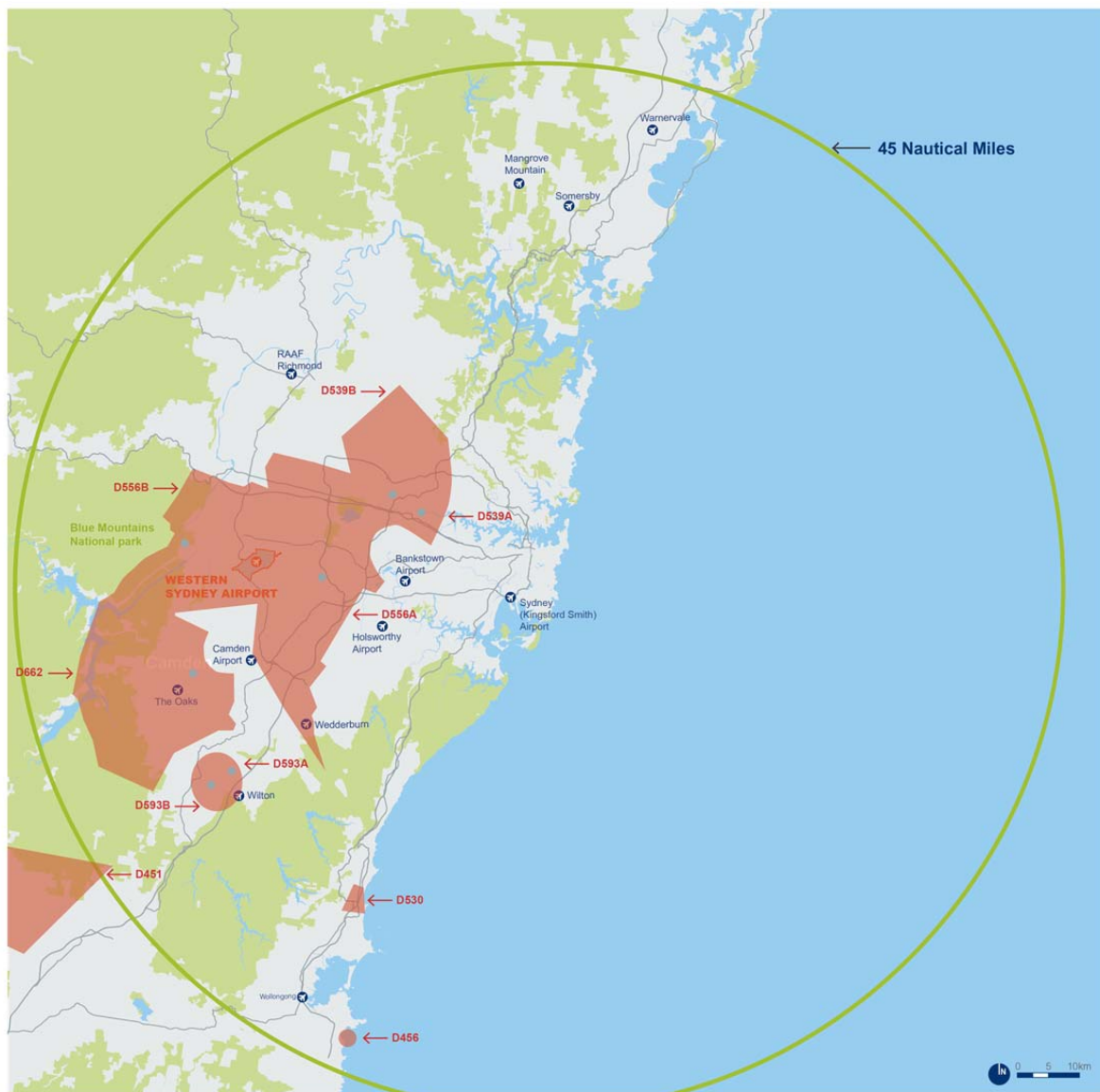


Figure 7-4 – Sydney region danger areas

Holsworthy restricted areas are provided to protect activities in support of both flying and non-flying operations. Holsworthy is home to special operations personnel and includes helicopter support located at the barracks. Additionally there are firing and demolition activities occurring.

A minor portion of the restricted area is active 24-hours per day and has a RA3 conditional status to prevent civilian entry to potentially hazardous military airspace. The other portions are a combination of RA2 and RA3. These statuses exist to protect non-participants from the dangerous operations in the areas. A local arrangement is in place which allows rescue and police operations into specific areas with prior notice.

7.3 Preliminary assessment of airspace

Airservices Australia provided a preliminary assessment of airspace implications and air traffic management arrangements for airspace in the Sydney region associated with the potential introduction of flights to and from the proposed airport.

Because the operation of the Stage 1 development is potentially more than ten years away (and construction for the long term development potentially more than 30-40 years away), the preliminary assessment undertaken by Airservices Australia is limited to a conceptual level airspace management design.

The principal objective of the preliminary assessment was to establish whether safe and efficient operations could be introduced at the proposed airport through the development of indicative proof-of-concept air traffic management designs. The analysis was conducted in two stages and included the development of three assessment models as shown in Figure 7–5.

An important aspect to note relevant to this draft EIS is that a proof-of-concept design does not take into account other influences on air traffic movement such as consideration of noise impacts. These factors would be incorporated into the final design of the airspace, which would also be subject to community and industry consultation and may require further environmental assessment processes. In the meantime, this draft EIS provides an assessment of noise and other impacts based on the preliminary design information currently available.

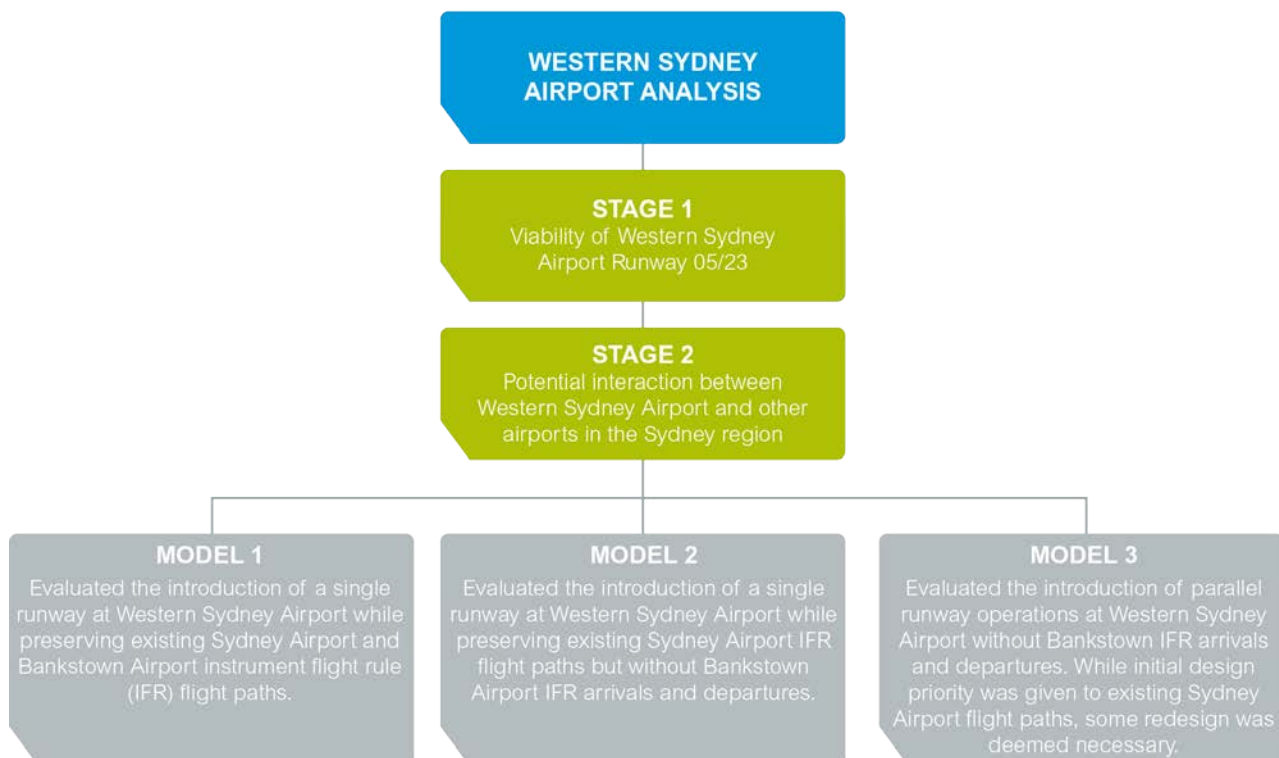



Figure 7–5 – Scope of the analysis to develop the indicative airspace architecture

The Stage 1 assessment evaluated the viability of the proposed airport operations with a single runway orientation of 05/23. It included consideration of terrain and man-made objects and their implications on airport operations and potential solutions to these where required.



The Stage 2 assessment analysed the potential interactions between the proposed airport indicative flight paths and the operation of other airports in the Sydney region including Sydney Airport and Bankstown. Three models were developed for this Stage 2 assessment.

- Model 1 evaluated the introduction of a single runway at the proposed airport, whilst preserving the existing Bankstown Airport and Sydney Airport flight paths. The objective of this model was to inform a potential scenario for the opening day operation of Western Sydney Airport to identify potential significant operating restrictions caused by the proximity of the flight paths to and from Sydney Airport and Bankstown Airport.
- Model 2 evaluated the introduction of a single runway at the proposed airport, whilst preserving the existing Sydney Airport flight paths. This model removed instrument flight rules arrivals and departures at Bankstown Airport.
- Model 3 evaluated the increased airspace activity associated with the introduction of a second runway at the proposed airport but removing instrument flight rules arrivals and departures at Bankstown Airport. While initial design priority was given to existing Sydney Airport flight paths, some redesign was deemed necessary.

