Australian Government
Department of Infrastructure and Regional Development

WESTERN SYDNEY AIRPORT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2a
STAGE 1 DEVELOPMENT

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Western Sydney Airport Environmental Impact Statement

Proponent	The Australian Government Department of Infrastructure and Regional Development.
EPBC Referral	The action was referred to the Commonwealth Minister for the Environment on 4 December 2014, referral 2014-7391
Proposed action	The proposed Western Sydney Airport would be developed over a number of stages in response to increasing demand. The proposed action is the construction and operation of the first stage of development for the proposed Western Sydney Airport at Badgerys Creek. The environmental impact statement (EIS) provides a detailed consideration of likely environmental impacts arising from the Stage 1 development. The Stage 1 development includes a single runway with associated aviation facilities for approximately 10 million passengers each year and is fully described in the revised draft Airport Plan. The EIS assumes the airport could be operating at this level approximately 5 years after operations commence which for assessment purposes has been assumed to be 2030.
Airport Plan	The Stage 1 development would take place under an Airport Plan determined under Division 4A of Part 5 of the *Airports Act 1996.*
Airport site	The Airport site covers approximately 1,780 hectares at Badgerys Creek. The Stage 1 development impacts about 1,150 hectares within this site. The Airport site currently comprises the following properties owned by the Commonwealth: - Lot 1 on DP838361 - Lot 1 on DP851626 - Lot 2 Section C on DP1451 - Lot 17 on DP258581 - Lot 22 on DP258581 - Lot 23 on DP259698 - Lot 32 on DP259698 - Lot 33 on DP259698 - Lot 7 on DP3050 - Lot 8 on DP3050 - Lot 9 on DP226448 - Lot 3 on DP611519 - Lot 11 on DP226448 - Lot 1 on DP129674 - Lot 1 on DP129675 - Lot 1 on DP996420 - Lot 2 on DP996420 - Lot 28 on DP217001 - Lot 1 on DP996379 - Lot 2 on DP996379 It is also anticipated that one or more easements and a small amount of additional land would be acquired by the Commonwealth and incorporated into the airport site for operational and safety reasons.
EIS	This EIS has been prepared by the Department of Infrastructure and Regional Development supported by GHD Pty Ltd, RPS Manidis Roberts Pty Ltd and various specialist sub-consultants. The EIS has been prepared in accordance with the *Guidelines for the content of a draft environmental impact statement* for the proposed airport issued on 29 January 2015. The EIS is divided into five volumes. Volume 1 provides a description of the proposed Stage 1 development. Volume 1 also explains the approvals and community consultation process. Volume 2 provides a detailed impact assessment of the Stage 1 development. Volume 3 provides a strategic level assessment of environmental impacts of an indicative long term development of the airport site. The assessment has been undertaken to provide a broad understanding of the potential impacts facilitated by the Stage 1 development, given that development beyond Stage 1 would be the subject of future approvals processes. Volume 4 contains detailed technical assessments that have informed the assessment of environmental impacts in Volume 2 and Volume 3. Volume 4 also contains the further information about the proponent, the EIS study team and the *Guidelines for the content of a draft environmental impact statement*. Volume 5 outlines the feedback received from the community and stakeholders. It provides responses to the issues raised and describes how these were addressed in finalising the EIS and revised draft Airport Plan, where relevant.

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Terms and abbreviations

Term	Definition
05/23	The proposed runway orientation. Refers to a generally north-east/south-west orientated runway at 50 degrees north-east and 230 degrees south-west.
1997-99 EIS	PPK 1997, Draft Environmental Impact Statement Second Sydney Airport Proposal, Commonwealth Department of Transport and Regional Development and PPK Environment and Infrastructure Pty Ltd 1999, Supplement to Environmental Impact Statement Second Sydney Airport Proposal, Volume 3 Supplement. Prepared on behalf of the Department of Transport and Regional Services.
90^{th} Percentile N60	The N60 value that is exceeded on 10 per cent of nights.
90^{th} Percentile N70	The N70 value that is exceeded on 10 per cent of days.
ABS	Australian Bureau of Statistics
Acid sulfate soils	Naturally occurring soils or sediments containing iron sulphides, which produce sulfuric acid when exposed to air.
AHD	Australian height datum
Airport Lessee Company	The company that is granted an airport lease over the Airport Site.
Revised draft Airport Plan	Draft plan developed in accordance with the requirements of the *Airports Act 1996*, setting out the Australian Government's requirements for the initial development of the proposed airport.
Airport site	The site for Sydney West Airport as defined in the Airports Act.
Airports Act	*Airports Act 1996* (Cth)
Airports Act amendment	*Airports Amendment Act 2015* (Cth)
ALC	Airport Lessee Company
ANEC	Australian noise exposure concept
ANEF	Australian noise exposure forecast
APU	Auxiliary power unit
ARI	Average recurrence interval – the average or expected value of the periods between exceedances of a given rainfall total accumulated over a given duration.
ATM	Air traffic movement
Australian Height Datum	A common reference level which is approximately equivalent to the height above sea level.
Australian Noise Exposure Concept	Noise exposure contours produced for a hypothetical future airport usage pattern used, for example, in the process of examining flight path options around an airport.
Australian Noise Exposure Forecast	Official forecasts of future noise exposure patterns around an airport. They constitute the contours on which land use planning authorities usually base their controls.
BoM	Bureau of Meteorology
Bulk earthworks	The removal, moving or adding of large quantities of soil or rock from a particular area to another.

Term	Definition
Bund	A constructed retaining wall designed to prevent inundation or breaches from a known source.
BWSEA	Broader Western Sydney Employment Area
CASA	Civil Aviation Safety Authority
Catchment	The area drained by a stream, lake or other body of water.
CO	Carbon monoxide
Construction impact zone	The area that would be directly impacted by construction of the Stage 1 development – indicatively shown in the revised draft Airport Plan.
Continuous descent approaches	A method by which aircraft approach an airport prior to landing that minimises segments of level flight. This type of approach can reduce fuel consumption and noise compared to other conventional descents.
Controlled airspace	Airspace of defined dimensions within which air traffic control services are provided.
Criteria pollutants	Air pollutants that have been regulated and are used as indicators of air quality.
Datum	A level surface used as a reference in measuring elevations.
dBA	A-weighted noise level – an expression of the relative loudness of sounds in air as perceived by the human ear.
DEC	NSW Department of Environment and Conservation (now Office of Environment and Heritage)
DECC	NSW Department of Environment and Climate Change (now Office of Environment and Heritage)
DECCW	NSW Department of the Environment Climate Change and Water (now Office of Environment and Heritage)
Decibel (dB)	A unit of sound.
Direct impact	Direct impacts are caused by an action and occur at the same time and place.
DoE	Australian Government Department of the Environment (now Department of the Environment and Energy)
DP&E	NSW Department of Planning and Environment
DPI	NSW Department of Primary Industries
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EIS guidelines	Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport
EMS	Environmental management system
Environmental assessment	A formal process of evaluating significant short term, long term and cumulative effects or impacts a project will have on the environment.
Environment Minister	The minister who administers the EPBC Act.
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPA	NSW Environment Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FTE	Full time equivalent

Term	Definition
Fugitive emissions	Dust derived from a mixture of sources (non-point source) or not easily defined sources. Examples of fugitive dust include dust from vehicular traffic on unpaved roads, materials transport and handling, and un-vegetated soils and surfaces.
GBAS	Ground based augmentation system
GBMWHA	Greater Blue Mountains World Heritage Area
GDE	Groundwater dependent ecosystem
GDP	Gross domestic product
General aviation	Name given to the aviation industry that is non-military (both fixed wing and helicopter) and that excludes the larger airlines operating scheduled passenger services. General aviation sector undertakes a diverse range of passenger and freight activities including charter operations, flight training, aerial agriculture, aerial work, private and business flying and sports related activities.
GPS	Global positioning system
Greenfield airport	A new airport on land which was not previously used for aviation purposes.
Grey water	Wastewater stream from all domestic wastewater sources other than the toilet (such as baths, sinks, washing machines, etc.).
Groundwater	Water found below the surface, usually in porous rock, soil or in underground aquifers.
GRP	Gross regional product
GSE	Ground support equipment
Hazard	The potential or capacity of a known or potential risk to cause adverse effects.
Hazardous material	Any item or agent that has the potential to cause harm to humans, animals or the environment.
Hazardous waste	Any waste that is classified as hazardous in accordance with the Waste Classification Guidelines (NSW EPA, 2014). Hazardous waste cannot be disposed to landfill unless it is treated to remove or immobilise the contaminants. – including waste batteries, fertilisers, fuels, herbicides, oils pesticides, paints, solvents, cleaners, clinical and pharmaceutical waste, and waste tyres.
Heavy metal	Any metal or metalloid of environmental concern.
HIAL	High intensity approach lighting
HIPAP	NSW Hazardous Industry Planning Advisory Papers
IAP2	International Association of Public Participation
ICAO	International Civil Aviation Organization – A specialised agency of the United Nations which codifies the principles and techniques of international air navigation and fosters the planning and development of international air transport to ensure safe and orderly growth.
ICAO Standards	Standards and recommended practices concerning air navigation, its infrastructure, flight inspection, prevention of unlawful interference and facilitation of border-crossing procedures for international civil aviation.
Impact	A change in the physical, natural or cultural environment brought about by an action. Impacts can be direct or indirect.
Impervious	Impervious surfaces are surfaces non-permeable to water.

Term	Definition
Indirect impact	As defined in the EPBC Act *Significant impact guidelines 1.2*, indirect impacts include downstream or downwind impacts, such as impacts on wetlands or ocean reefs from sediment, fertilisers or chemicals which are washed or dischardged into river system; upstream impacts, such as those associated with the extraction of raw materials and other inputs which are used to undertake the action; and facilitated impacts which result from futher actions (including actions by third parties) which are made possible or facilitated by the action, such as urban or commercial development of an area made possible by a project.
km/h	Kilometres per hour
L_{A90}	The L_{A90} level is the A-weighted noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.
L_{Aeq}	The equivalent continuous sound level (L_{Aeq}) is the energy average of the A-weighted noise level over a sample period, and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is sometimes used to describe aircraft noise, in which case it refers to the noise level that is due to aircraft only, excluding other noise. Variants of this measure have been defined that cover specific time periods, such as $L_{Aeq,9am\text{-}3pm}$, which is used to describe noise affecting school classrooms.
$L_{Aeq,9am\text{-}3pm}$	The equivalent-continuous noise level between 9am and 3pm (it is used to describe the impact of noise on school students and teachers).
Leachate	The liquid that passes through, or is released by, waste.
LEP	Local environmental plan
LGA	Local Government Area
$L_{night,outside}$	The equivalent-continuous noise level between 11pm and 7am, or $L_{Aeq,11pm\text{-}7am}$ (it is used to describe night time noise exposure and assess chronic health impacts associated with exposure)
Long term development	The long term development of the airport, including parallel runways and facilities for up to 82 million passengers annually (nominally occurring in 2063).
LoS	Level of service
m^2	Square metres
Main Construction Works	Main Construction Works means substantial physical works on the airport site (including large scale vegetation clearance, bulk earthworks and the carrying out of other physical works, and the erection of buildings and structures) described in Part 3 of the Airport Plan, other than Preparatory Activities.
Manual of Standards	Standard procedures for the operation of airports issued by the Civil Aviation Safety Authority.
MAP	Million annual passengers
Master plan	Master plan prepared and approved in accordance with the Airports Act.
Maximum noise level (L_{Amax})	L_{Amax} over a sample period is the maximum A-weighted noise level measured during the period. In the context of aircraft noise, L_{Amax} generally means the maximum A-weighted noise level recorded during a specific overflight, measured using "Slow" speed, and can therefore also be written L_{ASmax}. In this report, L_{Amax} denotes the maximum level attained during a single overflight.
MDP	Major development plan prepared and approved in accordance with the Airports Act.
mg/m^3	Milligrams per cubic metre

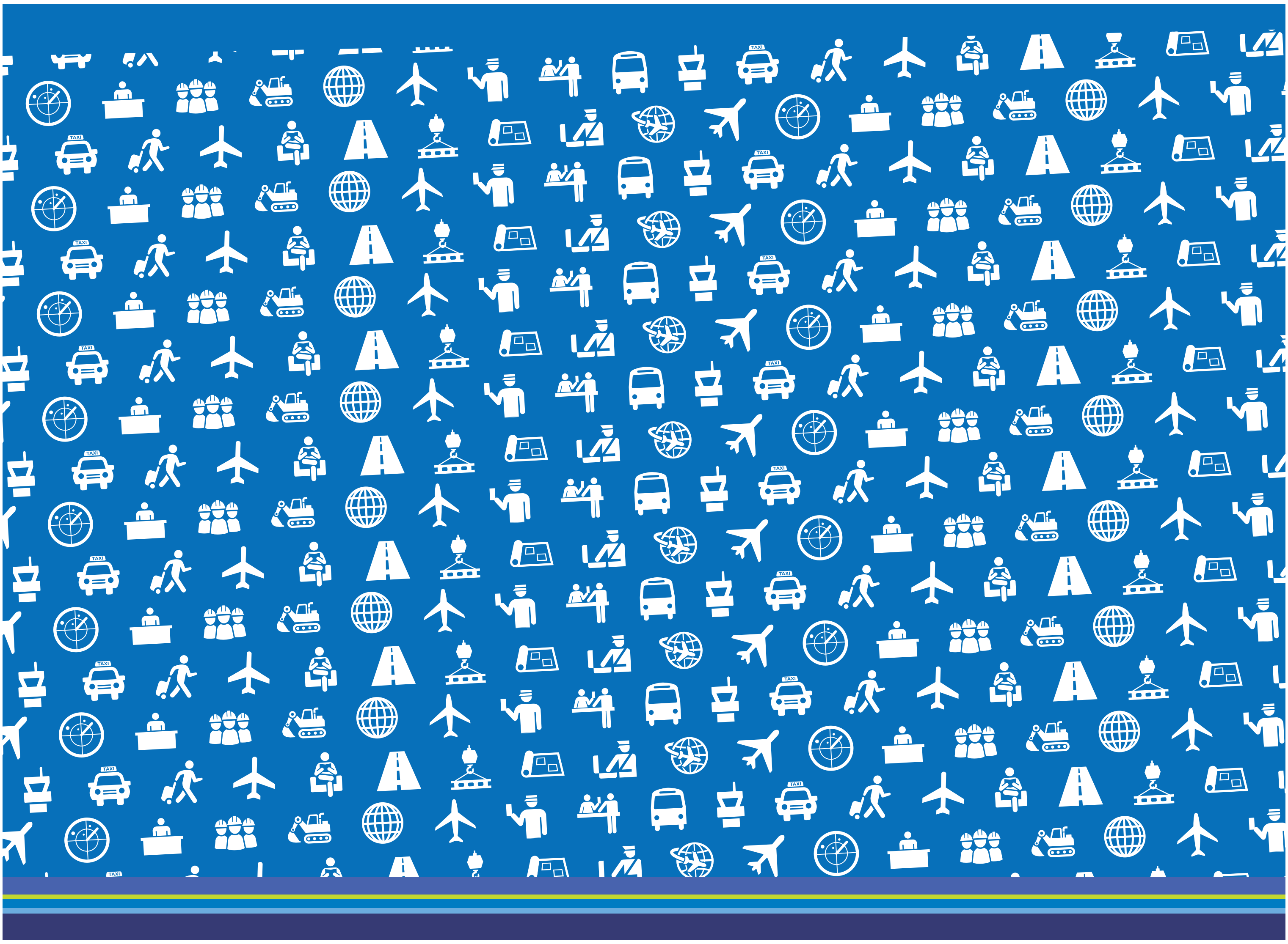
Term	Definition
MIKE21 modelling	MIKE21 is a two dimensional hydraulic modelling software program used to simulate surface flow and estimate flood levels and flow velocities.
Infrastructure Minister	The minister who administers the Airports Act.
Mitigation	The action of reducing the severity, seriousness, or painfulness of something.
MNES	Matters of national environmental significance
MOS	Manual of standards
MUSIC modelling	MUSIC is a software program used to estimate the performance of stormwater quality management systems.
N60	N60 is a measure of noise exposure that shows the number of aircraft overflights per day exceeding 60 dBA. N60 is generally used to describe night time noise exposure. In this EIS, unless otherwise noted, N60 values represent the number of aircraft overflights per day exceeding 60 dBA during the period 10pm to 7am.
N70	N70 is a measure of noise exposure that shows the number of aircraft overflights per day (or other specified time period) exceeding 70 dBA. The numbers of overflights are graded in contour lines on a map. N70 contours can be calculated for different time periods; however in this EIS they are presented for 24-hour periods.
NASF	National Airports Safeguarding Framework
National environmental protection measure	Broad framework-setting statutory instruments which outline agreed national objectives for protecting or managing particular aspects of the environment. NEPMs are similar to environmental protection policies and may consist of any combination of goals, standards, protocols, and guidelines.
Nautical mile	A unit of distance. One nautical mile equals 1.852 kilometres.
NEPM	National Environmental Protection Measure
NGER Regulations	*National Greenhouse and Energy Reporting Regulations 2008* (Cth)
Nitrogen	Nitrogen is a colourless element that has no smell and is usually found as a gas. It forms about 78% of the earth's atmosphere, and is found in all living things.
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxide
Non-putrescible	General solid waste including waste cardboard, glass, green waste, metals, paper, plastics, wood and electronic waste.
NPWS Act	*National Parks and Wildlife Act 1974* (NSW)
Nuisance dust	Dust which reduces environmental amenity without necessarily resulting in material harm. Nuisance dust comprises particles with diameters nominally from about one millimetre to 50 micrometres (microns).
O_3	Ozone
Offset measure	A conservation action that is intended to compensate for the negative environmental impacts of an action, such as a development. Offsets can include protecting at-risk environmental assets, restoring or extending habitat for threatened species, or improving the values of a heritage place.
OLS	Obstacle limitation surface – a series of surfaces that define the limits to which structures or objects may project into the airspace to ensure the safety of aircraft in visual flight conditions.
Organic	An organic compound is any member of a large class of gaseous, liquid, or solid chemical compounds whose molecules contain carbon.
PAH	Polycyclic aromatic hydrocarbon

Term	Definition
PANS-OPS	Procedures for air navigation services – aircraft operations
Particulate	A complex mixture of extremely small particles and liquid droplets.
Pathogen	A bacterium, virus, or other microorganism that can cause disease.
Permissible use	A land use which may receive development consent under the *Environmental Planning and Assessment Act 1979* (NSW). For the airport site, proposed permissible uses that would apply once an airport lease has been granted are set out in the land use plan in Part 2 of the revised draft Airport Plan.
PM	Airborne particulate matter
PM_{10}	Airborne particulate matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of less than 2.5 µm
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
Point Merge system	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 though 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.
ppb	Parts per billion
ppm	Parts per million
Preparatory Activities	Preparatory Activities mean the following: a. day to day site and property management activities; b. site investigations, surveys (including dilapidation surveys), monitoring, and related works (e.g. geotechnical or other investigative drilling, excavation, or salvage); c. establishing construction work sites, site offices, plant and equipment, and related site mobilisation activities (including access points, access tracks and other minor access works, and safety and security measures such as fencing); and d. enabling preparatory activities such as: i. demolition or relocation of existing structures (including buildings, services, utilities and roads) provided they are demolished or relocated in accordance with applicable environmental impact mitigation measures specifically referable to demolition or relocation of the relevant structures; ii. the relocation of cemeteries in accordance with an approved cemeteries relocation management plan; and iii. application of environmental impact mitigation measures.
Proposed airport	The proposed airport at Badgerys Creek and assessed in the Western Sydney Airport Environmental Impact Statement.
PSZ	Public safety zone
Putrescible	In relation to waste, material that may decay or putrefy.
RAAF	Royal Australian Air force
Ramsar Convention	An intergovernmental treaty that provides the framework for national action and international cooperation in wetland conservation. The treaty is named after the city of Ramsar in Iran, where it was signed.
Receivers	See sensitive receiver.
Receptors	See sensitive receiver.
Residual risk	Residual risk is the level of risk that remains after proposed mitigation and management measures are implemented.

Term	Definition
Restricted airspace	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.
Reticulated	In relation to water or another utility, transferred from one place to another.
Reverse thrust	A temporary redirection of aircraft engines so that the direction of exhaust is reversed, usually to provide a breaking effect during landings. Reverse thrusting generally produces an increase in noise during landing.
SACL	Sydney Airport Corporation Limited
SEIFA	Socioeconomic Indexes for Areas
Sensitive receiver	A place occupied by people that is sensitive to impacts. This term is usually used in air and noise studies to refer to dwellings, businesses, schools and the like. Also termed sensitive receptor.
SEPP	NSW State Environmental Planning Policy
SES Officer	An SES employee under the *Public Service Act 1999*
Significant impact	As defined in the EPBC Act *Significant impact guidelines 1.2*, a 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
SO_2	Sulfur dioxide
SO_x	Sulfur oxides
Stage 1 development	The initial stage in the development of the proposed airport, including a single runway and facilities for approximately 10 million annual passengers. (the EIS assumes the airport could be operating at this level approximately 5 years after operations commence which for assessment purposes has been assumed to be 2030).
Stage 1 operations	The airport operating at the Stage 1 capacity as defined in the revised draft Airport Plan.
STM3	Strategic Travel Model (Version 3)
SWRL	South West Rail Link
Sydney Airport	Sydney (Kingsford Smith) Airport
Sydney Basin	The Sydney Basin extends over approximately 350 kilometres of coastline from Newcastle in the north, to Durras Lake in the south. To the west the boundary runs in a line through Lithgow along the Liverpool Range to about 80 kilometres north of Muswellbrook and back to the coast at Newcastle. The total land area of the basin is approximately 44,000 square kilometres and the centre lies about 30 kilometres west of the Sydney CBD at Fairfield.
Sydney CBD	Sydney Central Business District
Sydney West Airport	The proposed airport. Note: this is the name used in the Act. The Airport is also commonly known as Western Sydney Airport.
TAPM	The Air Pollution Model
Taxiways	Defined paved areas provided for the surface movement of aircraft between runways and aprons.
The Department	Australian Government Department of Infrastructure and Regional Development
The Proponent	The proponent for the development and operation of the airport is the Australian Government Department of Infrastructure and Regional Development.

Term	Definition
The proposed airport	The proposed Western Sydney Airport.
Threatened species	Species of animals or plants that are at risk of extinction, or becoming endangered within the next 25 years ('vulnerable species'), defined by the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
TSP	Total suspended particulates
$\mu g/m^3$	Micrograms per cubic metre
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compounds
Western Sydney Airport	The proposed airport. The airport is referred to as Sydney West Airport under the Airports Act.
Western Sydney Region	Western Sydney is a major region of Sydney, New South Wales. Defined by the Western Sydney Regional Organisation of Councils (WSROC) as ranging from Auburn to the Blue Mountains and from Liverpool to Hawkesbury, with a total land area of about 5,400 square kilometres.
WHS	Work health and safety
WM Act	*Water Management Act 2000* (NSW)
WSEA	Western Sydney Employment Area
WSIP	Western Sydney Infrastructure Plan
WSU	Western Sydney Unit, Australian Government Department of Infrastructure and Regional Development

PART D:
Environmental Impact Assessment



9 Approach to impact assessment

9.1 Introduction

The Department of Infrastructure and Regional Development is proposing the design, construction and operation of the proposed Western Sydney Airport (proposed airport) to cater for ongoing growth in demand for aviation services in the Sydney region and to support economic and employment growth in Western Sydney. This environmental impact statement (EIS) has been prepared in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to support determination of an Airport Plan under the *Airports Act 1996* (Airports Act).

The revised draft Airport Plan, a companion document to the EIS, will provide the strategic direction for the proposed airport, and includes a specific proposal for the Stage 1 development and an indicative concept for the long term development.

This EIS assesses the Stage 1 development, incorporating a single runway and support facilities to cater for an operational capacity of approximately 10 million annual passengers and approximately 63,000 air traffic movements per year, allowing for the anticipated demand for the first five years of operation.

Volume 2 of the EIS has been prepared to provide a detailed consideration of environmental impacts arising from the Stage 1 development. The assessment is based on construction and operational parameters described in detail in Volume 1 of this EIS and included within Part 3 of the revised draft Airport Plan. The Stage 1 development broadly includes:

- construction activities associated with establishing a graded (level) site, which will include site clearing and major earthworks over approximately 1,150 hectares of the site;
- a 3,700 metre runway positioned on the northern portion of the site on an approximate north-east/south-west or 50/230 degree orientation and a single full length taxiway;
- aviation support facilities including passenger terminals, cargo and maintenance areas, car parks, car rental and navigational instrumentation; and
- operational capacity to accommodate up to 10 million annual passengers (domestic and international) for Stage 1 operations, which along with freight services is equivalent to approximately 63,000 air traffic movements per year.

The proposed airport is expected to be developed progressively as demand increases beyond the predicted capacity of the Stage 1 development. As demand increases beyond approximately 10 million annual passengers, additional aviation infrastructure and aviation support precincts will be developed to add capacity. The need for a second runway will be triggered when the demand approaches 37 million annual passengers by around 2050. The long term capacity of the airport to cater for 82 million passengers is expected to be required by around 2063.

All major infrastructure developments beyond the scope of the Stage 1 development will be subject to additional approvals in accordance with Part 5 of the Airports Act, and do not form part of the development for authorisation under the Airport Plan.

It is recognised that approval of the Stage 1 development would directly facilitate growth of the proposed airport beyond the scope of the development described in the Airport Plan. The progressive expansion of site operations has the potential to increase the level of impacts associated with the airport, particularly in regards to the surrounding community's exposure to aircraft noise.

A strategic level assessment has therefore been undertaken to assess the impacts arising from the long term development and these are presented in Volume 3 of this EIS. The strategic level assessment recognises the uncertainty in predicting impacts that may occur nearly 50 years into the future and the additional approval requirements for all future development. The approach provides flexibility in the master planning process to allow land use changes, technological improvements and changes in operational practices to be reflected in future development scenarios, while providing stakeholders and the community with greater clarity of the likely extent of future changes at the airport site to support the consideration of the Stage 1 development.

It is recognised that aircraft noise is one of the most sensitive issues associated with the development of the proposed airport and an increase in air traffic movements has the potential to increase the level of noise disturbance experienced by the surrounding community. Taking this into account, the EIS has assessed aircraft noise impacts for a 2050 scenario where the single runway is operating at a capacity of around 37 million annual passengers or approximately 185,000 aircraft movements per year. This scenario allows an assessment of the extent of noise exposure and associated potential impacts from the maximum capacity of the single runway that may result from the Stage 1 development.

A summary of assessment scenarios considered within the EIS is presented in Table 9–1. The potential impacts associated with the Stage 1 development are considered for all environmental aspects and are presented in Volumes 2a and 2b of this EIS. The long term development is addressed separately in Volume 3.

Table 9–1 Assessment scenarios

Development stage	Indicative year(s)	Environmental aspects considered	EIS reference
Preparatory activities and Construction	Late-2016 to mid-2020s	All relevant aspects	Volume 2a – Chapters 9 through 26
Stage 1 development (10 million annual passengers, approximately 5 years after the commencement of operations)	2030	All relevant aspects	Volume 2a – Chapters 9 through 27 Volume 2b – Chapters 28 and 29
Long term development Single runway at capacity (37 million annual passengers)	2050	Noise	Volume 3 – Chapter 31
Long term development Two runways operating at capacity (82 million annual passengers)	2063	Strategic assessment for all relevant aspects	Volume 3 – Chapters 31 through 40

9.2 Impact assessment process

The framework for the impact assessment has been designed to provide a structured and objective approach to identifying the proposed airport's environmental, social and economic impacts, and to developing effective mitigation, management and offset measures. The approach has generally involved:

- project definition including analysis of the need and alternatives to address the growing aviation demand in the Sydney basin;
- identification of key issues through reviewing previous investigations, preparation of an EPBC Act referral and a gap analysis and risk assessment process;
- identifying existing environmental, social and economic baseline conditions;
- completion of impact assessments for the project based on the broad parameters presented in the Airport Plan having regard to the baseline conditions;
- refinement of the project having regard to the impact assessments; and
- identification of appropriate mitigation, management, monitoring measures and (where appropriate) offset measures for the identified potential impacts.

The baseline (or existing environment) conditions for the airport site and surrounding locality were derived using a combination of desktop and field investigations relevant to each environmental aspect or value. Where possible, the investigations built on previous studies that have been completed at the airport site.

The impact assessment methodology for each environmental, social and economic value was developed to meet the EIS guidelines issued by the Australian Government Department of the Environment, now called the Department of the Environment and Energy, (see Appendix C (Volume 4)). The intent and objectives of the New South Wales legislative framework and assessment guidelines were also considered where appropriate for each environmental value.

Mitigation and management measures were applied to reduce the level of identified potential impacts. These measures aim to protect the identified environmental values and would be applied as required during the planning and design, construction and operation phases of the project.

A number of monitoring plans would also be developed and implemented to monitor and, in some situations, address various residual impacts associated with the development of the proposed airport.

9.3 Issues identification

9.3.1 Overview

Key issues and risks to be assessed within the EIS were identified using a number of related processes.

The EIS guidelines provide the overall framework of specific matters to be addressed by the EIS. A gap analysis and risk assessment process was undertaken at the start of the assessment to help prioritise key issues and develop the scope of the specialist investigations to be undertaken to support the preparation of the EIS.

Government and community stakeholders were also consulted to help identify their key issues, attitudes and concerns regarding the proposed airport, as outlined in Chapter 8 (Volume 1).

9.3.2 EPBC Act referral

The Department of Infrastructure and Regional Development submitted a referral under the EPBC Act for the Stage 1 development of the proposed airport on 4 December 2014. The referral was available for public comment for 12 business days.

On 23 December 2014, a delegate of the Minister for the Environment determined the proposed Western Sydney Airport to be a controlled action. The referral decision instrument identifies the following controlling provisions under the EPBC Act as being relevant for this proposal:

- world heritage properties (sections 12 & 15A);
- national heritage places (sections 15B & 15C);
- listed threatened species and communities (sections 18 & 18A); and
- Commonwealth actions (section 28).

At the same time the delegate decided that the proposed airport development would be assessed by preparation of an EIS.

Tailored guidelines for the preparation of a draft EIS were issued by the Department of the Environment on 29 January 2015. The EIS guidelines detail the information about the proposed airport and its relevant impacts that must be provided in the EIS; these are presented in full in Appendix B (Volume 4). The EIS guidelines also include a range of general requirements for the format and style of the EIS, together with specific requirements for the content of the EIS. Table 9–2 provides a summary of the specific guideline requirements and identifies where in the EIS they have been addressed for the Stage 1 development.

Table 9–2 EIS guidelines

EIS guideline requirement	Where it is addressed
Section 1 – General information	
This should provide the background and context for the action including: a. the title of the action; b. the full name and postal address of the designated Proponent; c. a clear outline of the objective of the action; d. the location of the action; e. the background to the development of the action; f. how the action relates to any other actions (of which the Proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action; g. the current status of the action; and h. the consequences of not proceeding with the action.	Chapters 1 and 2 (Volume 1)
Section 2 – Description of the action	
All construction, operational and (if relevant) decommissioning components of the action should be described in detail. This should include the precise location (including coordinates) of all works to be undertaken, structures to be built or elements of the action that may have impacts on matters of National Environmental Significance. The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Chapters 4 to 7 (Volume 1)
Section 3 – Feasible alternatives	
Any feasible alternatives to the action to the extent reasonably practicable, including: a. if relevant, the alternative of taking no action; b. a comparative description of the impacts of each alternative on the matters of national environmental significance and other matters protected by controlling provisions of Part 3 of the EPBC Act for the action; and c. sufficient detail to make clear why any alternative is preferred to another. Short, medium and long term advantages and disadvantages of the options should be discussed.	Chapter 2 (Volume 1)
Section 4 – Description of the environment	
(a) Listed threatened species (including suitable habitat) and ecological communities that are or are likely to be present in all areas of potential impact. To satisfy this requirement details must be presented on the scope, timing/effort (survey season/s) and methodology for studies and surveys used to provide information on the relevant listed threatened species/ecological community/habitat (as identified in Attachment 3). This includes details of: ▪ how best practice survey guidelines have been applied; and ▪ how surveys are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	Chapters 16 (Volume 2a) Appendix K1 (Volume 4)

EIS guideline requirement		Where it is addressed
(b)	A description of the World Heritage/National Heritage values of the Greater Blue Mountains Area World Heritage property/National Heritage Place, as described in the Statement of Outstanding Universal Value and including reference to the World Heritage criteria the area is listed for as well as the integrity of the property.	Chapters 26 (Volume 2a) and 38 (Volume 3)
(c)	A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: ▪ ecosystems and their constituent parts, including people and communities; ▪ natural and physical resources; ▪ the qualities and characteristics of locations, places and areas; ▪ heritage values of places; and ▪ the social, economic and cultural aspects of a thing mentioned in the preceding dot points.	Chapters 10 to 39 (Volumes 2a, 2b and 3) Relevant appendices (Volume 4)
Section 5 – Relevant Impacts		
(a)	The EIS must include a description of all of the relevant impacts of the action. Relevant impacts are impacts that the action will have or is likely to have on a matter protected by a controlling provision (as listed in the preamble of this document). Impacts during both the construction, operational and (if relevant) the decommissioning phases of the project should be addressed, and the following information provided: ▪ a detailed assessment of the nature and extent of the likely short term and long term relevant impacts (detailing direct and indirect impacts); ▪ a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible; ▪ analysis of the significance of the relevant impacts; and ▪ any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Chapters 10 to 39 (Volumes 2a, 2b and 3) Relevant appendices (Volume 4)
(b)	The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity). The EIS should address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact, a risk assessment should be conducted and documented.	Chapter 27 (Volume 2a) Volume 3
(c)	The EIS should address the potential for facilitated impacts upon MNES at the local, regional, state, national and international scale.	Chapters 10 to 39 (Volumes 2a, 2b and 3)
(d)	If the conclusion is made that any relevant controlling provision or element of a relevant controlling provision will not be impacted by the proposed action, then justification must be provided for how this conclusion has been reached. This includes any threatened species or ecological communities that are likely to be present on site, heritage items/places likely to be on site and other relevant elements of the environment that may be impacted by the proposed action.	Chapters 10 to 39 (Volumes 2a, 2b and 3) Detailed assessment has been undertaken for all controlling provisions.
(e)	To support the assessment of local historic and indigenous heritage values, the EIS must include a full heritage impact assessment and the findings of the further program of archaeological survey that was foreshadowed in the referral for this project.	Chapters 19, 20 and 39 (Volumes 2a and 3) Appendices M1 and M2

EIS guideline requirement	Where it is addressed
(f) Further details of threatened species and ecological communities protected by the controlling provisions of Part 3 of the EPBC Act are provided at Attachment 3.	Chapters 16 and 39 (Volumes 2a and 3) Appendix K1 (Volume 4)
▪ changes to water quality on site and downstream of the site ▪ changes to siltation ▪ hydrological changes	Chapters16, 18, 34 and 39 (Volumes 2a and 3) Appendices K1 and L (Volume 4)
▪ removal and degradation of heritage items/places (historic, natural and indigenous)	Chapters 19, 20 and 39 (Volumes 2a and 3) Appendices M1 and M2 (Volume 4)
▪ native flora and fauna habitat removal and degradation (on site and in surrounding areas that may be affected by the action)	Chapters 16 and 39 (Volumes 2a and 3) Appendix K1 (Volume 4)
▪ aircraft noise and vibration impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment). Discussion and quantification/modelling of aircraft noise impacts should include consideration of all potential flight paths, height of flights, noise exposure patterns, noise contours, the range of frequencies of the noise, cumulative exposure, peak noise, frequency of overflights and temporal variability of this (including long term trends), varying aircraft types, varying aircraft operating procedures, and variations in noise patterns due to seasonal and meteorological factors	Chapters 10 and 31 (Volumes 2a and 3) Appendices E1 and E2 (Volume 4)
▪ noise and vibration from construction activities and machinery	Chapter 11 (Volume 2a) Appendix E2 (Volume 4)
▪ changes to air quality during construction and operation (including consideration of seasonal and meteorological variations that influence local air quality)	Chapters 12 and 32 (Volumes 2a and 3) Appendices F1 and F2 (Volume 4)
▪ potential fuel dumping impacts	Chapter 7 and 13 (Volume 2a) Appendices F1 and F2 (Volume 4)
▪ changes in traffic movements during construction and operation (associated with both passenger movements and workers)	Chapters15 and 33 (Volumes 2a and 3) Appendix J (Volume 4)
▪ bird or bat air strike	Chapter 14 and 16 (Volume 2a) Appendix I (Volume 4)
▪ lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment)	Chapters 22 and 36 (Volumes 2a and 3) Appendix O (Volume 4)
▪ changes in recreational use and amenity of natural areas	Chapters 21, 22 and 23 (Volume 2a) Appendices N, O and P1 (Volume 4)
▪ change in qualities and characteristics of the surrounding areas and associated impacts to local communities (including land values and other economic impacts)	Chapters 21, 22, 23 and 24 (Volume 2a) Appendices N, O, P1, P2 and P3 (Volume 4)

EIS guideline requirement	Where it is addressed
▪ creation of any risks or hazards to people or property that may be associated with any component of the action.	Chapters 14 and 39 (Volumes 2a and 3) Appendix H (Volume 4)
Quantification and assessment of impacts should: • be against appropriate background/baseline levels; • be prepared according to best practice guidelines and compared to best practice standards; • consider seasonal and temporal variations where appropriate (including temporal changes in the sensitivity of the receptor); and • be supported by maps, graphs and diagrams as appropriate to ensure information is readily understandable. Guidelines and standards used to quantify baselines and impacts should be explained and justified.	Chapters 10 to 39 (Volumes 2a and 3) Relevant appendices (Volume 4)
Section 6 – Avoidance and mitigation measures	
(a) The EIS must provide information on proposed avoidance and mitigation measures to manage the relevant impact of the action on a matter protected by a controlling provision (as listed in the preamble of this document).	Chapter 28 (Volume 2b) Relevant appendices (Volume 4)
(b) The EIS must take into account relevant agreements and plans that cover impacts or known threats to a matter protected by a controlling provision (including but not necessarily limited to): (a) any recovery plan and/or conservation advice for the affected species or ecological community; (b) any threat abatement plan for a process that threatens an affected species or ecological community; (c) any wildlife conservation plan for the affected species; (d) any relevant strategic assessment undertaken in accordance with an agreement under Part 10 of the EPBC Act; and (e) For the Greater Blue Mountains Area World Heritage property, the World Heritage Convention; the Australian World Heritage Management Principles; the Greater Blue Mountains Area World Heritage Area Strategic Plan, and relevant NSW National Parks and Wildlife Service/Office of Environment and Heritage Plans of Management.	Chapters 16 and 26 (Volume 2a) Appendices K1 and K2 (Volume 4)

EIS guideline requirement	Where it is addressed
(c) The EIS must include specific and detailed descriptions of the proposed avoidance and mitigation measures based on best available practices. This must include the following elements : i. A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including: ▪ a detailed description of proposed measures; ▪ assessment of the expected or predicted effectiveness of the mitigation measures; ▪ any statutory or policy basis for the mitigation measures; and ▪ the likely cost of the mitigation measures. ii. A detailed outline of a plan for the continuing management, mitigation and monitoring of relevant matters protected by a controlling provision, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing. iii. Where appropriate, each project phase (construction and operation) must be addressed separately. It must state the environmental outcomes, performance criteria, monitoring, reporting, corrective action, contingencies, responsibility and timing for each environmental issue. iv. The name of the agency responsible for endorsing or approving each mitigation measure or monitoring program.	Chapter 28 (Volume 2b)
Section 7 – Residual impacts and offsets	
Residual impacts (a) The EIS must provide details of the likely residual impacts upon a matter protected by a controlling provision after the proposed avoidance and mitigation measures have been taken into account. This includes: i the reasons why avoidance or mitigation of impacts may not be reasonably achieved; and ii quantification of the extent and scope of significant residual impacts.	Chapters 10 to 28 (Volumes 2a and 2b)
Offset package (a) The EIS must include details of an offset package to be implemented to compensate for residual significant impacts associated with the project, as well as an analysis of how the offset meets the requirements of the Department's Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (EPBC Act Offset Policy).	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)
(b) The offset package can comprise a combination of direct offsets and other compensatory measures, as long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)
(c) Offsets should compensate for an impact for the full duration of the impact.	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)
(d) Offsets must directly contribute to the ongoing viability of the protected matter impacted by the project and deliver an overall conservation outcome that maintains or improves the viability of the protected matter, compared to what is likely to have occurred under the 'status quo' (i.e. if the action and associated offset had not taken place).	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)
(e) Note: offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)

EIS guideline requirement	Where it is addressed
(f) The EIS must provide: i details of the offset package to compensate for significant residual impacts on a protected matter; and ii an analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.	Chapter 16 (Volume 2a) Appendices K1 and K2 (Volume 4)
Section 8 – Environmental Record	
(a) The information provided must include details of any past or current proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: i the person proposing to take the action; and ii the person making the application for any related permits.	Appendix A (Volume 4)
(b) If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Appendix A (Volume 4)
Section 9 – Other approvals and conditions	
The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include:	
(a) details of any local or State Government planning scheme, or plan or policy under any local or State Government planning system that deals with the proposed action, including: • what environmental assessment of the proposed action has been, or is being, carried out under the scheme, plan or policy; and • how the scheme provides for the prevention, minimisation and management of any relevant impacts;	Chapter 3 (Volume 1)
(b) a description of any approval that has been obtained from a State, Territory or Commonwealth agency or authority (other than an approval under the Act), including any conditions that apply to the action;	Chapter 3 (Volume 1)
(c) a statement identifying any additional approval that is required; and	Chapter 3 (Volume 1)
(d) a description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Chapter 28 (Volume 2b)
Section 10 – Economic and social matters	
(a) The economic and social impacts of the action, both positive and negative, must be analysed. Matters of interest may include: i details of any public consultation activities undertaken, and their outcomes; ii details of any consultation with Indigenous stakeholders; iii projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies; and iv employment opportunities expected to be generated by the project (including construction and operational phases).	Chapters 24 and 37 (Volumes 2a and 3) Appendices P1, P2 and P3 (Volume 4)
(b) The economic and social impacts must include impacts at the local, regional and national level.	Chapter 23, 24 and 37 (Volumes 2a and 3) Appendices P1, P2 and P3 (Volume 4)

EIS guideline requirement	Where it is addressed
(c) Details of the relevant cost and benefits of alternative options to the proposed action, as identified in Section 3, should also be included.	Chapter 2 (Volume 1)
Section 11 – Information sources	
For information given in the EIS, the EIS must state:	
(a) the source of the information;	Throughout
(b) how recent the information is;	Throughout
(c) how the reliability of the information was tested;	Throughout
(d) what uncertainties (if any) are in the information; and	Throughout
(e) what guidelines, plans and/or policies have been considered during preparation of the EIS.	Throughout
Section 12 – Conclusion	
An overall conclusion as to the environmental acceptability of the proposal on protected matters must be provided, which includes:	Chapters 29 and 40 (Volumes 2a and 3)
(a) a discussion on how consideration has been given to the objects of the EPBC Act, the principles of ecologically sustainable development, and the precautionary principle (as detailed at Attachment 1);	Chapter 29 (Volume 2b)
(b) justification for undertaking the proposal in the manner proposed, including the acceptability of the avoidance and mitigation measures; and	Chapter 29 (Volume 2b)
(c) if relevant, a discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on protected matters, and the relative degree of compensation and acceptability.	Chapter 29 (Volume 2b)

9.3.3 Gap analysis

Consideration of the need and potential location of a second Sydney airport has been ongoing for a number of decades and has included the preparation of two previous EISs, in 1985 and 1997–99. Badgerys Creek was initially assessed as the preferred second Sydney airport site in the 1985 *Second Sydney Airport Site Selection Programme Draft Environmental Impact Statement* (1985 EIS) (Kinhill Stearns 1985). The 1997–99 *Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997) provides a comprehensive environmental assessment of the site and considered an airport concept (known as 'Option A') that had a similar runway configuration to the current proposal.

The previous EISs provided a substantial compilation of environmental baseline conditions and considered potential impacts associated with the development of the proposed airport at the Badgerys Creek site, in the context of the proposed operational parameters and approvals framework at the time of publication of each EIS.

A gap analysis was undertaken to determine the degree to which these previous studies could be relied or expanded upon to address the potential impacts associated with the proposal described in Part 3 of the Airport Plan. The length of time since previous investigations were completed was considered to limit their applicability to the current assessment.

Key observations from the gap analysis included the following:

- introduction of the EPBC Act, which has resulted in a revised Commonwealth statutory environmental assessments framework and increased stakeholder expectations about the level of assessment to be included within an EIS;
- listing of the Greater Blue Mountains Area on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List;
- an increased emphasis on biodiversity protection and consideration of offset requirements;
- the broadening of the legislative description of threatened species since 1999, at both the State and Commonwealth levels, which has meant that previous mapping of Cumberland Plain Woodland and threatened species at the site would no longer be considered accurate;
- the changing context of the airport site, including the emergence of Western Sydney as a focus for economic and urban growth and the need to consider current strategic land use planning considerations for Western Sydney;
- revised operational parameters for the proposed airport, changes in forecast aircraft fleet mix and improvements in aviation technology since the previous studies, which have the potential to change the predicted environmental performance of the proposed airport; and
- revised standards and stakeholder expectations for data collection, analysis and reporting across a range of environmental disciplines, which have also limited the applicability of the previous assessments.

Despite these limitations, the previous investigations were considered useful to provide a substantial baseline for the identification of some of the key issues to inform the scope of this EIS. Building on the previous studies, a range of specialist investigations were undertaken to support the preparation of the EIS and address the requirements of the EIS guidelines. These investigations are included in Volume 4.

9.3.4 Risk assessment

A risk assessment process was undertaken to build on the identification of issues through the EPBC referral and the gap analysis. The risk assessment was undertaken to help prioritise the assessment and inform the scope of specialist studies. The risk assessment involved the following four main steps:

- identifying environmental aspects;
- identifying the source of potential risks associated with each of these aspects;
- evaluating the risks (including likelihood and severity) and applying a preliminary consideration of potential mitigation measures; and
- considering significant findings, including any residual risks after mitigation measures are applied.

The identified risks were then considered through a risk assessment workshop that involved subject matter experts and the EIS development team. A summary of key issues identified from the risk assessment, and where each risk has been assessed in detail as part of the EIS, is presented in Table 9–3.

Table 9–3 Risk assessment outcomes (initial risk ranking 'high' or above) for Stage 1 Development

Issue	Where addressed
Noise and vibration	
Amenity and health impacts caused by exposure to excessive construction noise	Chapters 11 and 13 (Volume 2a) Appendices E2 and G (Volume 4)
Amenity and health impacts caused by short term exposure to road traffic noise (construction traffic, haul, workforce etc.)	Chapters 11 and 13 (Volume 2a) Appendices E2 and G (Volume 4)
Exposure to excessive vibration impacting amenity, and/ or contributing to damage to nearby buildings/ structures.	Chapters 10 and 11 (Volume 2a) Appendices E1 and E2 (Volume 4)
Amenity and health impacts caused by exposure to aircraft noise beyond airport boundary	Chapters 10, 11, and 13 (Volume 2a) Appendices E1, E2 and G (Volume 4)
Amenity and health impacts associated with long term generation of road traffic noise (servicing the airport)	Chapters 11 and 13 (Volume 2a) Appendices E2 and G (Volume 4)
Amenity and health impacts caused by exposure to ground running noise and vibration adjacent to airport e.g. taxiing, refuelling, engine testing, general maintenance etc.	Chapters 11 and 13 (Volume 2a) Appendices E2 and G (Volume 4)
Air quality	
Generation of construction dust leading to amenity and human health impacts	Chapters 12 and 13 (Volume 2a) Appendices F1 and G (Volume 4)
Generation of construction vehicle emissions leading to amenity and human health impacts	Chapters 12 and 13 (Volume 2a) Appendices F1 and G (Volume 4)
Amenity and human health impacts caused by aircraft and other operational emissions (local)	Chapters 12 and 13 (Volume 2a) Appendices F1, F2 and G (Volume 4)
Community health	
Amenity and health impacts associated with potential construction impacts e.g. noise, air quality etc.	Chapter 13 (Volume 2a) Appendix G (Volume 4)
Local health and amenity impacts associated with exposure to operational impacts e.g. noise, air quality, water quality etc. for properties and communities surrounding the airport	Chapter 13 (Volume 2a) Appendix G (Volume 4)
Amenity and health impacts caused by reduction in regional air quality associated with aircraft operations	Chapter 13 (Volume 2a) Appendix G (Volume 4)
Amenity and health impacts caused by noise impacts associated with aircraft operations (over flights)	Chapter 13 (Volume 2a) Appendix G (Volume 4)
Surface transport and access	
Risk of injury or death caused by construction traffic (including haul) interacting with local traffic and pedestrians	Chapter 15 (Volume 2a) Appendix J (Volume 4)
Congestion on existing transport routes caused by increased traffic volumes associated with construction	Chapter 15 (Volume 2a) Appendix J (Volume 4)

Issue	Where addressed
Risk of injury or death caused by operational traffic servicing the airport interacting with local traffic and pedestrians	Chapter 15 (Volume 2a) Appendix J (Volume 4)
Congestion on existing transport routes caused by increased operational traffic servicing the airport	Chapter 15 (Volume 2a) Appendix J (Volume 4)
Regional accessibility insufficient to service the operation of the airport e.g. road network etc.	Chapter 15 (Volume 2a) Appendix J (Volume 4)
Biodiversity	
Clearing of vegetation and earthworks impacting on threatened species and communities	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Habitat removal	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Construction in waterways/crossings impacting on water quality, threatened species and aquatic habitat	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Increased erosion and sedimentation impacting on water quality, threatened species and aquatic habitat	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Potential impacts to threatened species, communities and habitat caused by indirect impacts during construction e.g. noise, dust, light	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Potential impacts to threatened species, communities and habitat caused by indirect impacts during operation e.g. noise, dust, light	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Bird and bat strike—mortality risk to threatened fauna	Chapter 16 (Volume 2a) Appendix K1 (Volume 4)
Hydrology and water quality	
Alteration of local hydrology caused by earthworks and interruption of existing local flow regime	Chapter 18 (Volume 2a) Appendix L1 (Volume 4)
Affectation of stream stability caused by vegetation clearing, earthworks and changes to existing flow regimes (increased flows, concentrated flows etc.)	Chapter 18 (Volume 2a) Appendix L1 (Volume 4)
Increased erosion and sedimentation associated with earthworks, exposed soil surfaces etc.	Chapters 17 and 18 (Volume 2a) Appendices L1 and L2 (Volume 4)
Poor on-site management of sewage effluent during construction causes overflow event/ impacts on water quality	Chapter 18 (Volume 2a)
Poor ongoing on-site management of sewage effluent causing overflow event/ impacts on water quality	Chapter 18 (Volume 2a)
Increase in nutrient/heavy metal pollutants during operation	Chapter 18 (Volume 2a) Appendix L2 (Volume 4)
Reduced groundwater recharge caused by increased impervious surface area	Chapter 18 (Volume 2a) Appendix L3 (Volume 4)

Issue	Where addressed
Hazards and risks	
Accident involving construction vehicle causing fatality or serious injury	Chapter 14 (Volume 2a) Appendix H (Volume 4)
Incident involving the transportation and/ or storage of fuel or other substances causing injury, fatality or environmental impact	Chapter 14 (Volume 2a) Appendix H (Volume 4)
Bird and bat strike causing aircraft accident	Chapter 14 (Volume 2a) Appendix I (Volume 4)
Visual impact	
Presence of construction site and plant in the landscape causing impact to visual amenity	Chapter 22 (Volume 2a) Appendix O (Volume 4)
Unacceptable light spill or visibility for closest residents causing amenity and/ or health impacts (with regard to sleep disturbance- perceived or otherwise)	Chapter 22 (Volume 2a) Appendix O (Volume 4)
Visibility of airport infrastructure, including ancillary facilities such as advertising billboards on airport approaches etc.	Chapter 22 (Volume 2a) Appendix O (Volume 4)
Aboriginal heritage	
Harm to registered Aboriginal artefacts, places and cultural values	Chapter 19 (Volume 2a) Appendix M1 (Volume 4)
Harm to unregistered Aboriginal objects or places	Chapter 19 (Volume 2a) Appendix M1 (Volume 4)
Degradation of surrounding Aboriginal objects, places and cultural values	Chapter 19 (Volume 2a) Appendix M1 (Volume 4)
European and other heritage	
Harm to listed buildings, sites or artefacts	Chapter 20 (Volume 2a) Appendix M2 (Volume 4)
Harm to non-listed buildings, sites or artefacts	Chapter 20 (Volume 2a) Appendix M2 (Volume 4)
Socio-economic	
Significant reduction in business activity and services caused by general access and land use changes associated with construction	Chapters 23 and 24 (Volume 2a) Appendices P1 and P3 (Volume 4)
Difficulty in sourcing of local airport workforce	Chapter 24 (Volume 2a) Appendix P3 (Volume 4)
Planning and land use	
Impacts associated with change of land use on site and off site	Chapters 21 and 23 (Volume 2a) Appendix N (Volume 4)

Issue	Where addressed
Loss of productive agricultural land	Chapter 21 (Volume 2a) Appendix N (Volume 4)
Property values	
Reduction in property values	Chapter 21 (Volume 2a) Appendix P2 (Volume 4)
Geology, soils and topography	
Impacts associated with change in topography e.g. hydrology, visual impact	Chapters 17 and 22 (Voume 2a) Appendix O (Volume 4)
Waste and resources assessment	
Generation of construction waste	Chapter 25 (Volume 2a)
Generation of operational waste	Chapter 25 (Volume 2a)
Cumulative impacts	
Congestion on existing transport routes caused by construction traffic	Chapter 27 (Volume 2a)
Cumulative impacts associated with construction of airport at the same time as other developments e.g. Northern Road deviation, Elizabeth Drive, TransGrid power line relocation etc.	Chapter 27 (Volume 2a)
Congestion on existing transport routes during operation	Chapter 27 (Volume 2a)
Impacts on other airport facilities during operation e.g. Sydney Airport, Bankstown, Camden	Chapters 7 and 27 (Volume 1 and Volume 2a)
Reduction/ impact on natural resources	Chapters 25 and 27 (Volume 2a)

9.4 EIS Volume 2 structure

Volume 2 provides a detailed impact assessment of the Stage 1 development presented in Part 3 of the revised draft Airport Plan. It is in three parts:

- Part D provides a detailed consideration of all environmental aspects potentially affected by the proposed airport;
- Part E provides the environmental management framework and mitigation requirements to be implemented as part of the proposed airport; and
- Part F provides a conclusion about the assessment of impacts.

10 Noise (aircraft)

Operation of the proposed airport would result in changes to the pattern of aircraft movements above Western Sydney through the introduction of new aircraft operations. Communities in Western Sydney and the Blue Mountains would be impacted by noise from aircraft during take-off, landing and when in flight. The greatest impacts are predicted to be experienced in those locations closer to the airport under or near the aircraft departure and arrival routes. The geographic extent and level of aircraft noise exposure that would result from operation of the proposed airport is complex, and depends on approved final flight paths and aircraft operating procedures, time of day, season, weather conditions as well as other factors.

This noise assessment of the proposed Stage 1 development is based on indicative flight paths prepared by Airservices Australia to cater for a demand of approximately 10 million annual passengers and about 63,000 aircraft movements a year (total passenger and freight movements). The flight paths for the proposed airport will be formalised as part of a separate process closer to the commencement of airport operations. While the Australian Government has stated that one element of the indicative flight paths, a single merge point over Blaxland will not be implemented, the indicative flight paths presented in the EIS continue to provide a reasonable and contemporary basis for assessing the potential extent and intensity of noise impacts associated with aircraft operations at the proposed airport.

The noise impact assessment undertaken for this EIS has adopted a conservative approach by assuming an aircraft fleet based on current day aircraft types, without taking account of any future reductions in aircraft noise emissions which may occur over time as a result of technological advancements. The assessment assumes the use of continuous descent approaches, which minimise the use of engine thrust by pilots. Continuous descent approaches are used at a variety of other airports and are embodied in the preliminary airspace design provided by Airservices Australia.

Individuals show varying sensitivity to noise. Experience at existing airports in Australia has shown that, while aircraft noise contours based on cumulative noise exposure measures such as the Australian Noise Exposure Forecast (ANEF) are useful for land use planning purposes near airports, they are not necessarily an indicator of the full extent of community reaction to, or individual annoyance from, aircraft noise or the total spread of noise impacts. The EIS assessment of aircraft noise is based on measures outlined in Australian Standard 2021:2015 and the National Airports Safeguarding Framework. These guidelines emphasise the challenge of communicating the complex nature and extent of aircraft noise and advocate using a number of different measures to aid interpretation of predicted noise exposure levels. While this EIS has used a range of measures for describing noise exposure, it is important to note that aircraft noise impacts would be experienced outside the areas depicted by the various noise exposure contours. Individuals and communities newly exposed to aircraft noise are likely to show an enhanced sensitivity to changes in the noise environment.

For the loudest aircraft operations (long-range departures by Boeing 747 aircraft or equivalent), maximum noise levels over 85 dBA are predicted at a small number of rural residential locations in Badgerys Creek close to the airport site. Noise levels of 70–75 dBA would be experienced over a greater area and could be expected within built-up areas in St Marys and Erskine Park. The Boeing 747 is, however, being phased out of passenger services by most airlines. Maximum noise levels due to more common aircraft types such as Airbus A320 or equivalent are predicted to be lower at 60–70 dBA in built-up areas around St Marys and Erskine Park, and over 70 dBA in some adjacent areas to the south-west of the airport site, such as Greendale.

Over a 24-hour period, between 1,500 and 1,600 residents are predicted to experience five or more aircraft noise events above 70 dBA. The number of residents affected by different levels of aircraft noise depends on the runway operating strategy adopted. Comparison of the two key strategies indicates that while there is limited variability of noise exposure levels in close proximity to the proposed airport, the choice of runway operating strategy has a more pronounced effect on communities further away.

On an average night, aircraft approaching and departing the proposed airport in a south-west to north-east direction are predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA. With an operating strategy in the opposite direction, approximately 6,000 people are predicted to experience on average more than five events above 60 dBA per night. This number would reduce to 4,000 if a head-to-head operating mode was implemented, in which aircraft would both approach and depart at the south-west end of the runway.

Most recreational areas in the vicinity of the airport site would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA. In recreational areas where this level of noise exposure is predicted, the average number of events above 70 dBA would be less than one event per day. The noise impact associated with take-offs in both directions and aircraft reverse thrust during landing would primarily affect Luddenham and Greendale. The potential impacts of aircraft noise on community health and social factors such as amenity and annoyance are discussed in Chapter 13 and Chapter 23 respectively.

Approaches to mitigating aircraft noise generally focus on reducing noise emissions from the aircraft themselves, planning flight paths and airport operating modes in a way that minimises potential noise and environmental impacts, and implementing land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas. Land use planning controls have largely protected the airport site from incompatible development for nearly three decades. It is expected that future land use planning around the proposed airport would be influenced by final long term ANEF contours, once flight paths and operating modes are finalised and approved. Subject to relevant considerations such as aircraft safety, all practicable opportunities for mitigating noise impacts will be considered in finalising the flight paths and aircraft operating procedures for the proposed airport.

10.1 Introduction

This chapter provides an assessment of potential aircraft overflight noise associated with the operation of the proposed airport. The chapter draws on a comprehensive aircraft noise assessment which is included as Appendix E1 (Volume 4). In considering anticipated aircraft overflight noise impacts, the assessment takes into account the projected air traffic volumes, indicative aircraft flight paths and airport operating modes, noise emissions from different aircraft types, and future population densities in areas surrounding the airport site.