Airservices Australia's preliminary assessment demonstrates a proof of concept and confirms the basic viability for the operation of the proposed airport for both single and parallel runway operations. The assessment indicates that there are no apparent physical impediments that would interfere with safe and efficient operations at the airport site.

Indicative concept designs for approach and departure routes demonstrate that Stage 1 and Sydney Airport could safely operate independently as high capacity airports. An airspace design could be implemented for a single runway operation at the proposed airport without making significant change to the current design and flight path structure for Sydney Airport or Bankstown Airport. However, as demand for aviation services grows at the proposed airport, instrument flight rule operations at Bankstown Airport are expected to be incrementally constrained. This is because aircraft arriving into the proposed airport on runway 23 and aircraft arriving at Bankstown Airport on runway 11 would operate on overlapping flight paths and would need to be sequenced between the two airports.

In the longer term, the operation of parallel runways at the proposed airport would also be viable. With parallel runways, the proposed airport could potentially achieve aircraft movement rates of around 100 movements per hour (one landing or one arrival constitutes an aircraft movement), with Sydney Airport maintaining a movement rate of 80 per hour. Preliminary analysis suggests that the following issues would need to be assessed in detail as part of the future airspace design process undertaken closer to the commencement of operations at the proposed airport:

- Whether there should be any changes to Sydney Airport flight paths to maintain independent operations at the proposed airport and Sydney Airport, and to achieve the expected demand capacity;
- Whether there should be any changes to flight paths serving Bankstown Airport, in particular instrument flight rule operations, in order to maintain independent operations at the proposed airport and Bankstown Airport, and to achieve the expected demand capacity.
- whether the restricted airspace area over the Defence Establishment Orchard Hills would impose any constraint on airspace and, if so, how that should be resolved; and

- further consideration of noise and visual sensitive receivers, such as residential areas and the Greater Blue Mountains World Heritage Area.

7.4 Interactions with Sydney Airport and the broader Sydney region airspace

7.4.1 Airspace architecture and potential impacts on air traffic movement

As discussed in Section 7.3, Airservices Australia undertook a preliminary assessment of airspace implications and air traffic management approaches associated with the proposed airport. The assessment considered the potential interactions between the proposed airport and other airports in the Sydney basin including Sydney Airport and Bankstown Airport.

The assessment demonstrated that the proposed airport and Sydney Airport could operate independently as high capacity aerodromes. Furthermore, the Stage 1 development for the proposed airport could be implemented without significant impact or change to current operations at Sydney Airport or Bankstown Airport. Indicative flight paths associated with this concept are presented in Figure 7–8 and Figure 7–9.

In addition to the matters identified by Airservices Australia, CASA recently identified a number of important Sydney basin airspace matters that should be considered in future airspace design process. These include:

- the need for a Sydney region revised airspace design in order to minimise constraints on operations for existing airports, as well as improved relationships between airports to increase efficiency and delays;
- new operator and airline preferences and requirements over time;
- integration with the national air traffic network;
- the role of new technologies both in aircraft and on the ground in the longer term, including new technologies and air traffic management approaches;
- potential unmet demand;
- continued and improved equitable access to airspace within the Sydney region;
- provision of optimum aircraft profiles for climbs and descents, continuous climb for aircraft from take-off to cruising level within the Sydney region and access to restricted airspace;
- priority for the proposed airport or Sydney Airport versus other operations within Sydney basin; and
- traffic conflicts/ disconnected airspace.

The long term development of the proposed airport would include a second parallel runway at the airport site (commissioned by around 2050) to accommodate expected demand. Airservices Australia also found that the operation of parallel runways at the proposed airport would be viable in the future. Under a parallel runway scenario at the proposed airport a number of issues would need to be addressed as part of the future airspace design process:

- changes to Sydney Airport flight paths to maintain independent operations at the proposed airport and Sydney Airport and to achieve expected demand capacity;
- changes to flight paths serving Bankstown Airport, in particular for instrument flight rule operations, in order to maintain independent operations at the proposed airport and Bankstown Airport and achieve the expected demand capacity; and
- resolution of a potential constraint associated with the restricted airspace over Defence Establishment Orchard Hills.

Overall there is a need for a whole of Sydney region focus on airspace architecture, which would provide an integrated model for airspace management.

7.4.2 Potential implications for aviation safety

The *Sydney Basin Aeronautical Study* undertaken by CASA (CASA 2015) reported an improving safety trend in total airspace related incidents in the Sydney region. The rate of airspace incidents in relation to total recorded basin movements has been declining consistently over the period between 2008 and 2013. The number of airspace related incidents has more than halved (a reduction of -56.4 per cent) in the five year period from 2008-2013.

Compared to other Australian capital city airports including Melbourne, Brisbane, Adelaide and Perth; Sydney has had the largest reduction in the rate of airspace incidents per 1,000 aircraft movements. The data indicates that despite increasing traffic at Sydney, airspace related safety has improved in the past six years.

The proof-of-concept airspace design developed by Airservices Australia demonstrates that the proposed airport and Sydney Airport could both safely operate independently as high capacity airports.


The provision of a safe and efficient airspace design will be a principal consideration during the detailed development of future airspace design.

7.5 Operating modes

Aircraft operations are allocated to a runway, which determines both the physical runway to be used for take-off and landing and the direction in which that runway is to be used. Allocation of the runway to be used is normally determined by air traffic control personnel and is based on a combination of meteorological conditions and airport operating policy.

Standard airport operating procedures (Airservices Australia 1997) indicate that a runway may not be selected for either approach or departure if the wind has a downwind component greater than five knots, or a cross wind component greater than 25 knots. If the runway is wet, it would not normally be selected if there is any downwind component at all. This applies to all aircraft types, although larger aircraft would be capable of tolerating relatively higher wind speeds.

Wind conditions at the airport site therefore limit the times when particular runways may be selected and the orientations on which landings and take-offs occur on runways (refer to Chapter 5 Stage 1 Western Sydney Airport). However, there would be a substantial proportion of the time, under low wind conditions, when the choice of runways would be determined by airport operating policy.



Based on the 05/23 runway orientation for Stage 1, there are two main operating modes that will occur depending on meteorological conditions at different times including:

- 'Prefer 05' operations whereby aircraft will take off and land on the 05 orientation. Under this operating mode, all aircraft will be directed to approach the proposed airport to land from the south west and directed to take-off to the north east, before redirecting towards their ultimate destination. If this is not possible due to meteorological or operating policy reasons, operations would occur in the opposite direction i.e. the 23 orientation. The concept of Prefer 05 operations is shown in Figure 7–6; and
- 'Prefer 23' operations whereby aircraft will take off and land on the 23 orientation. Under this operating mode, all aircraft will be directed to approach the proposed airport to land from the north east and directed to take-off to the south west, before redirecting towards their ultimate destination. If this is not possible due to meteorological or operating policy reasons, operations would occur in the opposite direction i.e. the 05 orientation. The concept of Prefer 23 operations is shown in Figure 7–6;

Under each of these operating modes, when the non-preferred operating direction is used for a period of time, operations would be switched back to the preferred direction when it becomes available after a time lag.

A third operating mode, 'head to head' may be feasible following further detailed assessment prior to the commencement of operations. This would involve all landings and take off movements occurring in opposing directions, either to or from the south west; or to or from the north east.

Under this mode all aircraft operations would effectively occur only on one side of the airport site for a period of time and therefore offer a period of no aircraft operations for other areas during that time. The concept of 'head to head' operations is shown in Figure 7–7.

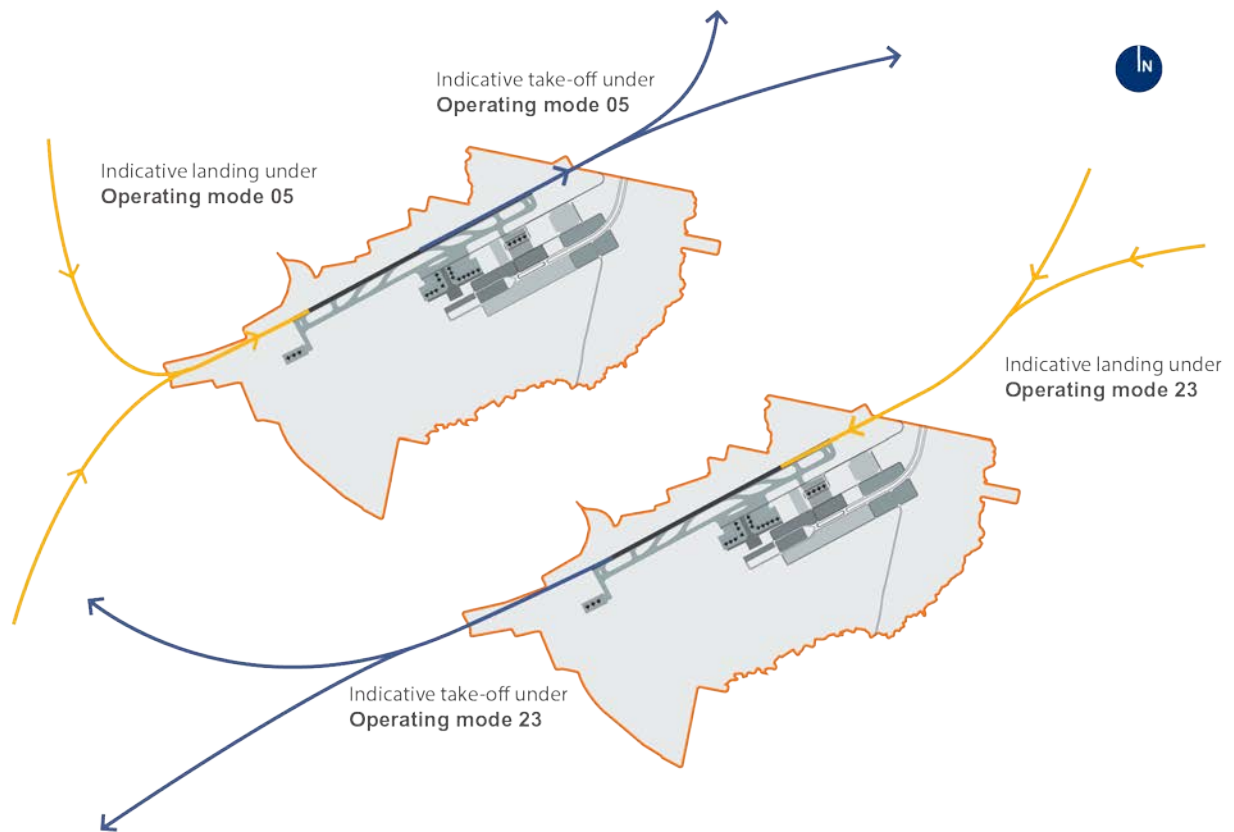


Figure 7-6 – ‘Mode 05’ and ‘Mode 23’ operating modes

Operation of the proposed airport would result in significant changes to the pattern of aircraft movements in the airspace above Western Sydney due to the introduction of new aircraft flight paths and airport operating modes.

The changes are expected to result in noise impacts which may be significant in some areas. In addition, projected future growth in air traffic would result in increased numbers of aircraft operations at the proposed airport, so noise impacts would also generally increase in the future. However, this would likely be mitigated to some extent by the introduction of new, quieter aircraft into the fleet over time.

The pattern of noise impacts which would result from operation is complex, and depends on operating mode, time of day, season and other factors. In some cases, alternative airport operating modes would be available, each with differing impacts on different areas. For example the operation of head to head arrivals and departures may offer respite for noise sensitive receivers in some areas for a period of time. Potential noise abatement opportunities such as the selection of operating modes will form a major part of the work required to finalise the airspace design prior to implementation.

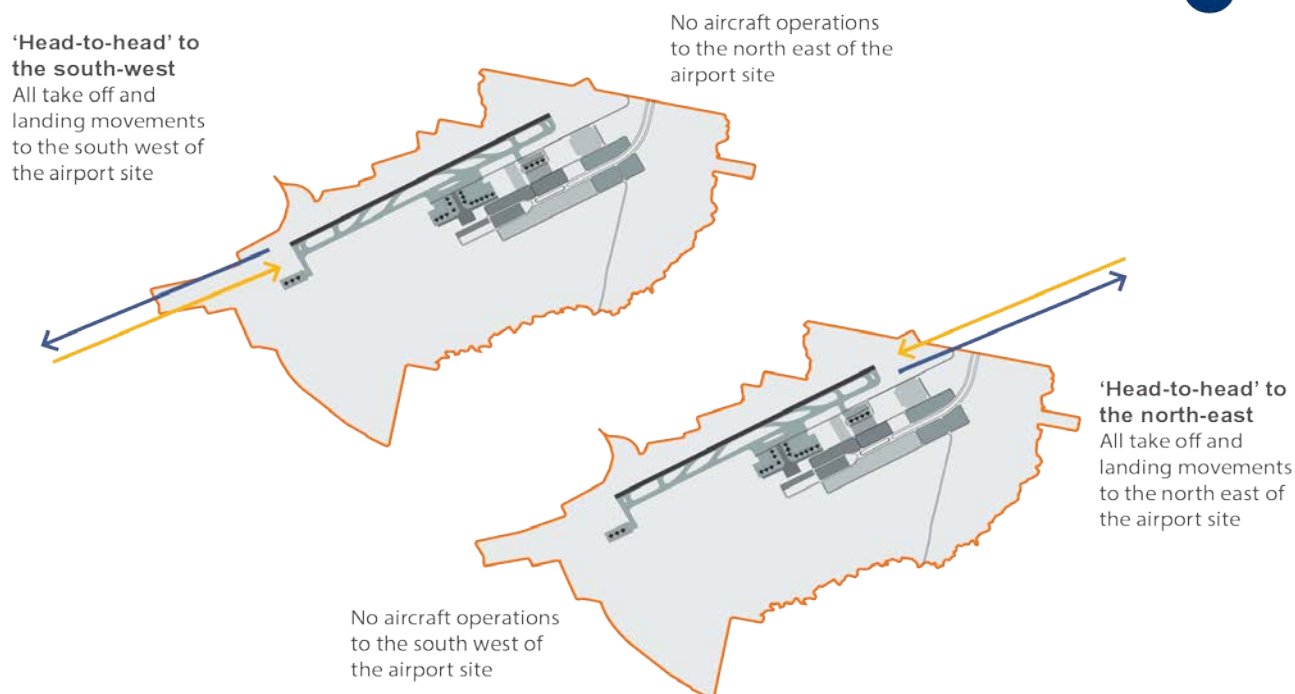


Figure 7-7 – 'Head to head' operating modes


7.6 Indicative flight paths

The main consideration when designing the indicative flight paths was air traffic management, particularly how the flights would interact with aircraft operating to and from Sydney Airport. Indicative flight paths developed by Airservices Australia have been designed on the premise that the proposed airport would operate independently of Sydney Airport in all cases. This ensures the selection of runways or operating modes at one airport can be made to suit local conditions without considering the operating mode at the other.

The design work and analysis was conducted using the current standards and procedures that apply to air traffic management, including:

- relevant provisions of the Australian Civil Aviation Safety Regulations 1998;
- International Civil Aviation Organization Procedures for Air Traffic Management (Doc 4444);
- International Civil Aviation Organization Procedures for Aircraft Operations (Doc 8168); and
- *Airspace Act 2007* and relevant regulations.

The conceptual airspace design presented in this draft EIS has not been developed to a level of detail necessary for implementation. A separate regulated airspace design process would be required to develop actual flight paths suitable for implementation prior to the commencement of operation.



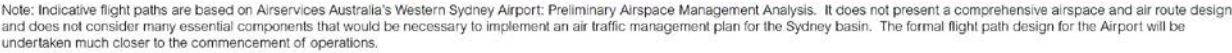
Importantly, the conceptual airspace design has not been developed with consideration to potential noise abatement opportunities, which would form a major part of the subsequent design work required prior to implementation. Consultation with airlines and other stakeholders would be undertaken through the design process, which would be subject to separate regulatory assessment processes required under the Airports Act. This process would be undertaken closer to the commencement of operations.

Important considerations in airspace design include:

- efficient use of the Sydney region airspace and integration with the national air traffic network as a whole;
- airspace protections for other aerodromes in the Sydney region including Defence establishments;
- the use of navigational technologies available both on ground and in aircraft at the time;
- opportunities to minimise potential noise and amenity impacts and other potential environmental issues; and
- consideration of operator and airline preferences and requirements.

While particular flight paths are depicted as single lines of travel, it is not always possible for each aircraft to fly precisely along the same line. In practice, flight paths tend to be corridors up to several kilometres wide, although the increasing use of new navigation technologies such as satellite will continue to assist in minimising this issue.

Indicative flight paths for Stage 1 operations are presented in Figure 7–8 and Figure 7–9.



7.6.1 Arrivals

In developing the preliminary flight paths, consideration has been given to potential options for the management of multiple aircraft approaching the airport. Different arrivals management systems offer different benefits depending on the needs of the airport and can provide flexibility in air traffic control, efficiency and fuel management. Three options were considered to provide a safe and efficient landing sequence:

- open standard terminal arrival route with radar vectoring to final;
- runway connected standard terminal arrival routes; and
- point merge system.

The mode of operation for arrivals depends primarily on meteorological conditions with aircraft landings preferably occurring into the prevailing wind. For a given mode, different approach flight paths may be assigned depending on whether meteorological conditions dictate either an instrument guided approach or, if visibility is good enough, a visual approach. Visual meteorological conditions are defined by:

- visibility greater than 10 kilometres; and
- cloud height greater than 4,000 feet.

Open standard terminal arrival route with radar vectoring to final

The open standard terminal arrival route with radar vectoring to final system is a method of processing approaching aircraft that focuses primarily on achieving consistent arrival spacing by allowing air traffic control personnel to adjust the approach path, descent and aircraft speed.

Standard terminal arrival routes are used to direct aircraft from approximately 65 nautical miles from landing to a position specified downwind position. From the downwind position, a radar vector is used to adjust the aircraft's final approach spacing.

This arrival management system is currently used at Sydney Airport, where runway demand is consistently high. The system has a focus on efficiency and can accurately control arrival spacing and deliver maximum runway capacity.

Runway connected standard terminal arrival routes

Runway connected standard terminal arrival routes is a system that enables a continuous descent profile that is defined in an aircraft's on board fuel management system. Runway connected standard terminal arrival routes are currently used at Brisbane, Melbourne and Perth airports and enable accurate fuel time and energy management; but they may not provide the flexibility required to maximise traffic throughput to the runway.

Point Merge System

The Point Merge System is a way of synchronising arriving aircraft and directing them to the runway in a structured manner through a single final approach track. By directing aircraft through a series of predictable routes, the vertical and lateral path taken on approach is more accurate and can result in a reduction in the number of level flight segments required at a low altitude. The system may help to reduce fuel consumption, emissions and noise impacts as it relies on a continuous decent path and therefore requires limited use of aircraft engines. The concept of the Point Merge System is presented in Figure 7–10 and can be seen on the indicative flight paths presented in Figure 7–8 and Figure 7–9.

Point merge is now operational in Oslo, Dublin, Seoul, Kuala Lumpur, Hannover and partially in Paris airports and has been demonstrated to result in fuel efficient flight paths at these busy international airports.