As discussed in Chapter 7 (Volume 1), the Australian Government has stated that the airspace design to be implemented for the proposed airport will not converge arriving aircraft at a single point over the community of Blaxland. While this aspect of the airspace design will not be realised, the indicative flight paths presented in the EIS provide a reasonable and contemporary basis for assessing the potential extent and intensity of impacts associated with aircraft operations at the proposed airport. The indicative flight paths have been used to calculate the potential extent of noise exposure associated with aircraft overflights. The use of preliminary flight paths for noise assessment in an EIS is consistent with other environmental assessments of new runway infrastructure, including the 1997-1999 Second Sydney Airport Proposal EIS and more recent proposals such as the Brisbane Airport New Parallel Runway. Final flight paths can only be implemented following further analysis, including detailed consideration of potential noise abatement opportunities and additional community consultation.

The assessment addresses the requirements of the EIS Guidelines, which specifically require consideration of aircraft noise and vibration impacts on everyday activities and on sensitive receptors. For the purposes of assessment, aircraft noise has been divided into two main categories generally in line with the regulation of aircraft and airport noise, and having regard to the noise characteristics of different operations and the modelling approaches adopted for this EIS. These categories are:

- aircraft overflight noise (including noise generated during flight, take-off and landing); and
- ground-based noise (including noise generated from aircraft taxiing, aircraft engine ground running and airport construction).

This chapter assesses noise associated with aircraft overflights which are defined as being from the start of roll for departures and until an aircraft exits the runway on arrival. This includes noise generated by operations when the aircraft is on the ground such as elevated thrust during take-off and reverse thrust during landing.

Ground-based noise from sources such as fixed-wing engine runs, aircraft taxiing and other on-airport operations (e.g. road traffic, plant and equipment) is considered separately in Chapter 11.

10.2 Understanding aircraft noise

10.2.1 Nature of noise

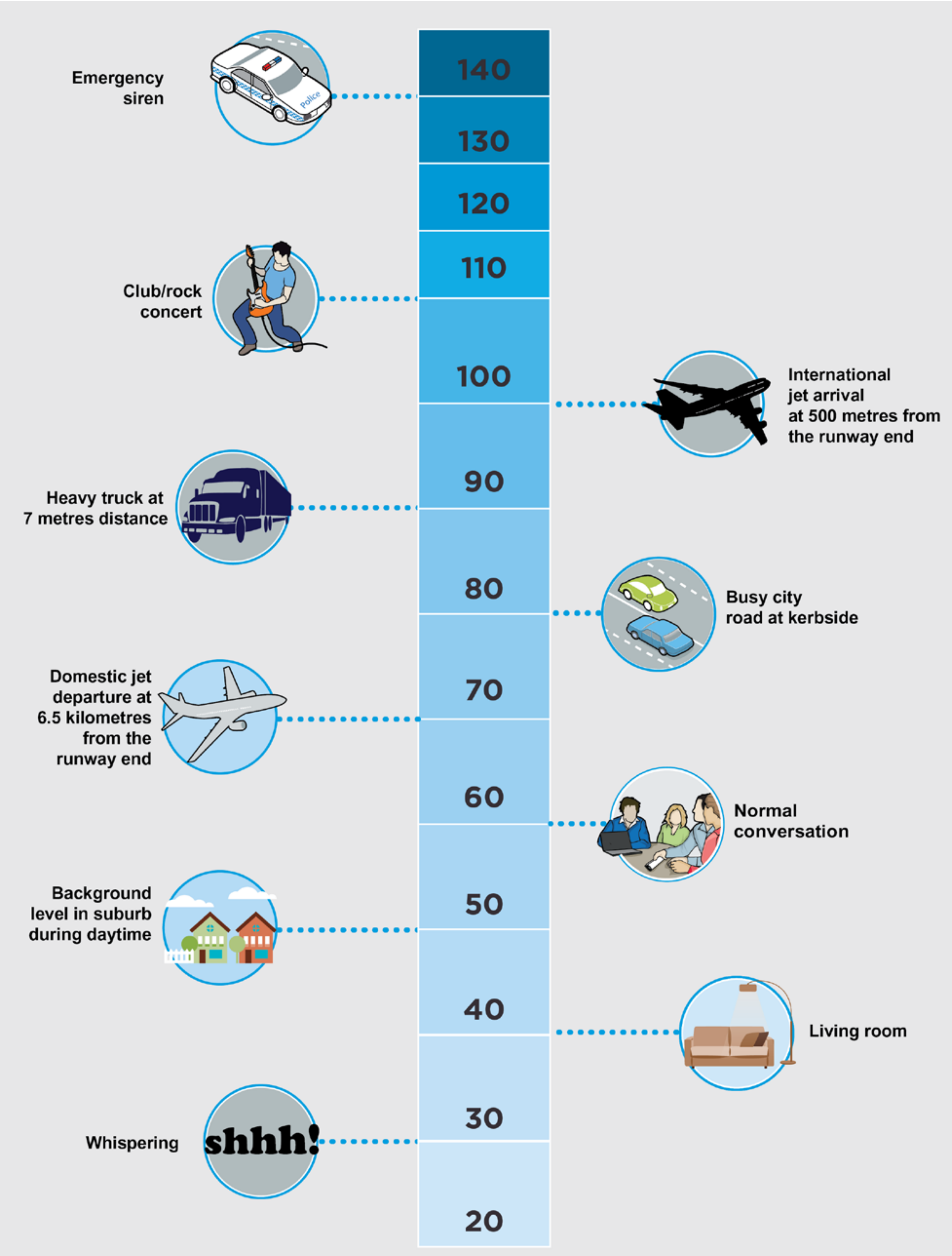
Sound is a vibration travelling as a wave of pressure through the air from a source to a receiver, such as the human ear. The frequency of a sound is what gives it a distinctive pitch or tone – the rumble of distant thunder is an example of a low frequency sound and a whistle is an example of a high frequency sound. The human ear is more sensitive to high frequency sounds.

The loudness of a sound depends on its sound pressure level, which is expressed in decibels (dB). Most sounds we hear in our daily lives have sound pressure levels in the range of 30-90 decibels. A-weighted decibels (dBA) are generally used for the purposes of assessment and have been adjusted to account for the varying sensitivity of the human ear to different frequencies of sound. The main effect of the adjustment is that low and very high frequencies are given less weight.

The sound level in a typical residential home is about 40 dBA. The average noise level of conversation is about 60-65 dBA. Typical levels for listening to music at home are about 85 dBA, while a loud rock concert would produce about 110 dBA. Figure 10–1 illustrates indicative sound levels measured in dBA for these and other typical situations.

In terms of sound perception, 3 dBA is the minimum change in sound level that most people can detect and every 10 dBA increase in sound level is perceived as a doubling of loudness. However, individuals may perceive the same sound differently and may be more or less affected by a particular sound. For example, experience has shown that many factors can influence an individual's response to aircraft noise, including:

- the specific characteristics of the noise (e.g. the frequency, intensity and duration of noise events) and the time of day noise events occur;
- their personal circumstances and expectations about the number, frequency, loudness and timing of noise events;
- their individual sensitivities and lifestyle (e.g. whether they spend a lot of time outdoors or sleep with a window open);
- their reaction to a new noise source (in the case of a new airport or new runway infrastructure) or to changed airport operational procedures;
- their understanding of whether the noise is avoidable and their notions of fairness; and
- their attitudes towards the source of the noise (e.g. general views about aviation activities and airports).



Note: Noise levels adapted from Melbourne Airport website

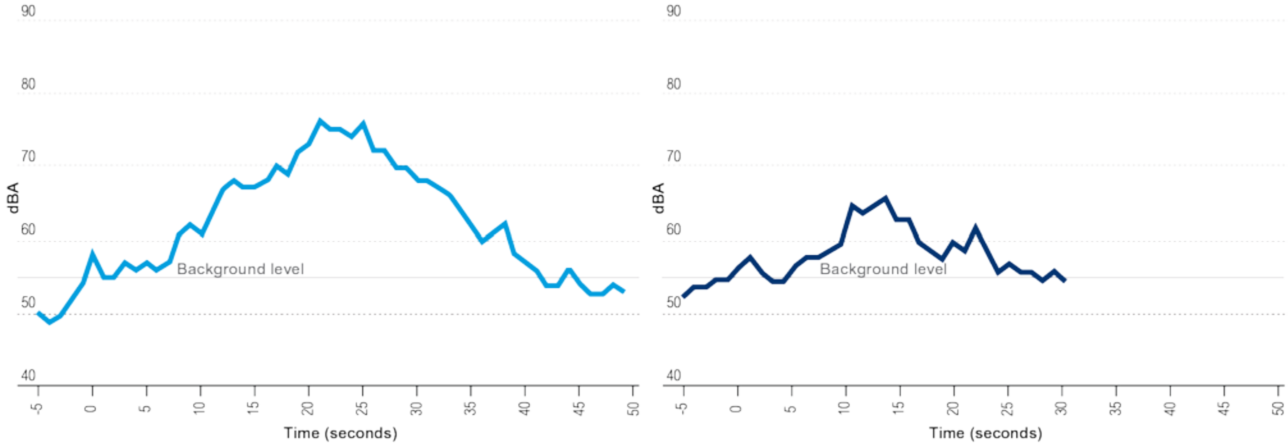
Figure 10–1 Indicative dBA noise levels in typical situations

10.2.2 Typical profile of aircraft noise

Figure 10–2 shows the measured duration and noise level from an overflight of a jet aircraft. The figure on the left shows the noise profile for a flight passing directly overhead of a noise monitor while the figure on the right shows the noise profile measured at a horizontal distance of approximately three kilometres from the flight path.

While the two figures are broadly comparable, there are some notable differences. The noise profile for a jet aircraft flying directly overhead shows that aircraft noise levels rise above the background noise level for approximately 45 seconds and the peak noise level, about 76 dBA, is more than 20 dBA above the background level. In the figure on the right, where the aircraft is further away from the receiver, the duration of the aircraft noise event is approximately 30 seconds or about two-thirds of that measured from the overhead flight. The peak noise level of about 65 dBA is about 10 dBA above the background level.

As indicated above, these key differences in measured noise level and duration from typical aircraft overflights would be perceived differently by individuals in different locations, potentially leading to a different reaction to the measured noise level.



Source: Burgess and McCarty, Acoustics Australia Vol 38 August 2010 No 2

Figure 10–2 Noise profile for a typical jet aircraft overflight

10.2.3 Sources of aircraft noise

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

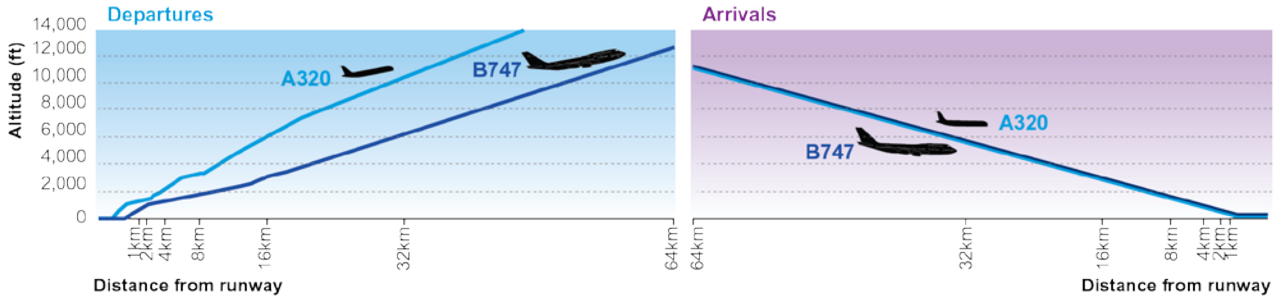
The characteristics of sound from aircraft can vary depending on a range of factors, including the type of engine, the stage of flight, the height of the aircraft and the prevailing meteorological conditions. While there are many sources of noise from an aircraft, including noise generated by the airframe, engines are the dominant source of noise for the majority of the flight cycle.

Engine noise can be particularly pronounced when aircraft are operating on the ground as a result of elevated thrust during take-off and reverse thrust during landing. Reverse thrust noise levels are typically higher than take-off noise levels as a result of the diversion of the engine exhaust to assist with deceleration, which results in a characteristic noise contour bulge surrounding a runway.

The pattern of noise exposure that would result from operation of the proposed airport is complex, and depends on final flight paths and airport operating procedures, time of day, season, weather conditions and other factors.

The Government's primary objectives for the proposed airport are to improve access to aviation services for Western Sydney and solve the long term regular transport capacity constraints in the Sydney basin. Bankstown Airport remains the principal general aviation aerodrome in the Sydney basin. Planning for the proposed airport does not include specific provisions for general aviation facilities, such as helicopters and tourist flight facilities. The potential noise impacts of general aviation operations are therefore not assessed in this EIS. Should such facilities be proposed in the future, they (and any associated aviation activities) would be subject to any relevant requirements of the *Airports Act 1996*.

Generally speaking, aircraft noise levels would decrease with distance from the proposed airport primarily as a result of the higher altitude of aircraft operations. Indicative departure and arrival profiles and associated sound levels for a Boeing 747 and an Airbus A320 aircraft at specified distances from the runway are shown in Figure 10–3.



	Departures – Sound levels (dBA)							Arrivals – Sound levels (dBA)						
	1km	2km	4km	8km	16km	32km	64km	64km	32km	16km	8km	4km	2km	1km
B747	96	92	86	82	75	66	56	51	61	70	79	87	94	100
A320	83	81	74	68	61	54	46	44	54	63	71	79	86	93

This figure provides information on indicative noise levels at certain distances from the end of the runway for A320 and B747 aircraft. The estimates present the height of the aircraft relative to the runway and do not account for local terrain. The indicative noise levels were calculated at the runway height.

Figure 10–3 Indicative sound levels for B747 and A320 aircraft – departures and arrivals

10.2.4 Responsibilities for aircraft noise

A number of organisations have a role in managing aircraft noise. A summary of relevant organisations and their role in managing aircraft noise is provided in Table 10–1. These include the Airport Lessee Company (ALC), the Australian, State and local governments, airlines, aircraft and engine manufacturers, and regulators.

Table 10–1 Responsibilities for managing airport related noise at civilian airports

Organisation	Summary of responsibilities concerning the management of civil aircraft noise
International Civil Aviation Organization ICAO is a United Nations specialised agency established under the Convention on International Civil Aviation (Chicago Convention) that works with member states and global aviation organisations to develop international standards and recommended practices for adoption in national civil aviation regulations.	• Aircraft built today are required to meet ICAO's strict aircraft noise standards. • As an ICAO member state, Australia has adopted laws and regulations to reflect these international standards, for example through the Air Navigation (Aircraft Noise) Regulations 1984.
Airservices Australia Airservices Australia would be responsible for managing aircraft movements at the proposed airport.	Under the *Air Services Act 1995*, Airservices Australia must exercise its powers and perform its functions in a manner that ensures that, as far as is practicable, the environment is protected from the effects of, and the effects associated with, the operation and use of aircraft. In meeting its responsibilities, Airservices Australia: • provides air traffic control management and related airside services to the aviation industry; • prepares and publishes noise abatement procedures; • determines aircraft flight paths and airport operating procedures; • publishes information on aircraft movements, runway and track usage and noise impacts using a range of noise descriptors; • handles aircraft noise complaints and inquiries (other than ground-based noise complaints which would be handled by the ALC); • operates flight and noise monitoring equipment in the vicinity of major airports and publishes results; and • reviews and endorses for technical accuracy the ANEF noise contours for airports.
Australian Government: Aircraft Noise Ombudsman Conducts independent administrative reviews of Airservices Australia's management of aircraft noise-related activities.	The Aircraft Noise Ombudsman: • reviews the handling of complaints or enquiries made to Airservices Australia and the Department of Defence (Defence); • reviews community consultation processes related to aircraft noise for Airservices Australia and Defence; and • reviews the presentation and distribution of aircraft noise-related information for Airservices Australia and Defence.
Airport Lessee Company (ALC) This is the airport lessee and the operator of an airport.	The Airport Lessee Company's responsibilities include: • managing operations at the airport and ensuring the effective delivery and coordination of airport-related services and facilities; • preparing an airport master plan, including publication of an ANEF and an environment strategy that identifies measures to manage noise impacts; • establishing procedures to control noise generated by engine ground running; • engaging with the community; and • managing ground-based noise complaints.

Organisation	Summary of responsibilities concerning the management of civil aircraft noise
Civil Aviation Safety Authority (CASA)	Under the *Civil Aviation Act 1988*, and subject to its primary responsibilities being to maintain, enhance and promote the safety of civil aviation, CASA must exercise its powers and perform its functions in a manner that ensures that, as far as is practicable, the environment is protected from the effects of, and the effects associated with, the operation and use of aircraft. Through the Office of Airspace Regulation, CASA ensures that proposed changes to airspace adequately consider environmental implications.
Infrastructure Minister	The Minister and his or her Department are responsible for administering airports and aviation legislation and developing and implementing national aviation policy. Specific responsibilities relating to the management of aircraft overflight noise include: • approving airport master plans in accordance with the *Airports Act 1996*; • promoting policies and guidance material, such as the National Airports Safeguarding Framework, to support the implementation of best practice land use assessment and planning in the vicinity of airports (e.g. by ensuring due recognition is given to aircraft noise impacts in land use and related planning decisions); • regulation of airport curfews at Sydney, Adelaide, Coolangatta and Essendon airports; and • development of national airspace and air traffic management policies.
Airlines and aircraft operators	Airlines and aircraft operators are responsible for: • maintaining aircraft fleets and engines that meet the ICAO and Australian standards; and • implementing noise abatement principles for flight operations, where applicable.
Aircraft and engine manufacturers	Aircraft and engine manufacturers need to design and manufacture new aircraft that comply with ICAO certification standards.
State government and local councils	State governments and local councils regulate land use planning and development in the vicinity of airports.

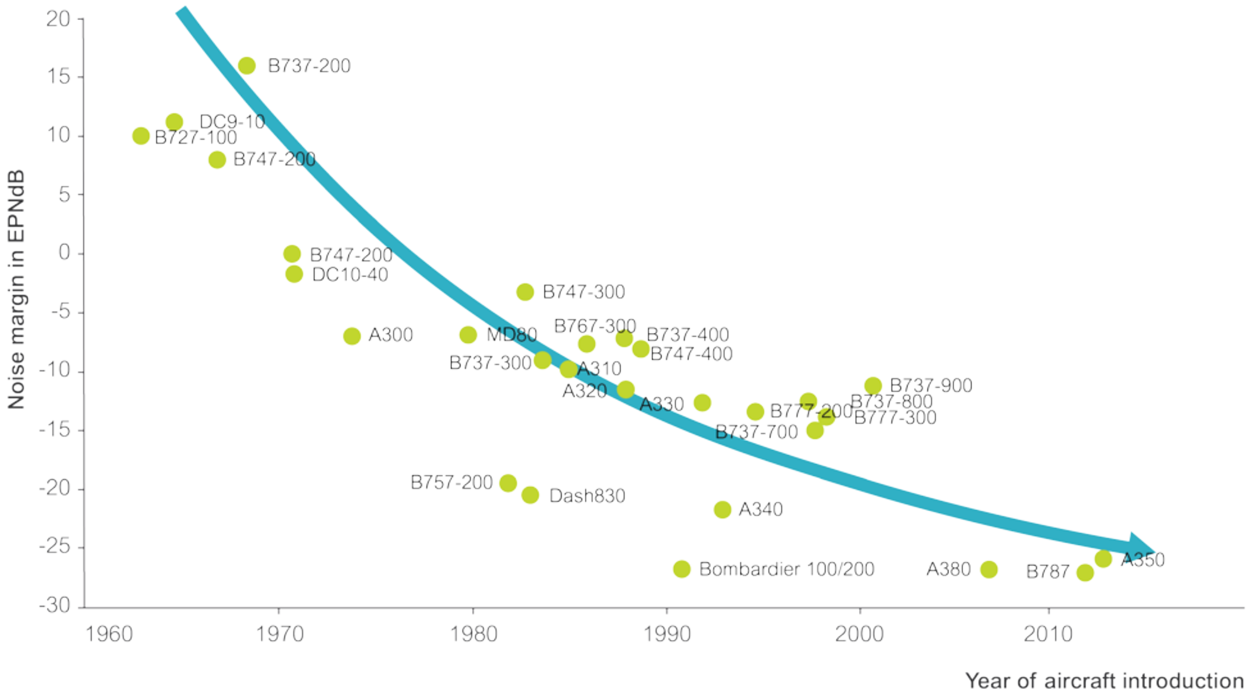
10.2.5 Aircraft noise emissions control

The International Civil Aviation Organization (ICAO) has responsibility for setting noise emissions standards for aircraft globally. The standards are contained in Annex 16, Volume 1 – Procedures for the Noise Certification of Aircraft which underpins the global effort by aircraft manufacturers to design quieter aircraft.

Aircraft operating in Australia must meet noise standards specified in the Air Navigation (Aircraft Noise) Regulations 1984. These regulations require aircraft to be verified as complying with noise standards established by ICAO. The regulations carry strict penalties for operating an aircraft without a noise certificate issued under ICAO standards. The regulations also provide for exceptional circumstances where dispensations may be applied for to enable limited operation of non-compliant aircraft. Dispensations will include conditions that are intended to mitigate the impact of aircraft noise on the community. These regulations ensure that aircraft using airports in Australia—including the proposed airport—whether in flight or on the ground are compliant with internationally accepted noise standards and practices.

Figure 10–4 shows how aircraft have become progressively quieter over the past several decades through the incorporation of new airframe technologies and engine innovations. In 2013, ICAO agreed that more stringent noise standards would apply to all new aircraft types over 55 tonnes in weight submitted for certification on or after 31 December 2017. The amendments include a new noise standard for jet and turboprop aircraft, which represents a reduction of 7 EPNdB[1] relative to the current Chapter 4 cumulative levels.

Despite the likely introduction of these next-generation aircraft in the future, the assessment of noise impacts in this EIS has been based on aircraft types that are commonplace today, including the louder Boeing 747 and the Airbus A320. The Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport and airlines are already beginning to retire it from regular passenger services. The Airbus A320 is an example of a more common type of aircraft expected to operate at the proposed airport.



Source: Brisbane New Parallel Runway EIS, 2007, CANSO and ACI 2015. Composited by GHD 2016.
Note: Noise levels are relative to ICAO Chapter 3 which took effect in 1978.

Figure 10–4 Reduction in commercial aircraft noise over time

[1] EPNdB, or Effective Perceived Noise level in decibels, is used for the certification of aircraft according to ICAO procedures. It is a measure of human annoyance to aircraft noise that takes into account the special spectral characteristics, intensity, tonal content and duration of noise from an aircraft pass-by event. EPNdB values cannot be directly measured. They are calculated using noise monitoring data recorded at certification points that account for different phases of an aircraft movement (e.g. approach and flyover on departure) and the lateral spread of noise.

10.3 Airport operations

10.3.1 Indicative flight paths

Airservices Australia undertook a preliminary assessment of airspace implications and air traffic management arrangements for Sydney region airspace associated with the potential commencement of operations at the proposed airport (see Chapter 7 (Volume 1)). This assessment of aircraft overflight noise is based on indicative flight paths prepared by Airservices Australia. As discussed in Chapter 7 (Volume 1) of this EIS, it is expected that a detailed airspace design process will be undertaken closer to the commencement of operations at the proposed airport.

The principal objective of Airservices Australia's preliminary assessment was to establish whether safe and efficient operations could be introduced at the proposed airport through developing indicative proof-of-concept flight paths. The assessment confirms the basic viability of the proposed airport for both single and parallel runway operations, and shows that the proposed Stage 1 development and Sydney (Kingsford Smith) Airport could safely operate independently as high capacity airports. 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. While the indicative flight paths provide a reasonable and contemporary basis for assessing the potential extent and intensity of impacts associated with aircraft operations at the proposed airport, the conceptual and preliminary airspace design illustrated in this EIS has not been developed to a level of detail necessary for implementation. New flight paths can only be implemented following further analysis, including detailed consideration of potential noise abatement opportunities and extensive community consultation, and final approval by CASA. The process for developing final flight paths, which would commence after determination of the Airport Plan by the Infrastructure Minister, is explained in Chapter 7 (Volume 1).

10.3.2 Operating strategies

Assessment of aircraft overflight noise for the proposed Stage 1 development focuses on the point at which passenger demand reaches approximately 10 million annual passenger movements and related freight movements (referred to as 'Stage 1 operations'). This level of demand is expected to occur around five years after the proposed airport commences operations. At this stage, the airport would comprise a single (northern) runway.

The approximate north-east/south-west or 050/230 degree runway orientation resulted in three primary operating modes being considered:

- Mode 05 – aircraft arrive from the south-west and depart to the north-east;
- Mode 23 – aircraft arrive from the north-east and depart to the south-west; and
- Head-to-head[2] – all landings and take-off movements occur in opposing directions, to and from the south-west.

[2] The feasibility of head-to-head operations would be established as part of the detailed design of air traffic procedures for the proposed airport. The conditions applying to this mode of operation assumed in the noise modelling are based on similar conditions adopted at other airports where head-to-head operations are used.

The availability of each operating mode (described in greater detail in Chapter 7 (Volume 1)) at any given time would depend on meteorological conditions, particularly wind direction and speed, the number of presenting aircraft and the time of day. Due to the relatively low and consistent wind speeds at the airport site, it is likely that either the 05 operating mode or 23 operating mode could be used over 80 per cent of the time based solely on these factors. However, the selection of a preferred or priority operating mode, or a preferred combination of operating modes (i.e. preferred operating strategy), for noise management or other operational purposes has a notable effect on the overall noise impact of the airport. In this context, the preferred operating strategies that were considered as part of the noise impact assessment are as follows:

- Prefer 05 strategy – all aircraft would be directed to approach and land from the south-west and take-off to the north-east. If this is not possible for meteorological or operating policy reasons, then second priority would be given to operations in the opposite direction (i.e. the 23 direction).
- Prefer 23 strategy – all aircraft would be directed to approach and land from the north-east and take-off to the south-west. If this is not possible for meteorological or operating policy reasons, then second priority would be given to operations in the opposite direction (i.e. the 05 direction).
- Prefer 05 strategy with head-to-head – as per Prefer 05, except that during the night time period between 10.00 pm and 7.00 am, the head–to-head operating mode to the south-west would be used when:
    - there are no more than a total of 20 aircraft movements expected in the hour following the relevant time; and
    - wind conditions allow the use of both runway directions.
- Prefer 23 strategy with head-to-head – as per Prefer 05 with head-to-head, except that when the head-to-head operating mode is not in use, Prefer 23 applies rather than Prefer 05.
- If either the Prefer 05 or Prefer 23 operating strategy is in use during the night time period, the operating mode would revert to head-to-head under the following conditions:
    - the use of head-to-head has been allowed for at least two hours before the change time; and
    - the use of head-to-head would be allowed for at least two hours after the change time.

10.3.3 Hours of operation

As the airport is proposed to operate on a curfew-free basis, the assessment of overflight noise considers the operation of the proposed airport over a range of timeframes, including a full operating day (24-hours) and night time hours (10.00 pm–7.00 am). This range of timeframes has been adopted to capture the range of potential noise impacts at sensitive receivers and on particular activities (including the potential for sleep disturbance).

These timeframes are considered in conjunction with the various operating modes discussed in Section 10.3.2 to capture a wide range of potential conditions. The effect of seasonality is also considered as part of the technical paper presented in Appendix E1 (Volume 4). Minimal variation in noise impacts between summer and winter seasons was evident from this analysis.

10.4 Methodology

10.4.1 Assessing aircraft overflight noise

The impact of aircraft noise is dependent on a number of factors, of which four key variables are:

- aircraft noise levels;
- frequency of occurrence;
- duration of each event; and
- the character of aircraft noise (i.e. low frequency rumble, etc.).

A number of different noise measures referenced in Australian Standard 2021:2015 – *Acoustics—Aircraft noise intrusion—Building siting and construction* (AS 2021) and the *National Airports Safeguarding Framework* (NASF) have been used in this EIS. Each measure has different purposes and may include some or all of the above factors. Consistent with best practice communication of aircraft noise impacts, it is important to describe noise using a range of descriptors and to understand the differences in the outputs produced. Table 10–2 summarises each of the measures used in this EIS and how they combine each of the four key aircraft noise variables listed above. A more detailed explanation of each measure is provided below the table.

Table 10–2 Key attributes of noise measures used in this EIS

Noise measure	Aircraft noise levels	Number of events	Duration of events	Aircraft noise character
ANEF/ANEC	Yes, this variable is included in calculating ANEF/ANEC values but this information is not discernible from the output.	Yes, this variable is included within the calculations but this information is not discernible from the output.	Yes, this is included within the calculations but this information is not discernible from the output.	Yes, ANEF/ANEC is based on the Effective Perceived Noise Level (EPNL), which includes modification for noise tonal characteristics.
N70/60	Partially – this is included in the calculations but noise level information is grouped within bands and areas exposed to higher noise levels are not readily discernible.	Yes this information is illustrated in contours of equal numbers of noise events.	No	No
Single event or maximum noise level (L_{Amax})	Yes, the output indicates the maximum noise level from a single (chosen) aircraft type.	No	No	No

10.4.1.1 ANEF and ANEC

For land use planning around airports, Australia has adopted the Australian Noise Exposure Forecast (ANEF) system, which describes cumulative aircraft noise for an 'average annual day'. The ANEF system was developed on the basis of social survey data which aimed to correlate aircraft noise exposure with community reaction in residential areas. The ANEF system is useful for controlling new noise sensitive developments near airports. It is not intended to present information about the nature or potential impact of aircraft noise the community may experience on a day-to-day basis.

An "ANEF chart" is a set of noise exposure contours for an airport that has been formally endorsed for technical accuracy by Airservices Australia. The Airports Act requires all major airports to produce an ANEF chart for inclusion in their airport master plan.

An Australian Noise Exposure Concept (ANEC) is a noise exposure chart produced for a hypothetical future airport usage pattern, and is useful for considering the land use planning consequences of alternative operating strategies. ANEC noise exposure contours are calculated using the same methods as the ANEF; however, they use indicative data on aircraft types, aircraft operations and flight paths. They are generally used in environmental assessments to depict and compare noise exposure levels for different flight path options.

AS2021 contains advice on the acceptability of building sites based on ANEF zones. The acceptability criteria vary depending on the type of land use as shown in Table 10–3. An aircraft noise exposure level of less than 20 ANEF is considered acceptable for the building of new residential dwellings.

Table 10–3 Building site acceptability based on ANEF zone (AS 2021)

Building Type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Public building	Less than 20 ANEF	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial		Acceptable in all ANEF zones	

This EIS has calculated ANECs to describe specific elements of aircraft noise and to allow comparison with ANECs produced for previous environmental assessments for an airport at Badgerys Creek. It is important to note that areas within the 20 ANEF/ANEC contours do not represent the only areas in which aircraft noise may be experienced or that residents outside of these contours will not be annoyed by aircraft noise. Some individuals may be relatively unaffected by noise within the highest ANEF/ANEC contour zones, while others may be seriously affected by relatively low levels of noise in areas outside the lowest depicted contours.

A series of ANECs[3] was developed for the 1985 *Second Sydney Airport Site Selection Programme Draft Environmental Impact Statement* (1985 Draft EIS) (Kinhill Stearns 1985). These contours have guided subsequent planning controls implemented by the NSW Government and relevant local councils in the vicinity of the airport site.

Planning controls that are implemented based on an ANEF typically serve to limit the types of development permitted to occur within particular noise exposure zones.

The key planning decision made subsequent to the 1985 Draft EIS is the ministerial direction under section 117(2) of the *Environmental Planning and Assessment Act 1979* (NSW). The direction applies to all land within the 20 ANEF contour in the local government areas of Fairfield, Liverpool, Penrith and Wollondilly and requires that planning instruments do not contain provisions enabling development that could hinder the potential for development of a second Sydney Airport. The direction has subsequently been given effect through the *Penrith Local Environmental Plan 2010* and *Liverpool Local Environmental Plan 2008,* with the inclusion of provisions aimed at preserving noise related buffers around the airport site (see Chapter 21). This has resulted in limited noise sensitive development around the airport site.

It is expected that a formal ANEF would be produced and endorsed by Airservices Australia prior to the commencement of operations at the proposed airport, as described in Chapter 7 (Volume 1).

While useful for land use planning purposes, there are limitations in using the ANEF system as an accurate or reliable predictor of community reaction to aircraft noise or of impacts on people as individuals. Data produced by the ANEF system have also been shown to be difficult for people to interpret. This is largely because these data represent cumulative noise exposure levels for an ‘average annual day’ and do not reflect how people experience noise events in their day to day lives. Also, this approach does not generally portray variations in patterns of noise exposure (e.g. from day to day, season to season or at different times of the day).

In isolation, ANEF/ANEC data do not enable people potentially exposed to aircraft noise to make a reasoned judgement on whether the predicted level of noise would be acceptable to them, particularly in an environment of changing noise exposure (DASETT 1991) or where the number of aircraft movements changes substantially over a period. Accordingly, this EIS presents updated and long term ANEC contours for the purpose of showing those areas around the airport site potentially subject to future aircraft noise-related planning controls, which are currently based on 30-year old predictions of aircraft noise exposure.

10.4.1.2 ‘Number Above’ measures

Noise measures based on the intensity and frequency of individual aircraft noise events provide a more realistic and effective way of conveying information to the public about aircraft noise impacts. These measures potentially offer a more easily interpreted measure of noise impact compared to cumulative measures such as the ANEC/ANEF, for example, as indicators of disturbance to communication, sleep and every-day activities such as listening to the television or the radio. Interruption to these types of activities represents some of the most common causes of annoyance from aircraft noise (Environment Australia 1999). Measures that more explicitly portray the number of aircraft movements may also be more effective for communicating aircraft noise impact as over time individual aircraft events have become quieter but the frequency of movements has increased.

[3] The 1985 EIS included a scenario-based noise exposure chart in the form of an “ANEF”, which we would today term an “ANEC”.

‘Number Above’ (NXX) measures indicate the average number of aircraft overflights per day (or other nominated time period) exceeding a specified noise level (XX dBA). The N70 and N60 measures are commonly used in environmental impact assessments to better inform strategic planning and provide more comprehensive and understandable information on aircraft noise for communities.

- N70 – this is the average number of aircraft noise events per day with maximum noise levels exceeding 70 dBA. A noise level of 70 dBA outside a building would generally result in an internal noise level of approximately 60 dBA, i.e. a reduction of 10 dBA if windows are partly open. This noise level is sufficient to disturb conversation, such that a speaker would generally need to raise their voice to be understood or some words may be missed in speech from a television or radio. If windows are closed, an external noise of 70 dBA would result in an internal noise level of approximately 50 dBA; and
- N60 – this is the average number of aircraft noise events with maximum noise levels exceeding 60 dBA during the night-time period 10:00 pm – 7:00 am. An external noise level of 60 dBA approximates an internal level of 50 dBA if windows are partly open or 40 dBA if windows are closed. An internal noise level of 50 dBA is commonly used as a design criterion for noise in a bedroom, to protect against sleep disturbance. An outdoor noise criterion of 60 dBA is also considered appropriate for recreation areas, both passive and active, on the basis that at this level, a person may need to raise their voice to be properly heard in conversations.

Standard calculations of N70 and N60 represent an average over all days (or all days in a specified season or period), and may not provide a representative measure if the number of events above 70 dBA or 60 dBA varies significantly between days. To overcome this potential shortcoming, this EIS has also calculated modified N70 and N60 values (known as 90th percentile N70s and N60s) to identify the upper range of aircraft movements likely to be experienced. The 90th percentile is a statistical category representing noise values that would be exceeded on only 10 per cent of days. Accordingly, the 90th percentile N70 and N60 values represent days where there would be a particularly high number of aircraft movements and may therefore be likened to a near worst case scenario compared to the standard ‘average’ N70 or N60.

While ‘Number Above’ data show the number of events that are predicted to exceed a certain noise level at a given location, they do not show the intensity of noise to be experienced at that location from individual flyovers. That is, two different locations having the same N70 value may be exposed to different noise exposure levels (e.g. one location may generally experience noise levels in the 70 dBA to 75 dBA range, while another location closer to an airport may generally experience the same number of events but at a noise level of between 80 dBA to 85 dBA). Also, experience at other airports has shown that a large number or concentration of low noise events may result in similar levels of annoyance as a small number of high noise events.

10.4.1.3 Single event or maximum noise level

L_{Amax} is the maximum A-weighted noise level predicted or recorded over a period. In this assessment, L_{Amax} denotes the maximum level of noise predicted at a location during a single overflight from a particular aircraft occurring at any time.

10.4.1.4 Population exposure estimates

An estimate of the population likely to be exposed to particular levels of noise—based on the N70 and N60 measures—has also been calculated to show differences resulting from the use of different runway operating strategies, e.g. Prefer 05 and Prefer 23. These estimates show the number of noise events that a proportion of the total future forecast population are predicted to experience.

Existing and forecast population estimates were developed based on the September 2014 release of the NSW Bureau of Transport Statistics population forecasts. These forecasts take into account metropolitan planning development forecasts for future land use in Sydney as well as NSW Department of Planning and Environment population forecasts. The limit of these forecasts is currently 2041; therefore, in order to project to 2063 and beyond, Series B population growth rate estimates used by the Australian Bureau of Statistics in their long term population forecasts were applied.

GIS databases based on the above population forecasts and address point data provided by NSW Land and Property Information were assembled and used to estimate the future population location and distribution. The address point dataset provided a set of GIS coordinates for each registered address point within the data area and was used to represent the spatial distribution of the existing population. The address point data were then divided into subareas based on statistical local area (SLA) boundaries developed for the Census. By matching the population estimates and address points to a common SLA, an estimated population per SLA and average population per address point were calculated.

The noise contours generated by the noise studies were then overlaid with the address point dataset for each forecast year to enable a count of future population potentially affected by each airport operational scenario.

10.4.2 Aircraft overflight noise modelling

The modelling of aircraft overflight noise uses information and projections from a number of sources, including projected air traffic volumes, aircraft flight paths, airport operating modes, assumed fleet mix and scheduling, noise emissions from representative aircraft types, and predicted future population densities in areas around the airport. A summary of the modelling process is described below and shown in Figure 10–5. Full details of the noise assessment methodology are included in Chapter 2 of Appendix E1 (Volume 4).

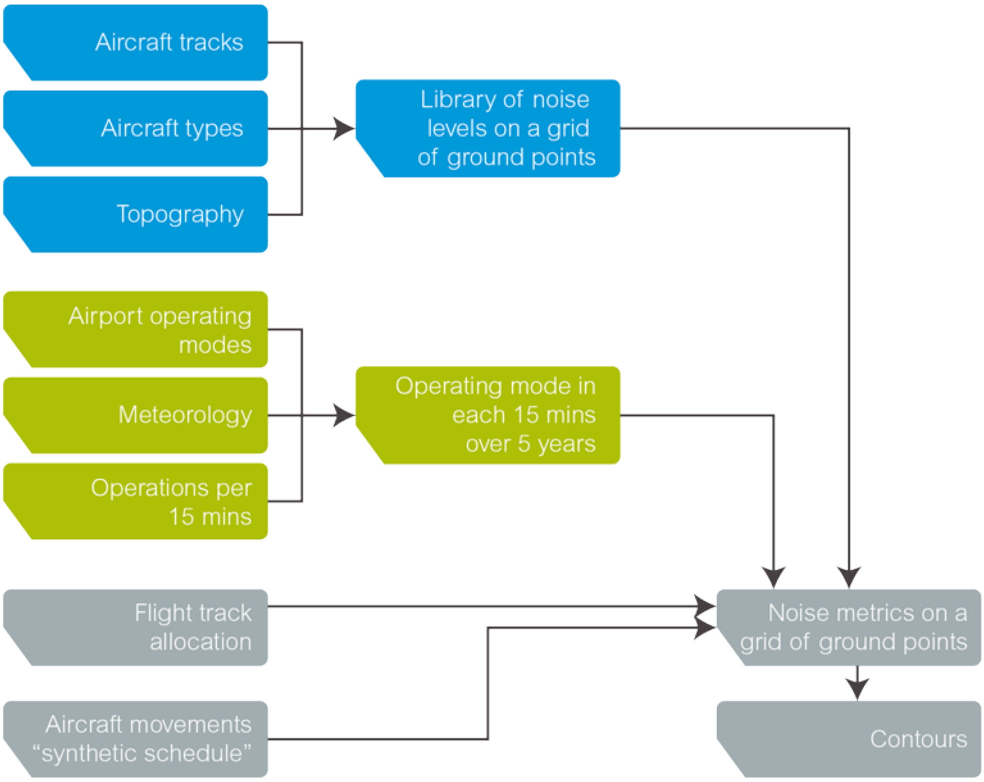


Figure 10–5 Noise modelling process

The Integrated Noise Model (INM) aircraft noise prediction software, produced by the US Federal Aviation Administration, was used to predict noise levels from each of the 22 aircraft types on the 245 indicative flight paths for Stage 1 operations. The model includes aircraft overflight noise together with departure noise, landing and reverse thrust noise when the aircraft is on the runway.

Predicted future numbers of aircraft movements (one movement consists of an aircraft either taking off or landing) were in the form of 'synthetic schedules' which detail a list of aircraft operations for a typical busy day[4], including aircraft family, operation type (arrival or departure), time of operation and port of origin or destination for each operation.

Predicted total daily aircraft movements for Stage 1 operations (see Section 2.5 in Appendix E1 (Volume 4)) are summarised in Table 10–4 and the predicted number of movements for each hour of the day is shown in Figure 10–6.

[4] The proposed Stage 1 airport development assumes 63,000 aircraft movements per year, which equates to about 173 aircraft movements per day. The synthetic schedule used as a basis for all noise modelling assumes that 198 aircraft movements would occur at the proposed airport each day. The aircraft traffic levels used in the noise modelling are therefore representative of those expected on a 'typical busy day'. This provides some conservatism in estimates of noise exposure. For simplicity, these 'conservative' noise exposure outcomes are referred to as 'average' outcomes throughout this assessment.

Table 10–4 Predicted daily aircraft movements for Stage 1 operations by aircraft family

Aircraft	Daily movements
Passenger Movements	
Airbus A320	100
Airbus A330	18
Airbus A380	–
Boeing 737	28
Boeing wide-body general	–
Boeing 777	4
DeHaviland DHC8	8
Saab 340	12
Freight Movements	
Airbus A330	2
Boeing 737	2
Boeing 747	10
Boeing 767	4
Boeing 777-300	–
Small Freight	10

The aircraft types shown in Table 10–4 were used to calculate noise exposure levels in the noise modelling software. The use of these representative aircraft types is considered to be a conservative assumption as aircraft are predicted to become progressively quieter with the introduction of new models into service over time.

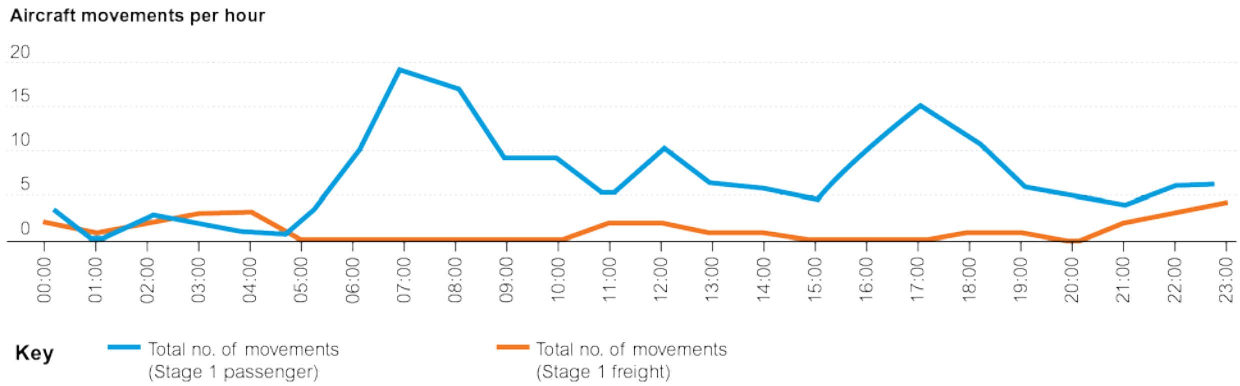


Figure 10–6 Predicted aircraft movements per hour for Stage 1 operations

An airport operating mode was assigned for each 15-minute period over the five years covered by the meteorological data, using the rules for operating mode selection described in Section 10.3.2. Aircraft operations occurring in that 15-minute period (taken from the synthetic schedule) were then assigned to flight paths according to meteorological conditions, visual or instrument landing conditions (for arrivals), aircraft type (e.g. assignment of only turboprop aircraft to certain flight paths) and the direction of the destination airport (for departures).

Arrival flight paths were assumed to follow a ‘point merge’ configuration where all aircraft approaching the airport pass over a single point to the north of the airport then move to a final approach in either of the two runway directions (see Chapter 7 (Volume 1)).

The Point Merge system is a way of synchronising arriving aircraft and directing them to the runway in a structured manner. By directing aircraft though a series of predictable routes, the vertical and lateral path taken on approach is more accurate and can result in a reduction of the number of level flight segments required during descent. The system may help to reduce fuel consumption, emissions and noise impacts, as it allows for a continuous descent profile and therefore limits use of engine power settings above idle. Figure 10–7 illustrates the zone of potential noise benefit from a continuous descent approach. The concept of a continuous descent approach and Point Merge system is explained in further detail in Chapter 7 (Volume 1).

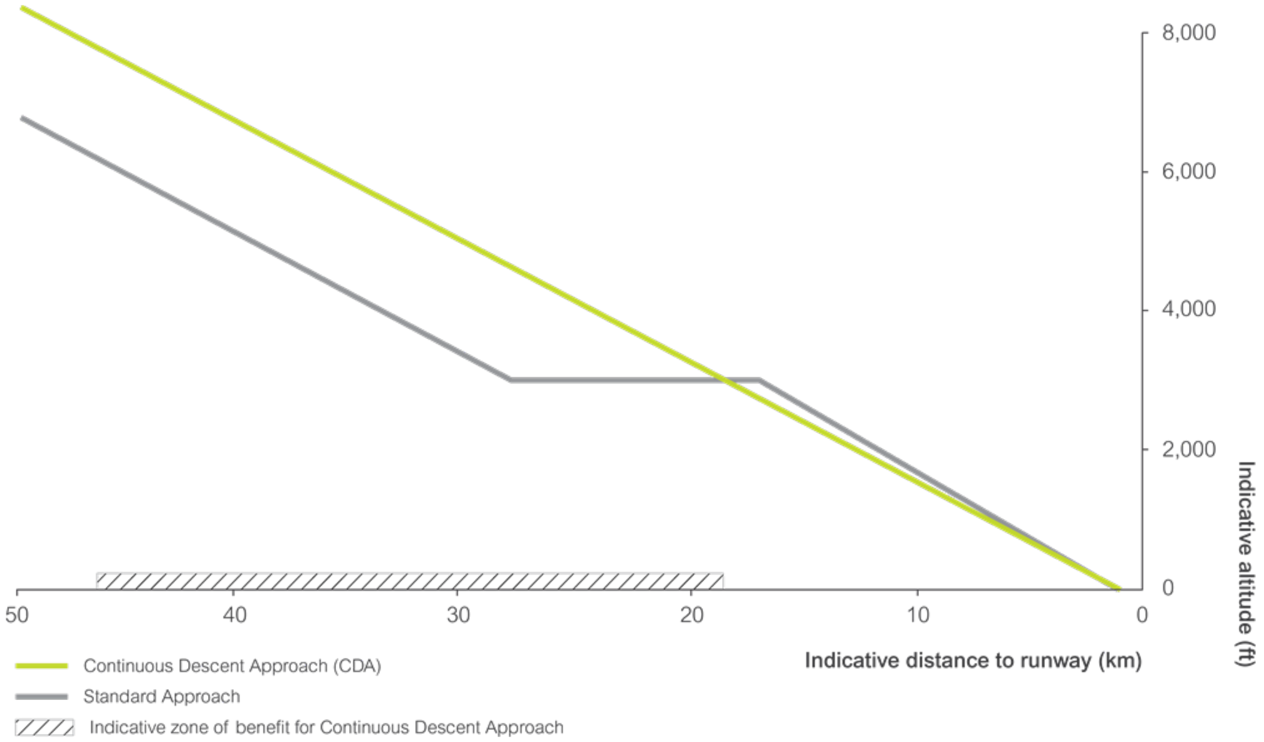


Figure 10–7 Concept diagram of continuous descent approach showing zone of noise benefit

For each aircraft type, flight path and possible stage length (a measure of distance to destination for departing aircraft), specialist software was used to calculate noise levels at each point on a 185 x 185 metre grid, covering the assessment area. Maximum noise levels for every aircraft movement within this assessment area were used to form the ‘library of noise levels’ shown in Figure 10–5.

For N70 and similar units, this library was used to determine the number of events at each grid point exceeding the relevant L_{Amax} threshold, and the results used to produce contours.

10.5 Assessment of aircraft noise impacts

10.5.1 Sensitive receivers

Aircraft noise would be experienced across a broad area of Western Sydney as a result of aircraft arrival and departures at the proposed airport. Noise contour maps have been produced at a range of scales which represent the geographic extent of exposure for each noise assessment measure adopted as part of the analysis. For example, maximum noise levels during a single overflight from a particular aircraft have the widest potential geographic exposure and have therefore been mapped at a relatively small scale. “Number above” measures affect a comparatively smaller geographic area and therefore the noise contours have been presented on maps with a larger scale and show more detailed information.

Sensitive receivers located in proximity to the airport would generally be exposed to higher levels of aircraft noise. Maximum single event noise contours have therefore also been produced at a meso scale (zoomed in) to provide higher resolution mapping of noise exposure near to the airport site.

Noise-sensitive receivers in the area surrounding the proposed airport are represented in Figure 10–8. Noise sensitive receivers include residences, recreational areas, schools and other educational facilities, hospitals and other health care facilities. The noise assessment has primarily focussed upon the size of the affected population for each noise assessment measure and the impact upon surrounding recreational areas. More detailed consideration of impacts on individuals and to other potentially affected sensitive receivers such as schools and hospitals is provided in the community health and social assessments (Chapter 13 and Chapter 23 respectively) of this EIS. Consideration of potential impacts on the Greater Blue Mountains World Heritage Area is presented in Chapter 26.

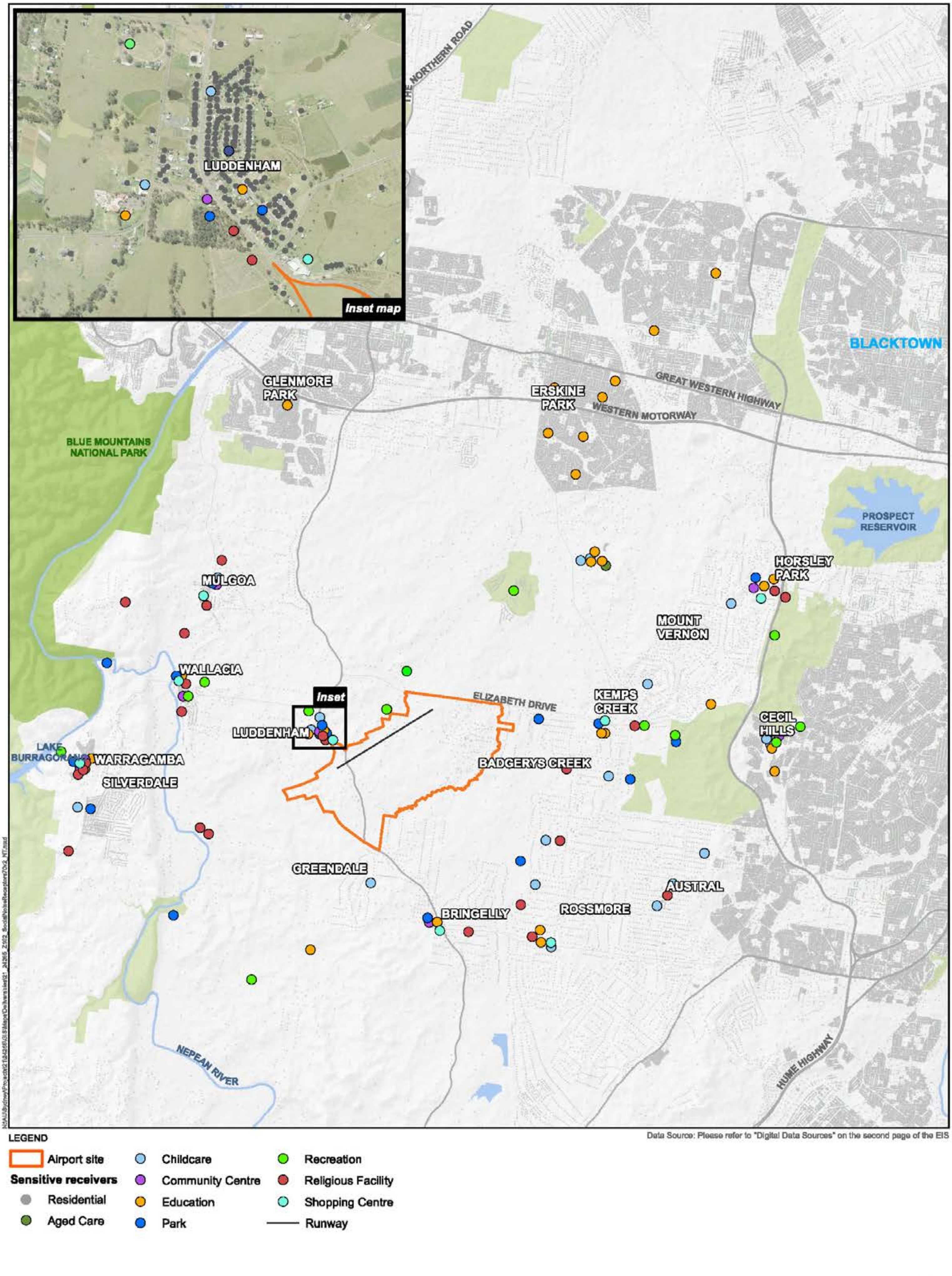


Figure 10-8 - Sensitive Receivers surrounding the airport site

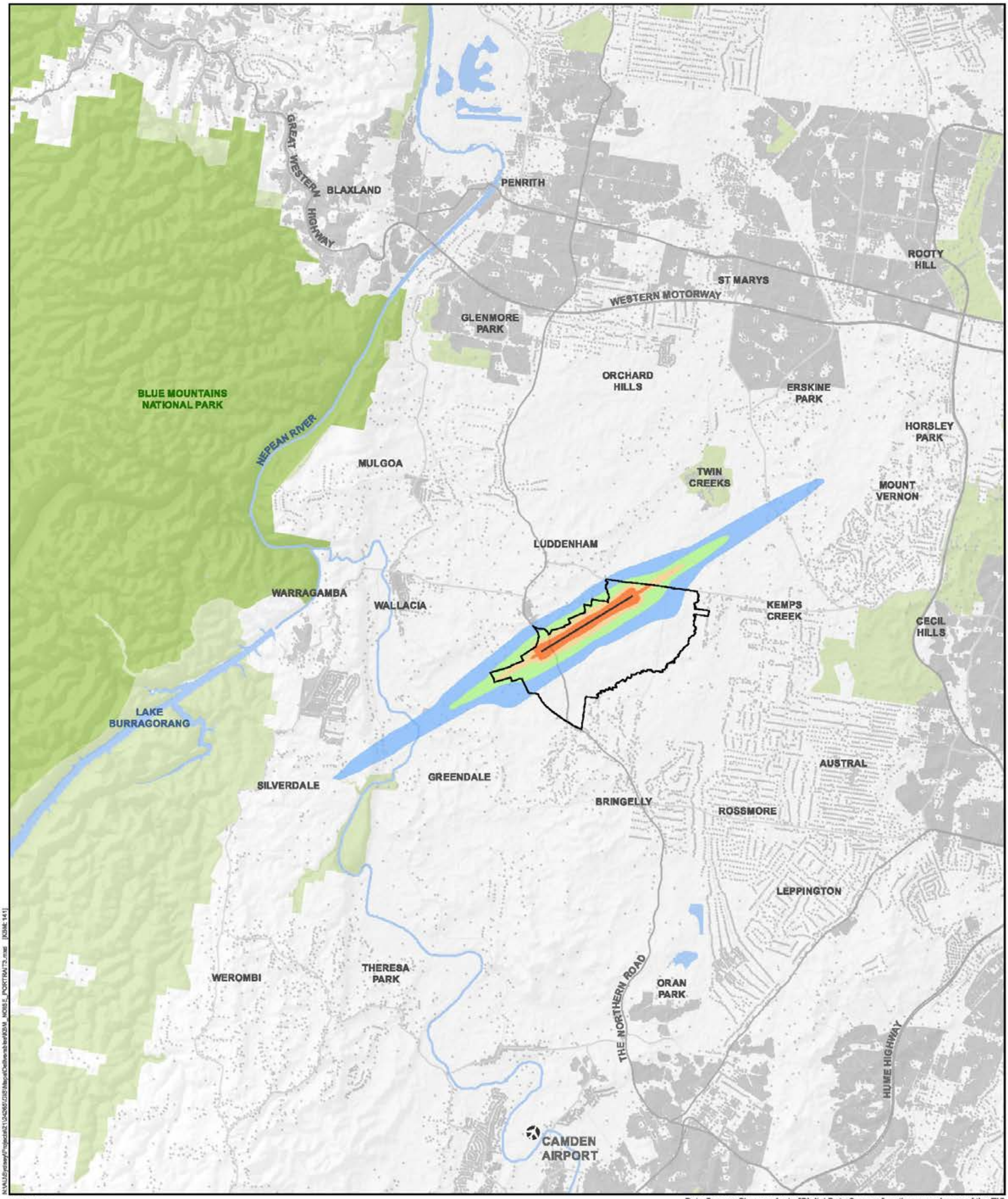
10.5.2 Land use planning implications

ANEC contours have been developed based on indicative flight paths and operating strategies to provide an indication of the likely acceptability of building types based upon AS 2021. An endorsed ANEF noise exposure chart would be produced prior to commencement of operations at the proposed airport. Figure 10–9 shows the Stage 1 operations ANEC contours for the combined Prefer 05 and Prefer 23 operating strategies.

Figure 10–10 shows the combined ANEC 20 contour for Stage 1 operations compared to the ANEC 20 contour presented in the 1985 Draft EIS (Kinhill Stearns 1985). The 1985 ANECs were prepared for a dual runway airport and have been used for land use planning purposes to date.

These figures show that the new 2030 ANEC contour is generally less extensive than that developed for the 1985 Draft EIS (Kinhill Stearns 1985). It is important to note that the ANEC contours for the proposed Stage 1 development are not intended to guide future land use planning and are provided primarily for comparative purposes and to provide information about predicted noise exposure. It is intended that any change to current land use planning instruments would be based on longer term forecasts of noise exposure and the final airspace design.