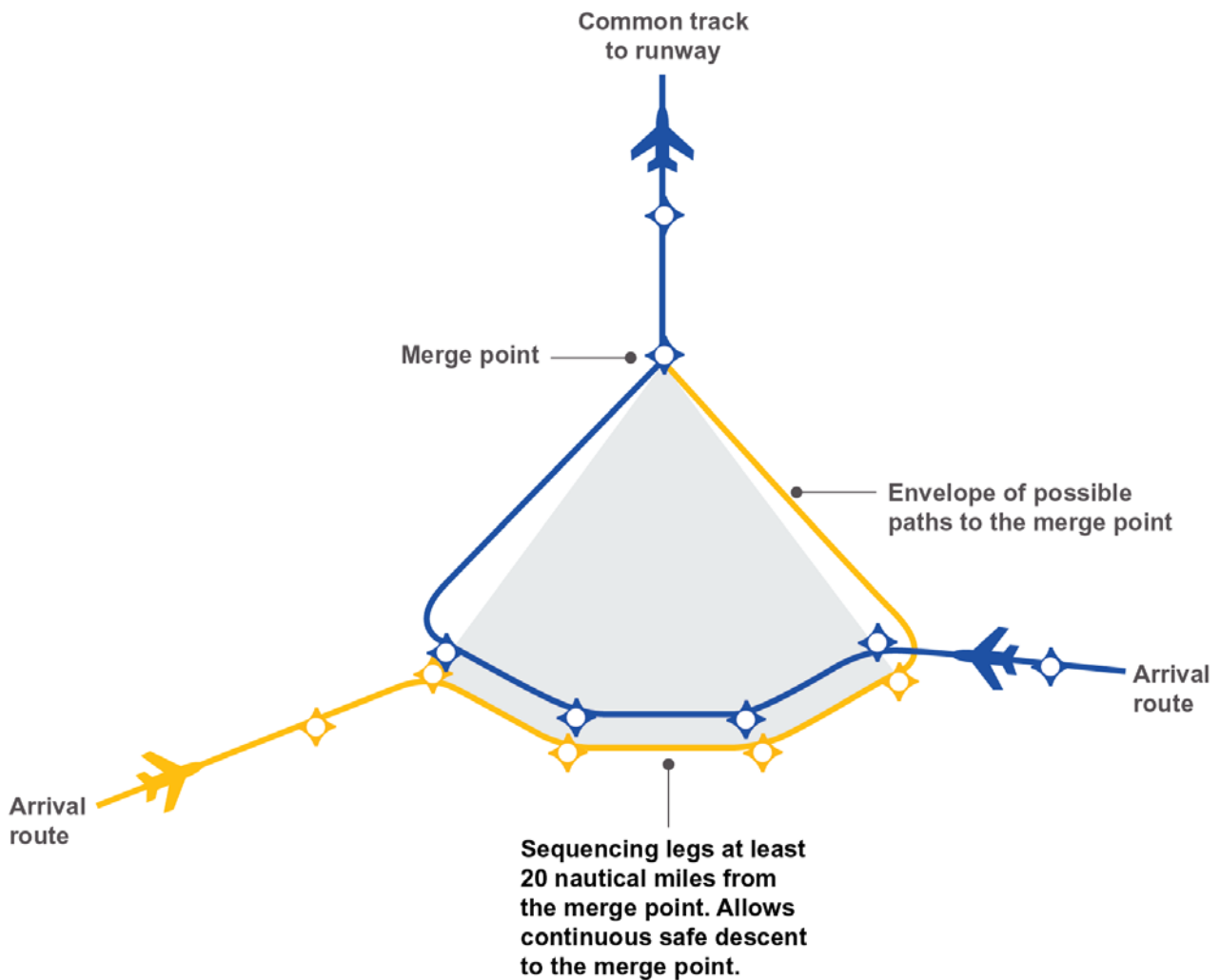



Figure 7–10 – Point Merge arrivals management system



Airservices Australia adopted the Point Merge System for the development of the indicative flight paths for the proposed airport. This is because it is simple, predictable and repeatable, potentially offering economies in fuel, efficiency, standardisation of procedure and reduction of noise impacts. It may also provide flexibility and the easiest method for adopting runway changes which are independent to Sydney Airport operations.

The conceptual airspace design presented in this draft EIS nominates one location for the merge point for each mode of operation. The location of this point makes little difference to analysis of environmental impacts, particularly noise impacts, relatively close to the airport. However, when considering impacts closer to the merge point and along the single arrival path from the merge point, the location is important because the potential impacts effectively become concentrated.

Potential noise impacts and consideration of noise abatement opportunities would form a major part of the subsequent design work required prior to implementation of the final airspace design. If the point merge system is adopted for the proposed airport, the location of the merge point would be a key component of this further development.

7.6.2 Departures

The indicative flight paths presented in this draft EIS show two major departure flight paths in each direction from the proposed airport. Both of these would branch off to other flight paths at distances that are relatively far from the proposed airport.

For departures to the south-west (the 23 direction) there is a third flight path passing roughly over the township of Warragamba that is nominated to be used by non-jet aircraft only.

The indicative use of this flight path is for non-jet aircraft only and would limit predicted noise exposure in areas beneath this route.


7.6.3 Flight path dispersion

Dispersion refers to the assumed variability of actual flight paths around a nominated flight path. In undertaking modelling required for the assessment in this draft EIS, dispersion for departure tracks was applied using one main track and four sub-paths, two on either side of the main flight path. The concept of dispersion is illustrated in Figure 7–8 and Figure 7–9.

No dispersion is added for instrument controlled arrival flight paths, on the basis that these will be strictly controlled through the Point Merge System. However the use of a number of flight paths for visual approaches provides a form of dispersion over the relevant areas.

7.7 Airspace protection

Obstructions in the vicinity of an airport, such as tall buildings and exhaust plumes from vent stacks, have the potential to create air safety hazards and to seriously limit the scope of aviation operations into and out of an airport. The most critical areas of concern are the immediate approach and take-off areas.



The airspace around the proposed airport would be protected in the interests of the safety, efficiency or regularity of future air transport operations. The airspace protection measures are described in terms of airspace surfaces at varying altitudes around the airport site, including:

- Obstacle Limitation Surfaces (OLS); and
- Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) Surfaces.

7.7.1 Obstacle Limitation Surfaces (OLS)

Under the CASA Manual of Standards (MOS), the airspace to be protected for aircraft operating during the initial and final stages of flight, or manoeuvring in the vicinity of an airport is defined by the OLS. This includes assessment of surrounding terrain and obstacles so as to provide protection to a height of 300 metres for take-off and landing.

The OLS serves as a first filter for assessing the operational impact of an obstacle. Subject to an operational assessment (refer Section 7.7.4), an obstacle penetrating the OLS may need to be lowered or removed; or it may be adequate for the obstacle to be marked and/ or lit and noted in aeronautical publications.

7.7.2 Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)

At major airports radio-navigation aids and satellite navigation enable aircraft to operate in poor weather conditions. The PANS-OPS are established to protect those stages of take-off, landing or manoeuvring, when aircraft are operating in non-visual (instrument) conditions. Pilots must be assured of obstacle clearance in these circumstances. Obstacles cannot be permitted into the PANS-OPS. If an obstacle were within the PANS-OPS the published approach or departure procedure would need to be withdrawn and redesigned to ensure safe operation of aircraft.


The design of a full set of PANS-OPS for Stage 1 and long term operations would be required in response to the formal flight path design prior to commencement of operations.

7.7.3 One-Engine-out Procedures

Operators of aircraft having a weight in excess of 5,700 kilograms are required to consider obstacle clearance requirements in the event of an engine failure. The airport operator does not specifically consider obstacle clearance requirements in the event of an engine failure. The specific procedure design to meet these requirements will be a matter for the individual aircraft operator concerned.

7.7.4 Obstruction analysis

It is important to note that the OLS does not prohibit all intrusions. The aim is to ensure that all objects that intrude into the OLS can be identified and assessed for their potential impact on aircraft operations. This determination will be based on an assessment of the PANS-OPS surfaces and the object's impact to air navigational operations.



A preliminary analysis of terrain around the airport site was undertaken as part of the development of indicative flight paths. The Blue Mountains escarpment encroaches into the OLS airspace to the north-west of the airport site by between 0.6 metres and up to 95 metres in some places. Other potential encroachments in the area include various mobile telephone towers and power transmission lines. Notably, the existing TransGrid 330kV transmission line that currently crosses the airport site, but this line will be relocated prior to commencement of operations.

Vegetation close to the runway, such as tall trees, would require assessment and may need to be removed or lowered. Height limitations will also apply to airport buildings, street lighting, and signage within the protected surfaces.

Vertical exhaust plumes may pose a hazard to aviation and would be controlled under the *Airports (Protection of Airspace) Regulations 1996*, subject to a plume rise assessment. The airport operator will need to determine if there are any potential impacts from plume rise from chimney stacks in the vicinity of the airport site prior to the commencement of operations.

7.8 National Airport Safeguarding

Protection of operational airspace around airports is a part of the National Airports Safeguarding Framework (NASF). The NASF is a national land use planning framework applied by each state that aims to improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions.

NASF includes guidelines on building generated windshear and turbulence, wildlife airport buffers to prevent bird strike, lighting restrictions to prevent pilot distraction and wind turbine risks.

Importantly, NASF also covers noise from aviation activity and seeks to improve community amenity by minimising aircraft noise-sensitive developments near airports. Public safety zones (PSZ) protection against development or activity in the areas immediately off runway ends is an additional consideration that may be included in the NASF in due course.

7.8.1 Windshear and turbulence

The shape, height and arrangement of buildings in relatively close proximity to the runway may adversely affect safe aviation movement on runway operations. All elements of the airport development will need to be assessed for its potential windshear and turbulence effects.

7.8.2 Wildlife airport buffer

A Wildlife Hazard Management Programme to control the risk of wildlife hazards on and near the airport site would be developed by the airport operator, in consultation with local authorities prior to commencement of operations.