While there are differences between the Prefer 05 and Prefer 23 operating strategies, the introduction of head-to-head operations at night does not greatly influence the contours (see Section 3.6 of Appendix E1 (Volume 4)). This is because even with the additional 6 dBA weighting for night time noise events included in the ANEF formula, overall noise exposure is still dominated by daytime events.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- ANEC = 20-25
- ANEC = 25-30
- ANEC = 30-35
- ANEC = 35+

0 1 2 4
Kilometres

Figure 10-9 - Stage 1 combined ANEC contours – Prefer 05 and Prefer 23 operating strategies

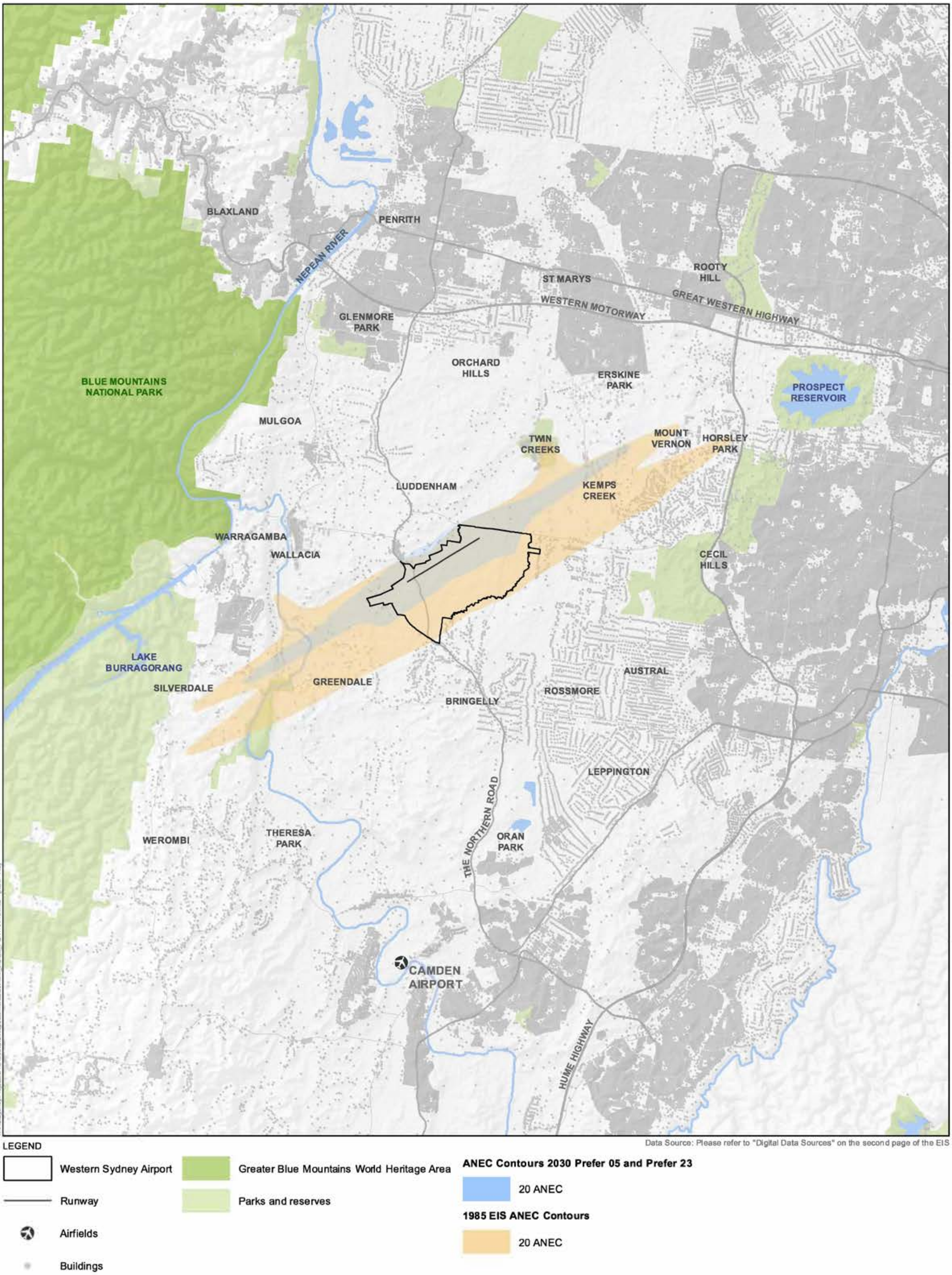


Figure 10-10 1985 ANEC 20 contour compared to Stage 1 operations combined Prefer 05 and 23 ANEC 20 contour

10.5.3 Single event or maximum noise levels

Single-event noise contours depict the maximum (L_{Amax}) noise levels resulting from a single operation of a specific aircraft type on all applicable arrival or departure flight paths.

In the Integrated Noise Model, each aircraft departure is assigned a ‘stage length’, which represents the distance to the aircraft’s destination. Stage 1 is the shortest stage with a destination distance of at least 1,500 nautical miles, while stage 9 is the longest with a destination distance of over 6,500 nautical miles. Aircraft flying greater distances require higher fuel loads and this additional weight at take-off, and its effect on aircraft performance, is taken into account in calculating noise exposure levels.

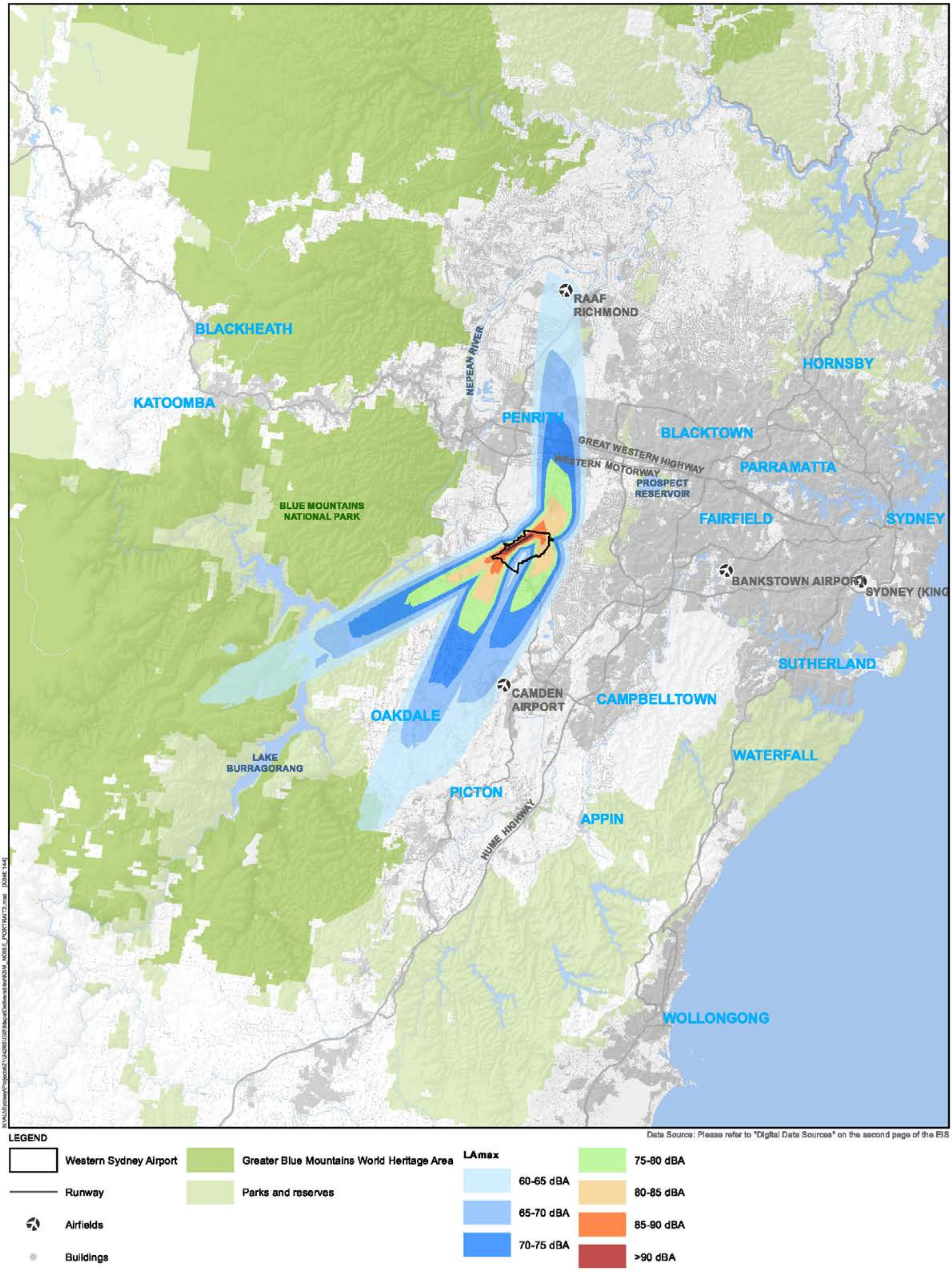
Figure 10–11 shows single-event L_{Amax} noise level contours for the loudest noise event predicted to occur at the proposed airport under this assessment scenario – a B747 departure with stage length 5, corresponding to a departure for Singapore. These events are predicted to occur once per day on average, on any of a number of flight paths. Although contours are shown for these events on paths heading south from the airport, it is very unlikely that a stage 5 departure would occur on these paths.

At the most-affected locations close to the airport, L_{Amax} noise levels from these events would be in the range of 80 to 90 dBA. This is clearly demonstrated in Figure 10–12, a meso scale (zoomed in) version of the single-event L_{Amax} noise level contours for a B747 departure with stage length 5. There are less than 10 existing residences within the 85 dBA L_{Amax} contour for these events, located to the south-west of the proposed airport. When these events occur on the flight path leading north in the 05 operating mode (i.e. departures to the north-east), L_{Amax} noise levels exceeding 70 dBA are predicted over more densely-populated areas around St Marys, with levels above 75 dBA predicted in some parts of Erskine Park.

Figure 10–13 shows L_{Amax} noise levels from a B747 arrival on any flight path. In this case, noise levels of 60 to 70 dBA could be expected over sections of Erskine Park and St Marys, extending to parts of Blacktown as shown at a meso scale in Figure 10–14. Noise levels from this event would also reach 60 dBA in parts of the lower Blue Mountains. In 2030, there are predicted to be five such arrivals per day.

Figure 10–15 to Figure 10–17 show L_{Amax} noise levels for much more common events – departures (stage 4 and stage 1) and arrivals by A320 and similar aircraft types. Stage 3 or 4 departures by A320 aircraft (on any flight path) are predicted to occur 12 times per day for Stage 1 operations. When these events occur to the north in the 05 operating mode, maximum noise levels in parts of St Marys would be up to 64 dBA. For stage 1 or 2 departures (for example, to Brisbane or Melbourne), the maximum noise level over built-up areas is not predicted to exceed 60 dBA.

Arrivals by A320 aircraft, when they occur in the 23 operating mode—from the north-east—are predicted to produce L_{Amax} noise levels exceeding 60 dBA over areas between Erskine Park, St Marys and Blacktown. A320 arrivals in the 05 operating mode—from the south-west—would produce L_{Amax} levels exceeding 60 dBA over limited areas in the Blue Mountains National Park and Greater Blue Mountains World Heritage Area.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Figure 10-11 - Single event B747 departure - stage 5 - on all flight paths

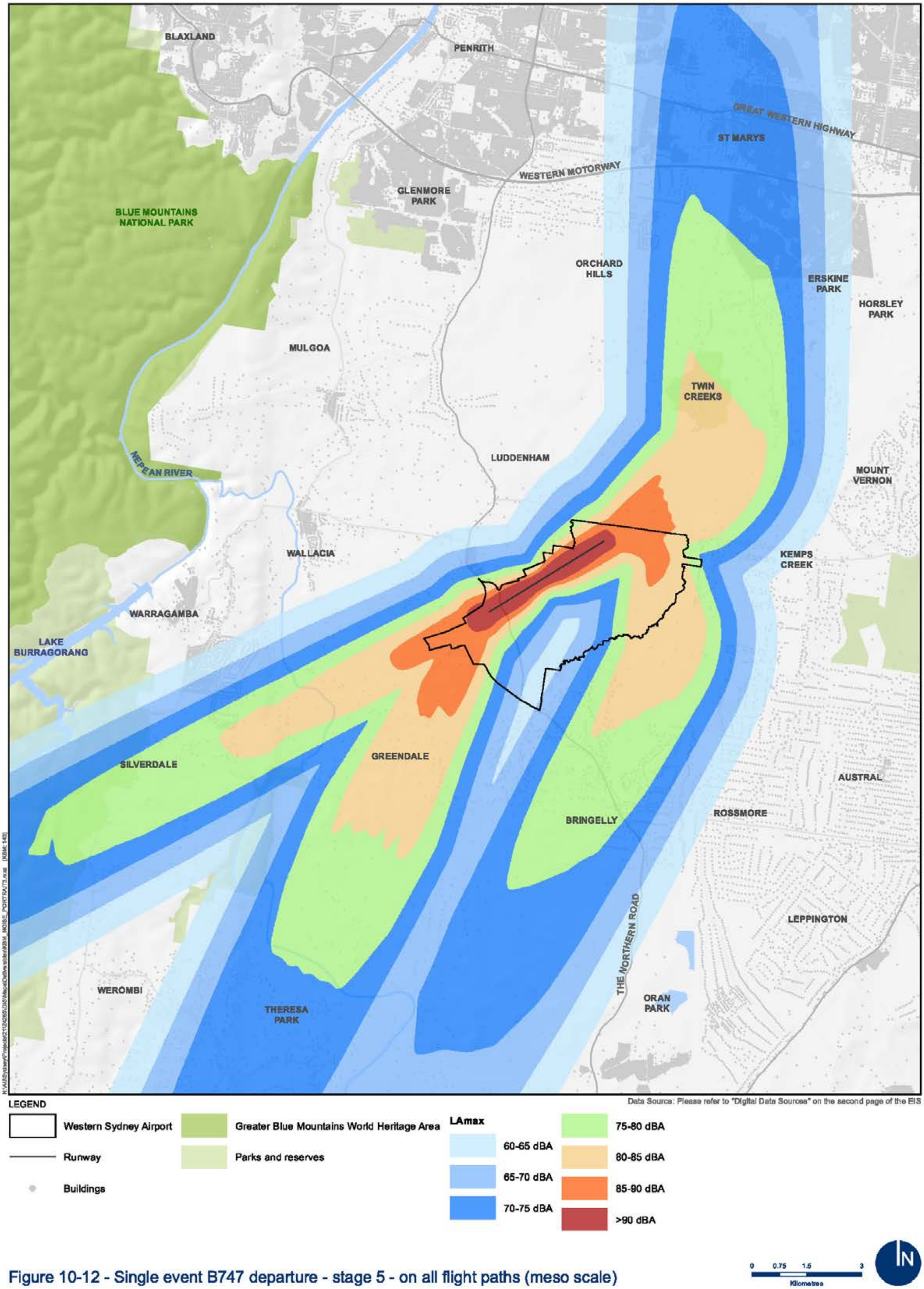
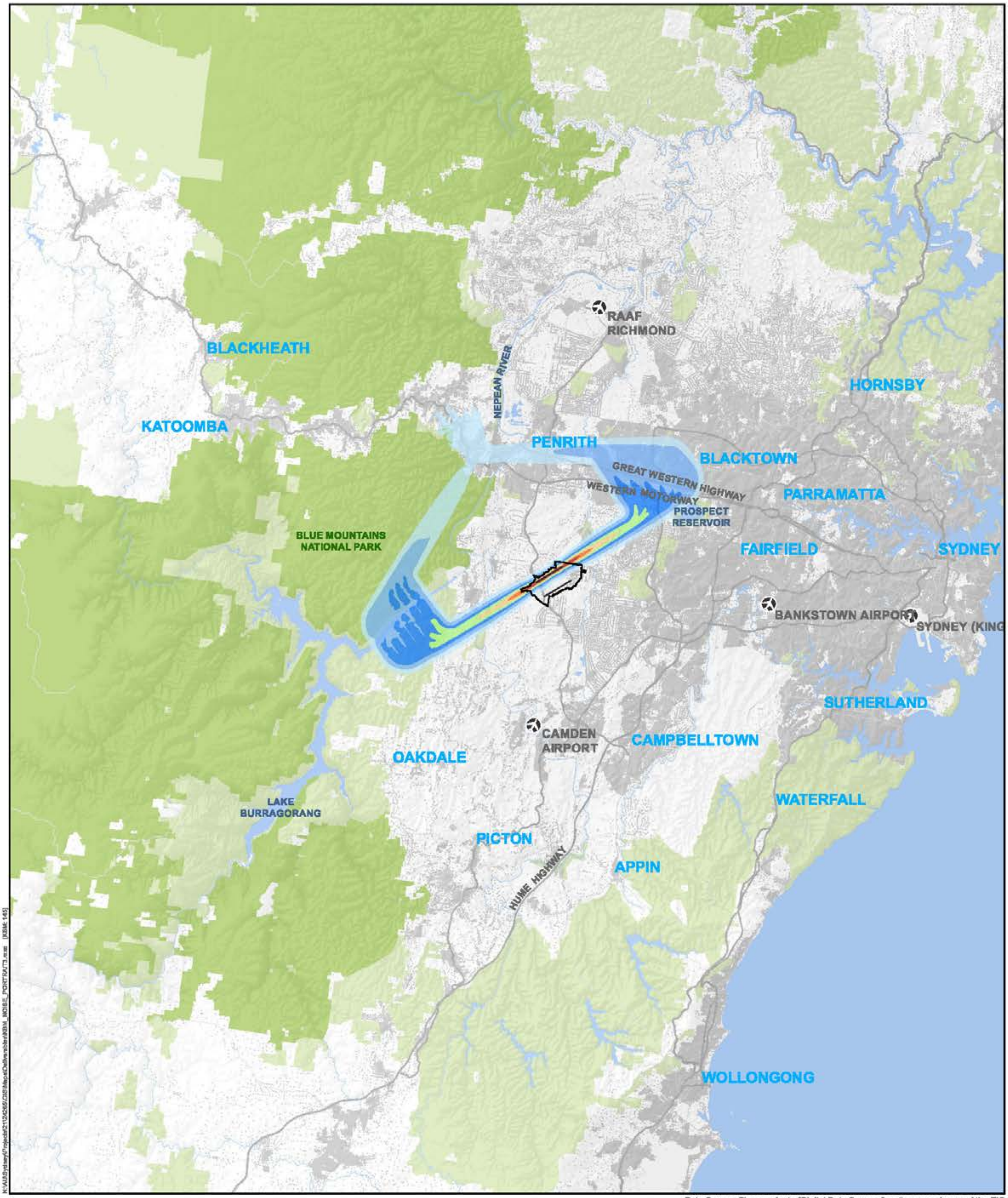


Figure 10-12 - Single event B747 departure - stage 5 - on all flight paths (meso scale)



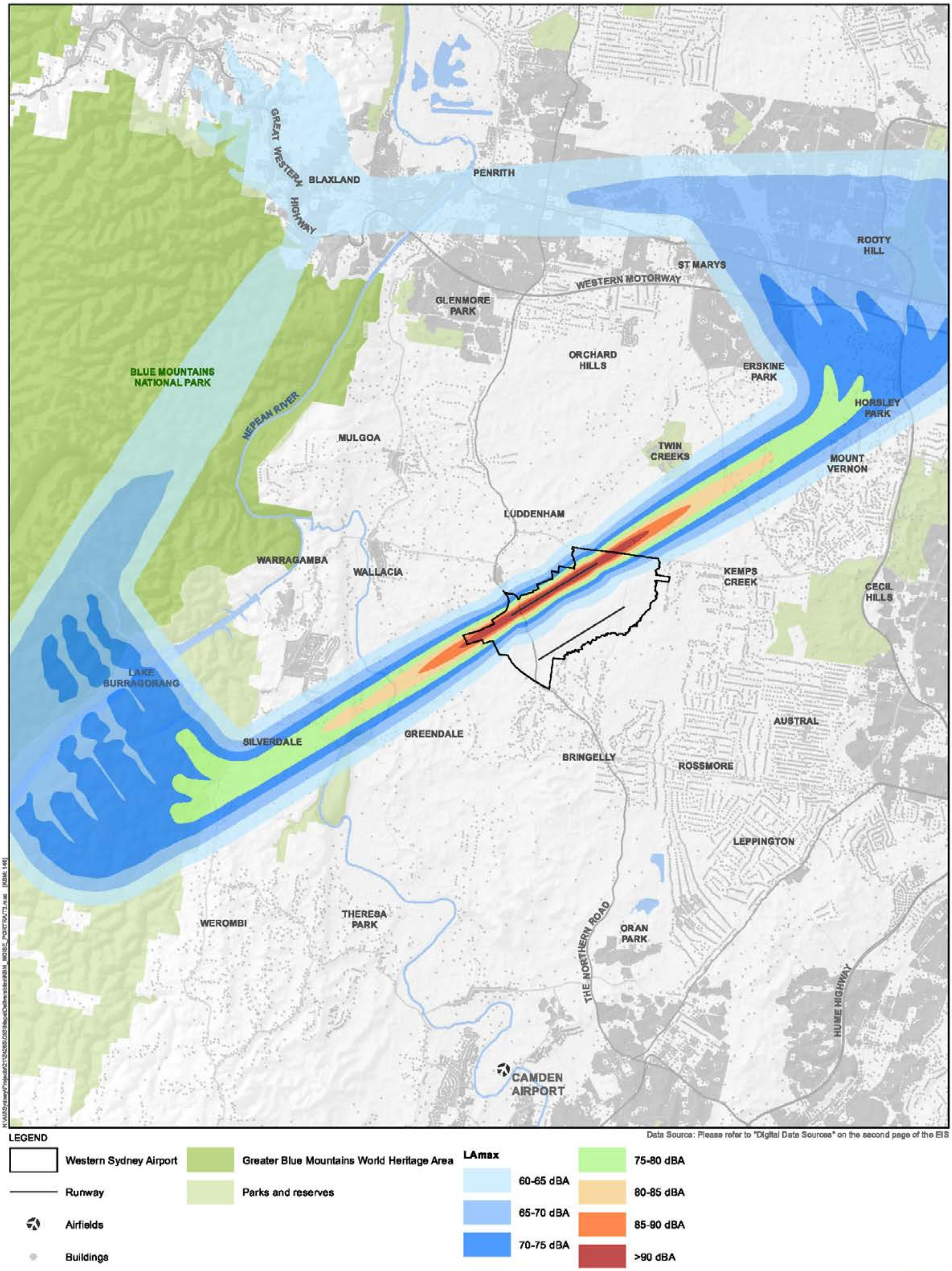
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

Western Sydney Airport	Greater Blue Mountains World Heritage Area	LAmax			75-80 dBA
Runway	Parks and reserves		60-65 dBA		80-85 dBA
Airfields			65-70 dBA		85-90 dBA
Buildings			70-75 dBA		>90 dBA

0 3.5 7 14
Kilometres

Figure 10-13 Single event B747 arrival on all flight paths



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Figure 10-14 Single event B747 arrival on all flight paths (meso scale)

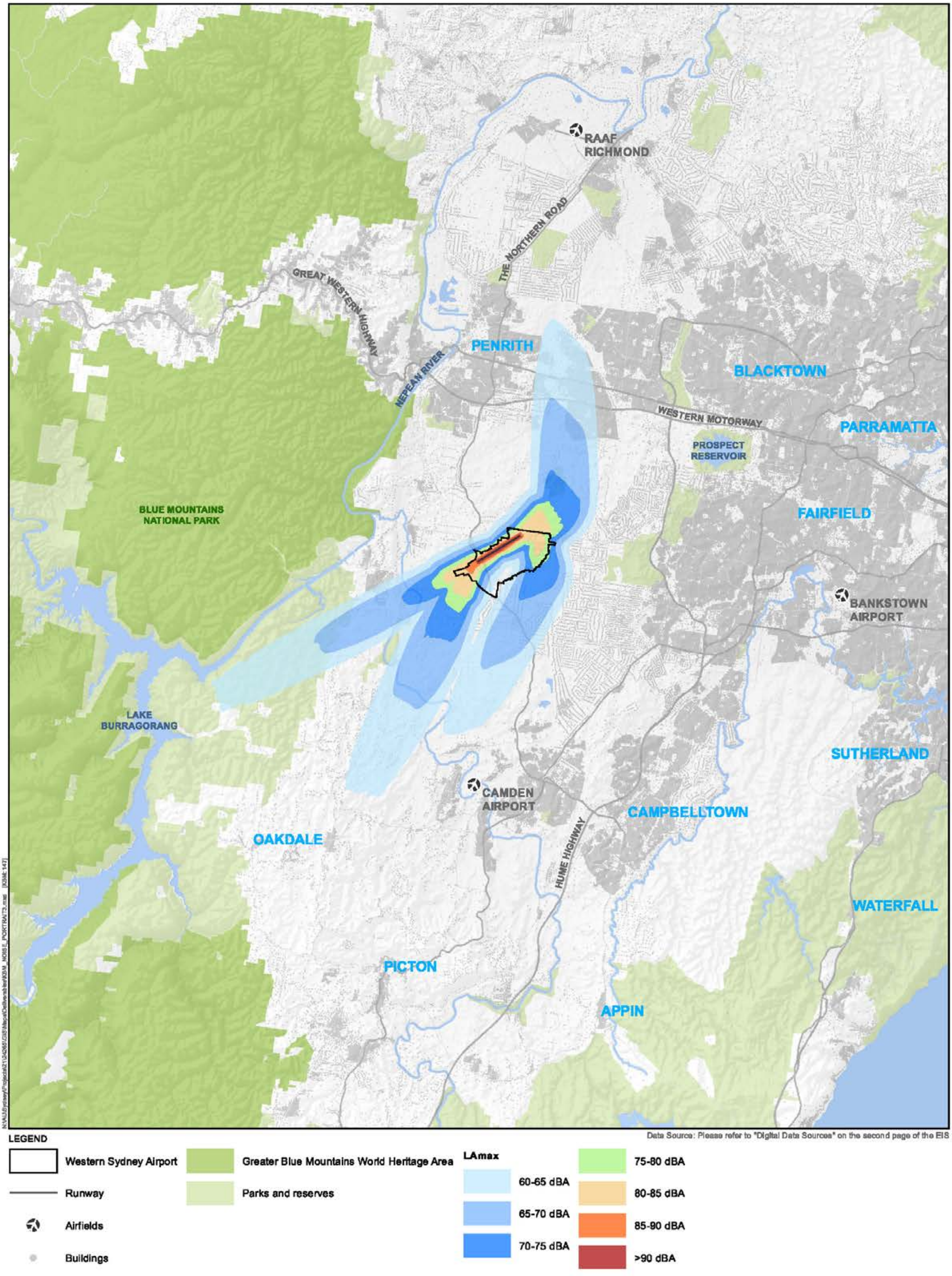


Figure 10-15 - Single event A320 departure - stage 4 - on all flight paths

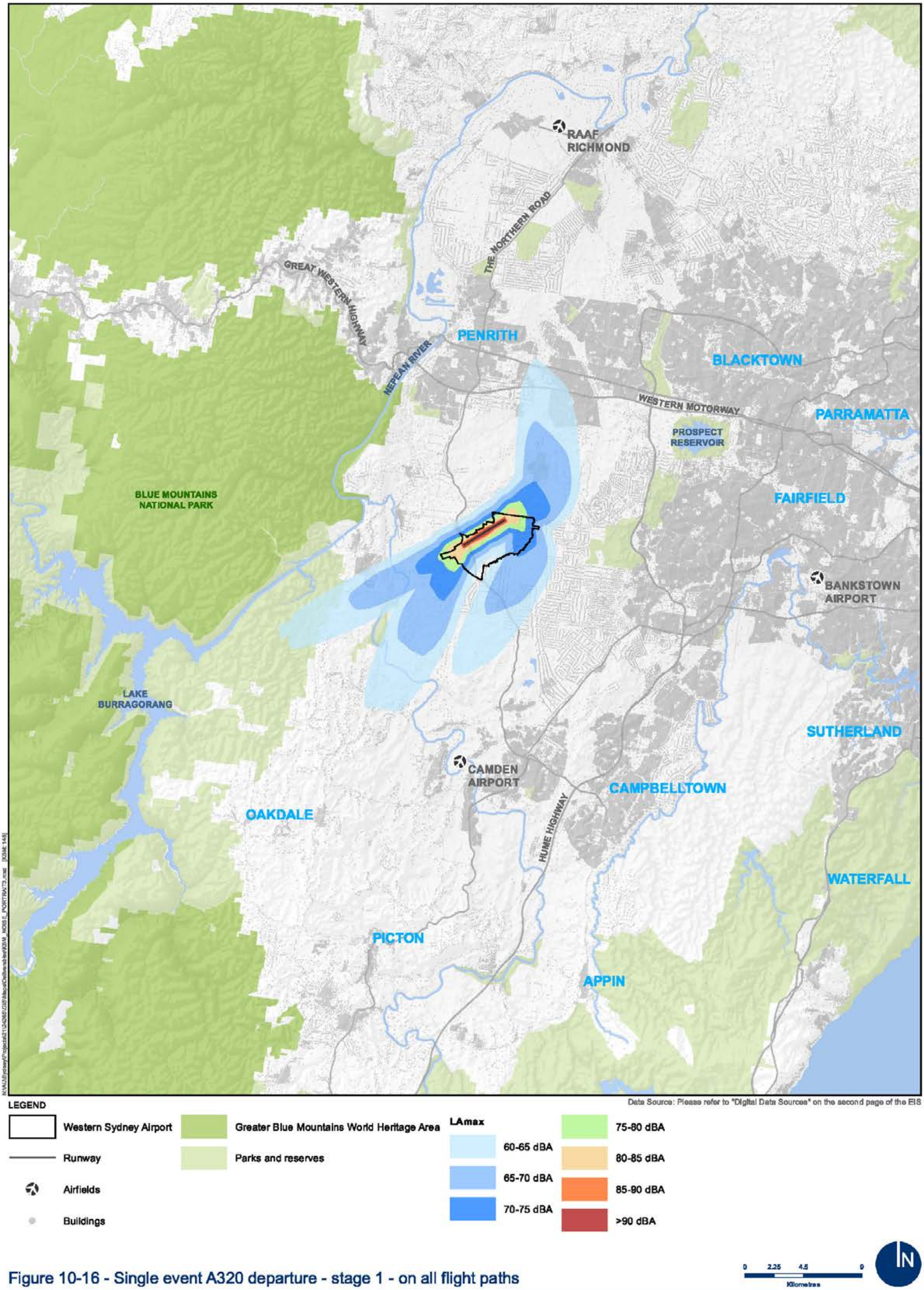


Figure 10-16 - Single event A320 departure - stage 1 - on all flight paths

Figure 10-17 - Single event noise level for an A320 arrival (left) and departure (right)

10.5.4 Noise over 24 hours

10.5.4.1 N70 contours

Aircraft noise exposure over a full day can be described by the number of noise events exceeding 70 dBA, or N70 (see Section 10.4.1).

Calculated N70 noise contours for each of the four airport operating strategies described in Section 10.3.2 are shown on Figure 10–18 to Figure 10–21. These represent the predicted annual average number of movements per day with L_{Amax} noise levels exceeding 70 dBA.

10.5.4.2 90th percentile N70 results

Figure 10–22 and Figure 10–23 show 90th percentile values of N70 calculated over all days. These figures show the number of daily aircraft noise events over 70 dBA that would be exceeded on only 10 per cent of days. This can be thought of as a typical worst case day. Head-to-head operations are not shown as this operating strategy makes very little difference to the results for the 90th percentile N70 values.

The most noticeable aspect of these figures is that generally the difference between noise impact on average and typical worst case days is not large. This is due to the relatively low and consistent wind speeds at the airport site, which means that the proposed airport’s preferred operating strategy could be selected over 80 per cent of the time.

10.5.4.3 N70 population exposure estimates

Table 10–5 shows the population estimated to be affected by noise above 70 dBA from Stage 1 operations on an average day for each operating strategy. The number of people experiencing five or more aircraft noise events per day above 70 dBA would be roughly 1,500–1,600 and would depend very little on which operating strategy is adopted. The Prefer 23 operating strategy results in fewer people being affected at lower noise levels (generally to the north of the proposed airport), but this is offset by more people being affected at higher noise levels, generally located in rural residential areas to the south and west of the airport site. Head-to-head operations are expected to only occur in favourable meteorological conditions during the night hours of 10.00 pm to 7.00 am. Because night-time movements would represent a relatively small component of the overall daily number of aircraft operations for Stage 1 operations, the inclusion of a head-to-head operating mode does not substantially affect the number of residents predicted to experience noise levels above 70 dBA.

There are differences in the number of residents affected by the different operating strategies. The Prefer 05 operating strategy results in greater impacts on residents in areas north-east of the proposed airport. However, no densely populated residential areas are predicted to experience more than five events per day above 70 dBA (Figure 10–18).

Table 10–5 Estimated population within N70 contours for Stage 1 operations (based on predicted 2030 population levels)

N70	Operating strategy			
	Prefer 05	Prefer 23	Prefer 05 with head-to-head	Prefer 23 with head-to-head
5–10	563	399	852	405
10–20	581	450	326	439
20–50	192	426	258	431
50–100	152	192	167	178
100–200	5	0	10	10
>200	0	0	0	0
Total	1,493	1,468	1,614	1,464

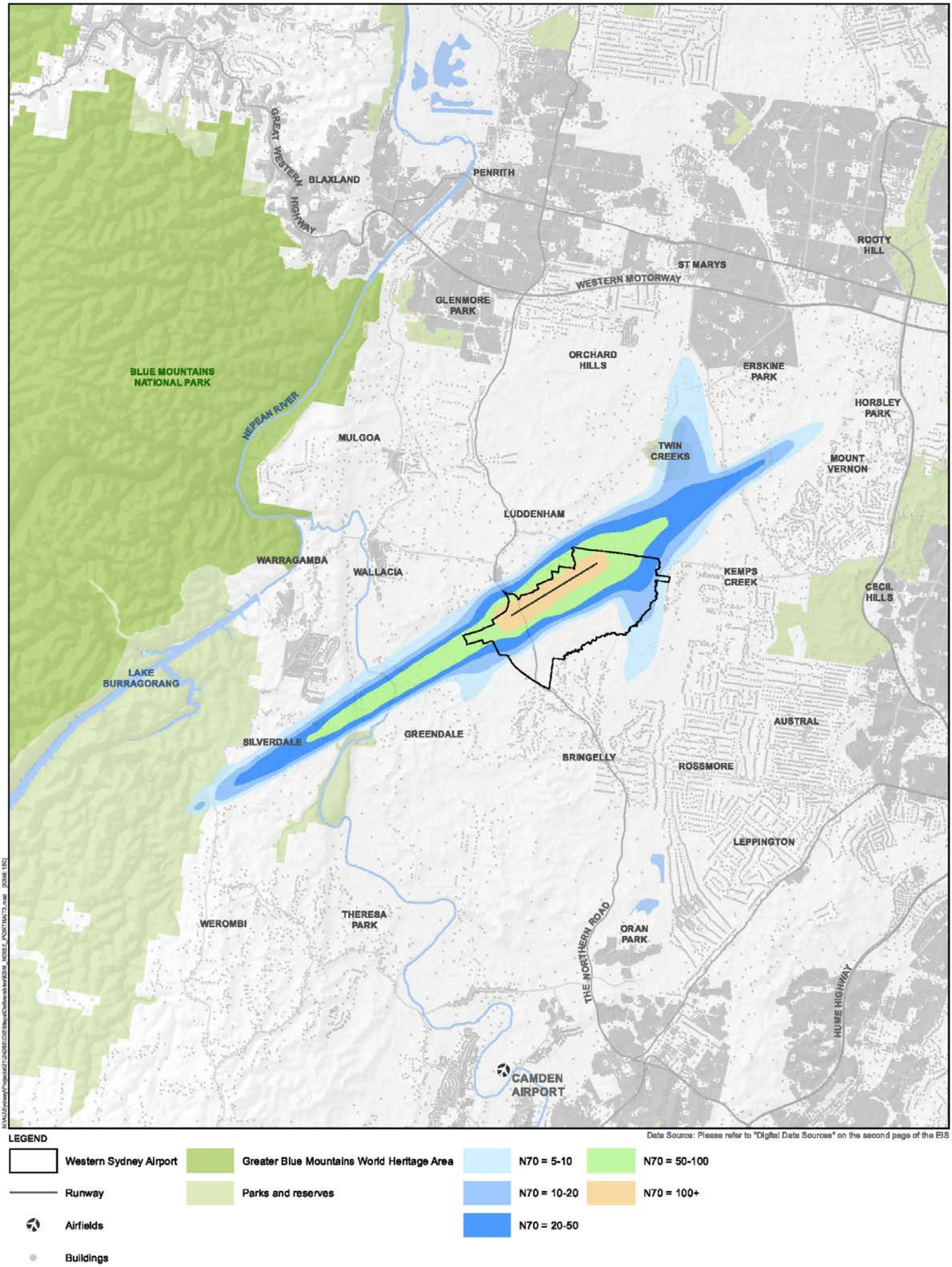
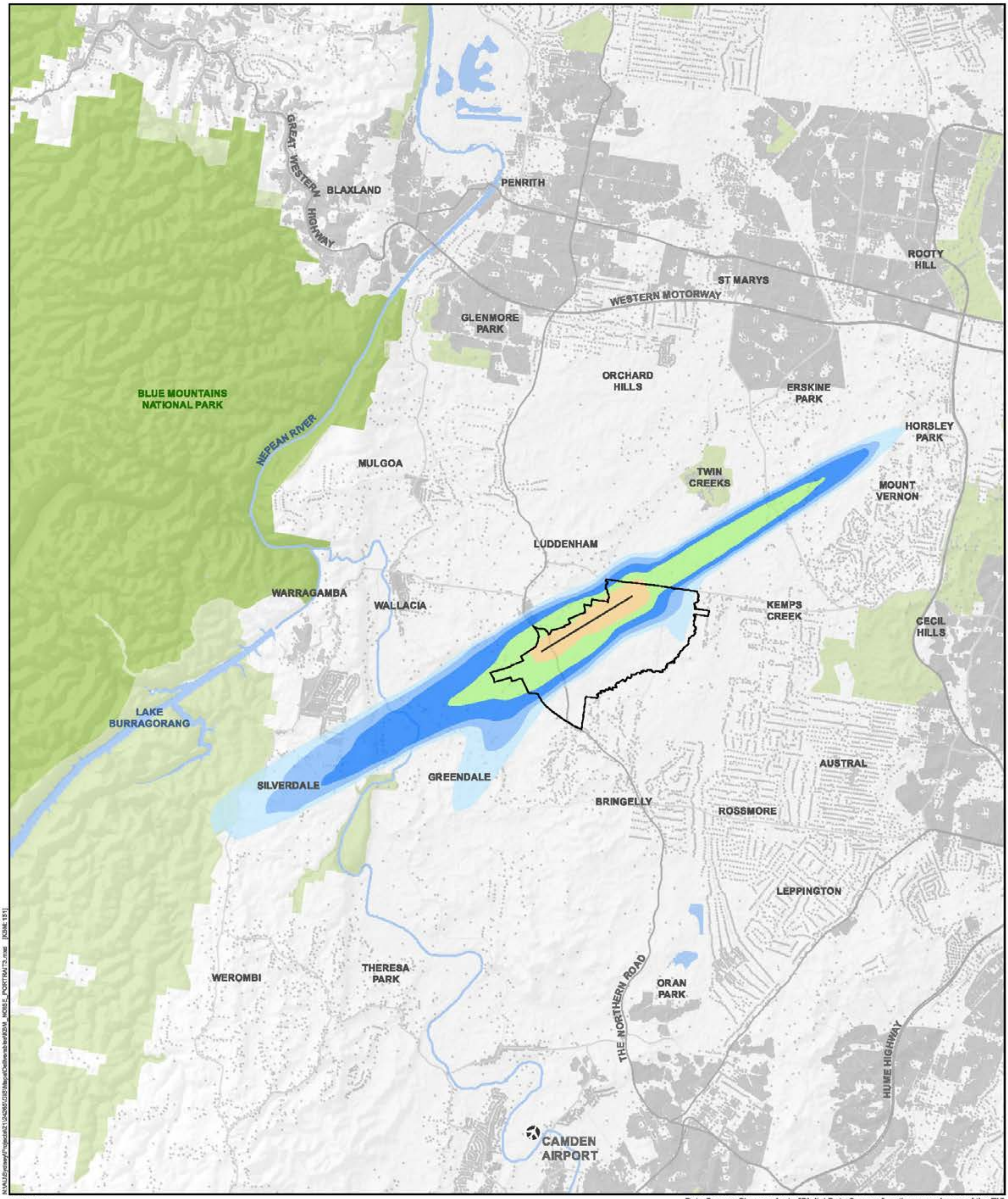


Figure 10-18 - N70 contours - Stage 1 operations - Prefer 05



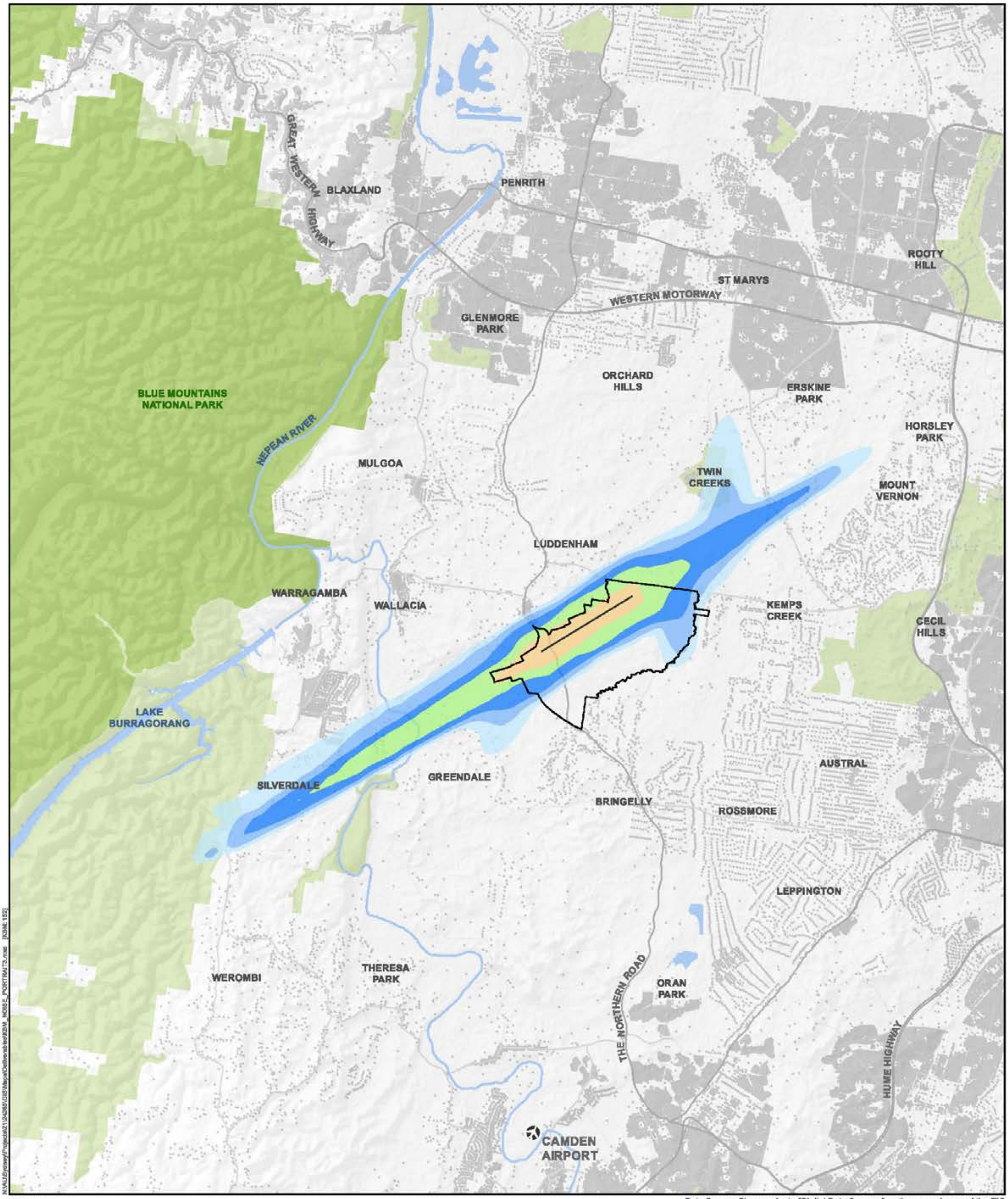
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Western Sydney Airport
- Runway
- Airfields
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- N70 = 5-10
- N70 = 10-20
- N70 = 20-50
- N70 = 50-100
- N70 = 100+

0 1 2 4
Kilometres

Figure 10-19 - N70 contours - Stage 1 operations - Prefer 23



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Western Sydney Airport	Greater Blue Mountains World Heritage Area
Runway	Parks and reserves
Airfields	
Buildings	
N70 = 5-10	N70 = 50-100
N70 = 10-20	N70 = 100+
N70 = 20-50	

0 1 2 4
Kilometres

Figure 10-20 - N70 contours - Stage 1 operations - Prefer 05 with head-to-head

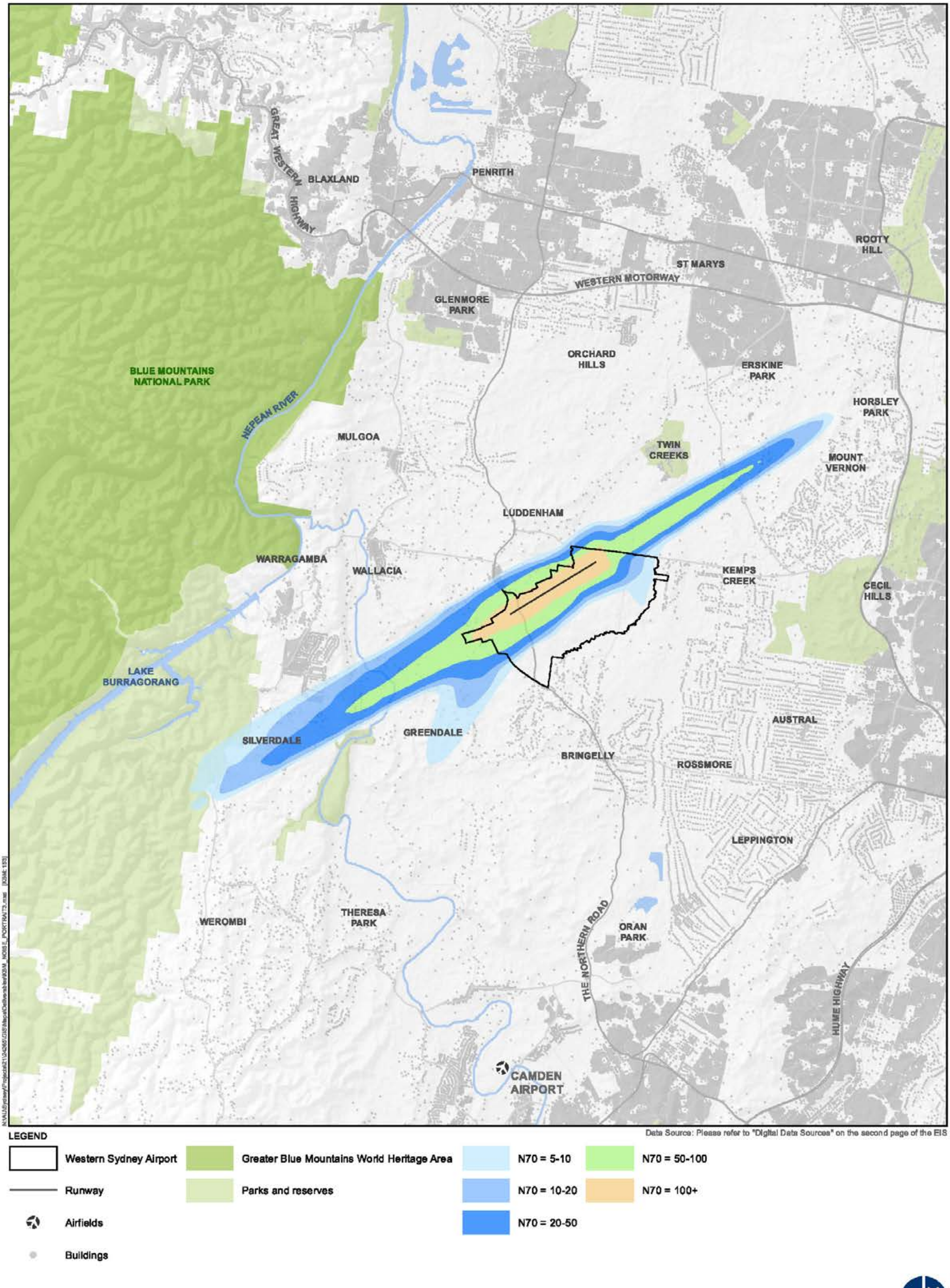


Figure 10-21 - N70 contours - Stage 1 operations - Prefer 23 with head-to-head

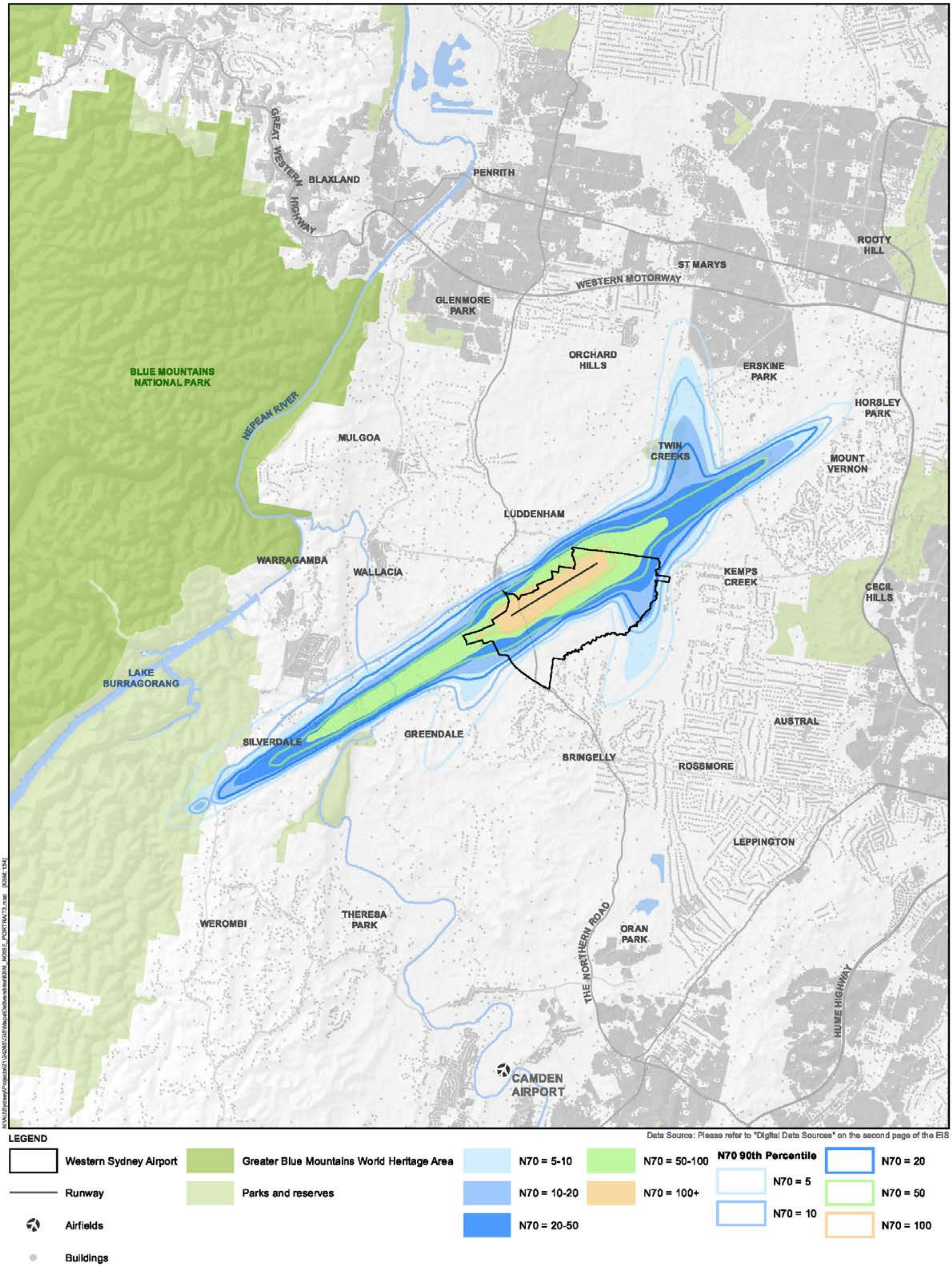


Figure 10-22 - 90th percentile N70 contours - Stage 1 operations Prefer 05

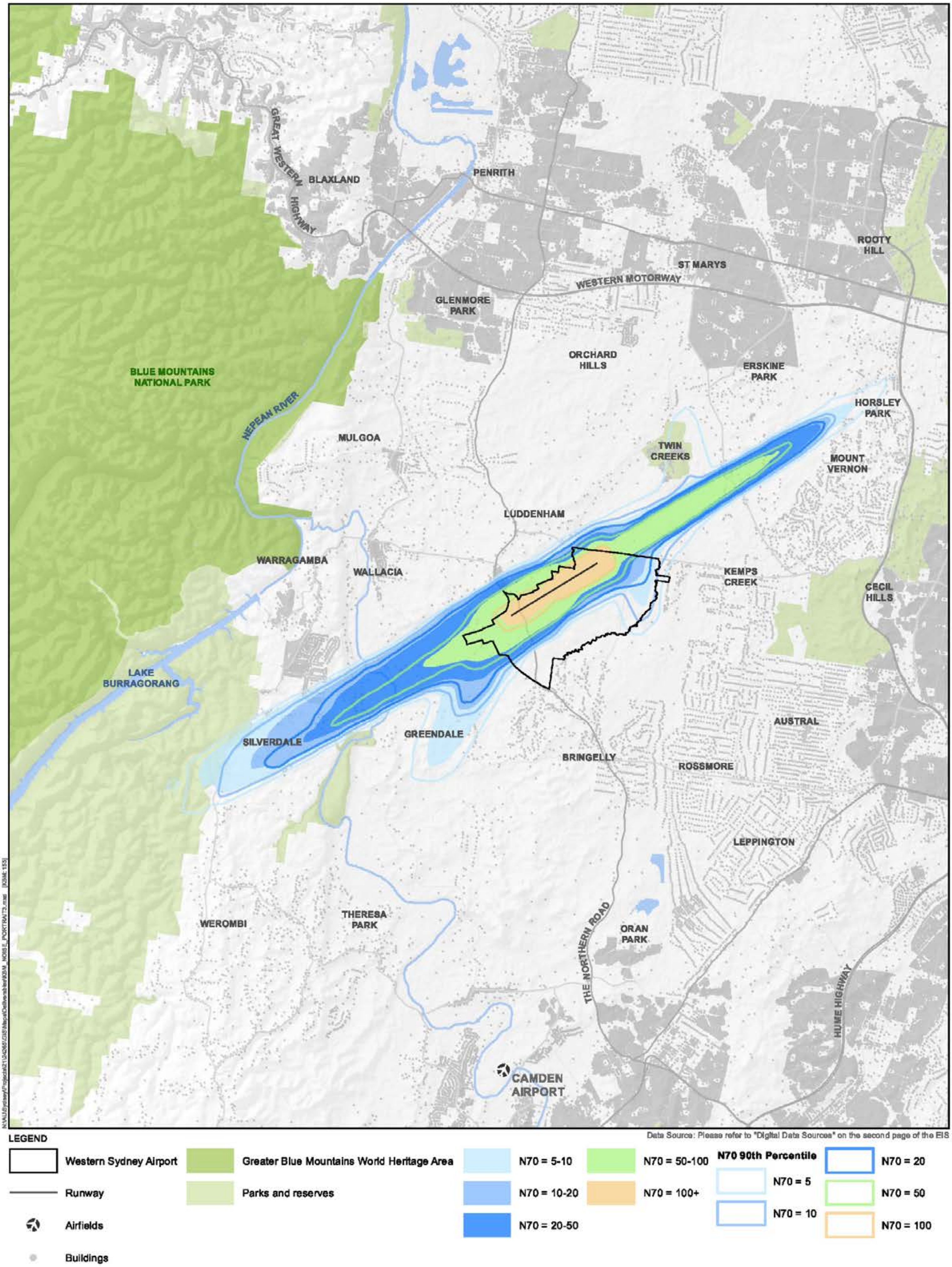


Figure 10-23 - 90th percentile N70 contours - Stage 1 operations Prefer 23

10.5.5 Night time noise

10.5.5.1 N60 contours

The number of noise events exceeding 60 dBA (N60) has been used to describe the impact of noise at night.

N60 values have been predicted for the standard night time period 10.00 pm – 7.00 am.

Figure 10–24 to Figure 10–27 show contours for the four operating strategies considered for the Stage 1 development.

The difference between Prefer 05 and Prefer 23 operating strategies is notable. The Prefer 05 strategy is predicted to have a greater impact on built-up areas around St Marys, while the Prefer 23 strategy is predicted to have a greater impact on rural residential areas around Greendale and Silverdale. A small area to the south of Blacktown would experience up to 20 noise events per night above 60 dBA under the Prefer 23 strategy. Both strategies would impact areas of Luddenham to the north of the runway; however, the Prefer 23 strategy is predicted to affect a larger area of Luddenham village.

The number of night time noise events in densely populated areas could be reduced by use of head-to-head operations where available. As demonstrated in Figure 10–26 and Figure 10–27, this would result in no built-up residential areas being exposed on average to more than five events per night above 60 dBA.

10.5.5.2 90th percentile N60 results

Figure 10–28 to Figure 10–31 show predicted 90th percentile night-time N60 values for Stage 1 operations. These figures give an indication of the number of events per night predicted to exceed 60 dBA on a typical worst case night compared to an average night. As for the N70 90th percentile results, differences between ‘average’ and ‘typical worst case’ days are generally not large.

10.5.5.3 N60 population exposure estimates

Table 10–6 shows the population estimated to be affected by night time noise above 60 dBA from Stage 1 operations. A Prefer 05 operating strategy is predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA on an average night. This is predicted to reduce to approximately 6,000 with a Prefer 23 operating strategy, or about 4,000 if head-to-head operations are combined with either the Prefer 05 or Prefer 23 operating strategies. However, compared to the Prefer 05 strategy, a Prefer 23 strategy or either of the head-to-head strategies would result in more people experiencing a higher number of night time noise events in rural residential areas to the south and west of the airport site.