Considerations for the wildlife hazard management program may include recommendations for the location of waste facilities in the vicinity of the airport site or the netting of standing water features such as detention basins. A bird and bat strike assessment has been undertaken as part of this draft EIS (refer Chapter 14 Hazards and Risks and Chapter 16 Biodiversity).

7.8.3 Restrictions to lighting

CASA has the authority to determine the potential impact of surrounding ground lighting on pilots during take-off and landing operations and to control ground lights where they have the potential to cause confusion or distraction to pilots within a six kilometre radius of an airport.

7.8.4 Public Safety Zones (PSZ)

The Australian Government is working with the states and territories on the development of a national standard for PSZs to be incorporated into the NASF. A nominal 1,000 metre trapezoid-shaped clearance off the end of each runway threshold is provided as part of the protected runway strip. The PSZ would manage risk associated with an aircraft undershoot or overrun by placing restrictions on land use within the zone. The zone would be sized to cover the area of highest risk to safety in such an event. These public safety zones are discussed in Chapter 5.

7.9 Operational parameters

Based on the layout of the airport site, operating parameters including the expected hours of operation, number of expected arrivals and departures; and the expected operating heights for aircraft need to be considered in designing the airspace architecture. These parameters affect not only operational and commercial viability, but also the safety of operations and the potential for environmental and social impacts.

7.9.1 Hours of operation

The development of the proposed airport is a rare opportunity to establish major transport gateway in the Western Sydney region. As outlined in Chapter 2, the development of the proposed airport is necessary for the continued success of Sydney as a global city and would provide substantial economic and employment opportunities to the region and the national economy. To maximise these opportunities and ensure long-term competitiveness with other major airports such as Brisbane, Melbourne and Canberra, the proposed airport has been planned to operate on a 24-hour basis and measures have been put in place at all levels of government to reflect this. NSW Government planning restrictions, in particular Local Planning Direction 5.8 made by the NSW Planning Minister under section 117 of the NSW *Environmental Planning and Assessment Act 1979*, have been in place for more than 20 years and require local governments to limit noise-sensitive developments around the airport site.

7.9.2 Number of flights

Predicted future numbers of aircraft movements have been based on synthetic schedules which estimate the expected number of aircraft operations for a typical day including aircraft family, operation type (arrival or departure), and time of operation and port of origin or destination for each operation. These schedules form the basis of modelling undertaken as part of this draft EIS such as noise and air quality modelling.

Predicted total aircraft movements per day for the proposed Stage 1 development and indicative long term operation of a parallel runway are presented in Table 7–1. Note that these figures represent a typical busy day and the number of movements is slightly greater than the annual average. For example, in 2030 the estimated 63,000 movements per year represents an annual average of approximately 173 aircraft movements per day, compared with 198 outlined in the schedule in Table 7–1.

Table 7–1 – Total predicted daily aircraft movements by type by year

Year	Aircraft movements Per Day		
	Freight	Passenger	Total
Stage 1 (2030)	28	170	198
First runway at capacity (2050)	74	480	554
Long term (2063)	104	1006	1110

Table 7–2 shows the predicated daily aircraft movements for Stage 1 and the long term, as summarised in Table 7–1, categorised by aircraft family. Note that the breakdown by aircraft family is based on current generation aircraft. Not all types of aircraft listed in Table 7–2 are expected to be operating in 2030 or 2063. It is expected that aircraft technology will continue to improve and airlines will continue replace older aircraft with newer models which are generally quieter and more fuel efficient.

Table 7–2 – Predicted daily aircraft movements by aircraft family by year

Aircraft Family	Aircraft movements Per Day	
	Stage 1 (2030)	Long term (2063)
Passenger aircraft movements		
Airbus A320	100	378
Airbus A330	18	286
Airbus A380	-	8
Boeing 737	28	196
Boeing wide-body general	-	40
Boeing 777	4	78
DeHaviland DHC8	8	10
Freight aircraft		
Airbus A330	2	2
Boeing 737	2	6
Boeing 747	10	38
Boeing 767	4	16
Boeing 777-300	-	10
Small Freight	10	32

Although the airport is proposed to operate on a 24-hour curfew free basis, there is predicted to be relatively few aircraft movements occurring during the night-time period, particularly for the Stage 1 development. Indicative aircraft movements per hour are presented on Figure 7–11.

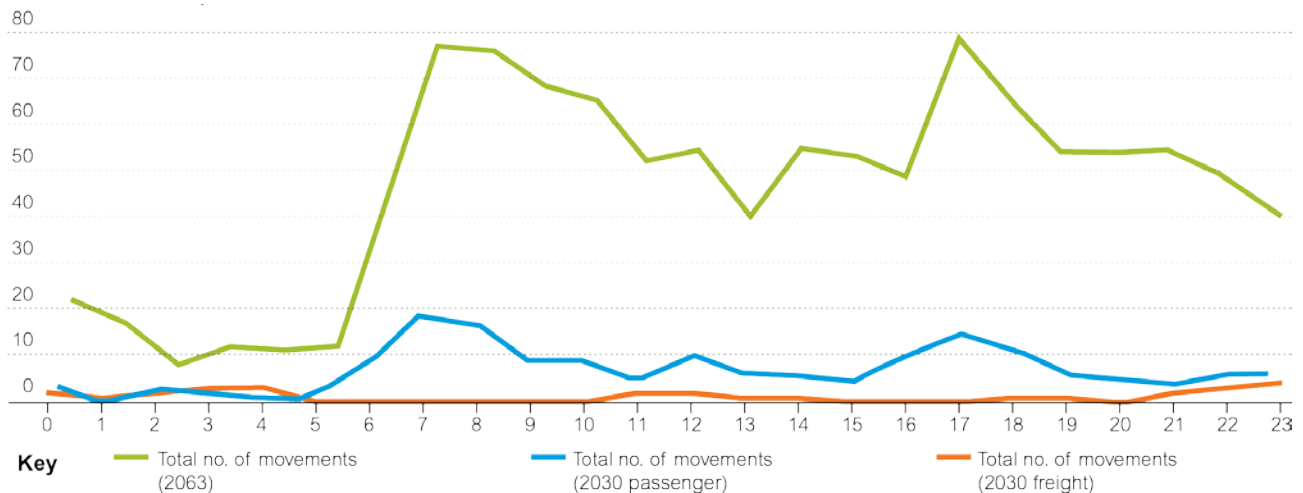
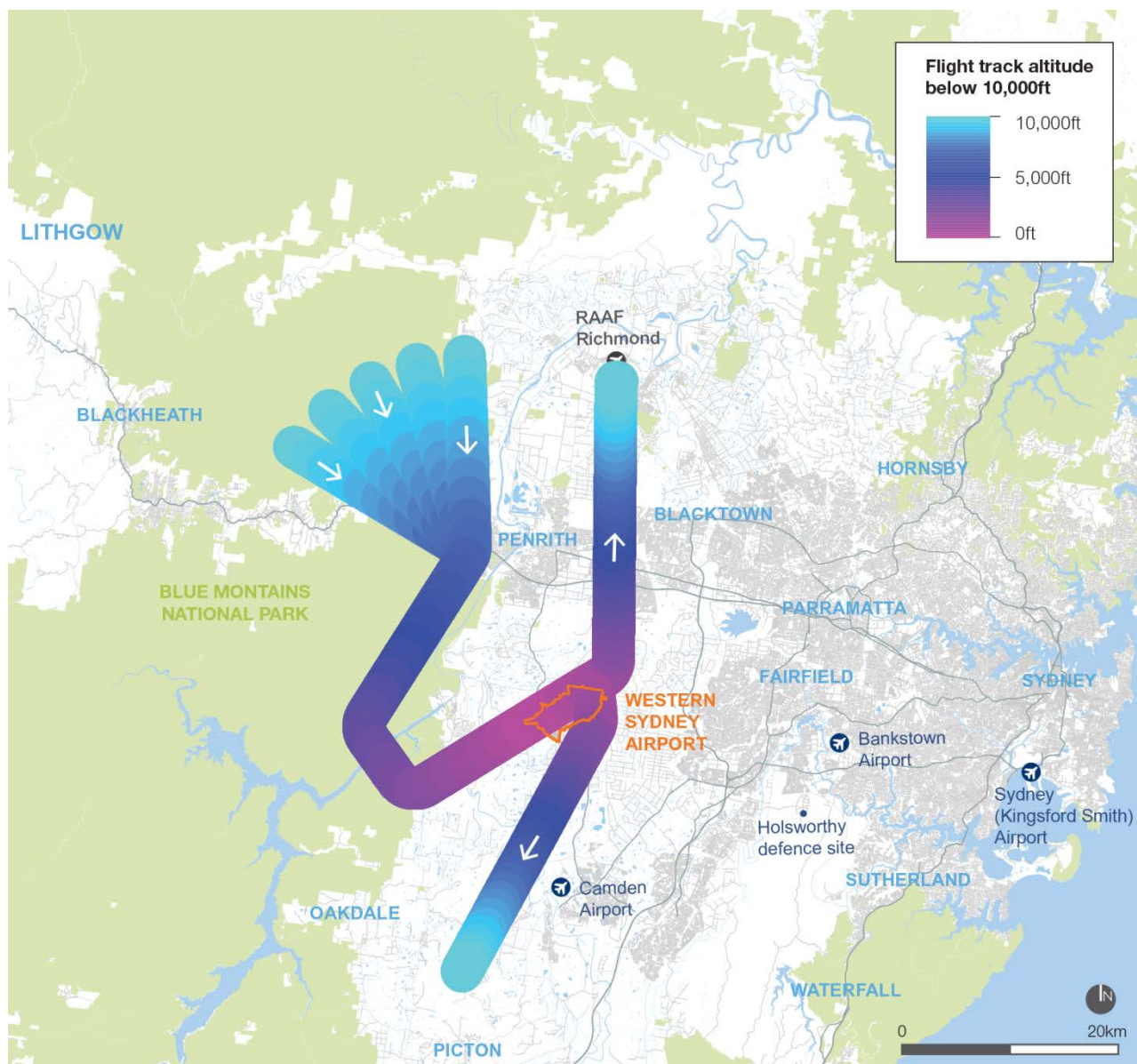