Table 10–6 Estimated population within N60 contours (for Stage 1 operations (based on predicted 2030 populations)

N60	Operating strategy			
	Prefer 05	Prefer 23	Prefer 05 with head-to-head	Prefer 23 with head-to-head
5-10	46,731	3,436	2,245	2,287
10-20	1,065	1,474	841	844
20-50	609	1,269	1,200	1,200
50-100	0	0	0	0
>100	0	0	0	0
Total	48,405	6,179	4,286	4,331

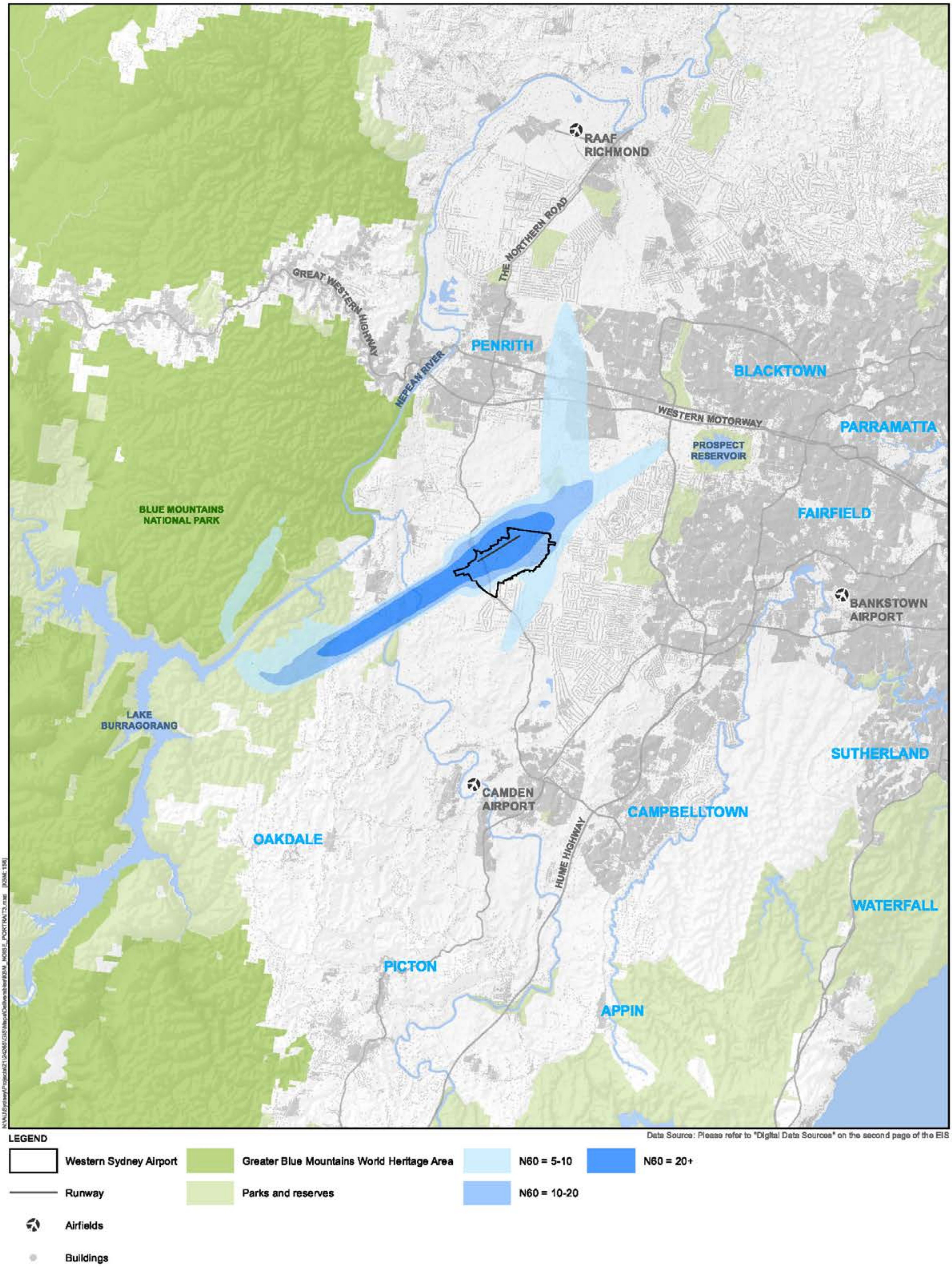


Figure 10-24 - N60 contours - Stage 1 operations Prefer 05

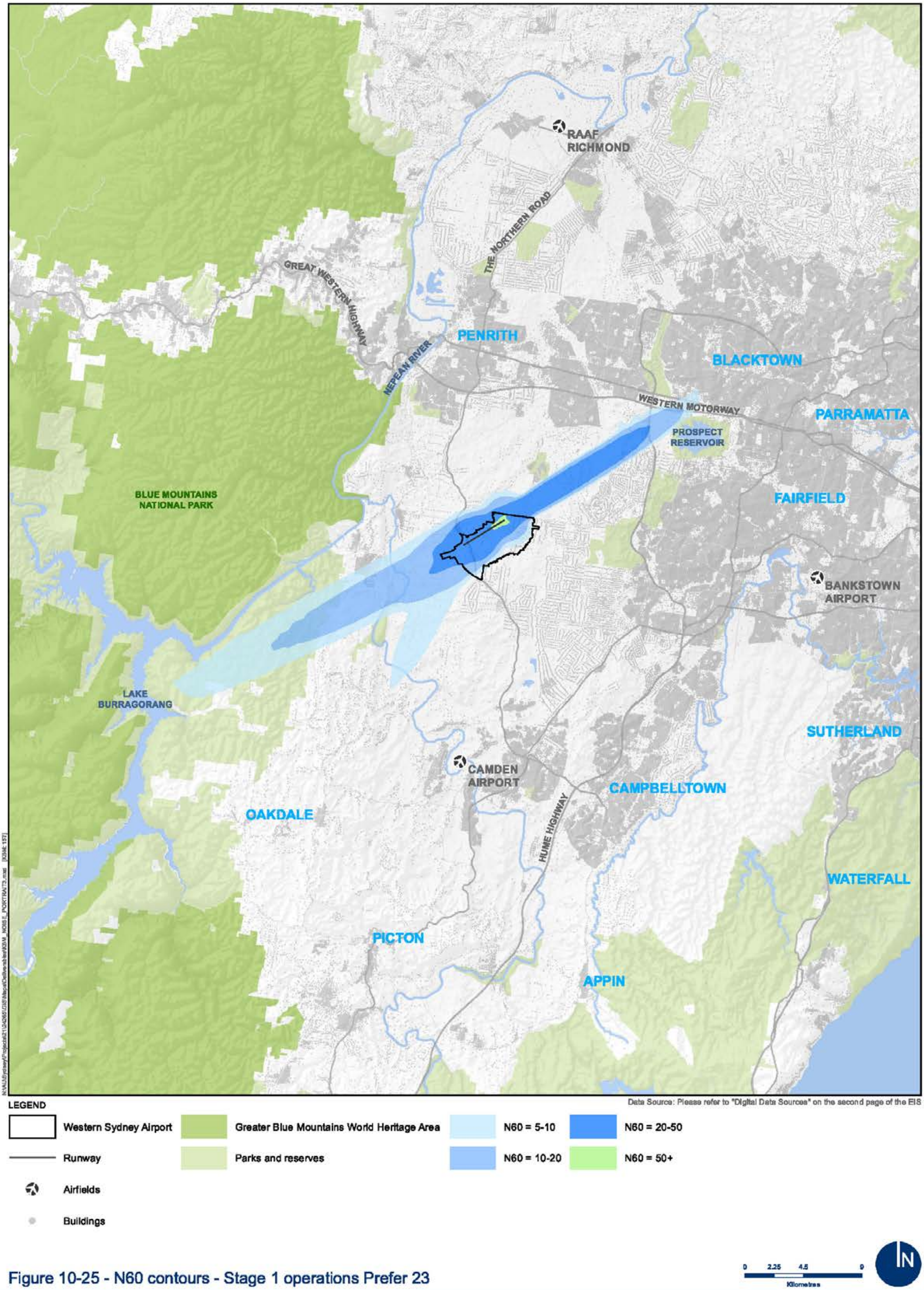
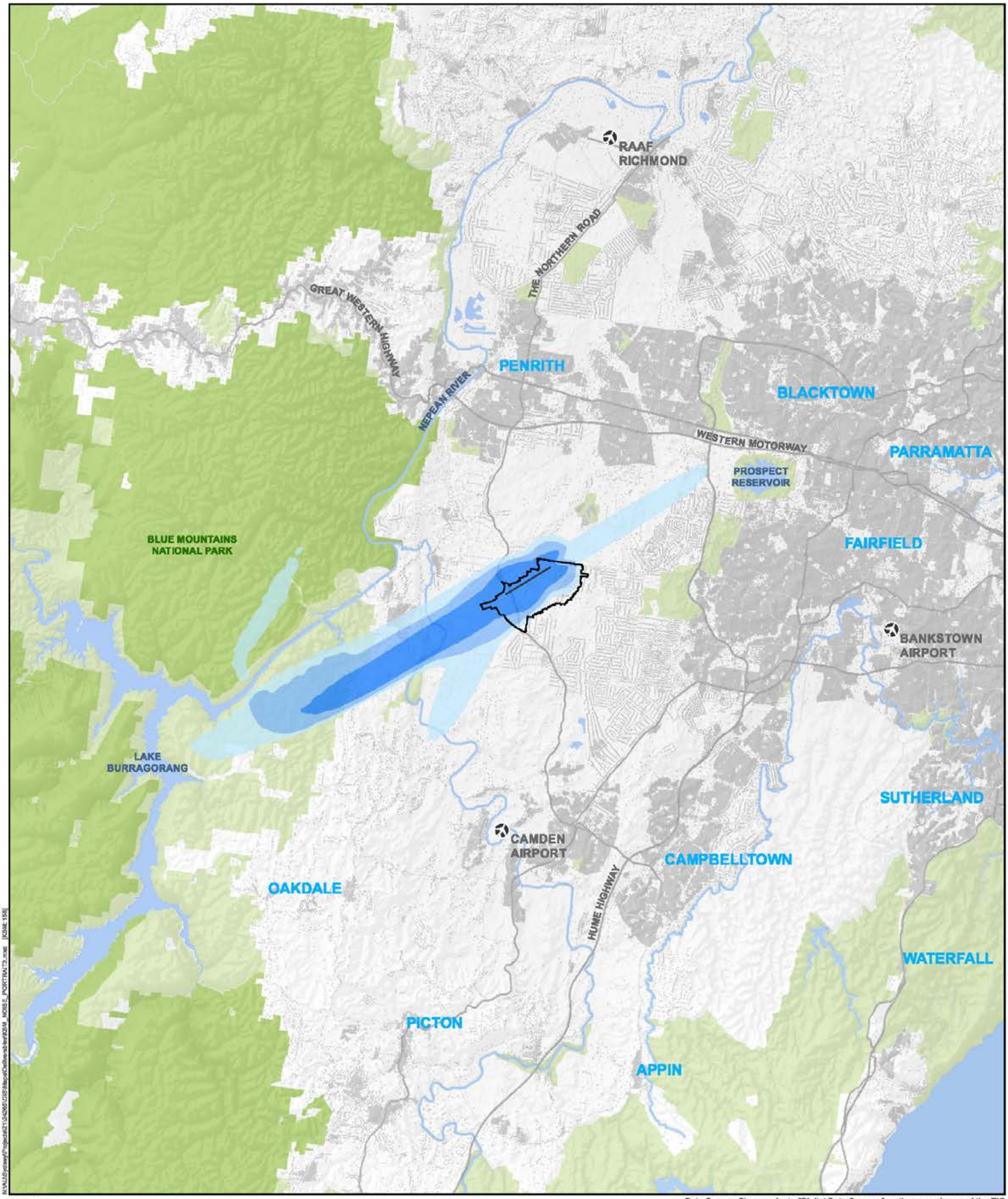


Figure 10-25 - N60 contours - Stage 1 operations Prefer 23



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Western Sydney Airport	Greater Blue Mountains World Heritage Area	N60 = 5-10
Runway	Parks and reserves	N60 = 10-20
Airfields		N60 = 20+
Buildings		

0 2.25 4.5 9
Kilometres

Figure 10-26 - N60 contours - Stage 1 operations Prefer 05 with head-to-head

Figure 10-27 - N60 contours - Stage 1 operations Prefer 23 with head-to-head

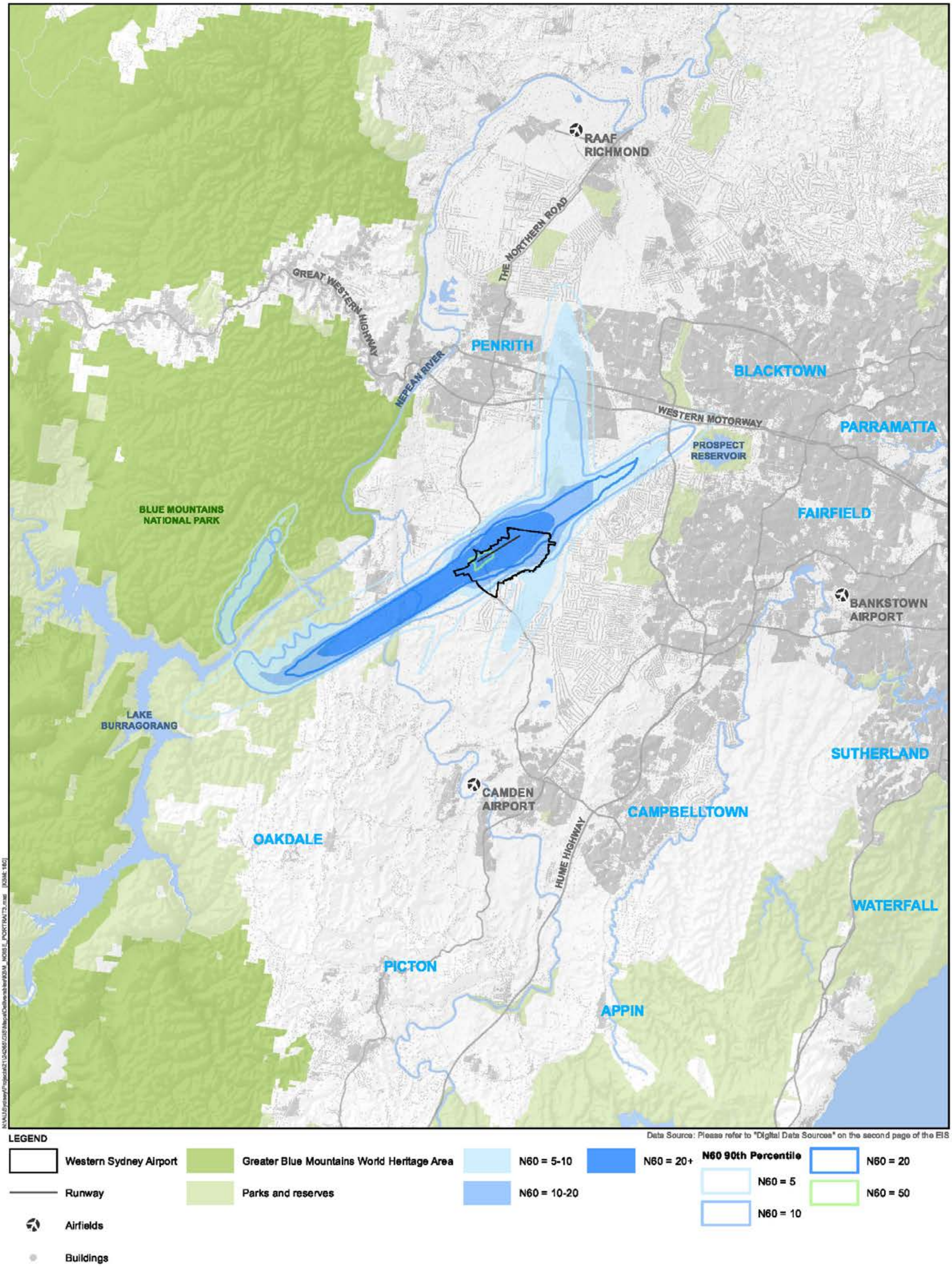


Figure 10-28 - 90th percentile N60 contours - Stage 1 operations - Prefer 05

Figure 10-29 - 90th percentile N60 contours - Stage 1 operations - Prefer 23

Figure 10-30 - 90th percentile N60 contours - Stage 1 operations - Prefer 05 with head-to-head

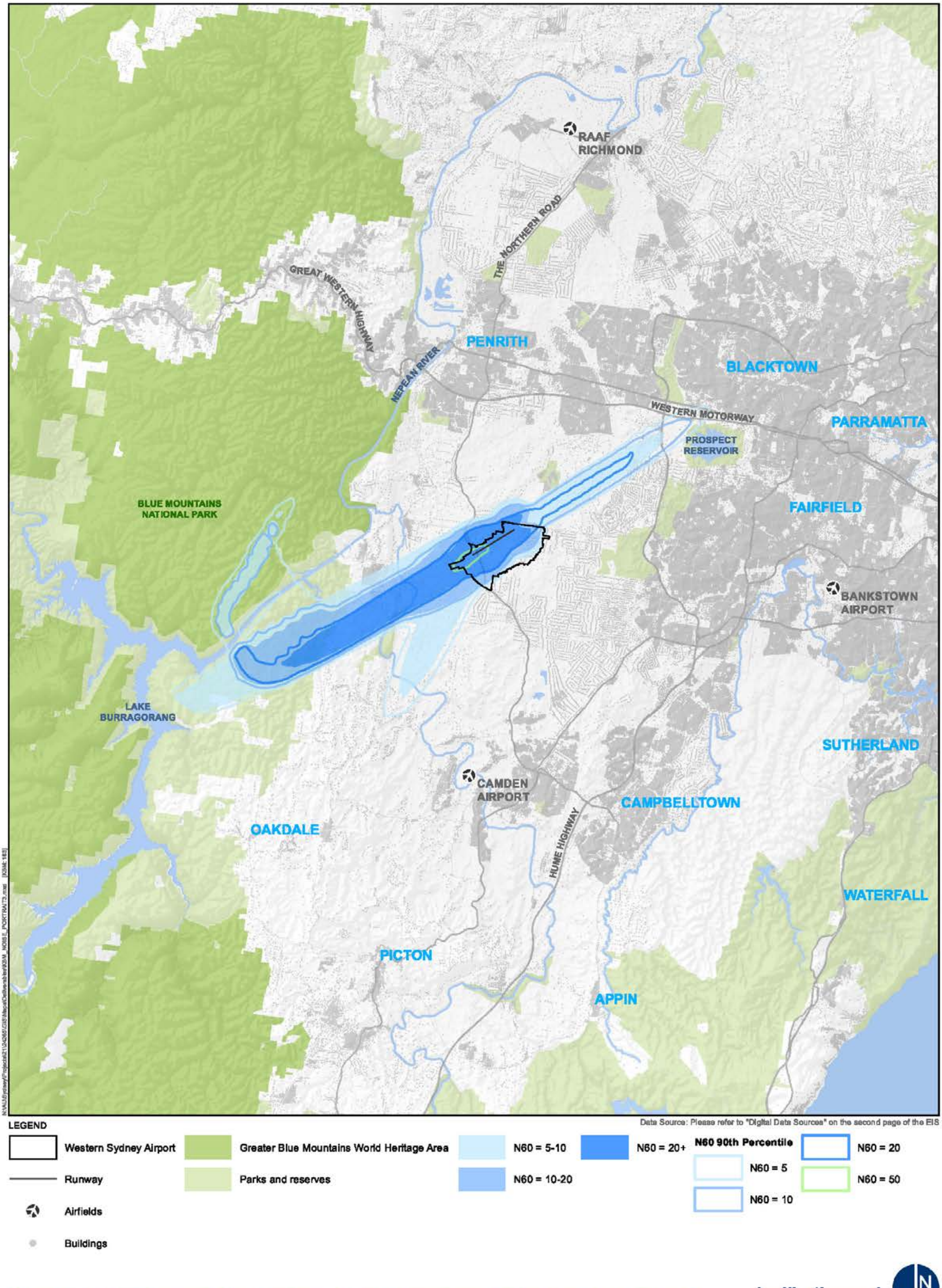


Figure 10-31 - 90th percentile N60 contours - Stage 1 operations - Prefer 23 with head-to-head

10.5.6 Recreational areas

Several recreational areas have been identified within the area potentially affected by the threshold levels of aircraft overflight noise exposure used in this assessment (see Figure 10–8). These range from sports areas used for active pursuits such as horse riding, bowling or golf to nature reserves which may be used for more passive activities.

The impact of aircraft noise in recreational areas can be quantified by calculating the number of events per day exceeding maximum noise levels of 60 dBA and 70 dBA. Where a noise level exceeds 60 dBA, a person may need to raise their voice to be properly heard in conversation but this level would be unlikely to cause disruption to active sporting pursuits. However, the noise would be noticeable and could impact on the acoustic amenity of areas used for passive recreation for the duration of the aircraft overflight. Noise levels above 70 dBA would require increased voice effort (although not shouting), for conversation to be understood and would likely be considered to be acoustically intrusive in passive recreation areas for the duration of the aircraft overflight.

Table 10–7 and Table 10–8 show the identified recreation areas and the predicted values of N60 and N70 for the Prefer 05 and Prefer 23 operating strategies. The values shown are for the period 7.00 am – 6.00 pm, representing the times when these areas would most likely be used.

Table 10–7 Average number of daily noise events with L_{Amax} exceeding 60 dBA (N60) at recreational areas

Recreational area	Stage 1 noise events	
	Prefer 05	Prefer 23
Bents Basin State Conservation Area & Gulguer Nature Reserve	7	13
Kemps Creek Nature Reserve	0	0
Rossmore Grange	3	1
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	23	6
Sydney International Equestrian Centre	0	0
Whalan Reserve, St Marys	1	2

Table 10–8 Average number of daily noise events with L_{Amax} exceeding 70 dBA (N70) at recreational areas

Recreational area	Stage 1 noise events	
	Prefer 05	Prefer 23
Bents Basin State Conservation Area & Gulguer Nature Reserve	0	0
Kemps Creek Nature Reserve	0	0
Rossmore Grange	0	0
Horsley Park Reserve	0	0
Twin Creeks Golf & Country Club	5	1
Sydney International Equestrian Centre	0	0

Recreational area	Stage 1 noise events	
	Prefer 05	Prefer 23
Whalan Reserve, St Marys	0	0

The results indicate that most of the identified recreational areas would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA, or their exposure would be less than one event per day on average.

Aircraft noise levels at Twin Creeks Golf and Country Club would be noticeable and at times a raised voice would be required for effective communication outdoors. At this location, predicted noise exposure would be significantly reduced under a Prefer 23 operating strategy.

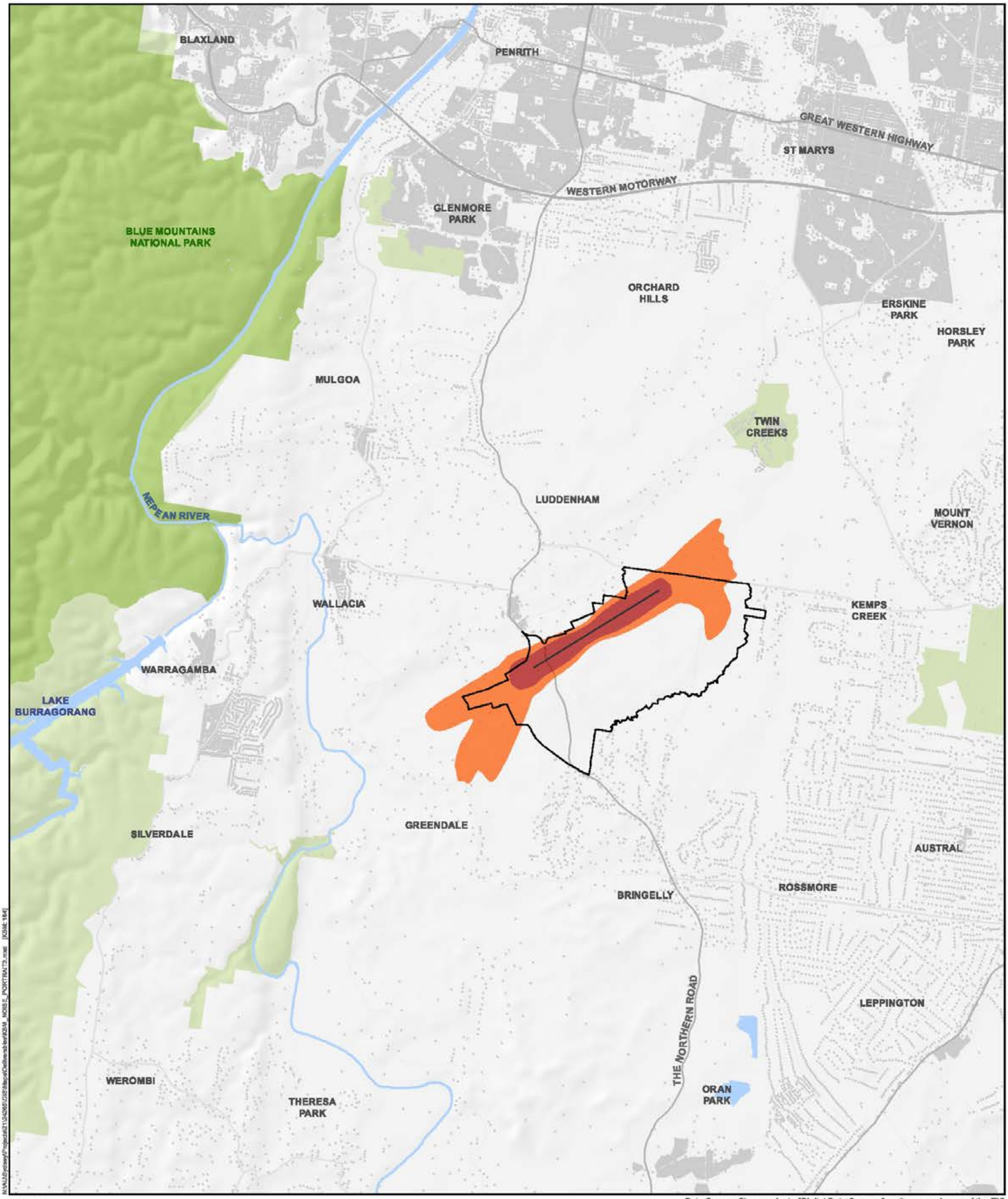
Bents Basin State Conservation Area and Gulguer Nature Reserve would be subject to a number of flyovers with noise levels exceeding 60 dBA, which would be noticeable to passive users of these areas. Bents Basin State Conservation Area is used for camping, and would on average be subject to less than five night time noise events exceeding 60 dBA each day. At this location, noise exposure would be lower under a Prefer 05 operating strategy.

10.5.7 Noise induced vibration

At high noise levels, the low frequency components of aircraft noise can result in vibration of loose elements in buildings, notably windows.

Even at the highest expected noise levels, the levels of vibration due to low frequency noise would be well below those which may cause structural damage to buildings. With typical light building structures, noise induced vibration may begin to occur where the maximum external noise level reaches approximately 90 dBA. The effect is more common on take-offs than for landings because the noise spectrum for a take-off close to the airport has stronger low frequency components.

Figure 10–32 shows 85 dBA and 90 dBA noise level contours for a B747 aircraft departure (stage length 5). Only areas within the 90 dBA contour could expect to experience any noise-induced vibration of building structures, and even then only during a departure of a B747 aircraft with maximum stage length 5. For Stage 1 operations, there are no existing residences within the 90 dBA contour.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Western Sydney Airport
- Runway
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves

LAmax

- 85-90 dBA
- >90 dBA

0 0.75 1.5 3 Kilometres

Figure 10-32 - 85 dBA and 90 dBA L_{Amax} contours - stage 5 B747 departure - Stage 1 development

10.6 Mitigation and management measures

This section describes potential noise mitigation and management approaches having regard to the elements of the ICAO Balanced Approach and potential operations at the proposed airport. Consideration of feasible noise abatement operational procedures would be a key component of the future airspace and flight path design process (see Chapter 7 (Volume 1)).

10.6.1 ICAO Balanced Approach

In 2008, the International Civil Aviation Organization (ICAO) developed an internationally agreed approach to managing aircraft noise at international airports. The *Guidance on the Balanced Approach to Aircraft Noise Management* (ICAO 2008) provides advice for managing noise in a transparent and consultative manner that is tailored to the individual airport situation. It supports airport authorities addressing aircraft noise problems in an environmentally responsive and economically responsible way. The four principal elements of the ICAO Balanced Approach are:

- reduction of noise at source (i.e. reducing noise emissions from aircraft through improved engine and airframe design and performance);
- land use planning and management (i.e. using land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas, and ensuring new airspace procedures take into account local and regional land uses and sensitivities);
- noise abatement operational procedures (e.g. developing flight paths and operational procedures that avoid or reduce noise over populated or otherwise sensitive areas); and
- operating restrictions on aircraft – to be used only after potential benefits from the preceding three options have been exhausted.

The ability and responsibility for implementing each of these elements lie with different aviation stakeholders. The third element, implementation of noise abatement operational procedures, is the typical path for airport operators to work with regulators and the community to implement procedures for local noise management.

10.6.1.1 Improvements in aircraft technology

Aircraft engine and airframe manufacturers continually improve low noise technology and aircraft operators continually modernise their fleets by buying new, quieter aircraft. While significant reductions in aircraft noise emissions have been achieved over the previous four decades, it is difficult to predict future reductions in aircraft noise emission levels. Even without further technological advances, it is reasonable to assume that average aircraft noise emissions from individual aircraft would decrease over time as quieter new generation aircraft make up a greater share of the commercial fleet mix. For example, Singapore Airlines has already removed the louder Boeing 747 aircraft from passenger services. Qantas has also reduced the size of its Boeing 747 fleet and is expected to retire its remaining Boeing 747s by the time operations commence at the proposed airport.

As noted earlier, ICAO has agreed to introduce more stringent standards that will require further reductions in engine noise emission levels for all new aircraft types over 55 tonnes in weight submitted for certification on or after 31 December 2017.

10.6.1.2 Land use planning

Land use planning around airports in Australia is based on the ANEF system for predicting noise exposure and the recommendations of AS 2021. Commonwealth, State and local government agencies implement planning controls having regard to AS 2021 and national policies for protecting airport operations, in particular the National Airports Safeguarding Framework (NASF).

As noted in Section 10.4.1.1, noise exposure forecasts developed for the 1985 Draft EIS (Kinhill Stearns 1985) have guided current planning controls implemented by the NSW Government and relevant local councils in the vicinity of the airport site. These earlier ANECs are broadly consistent with the ANECs presented in this EIS, in particular those prepared for the long term assessment scenario (see Chapter 31 (Volume 3)). Consistent with these planning controls, land to the north of the airport site has been earmarked for employment generating land uses. Development in accordance with this strategic planning will continue to provide a buffer between the airport site and residential areas. It is expected that future land use planning around the proposed airport would be based on formal long term ANEF contours endorsed by Airservices Australia prior to the commencement of airport operations (see Chapter 7 (Volume 1)).

The NASF is a further initiative that addresses land use planning and aircraft noise. NASF is a national land use planning framework, agreed to by Commonwealth, State and Territory ministers in 2012 that establishes planning principles and guidelines in order to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports including through the use of additional noise metrics and improved noise-disclosure mechanisms; and
- improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

Further detail on the NASF is included in Chapter 21.

10.6.1.3 Noise abatement operational strategies

The location of flight paths and the selection of airport operating modes and strategies are key factors affecting the pattern of noise exposure presented in this EIS. Flight path alteration and the selective use of different operating modes can help reduce the impacts of airport operations on surrounding communities. For example, subject to safety and operational requirements, alternating operating modes (i.e. the direction in which landings and departures occur) can be an effective way of sharing aircraft noise impacts more equitably at airports with an identified noise problem. As the proposed airport is planned to operate 24-hours a day, the determination of preferred operating modes and other possible noise abatement operational procedures would be particularly important for managing night time noise impact on surrounding communities.