Figure 7–11 – Aircraft movements per hour

7.9.3 Flight altitude

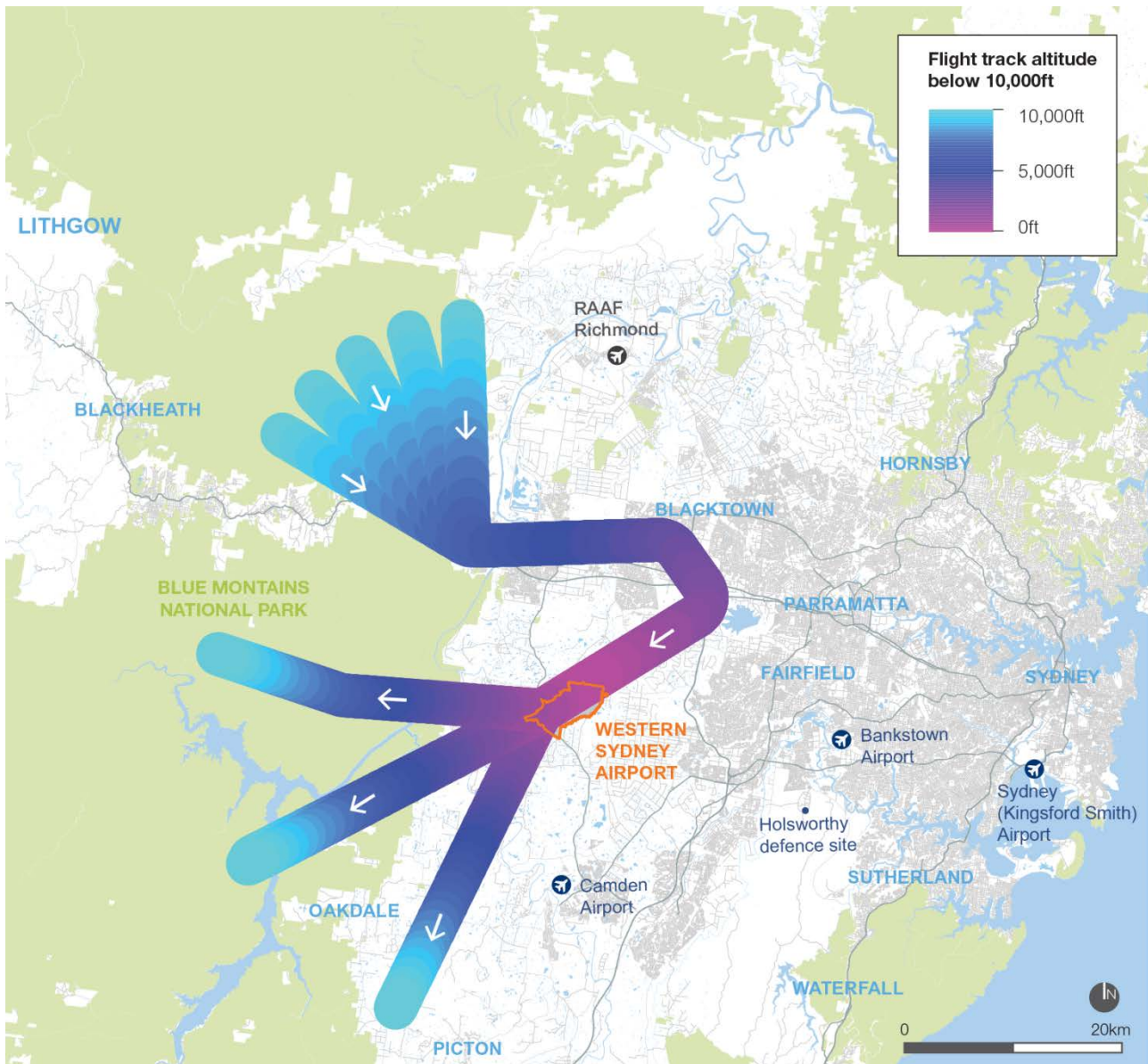
The altitude of an aircraft at a particular point along a flight path can have a significant effect on potential noise and other environmental impacts to receivers beneath the flight path. At altitudes above 10,000 feet (approximately three kilometres), the expected impacts are likely to be minor. Expected altitude of aircraft has been considered as part of the assessment required for this draft EIS and further information regarding specific environmental and amenity impacts is provided in Volume 2.

Indicative altitudes of flights arriving and departing the proposed airport at Stage 1 are illustrated in Figure 7–12 and Figure 7–13.



Note: Indicative flight paths are based on Airservices Australia's Western Sydney Airport: Preliminary Airspace Management Analysis. It does not present a comprehensive airspace and air route design and does not consider many essential components that would be necessary to implement an air traffic management plan for the Sydney basin. The formal flight path design for the Airport will be undertaken much closer to the commencement of operations.

Figure 7-12 – Stage 1 Indicative altitude of flights arriving and departing for the Prefer 05 operating mode




Note: Indicative flight paths are based on Airservices Australia's Western Sydney Airport: Preliminary Airspace Management Analysis. It does not present a comprehensive airspace and air route design and does not consider many essential components that would be necessary to implement an air traffic management plan for the Sydney basin. The formal flight path design for the Airport will be undertaken much closer to the commencement of operations.

Figure 7-13 – Stage 1 Indicative altitude of flights arriving and departing for the Prefer 23 operating mode

7.9.4 Emergency fuel jettison (fuel dumping)

Emergency fuel jettison for civilian aircraft, commonly referred to as fuel dumping, is a rare procedure used by aircraft in certain emergency situations to reduce an aircraft's weight to allow it to land safely. This may occur if an aircraft is required to undertake an emergency landing before reaching its destination airport, or if it needs to return to its origin airport shortly after take-off (for example due to a mechanical problem, or a passenger medical issue). In these instances, there would not be enough time to consume the amount of fuel expected to get the aircraft to its destination and it would be heavier than its maximum landing weight limit.



Landing over weight may cause a safety issue and an aircraft would need to reduce its weight in order to minimise the risk of structural damage.

Not all aircraft have the capacity to jettison fuel. For example, the most common types of civilian aircraft that perform the majority of domestic flights in Australia, such as the Boeing 737 and others of similar (or smaller) size, do not have the capability to jettison fuel as they do not need reduce their weight in this way in order to make an emergency landing. All international long haul aircraft, and some medium-to-long haul aircraft including the Boeing 777, Boeing 747 and Boeing 787 and the Airbus A330 Airbus A340 and A380 are able to jettison fuel.

If fuel is jettisoned, the exact evaporative characteristics of jettisoned fuel depends on a number of factors like the altitude at which it was released, the atmospheric temperature, and the dumping pressure. Most of the fuel evaporates as it falls within the first few hundred metres.

Instances of fuel jettisoning are extremely rare worldwide. In Australian airspace, where there is mandatory reporting of fuel jettisoning events, there were 10 reported instances of civilian fuel jettisoning in 2014 from 698,856 domestic air traffic movements and 31,345 international movements. This equates to emergency fuel jettisoning occurring in approximately 0.001 per cent of all aircraft movements.

The procedure for jettisoning fuel is specified in the En Route supplement of the Aeronautical Information Package published by Airservices Australia. When fuel jettisoning is required, the pilot in command requests authority from air traffic control before commencing a fuel jettison and must:

- take reasonable precautions to ensure the safety of persons or property in the air and on the ground;
- where possible, conduct a controlled jettison in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control; and
- notify air traffic control immediately after an emergency jettison.

The authority for fuel jettisoning is the Air Navigation (Fuel Spillage) Regulations 1999, which prescribe penalties for the unauthorised release of fuel from an aircraft other than in an emergency.

Instances of fuel jettisoning are extremely rare worldwide. In Australian airspace, where there is mandatory reporting of fuel jettisoning events, there were 10 reported instances of civilian fuel jettisoning in 2014 from 698,856 domestic air traffic movements and 31,345 international movements. This equates to emergency fuel jettisoning occurring in approximately 0.001 per cent of all aircraft movements.

Given the rarity of fuel jettisoning globally, the known low occurrence in Australian airspace, the standards set out in the Aeronautical Information Package, and the high evaporation rates known to occur at high altitude, authorised fuel jettisoning associated with the operation of the proposed airport, is unlikely to cause significant environmental or social impacts.

7.10 Potential meteorological impacts on operation

Weather conditions at different locations across the Sydney region are largely influenced by topography in and around the Sydney Basin. Generally, the weather conditions experienced at a given location depends upon proximity to the ocean or some other body of water, elevation, and the surrounding topography. These factors influence daily and seasonal temperature ranges and variability, humidity, rainfall, fog occurrence, and wind gustiness, direction and speed.

In 2014 the Bureau of Meteorology was engaged to provide a preliminary report on the meteorological parameters affecting the usability of the proposed airport and provide a comparison of expected conditions with Sydney Airport and other airports in the region. The *Western Sydney Airport Usability Report* (Bureau of Meteorology 2015) is provided in Appendix D.

The Bureau of Meteorology works closely with Airservices Australia and CASA in providing services for civil aviation, a role which is established through the *Meteorology Act 1995*. Under the Convention for International Civil Aviation (the Chicago Convention) the Bureau of Meteorology is the designated Meteorological Authority for Australia and also provides meteorological services for civil aviation in Australia in accordance with the standards and practices set out in Annex 3 to the Convention.

7.10.1 Badgerys Creek automatic weather station

In 1995 the Bureau of Meteorology installed an automatic weather station at Badgerys Creek, which has recorded a continuous supply of meteorological information including wind, temperature, dewpoint temperature, pressure and rainfall. Owing to the location of the airport site in the Western Sydney Basin, the climate and weather phenomena that may affect the proposed airport can be significantly different to those experienced at Sydney Airport.

Topography in the Sydney Basin is likely to cause local disparities in temperature, moisture, pressure, rainfall and wind. Any combination of these factors will indirectly affect the frequency and severity of weather phenomena such as fog, thunderstorms, turbulence, wind shear and low cloud. A topographical map of the Sydney Basin is provided in Figure 7–14.

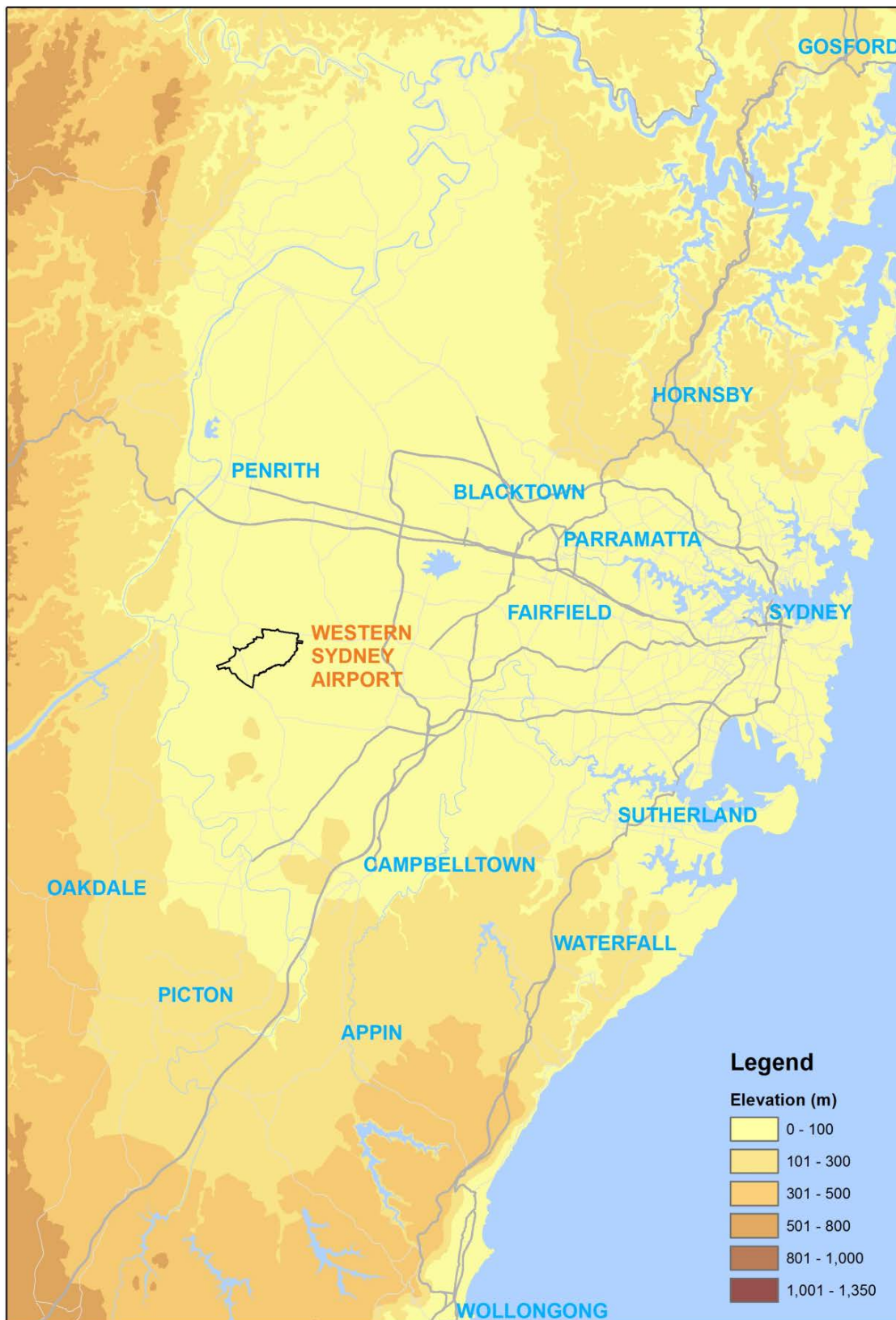



Figure 7-14 – Topographic map of the Sydney Basin



It is expected that the proposed runway configuration for Stage 1 will be usable approximately 99.5 per cent of the time based on crosswinds alone. Other weather phenomena such as fog, low cloud and low visibility conditions may lower the usability of the proposed airport; however mitigation is obtainable through navigational systems and aids. In addition, many of these other weather phenomena occur at other major airports (e.g. fog at Canberra Airport) demonstrating that these weather phenomena could be effectively managed at the proposed airport and do not preclude the safe operation of an airport.

7.10.2 Wind

The wind at the airport site in all seasons is effectively blocked by topography from the west to north-westerly directions. Under the proposed runway orientation, the proposed airport would likely be less susceptible to both crosswind and headwind effects than Sydney Airport.

The analysis undertaken by the Bureau of Meteorology indicates that there appears to be a threshold (approximately 20-25 knots) in which the north-westerly synoptic winds are sufficiently strong to overcome the terrain and produce a crosswind at the airport site.

The months of August to October are the most probable times to experience a crosswind exceeding 20 knots at the airport site, with the majority of crosswind events occurring from the southwest. This has been taken into consideration during the planning of the functional elements of the airport as discussed in Chapter 5.

Headwinds in excess of 25 knots would be rare at the proposed airport but could occur in almost any month of the year.

It is important to note that the clearance of vegetation and the erection of buildings can cause changes in wind speed and direction. Removal of vegetation is likely to cause a reduction in surface drag resulting in slightly stronger wind speeds than would have occurred otherwise. The effect may be more pronounced at the base of the lee side of the Great Dividing Range.

7.10.3 Temperature

Whilst average daily temperatures are important, it is the extremes in heat or cold that can have the most impact on airport operations generally.

A summary of the temperature information recorded at the Badgerys Creek weather station is presented in Table 7–3 and Table 7–4.

The month of January has the most days on average above 30 degree Celsius and 35 degrees Celsius with 13.4 and 5.2 days respectively. July has the most number of days on average below zero degrees Celsius with 3.3 days.

Table 7-3 – Temperature climatology at the airport site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean daily maximum temperature (°C)	29.9	28.5	26.7	23.9	20.6	17.8	17.3	19.3	22.7	24.7	26.1	28.1
Highest temperature (°C)	45.5	42.6	40.0	34.6	27.9	25.2	25.4	28.8	34.8	37.2	41.9	42.5
Mean daily minimum temperature (°C)	16.9	17.1	15.1	11.3	7.6	5.4	4.2	4.6	7.7	10.2	13.4	15.2
Lowest temperature (°C)	8.2	8.5	6.4	-0.1	-1.1	-3.0	-4.5	-1.9	-0.5	2.2	5.3	6.6

Table 7-4 – Temperature extremes at the airport site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean number of days over 30°C	13.4	9.6	4.8	0.8	Nil	Nil	Nil	Nil	1.7	5.1	6.8	10.2
Mean number of days over 35°C	5.2	2.6	0.5	Nil	Nil	Nil	Nil	Nil	Nil	0.8	1.8	2.8
Mean number of days below 0°C	Nil	Nil	Nil	0.1	0.3	2.0	3.3	2.1	0.2	Nil	Nil	Nil

High temperatures

High temperatures have the ability to affect airport operations and temperature has an indirect relationship with air density. As temperature climbs the air becomes less dense and affects aerodynamical lift.

High temperatures can also affect fuel, causing it to expand and restrict the capacity to adequately refuel aircraft in some cases. A temperature exceeding the flash point for jet fuel (approximately 38 degrees Celsius for Jet A/A1) is extremely important as liquid becomes a gas at this temperature and becomes extremely hazardous.

Data recorded at the Badgerys Creek weather station indicates that the temperature is equal to or greater than 30 degrees Celsius regularly throughout the end of spring, summer and the start of autumn at Badgerys Creek. Temperatures exceeding 30 degrees Celsius are most commonly during the middle to late afternoon. It is also not unusual to see temperatures exceed 35 degrees Celsius in late spring and summer at these times of the day.

Whilst it is possible to see temperatures exceed 40 degrees Celsius in late spring and summer it is not common at the airport site. Temperatures are most likely to exceed 40 degrees Celsius in January.

Low temperatures

Temperatures below zero degrees Celsius at surface level have the ability to produce adverse weather conditions that affect aircraft operations including hail, snow, sleet, frost, icing and freezing fog.

Data recorded at the Badgerys Creek weather station indicates that it is common for temperatures to drop below zero degrees Celsius in the months from June to August. This occurs most commonly in July, on average for more than 75 hours a month. The early morning period prior to sunrise is the most common time for temperatures to be recorded below zero degrees Celsius at the airport site.

Frost

Frost and ice accumulation on ground surfaces can occur at temperatures below zero degrees Celsius. Data with a temperature of below zero degrees Celsius was analysed by the Bureau of Meteorology to indicate the potential for frost at the airport site and compared to data for Canberra Airport.

Analysis found that frost could potentially form between the months of May to September at the proposed airport, with occurrence most likely in July with an expected average of over four hours. Frost is most likely to occur near sunrise.


In comparison, Canberra Airport experiences approximately 20 times more hours of frost occurrence than Badgerys Creek between the months of April to October.

7.10.4 Freezing fog

Conditions are conducive to the formation of freezing fog when the temperature is below zero degrees Celsius and the relative humidity is greater than or equal to 95 percent. In these conditions the density of super-cooled liquid water suspended in the air would be high enough to potentially cause rime icing on an aircraft's surface whose temperature is below zero degrees Celsius. Rime icing is rough opaque ice, formed by supercooled drops rapidly freezing on impact producing 'horns' or protrusions. Rime icing can reduce the performance of aircraft operations by increasing the weight of an aircraft, decreasing thrust and increasing drag.

These atmospheric conditions are also conducive to the formation of black ice on paved areas such as runways and taxiways, especially after rain. Black ice or 'clear ice' refers to a thin coating of glazed ice that is often practically impossible to see and therefore presents a risk of aircraft skidding due to loss of traction.

Conditions conducive to freezing fog could potentially occur in the months of May to September at the airport site; however it is more common from June to August. On average there are 3.5 hours in July in which icing may impact surfaces at the airport site. In comparison, Canberra Airport experiences on average 10 times more hours a month of freezing fog conditions during the winter months.



Freezing fog would most commonly occur in the hours surrounding sunrise during the winter months. It would be possible, though rare, for events to initiate in the early morning hours. The availability of de-icing equipment will mitigate the impact of icing on aircraft and hard surfaces at the proposed airport.

7.10.5 Temperature inversions

Under normal conditions the air temperature reduces with height above a location. A temperature inversion occurs when there is an increase in temperature with height. The atmosphere beneath the inversion forms a stable layer of cold air trapped by the warm air above. Temperature inversions tend to be more significant during the cooler months where the air at the surface is cooler than the air above and the ability of the surface to heat during the early morning is diminished.

The main impact of a temperature inversion is on local air quality and noise propagation. The presence of a temperature inversion has a significant influence on the ability of the atmosphere to disperse pollutants. An inversion layer effectively forms a barrier in the lower atmosphere which restricts the mixing of air, and causes a build-up in pollutants. Pollutants from the previous day and those advected overnight into the area can be trapped by the inversion causing morning pollution problems. Generally, the concentration of pollutants in the air is strongest during the early morning hours when a low-level temperature inversion exists and wind speeds are light. The effects of temperature inversions on air quality are discussed in more detail in Chapter 12 Air Quality and Greenhouse Gases.

7.10.6 Rainfall

An airport's operations can be affected by rainfall in many ways including aircraft landing distance, runway nomination and the type of approach due to poor visibility or low cloud. Additionally, heavy rainfall leading to flash flooding can affect aircraft operations by flooding taxiways and runways, damaging the runway, severely reducing tyre traction and in the worst case lead to aircraft hydroplaning. These risks can be managed effectively through runway design.

Rainfall climatology

Rainfall data for Badgerys Creek has been extracted and analysed by the Bureau of Meteorology and findings show that the average annual rainfall at Badgerys Creek is 680.9 millimetres with rain recorded on average on 117.8 days per year. The recorded monthly rainfall statistics are presented in Table 7–5.

Table 7–5 – Rainfall statistics at the airport site

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly rainfall (mm)	77.4	108.0	77.3	43.2	40.1	52.1	23.0	35.9	33.9	52.7	74.5	63.6
Highest monthly rainfall (mm)	192.2	342.4	198.0	129.4	155.6	220.0	71.6	231.0	82.2	182.2	173.2	131.2
Lowest monthly rainfall (mm)	13.6	13.4	21.4	1.8	1.8	2.0	2.8	1.0	6.4	0.4	8.4	14.2
Highest daily rainfall (mm)	138.0	106.8	67.8	82.4	54.0	63.8	28.4	70.0	50.8	63.0	63.0	65.0

Monthly rainfall in excess of 50 millimetres on average occurs in the months from October to March at Badgerys Creek.

Rainfall and the amount of rain days appear to be less variable at Badgerys Creek than at Camden and Sydney airports. Badgerys Creek experiences lower monthly highs and higher monthly lows in rainfall than the other two airports. This may be due to topographical effects or the shorter length of rainfall records.

7.10.7 Fog and low cloud

Fog is caused by a suspension of water droplets in the air near the surface of the earth. Internationally fog is reported when the horizontal visibility has dropped below 1,000 metres (ICAO 2007). However in order to exclude smoke and other circumstances which may cause a reduction in visibility an additional condition of relative humidity above 95 per cent has been applied to data analysis by the Bureau of Meteorology.

For aviation purposes, a visibility of less than 1000 metres must be observed at a height of two metres above the ground or the fog is termed shallow fog. Observations instrumentation is currently unable to determine the difference between shallow fog and fog at an airport.

Most major Australian airports are equipped with Instrument Landing Systems (ILS) which allows a pilot to attempt to approach an airport in reduced visual conditions. However, in the event of a fog it is the Runway Visual Range (RVR) system which becomes critically important. The RVR system may allow aircraft to land in dense fog provided the RVR is above specified thresholds for the aircraft that is landing, the aircraft has the required instrumentation, and the pilot has valid certification.

The presence of a low cloud ceiling has the ability to affect airport operations and air traffic flow. To ensure that aircrew can adequately prepare for low cloud situations an 'alternate minima' is assigned dependant on aircraft type. The alternate minimum represents the broken cloud height below which additional fuel must be carried to enable the aircraft to safely land at an alternative aerodrome.

The formation of low cloud is dependent on factors such as temperature, low-level moisture content, low-level wind direction, atmospheric stability, and topography. From data recorded at the Badgerys Creek weather station it is possible to calculate the dewpoint depression, which is the difference between temperature and dewpoint. The dewpoint is the temperature to which the air must be cooled to reach saturation, or the temperature at which dew would form should the air temperature fall sufficiently.

7.10.8 Turbulence and wind shear

Turbulence is caused by a disruption to air flow. Turbulence in the lower atmosphere is generally created by the flow of air around an obstacle such as topography or buildings. However, meteorological conditions such as boundaries between different air masses can also provide turbulent effects.

Moderate and severe turbulence at the proposed airport would be most common in the months of June to August. Analysis indicates that the proposed airport would experience slightly fewer turbulence events than Sydney Airport.

7.10.9 Thunderstorms

Regardless of size or intensity, any thunderstorm can be hazardous to aviation. Potential impacts include disruption to the management of air traffic both in the air and landside, in the terminal area; and disruptions to airport ground operations. Aviation hazards encountered in and near thunderstorms include severe wind shear and turbulence, severe icing, downbursts, hail, lightning, heavy rain, tornadoes, low cloud, poor visibility, and rapid air pressure fluctuations.

While most 'ordinary' thunderstorms individually have lifetimes of thirty minutes to an hour, under certain atmospheric conditions organised systems of thunderstorms or even individual storms may last for several hours.


The Bureau of Meteorology analysis suggests that the thunderstorm season in the vicinity of the proposed airport appears to start and finish earlier in the year by approximately one month when compared to Sydney Airport. Outside of the thunderstorm season, there is expected to be more thunderstorm activity at Sydney Airport when compared to the proposed airport.

Most thunderstorms in the region develop over the Great Dividing Range moving eastwards into the Sydney Basin. The close proximity of the airport site to the mountain ridge would mean that this would only allow for a relatively short lead time for thunderstorm warnings at the proposed airport. For example, a thunderstorm which initiates over the Great Dividing Range and moving at 20 knots, would reach the proposed airport in approximately 30 minutes.

7.10.10 Summary of meteorological impacts on operation

The Bureau of Meteorology found that siting of the proposed airport at Badgerys Creek has many meteorological advantages compared to Sydney Airport namely the minor exposure to significant crosswind and headwind, the lack of low-level vertical wind shear and lower frequency of thunderstorms.

Mitigation processes and equipment exist for most weather phenomena which are expected to occur at the proposed airport. The runway availability and usability of the proposed airport is primarily determined by crosswind at the airport site. Based on the proposed runway alignment, it is expected that the proposed airport would be usable approximately 99.5 per cent of the time, based on cross-wind analysis.



There are factors which need consideration during the operational planning of the proposed airport that are more likely to occur at the airport site than at Sydney Airport. These include weather phenomena such as high temperatures, freezing fog and frost. In some cases these weather phenomena would occur less frequently at the proposed airport when compared to other airports such as Canberra Airport. Through adequate planning and infrastructure it is possible to mitigate the influences of most weather phenomena.

The study undertaken by the Bureau of Meteorology indicates that perhaps the most significant aspect of the airport site is likely to be the occurrence of fog. The development of fog overnight in the western Sydney Basin is possible during all months of the year; and often for extended periods of time during winter. It is important to acknowledge that an increase in pollutants in the adjacent atmosphere to the airport site could likely affect fog formation in the future. Additional equipment for monitoring visibility and cloud is required in order to develop a true fog climatology at the airport site and for meteorologists to improve forecast skill into the future. However, while the occurrence of fog is relatively common, modern ILS and RVR systems allow aircraft to land safely in dense fog and when visibility is low.

Further meteorological studies are likely to be required in the following areas as part of the operational planning for the proposed airport:

- correlating low visibility statistics with instrument landing system categories will likely aid airport planners in determining the navigational aids required for optimal usability at the proposed airport;
- estimated correlation between the occurrence of fog events at Sydney Airport and the proposed airport may inform decisions regarding network management;
- anecdotal evidence of wind rotors at the airport site indicates that rotors may impact airport operations in certain wind regimes. It is unclear as to whether further effort in this area would yield any significant gain in airport usability. A scoping study into different methods of measuring rotors and associated costs could provide key elements for a cost-benefit analysis in this area;
- a comparison study into the numerical modelling of turbulence at major airports such as Brisbane and Melbourne will be considered and conducted as required;
- research into the potential impact of freezing fog at the proposed airport and associated mitigation measures available for implementation; and
- further calculations for crosswind and headwind will be conducted as required.