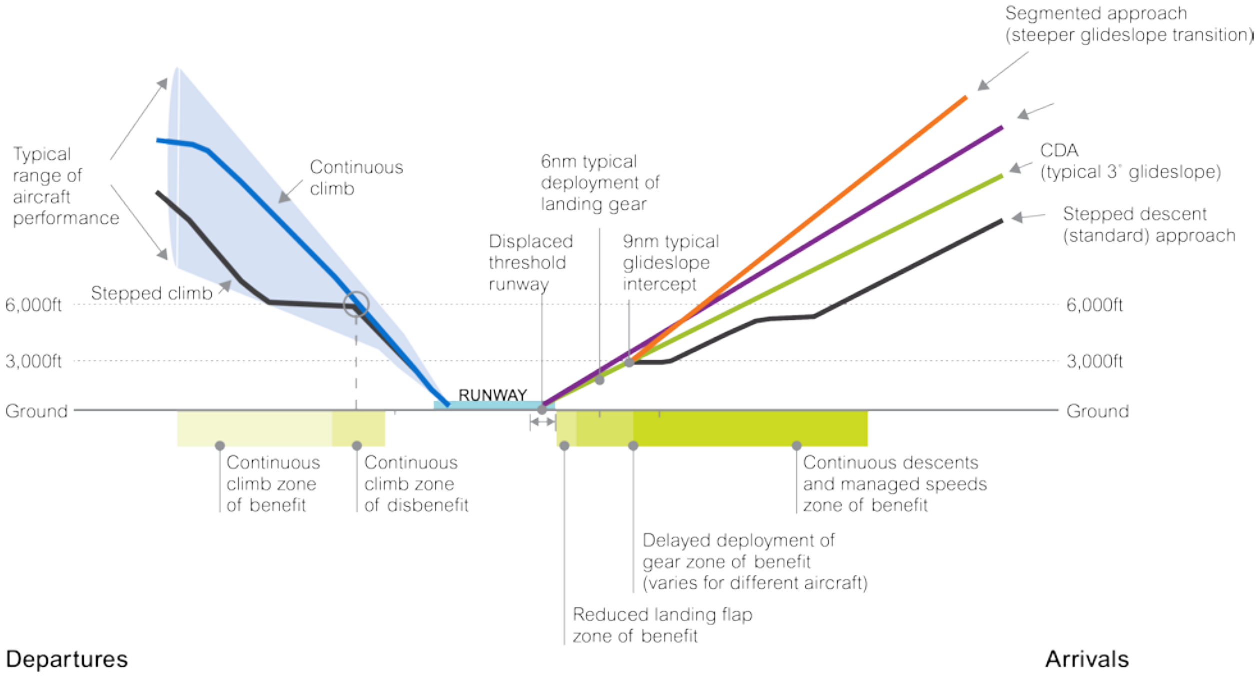
Table 10–9 lists a number of methods that have been developed to reduce or redistribute aircraft noise. The potential applicability of any particular measure to operations at the proposed airport would require detailed consideration during the airspace and flight path design process and ongoing review after the commencement of operations. Collaboration between stakeholders including airport operators, airlines, the community and regulators would be needed to implement some of these measures, noting that the operational efficacy and environmental benefits of newer measures are still being researched. All measures would be subject to overriding safety considerations.

Table 10–9 Potential methods for mitigating airport operational noise

Initiative or procedure	Overview
Departure and arrival management collaboration	This procedure enhances continuous descent and continuous climb operations that can minimise controller vectoring of aircraft and local noise during arrival and departures.
Thrust-managed climb	A noise abatement procedure that requires departing aircraft to reduce engine thrust after a safe altitude is reached.
Area navigation (RNAV) and Required Navigational Performance (RNP) arrivals and departures	RNAV/RNP are precision-based navigation procedures that take advantage of improving aircraft technology to provide precise adherence to a defined flight path. Such flight paths can be designed to reduce community noise, e.g. by directing aircraft over waterways or low sensitivity areas, where possible. By integrating with ground-based augmentation systems (GBAS), RNAV/RNP procedures can facilitate the definition of multiple departure/ approach profiles from different ends of the runway.
Continuous descent approaches	Continuous descent approaches facilitate more fuel-efficient and quieter arrivals by enabling aircraft to employ minimum engine thrust and by reducing the need for level flight segments during approach (see Figure 10–33).
Continuous climb operations	Similar to continuous descent operations but for departure traffic where an aircraft climbs without levelling off at intermediate levels. While very efficient at reducing fuel and emissions if performed with normal engine thrust, this procedure may lead to more noise over nearby communities than a thrust-managed departure.
Arrival and departure path alternation	These procedures incorporate local rules to dictate which arrival routes or departure paths may be used at certain times. This may support the use of respite periods.
Low power, low drag arrivals	This is a technique for making landing approaches less noisy. By delaying landing gear and flap deployment these operations keep the aircraft aerodynamically 'cleaner' and reduce noise generated by air passing over the airframe, which can be a significant source of aircraft noise close to an airport. Reducing drag also enables engine thrust to be reduced. The employment of these procedures may be dependent on air traffic levels, prevailing weather conditions and other safety considerations.
Increased angle approaches and displaced runway threshold	Increased angle final approaches keep the aircraft higher for as long as feasible (i.e. until the ILS glideslope is intercepted) to reduce the perceived noise levels on the ground. Displacing the runway threshold is another method for keeping arriving aircraft higher over nearby communities. This procedure permits an aircraft to land at a point further down the runway than the normal runway threshold.
Thrust reversal limitations at night	Limiting the use of thrust reversal for landings at certain times (e.g. at night or when arrivals are not closely spaced) may reduce noise impacts on nearby communities.

Source: Managing the Impacts of Aviation Noise, CANSO and ACI, 2015

Figure 10–33 illustrates a number of these methods and shows where the potential zone of noise benefit is provided.



Source: The Sustainable Aviation Noise Road Map: A Blueprint for Managing Noise from Aviation Sources to 2050

Figure 10–33 Aircraft overflight noise mitigation opportunities

10.6.1.4 Operating restrictions on aircraft

An operating restriction is any noise-related action that limits or reduces an aircraft's access to an airport. Restrictions may include limits on total movements, noise quotas, night time restrictions and curfews. Restrictions might be applied to specific runways or flight paths, specific aircraft types, aircraft arrivals or departures and/or to specific time periods.

Restricting aircraft operations at night by imposing a curfew or other measures can impact the efficiency and economic activity of an airport. Noise quotas or limits allow some minimum level of activity while placing a limit on total noise exposure levels. The economic consequences of a curfew are outlined in Chapter 2 (Volume 1). For these and other reasons, ICAO considers that operating restrictions should be considered only as a last resort.

10.6.2 Communication and coordination

It is important that both existing and potential residents in areas likely to be affected by aircraft noise have access to information about expected noise exposure levels and patterns. This includes ensuring that information about aircraft noise is presented in a way that is understandable to a non-expert and addresses issues such as the frequency and loudness of noise events and the variability in aircraft noise exposure throughout the day and when the airport is operating in different modes of operation (i.e. 05 versus 23 direction). By providing this type of information, communities are able to actively and meaningfully participate in any public consultation process and potential buyers are better placed to make informed decisions about whether or not to move into an area predicted to experience aircraft noise.

The Australian Government recognises the importance of engaging meaningfully with communities to understand their concerns about aircraft noise and to raise awareness of the constraints and restrictions that govern safe and efficient aircraft operations.

As discussed in Chapter 7 (Volume 1), further detailed technical work would be undertaken to optimise the design of flight paths and noise abatement procedures for the proposed airport so that noise and environmental impacts are reduced as far as practicable. This airspace planning and design process would involve extensive community and stakeholder consultation and would ensure alignment with international best practice, aviation industry expectations and Australia's obligations under international aviation agreements.

Any proposal to introduce a new airspace regime for the proposed airport would also comply with national environmental law. Accordingly, the proposed airspace design arrangements, including nominated flight paths, would be formally referred for consideration under the EPBC Act.

A community and stakeholder reference group would be convened by the Department of Infrastructure and Regional Development to ensure community views are taken into account in the airspace design process. The reference group would provide a forum for stakeholder representatives to exchange information on issues relating to the proposed airspace design and flight path options and their impacts.

The Australian Government also expects federally-leased airports to operate Community Aviation Consultation Groups (CACGs). Consistent with arrangements at other major Australian airports, the ALC for the proposed airport would establish a CACG before airport operations commence. There are guidelines for CACGs which specify that they should be independently chaired and should engage broad community representation. While they are not decision-making bodies, CACGs provide for effective and open discussion of airport operations and their impacts on nearby communities.

Major capital city airports are also required to establish Planning Coordination Forums. The purpose of Planning Coordination Forums is to support a strategic dialogue between the airport operator and local, State and Australian government agencies responsible for town planning and infrastructure investment. Effective discussions in Planning Coordination Forums support better integration of planning for an airport and for the surrounding urban and regional community.

10.6.2.1 Managing aircraft noise enquiries and complaints

Airservices Australia is responsible for managing complaints and enquiries about aircraft noise and operations through its Noise Complaints and Information Service (NCIS). This service is the Australian aviation industry's main interface on aircraft noise and related issues for the community. Complaints and enquiries about aircraft noise relating to operations at the proposed airport will be managed through the NCIS.

An airport's CACG provides another mechanism for aircraft noise enquiries and complaints to be registered and addressed.

Further information about the management of noise enquiries and complaints is provided in Chapter 28 (Volume 2b).

10.6.3 Monitoring noise

Noise associated with the proposed airport is expected to be monitored using the Noise and Flight Path Monitoring System operated by Airservices Australia.

The objectives of noise monitoring are to:

- determine the contribution aircraft noise makes to the overall noise to which a community is exposed;
- provide information to the community;
- help local authorities make informed land use planning decisions;
- inform impact estimates resulting from changes in air traffic control procedures – including changes to reduce aircraft noise impacts;
- validate noise modelling;
- inform the determination of aviation policy by government; and
- assist the government in implementing legislation.

Consistent with the practice at other major airports, a number of permanent monitors would be installed at locations that are representative of noise impacts at surrounding communities. The design and installation of a noise monitoring network at the proposed airport will be undertaken in consultation with the community and stakeholder reference group established for the detailed airspace and flight path design process. This network will be integrated into the noise and flight path monitoring system. In line with existing practice, the noise monitoring network and locations around the proposed airport will be regularly reviewed to ensure they meet contemporary needs.

Airservices Australia produces quarterly Noise Information Reports for major urban areas which include information and analysis on aircraft movements, noise monitoring and complaint issues. The reports are available online at Airservices Australia's website. Real time noise and aircraft operations information is also available for major airports in Australia through the agency's online WebTrak flight tracking tool. The tracking of aircraft operations at the proposed airport and measurement of their associated noise levels would be integrated into these existing monitoring programmes and reporting tools.

Further details about aircraft noise monitoring and reporting at the proposed airport are provided in Section 28.5 (Volume 2b).

10.6.4 Property acquisition and acoustical treatment for aircraft noise

In line with the 1985 recommendations of the Commonwealth House of Representatives Select Committee on Aircraft Noise, the Commonwealth acquired land within the 35 ANEF contour established in the 1985 EIS to provide a noise buffer for the proposed airport. Between 1990 and 1993, the Commonwealth acquired 12 properties within the 35 ANEF. A further eight properties were identified at the time as eligible for acquisition but the land owners did not take up the Government's offer of acquisition. No residential dwellings or other buildings have been insulated for aircraft noise through a Commonwealth programme, although new residential dwellings in some predicted noise-affected zones have been required by local planning regulation to comply with the internal noise criteria stipulated in AS 2021.

The Commonwealth would be responsible for any noise amelioration programme required for the proposed airport that aims to mitigate the impact of aircraft overflight noise for areas surrounding the airport site. Funding arrangements for any programme of this type would be considered at the time.

Government policy relating to any aircraft noise acquisition and insulation programme at the proposed airport would be established as part of the detailed airspace and flight path design process.

The establishment of eligibility criteria and other relevant parameters for such a programme will require consideration of several matters including:

- the calculation and endorsement of an appropriate ANEF chart to inform the identification of residential dwellings and other noise sensitive facilities within respective noise exposure zones, noting that delivery of a noise amelioration programme may be staged;
- the eligibility criteria for acquisition and insulation treatment with reference to the appropriate ANEF chart(s), noise exposure acceptability advice contained in AS 2021 and any other noise measures that may be deemed applicable;
- the timeframe for implementation, taking into account issues such as the date of commencement of operations, air traffic movement and noise exposure forecasts;
- staging priorities;
- for any voluntary acquisition scheme, the achievement of appropriate land use planning outcomes;
- funding arrangements; and
- compliance with the internal noise design criteria contained in AS 2021, having regard to the practicality and costs of achieving compliance for certain residences and other buildings.

10.6.5 Approach to managing aircraft overflight noise

Noise impacts from aircraft operations are inherently linked to the flight paths and operating procedures implemented at an airport. Aircraft in-flight or when landing, taking off or taxiing at an airport and their associated impacts are regulated by laws and regulations such as the *Air Services Act 1995*, the *Airspace Act 2007*, *Air Navigation Act 1920*, Air Navigation (Aircraft Engine Emissions) Regulations and the Air Navigation (Aircraft Noise) Regulations. These laws and regulations are administered through the Department of Infrastructure and Regional Development, CASA or Airservices Australia. The ALC would be responsible for managing the impacts of ground-based operations noise generated on the airport site from sources such as aircraft engine ground running, road traffic and construction activities in accordance with the airport's environment strategy and the Airports (Environment Protection) Regulations.

The Commonwealth is responsible for delivering the airspace and flight path design for single runway operations at the proposed airport prior to the commencement of operations. The Department of Infrastructure and Regional Development, in collaboration with Airservices Australia, CASA and the ALC (once appointed), will oversee a detailed airspace and flight path design process prior to the commencement of operations at the proposed airport. The process will include further analysis of flight path options and extensive community consultation.

The consideration of flight path options and airport operating procedures and their consequent noise impacts as part of the detailed airspace and flight path design for the proposed airport is consistent with the delineation of responsibilities described above. Airport operating procedures include measures to control the loudness of noise events, such as noise abatement departure and arrival procedures, and the use of reverse thrust during landings.

The detailed airspace design will consider the safety of all aircraft and airspace users across the Sydney basin, aircraft operation efficiency and opportunities to minimise noise and amenity impacts on all potentially affected communities, sensitive receivers and the environment. All feasible noise abatement and noise respite opportunities will be assessed throughout the design process. This will include:

- during the initial planning phase – the iterative design and assessment of conceptual air traffic management options, including consideration of predicted noise exposure levels and population and effectiveness of noise abatement procedures;
- during the preliminary design and environmental assessment phase – the development, evaluation and validation testing of the preferred preliminary airspace concept and referral of the preferred concept for consideration under the EPBC Act. Government policy on the voluntary acquisition and insulation of properties affected by aircraft overflight noise at the proposed airport would be announced in this phase of work; and
- during the detailed design phase – final development and testing of the proposed airspace design and flight paths based on the EPBC Act process, including comments received during community consultation, and input from all stakeholders to ensure the operating procedures, including noise abatement procedures, are fit for purpose and suitable for implementation.

Identifying flight paths and procedures that minimise aircraft noise impacts at night will be a critical component of this work. The change in air traffic complexity at night enables greater flexibility in designing arrival and departure routes for night time operations and improved scope to minimise aircraft overflight noise impacts from these particularly sensitive operations.

The future airspace design and associated noise abatement procedures will be planned in accordance with *Airservices commitment to aircraft noise management* (Airservices Australia 2013) which aligns with the strategies developed by ICAO in its *Balanced Approach to Aircraft Noise Management*. The design of flight paths for the proposed airport will also be guided by the principles provided in Table 7–1 (see Chapter 7 (Volume 1)). These principles closely align with the above national and international benchmarks for managing aircraft noise.

An ANEF chart based on long term parallel runway operations at the proposed airport will be prepared during the detailed design phase of the future airspace and flight path design process to inform land use planning in the vicinity of the airport site.

The specific noise abatement procedures and noise management measures developed through the airspace and flight path design process will be recorded in the ALC's Noise Operational Environmental Management Plan (see Chapter 11). This record will serve as a baseline for any future proposed amendments to the aircraft overflight noise abatement procedures and noise management measures developed for the proposed airport.

10.7 Conclusion

This chapter provides an assessment of potential aircraft noise impacts associated with Stage 1 operations at the point at which passenger demand reaches approximately 10 million annual passenger movements, which is anticipated to occur around five years after operations commence.

The noise assessment is based on indicative flight paths prepared by Airservices Australia as part of a preliminary proof-of-concept assessment of the air traffic management implications of introducing operations at the proposed airport. A future airspace design process will be undertaken closer to the commencement of operations at the proposed airport and further noise impact assessment would be carried out at that time. This would include further analysis of flight path options, detailed consideration of potential noise abatement opportunities and extensive community consultation.

The specific noise abatement procedures and noise management measures developed through the airspace design process will be recorded in the ALC's Noise Operational Environmental Management Plan. This record will serve as a baseline for any future proposed amendments to the aircraft overflight noise abatement procedures and noise management measures developed for the proposed airport.

The current assessment indicates that for the loudest aircraft operations, long-range departures by Boeing 747 aircraft or equivalent, maximum noise levels above 85 dBA would be experienced at a small number of residential locations close to the airport site. Maximum noise levels of 70–75 dBA could be expected within built-up areas in St Marys and Erskine Park as a result of worst case operations. Maximum noise levels due to more common aircraft types such as Airbus A320 or equivalent are predicted to be lower at 60–70 dBA in built-up areas around St Marys and Erskine Park, and over 70 dBA in some adjacent areas to the south-west of the airport site, notably in Greendale.

On an average day, about 1,500 residents are expected to experience five or more aircraft noise events above 70 dBA.

At night, the Prefer 05 operating strategy is predicted to result in an estimated 48,000 people experiencing more than five events above 60 dBA during the night time period. With a Prefer 23 operating strategy, approximately 6,000 people are predicted to experience on average more than five events above 60 dBA each night (i.e. between 10.00 pm and 7.00 am). This number is predicted to reduce to about 4,000 residents if a head-to-head strategy (both approaches and departures to the south-west) is used when weather conditions and traffic levels permit.

Most recreational areas would not be subject to aircraft overflight noise events with maximum levels exceeding 70 dBA, or their exposure would on average be less than one event per day. Aircraft noise levels at Twin Creeks Golf and Country Club would be noticeable—potentially exceeding 80 dBA from departures by the loudest modelled aircraft type—and at times a raised voice would be required for effective communication outdoors. At this location, predicted noise exposure would be significantly reduced under a Prefer 23 operating strategy.

Approaches to mitigating aircraft noise generally focus on reducing noise emissions from the aircraft themselves, planning flight paths and airport operating modes in a way that minimises potential noise and environmental impacts, and implementing land use planning or other controls to ensure that future noise-sensitive uses are not located in noise-affected areas.

11 Airport construction and ground operations noise

Noise associated with airport operations would be generated from a number of on-site sources, including aircraft taxiing and the ground running of aircraft engines for maintenance testing. Other operational noise sources associated with the airport include airport traffic using the surrounding road network. Noise generated by airport construction activities both on-site and resulting from the movement of vehicles and equipment have also been assessed.

Monitoring was undertaken in areas surrounding the airport site to determine existing background noise levels and identify assessment criteria for the construction and operational phases of the proposed airport development. Dominant noise sources include road traffic noise and local industry, reflecting the predominantly rural residential nature of the area. Construction and operation of the proposed airport would introduce new noise sources.

The Airports (Environment Protection) Regulations 1997 provide the regulatory framework for noise generated at an airport site other than noise generated by aircraft in flight, landing, taking off or taxiing. These regulations include specific limits for certain activities, including construction activities, at certain times of the day and provide other more general principles to avoid offensive noise that intrudes on individual, community or commercial amenity. Although aircraft taxiing is not considered to be part of the ground-based noise regulatory framework established under the Airports (Environment Protection) Regulations, it has been included in this chapter for noise assessment purposes.

Noise during construction of the proposed airport would be largely confined within the airport boundary, although there would be some impacts on Luddenham and Badgerys Creek under worst case meteorological conditions. Construction vehicles would need to access the airport during the construction stage. Modelling indicates that the resulting increase in traffic noise would not be audible. Vibration and airblast levels have been assessed in the event that blasting is required during construction. The assessment identifies precautionary measures that would likely be required to avoid significant vibration and airblast levels at surrounding sensitive receivers. Vibration generated by other construction activities and equipment is unlikely to cause building damage outside the airport site.

The primary sources of ground-based noise during operations would be aircraft engine maintenance testing and taxiing. Under worst case meteorological conditions, noise associated with engine maintenance testing has the potential to exceed the noise criteria established for this assessment in Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale. The impact of noise from taxiing extends over a much smaller area and would primarily affect Luddenham. Noise criteria were also established for other non-residential land uses, such as educational and recreational uses. The assessment indicates that five educational institutions, three places of worship, two passive recreation areas and one active recreation area are predicted to be affected by noise levels above the assessment criteria.

During the operation of the Stage 1 development, road traffic generated by the airport would increase local noise levels. Apart from a section of the proposed M12 Motorway and Elizabeth Drive, noise level increases attributable to airport traffic would be less than 2 dBA. Any new road construction or realignments as part of the Western Sydney Infrastructure Plan (or other road improvements over time) would be subject to separate environmental assessment and approvals processes including any necessary noise mitigation.

Mitigation measures have been proposed to address noise during construction of the proposed airport. These include the implementation of a Noise and Vibration Construction Environmental Management Plan. Operation of the proposed airport would be subject to further detailed design including further analysis of the location of noise generating facilities and activities, and detailed consideration of practicable noise mitigation measures for engine maintenance testing.

11.1 Introduction

This chapter provides a review of the potential construction, road traffic and ground-based operational noise and vibration impacts associated with the proposed airport. This includes consideration of:

- construction activities, including the noise and vibration generated by construction activities and equipment, blasting (if required) and construction traffic accessing the airport site;
- ground running of aircraft engines for maintenance testing;
- taxiing of aircraft; and
- road traffic changes in the surrounding area as a result of airport operations.

This chapter draws upon a comprehensive assessment of these ground-based noise sources included as Appendix E2 (Volume 4). It addresses the requirements of the EIS guidelines issued by the Australian Government Department of the Environment.

Aircraft overflight noise and noise generated during take-offs and landings, including reverse thrust noise, are addressed separately in Chapter 10 and by the comprehensive assessment of aircraft overflight noise included in Appendix E1 (Volume 4). Appendix E1 (Volume 4) includes a description of the framework under which noise from aircraft in flight is managed in Australia.

11.2 Methodology

11.2.1 Construction noise and vibration assessment methodology

For assessment purposes, construction activities for the proposed Stage 1 development are assumed to occur in three major work phases:

- site preparation activities (including major earthworks);
- aviation infrastructure activities; and
- site commissioning activities.

The bulk earthworks component of construction is expected to generate the most noise and therefore has been used as the basis of a ‘worst case’ construction noise assessment.

To predict construction noise levels in the surrounding area, typical sound power levels of the plant likely to be used during major earthworks were incorporated in a CadnaA proprietary noise model. Worst case weather consistent with a temperature inversion was also incorporated in the model. Temperature inversions cause sound to be deflected back toward the ground resulting in higher noise levels at receivers. They tend to occur in the evening and at night and can extend into the morning under calm conditions. Temperature inversions tend to be more common during cooler months when the air at the surface is cooler than the air above and the ability of the ground surface to heat during the early morning is diminished.

An assessment of vibration during the construction phase included consideration of typical vibration generating plant, the distance to vibration-sensitive receivers and relevant guideline values set out in German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures.* As construction might also involve the use of blasting, vibration and airblast noise levels generated from potential blasting activities were also assessed in relation to criteria recommended by the Australian and New Zealand Environment and Conservation Council.

11.2.2 Ground-based operations noise assessment methodology

Ground-based operations noise levels were predicted for the operation of the Stage 1 development based upon a demand of 10 million annual passenger movements, which is predicted to occur around five years after operations commence at the proposed airport. Noise levels were reported as A-weighted decibels (dBA), which is an expression of the relative loudness of sounds as perceived by the human ear. The following noise sources were considered:

- aircraft engine maintenance testing (or engine run-up) noise – it has been assumed that aircraft engine running would occur at a maintenance area nominally located in the western part of the airport site as shown in Figure 11–1. While the orientation of an aircraft during run-up would change depending on prevailing wind conditions, a conservative approach was adopted for this assessment by assuming that the emitted noise would be omnidirectional and at a level of 151 dBA. High power engine runs are expected to be relatively rare during Stage 1 operations and it has been conservatively assumed that no more than one run on full power would occur in a night and for no more than five minutes; and
- aircraft taxiing noise – the proposed aircraft taxi path is shown in Figure 11–1. A sound power level for each aircraft of 138 dBA has been assumed, being the highest level measured for aircraft taxiing at Brisbane Airport (B777, B747, B737, B717 and A330).

The assessment of noise impacts in this EIS has been based on aircraft types that are commonplace today, including the Boeing 747 and the Airbus A320. As indicated in Chapter 10, it is expected that quieter aircraft would be progressively introduced following the commencement of operations at the proposed airport, and consequently, the ground-based noise modelling is considered conservative. The Boeing 747 is the loudest aircraft anticipated to operate at the proposed airport and airlines are already beginning to retire it from regular passenger services.

Noise contours were generated for aircraft ground running and taxiing using CadnaA noise prediction software. Certain meteorological conditions such as temperature inversions and light winds may increase noise levels at nearby receivers, by focussing sound wave paths at a single point. Worst case weather consistent with a temperature inversion was assumed in the modelling conducted for this EIS. For engine run-up noise predictions, it was also assumed that there would be shielding from a maintenance building near the run-up area as shown on Figure 11–1.

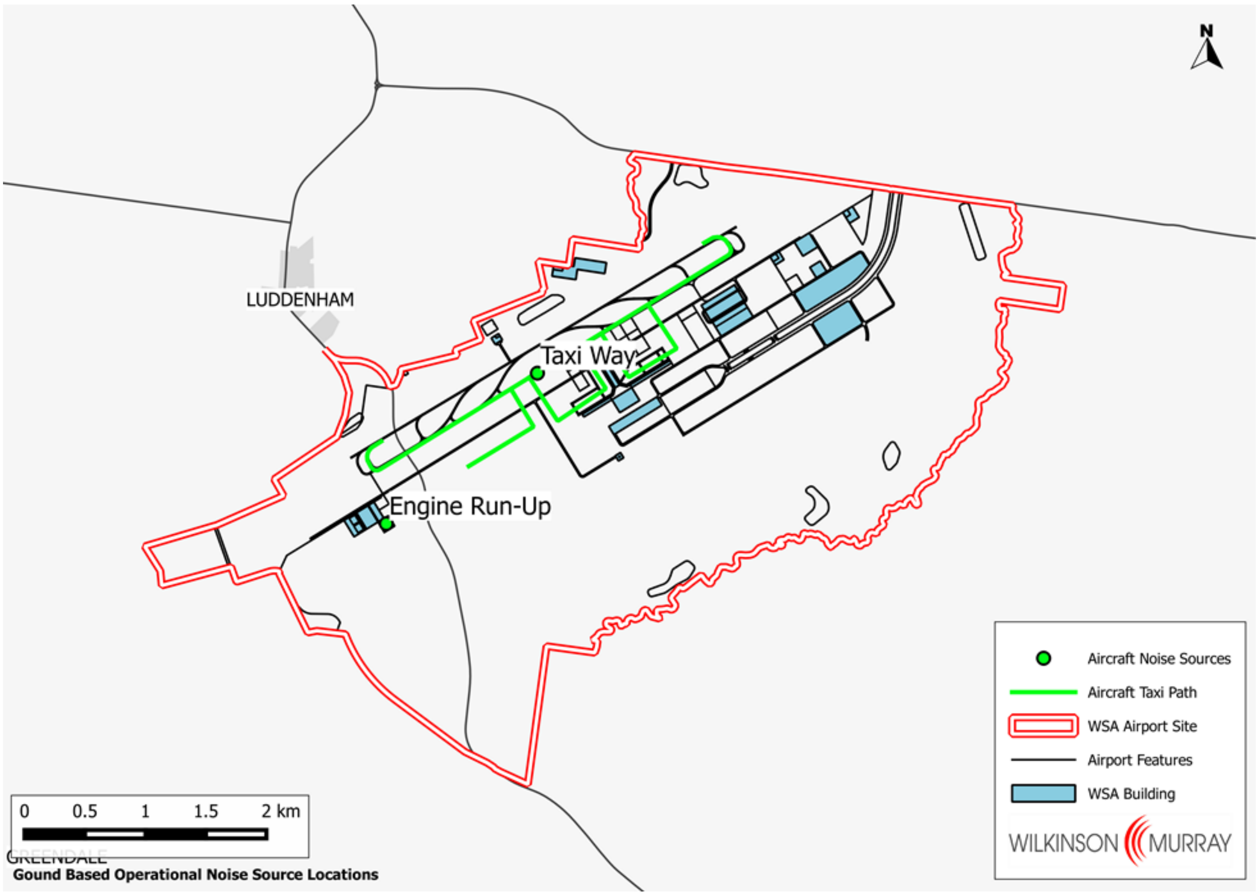


Figure 11–1 Ground-based noise source locations

Noise from vehicle movements and mechanical plant at the airport site has not been specifically assessed because it would be at a much lower level than that produced by the other operations. The use of auxiliary power units while aircraft are stationary at gates or stands has also not been assessed because aircraft are generally expected to be connected to mains power and preconditioned air when stationary at the proposed airport.

11.2.2.1 Revisions to engine run-up and taxiing modelling approach

Noise contours were prepared and incorporated in the draft EIS using the CadnaA proprietary computer modelling software including the prediction algorithms taken from ISO 9613-1:1993 *Acousitcs – Attenuation of Sound during Propagation Outdoors – Part 1: Calculation of the Absorption of Sound by Atmosphere* with the Concawe Class F stability.

Subsequent to publication of the draft EIS and during further analysis of ground running noise mitigation options, it was found that the ISO algorithm had led to unexpected and inconsistent results. Accordingly, the revised operational noise contours presented in this chapter have been prepared using CadnaA incorporating the Concawe prediction algorithm and Concawe Class F stability. The use of the Concawe algorithms results in the effects of ground absorption being taken into account more accurately.

11.2.3 Road traffic noise assessment methodology

The traffic and transport assessment presented in Chapter 15 modelled road traffic projections for major roads in the vicinity of the airport site both with and without the proposed airport. The traffic projections were used to calculate noise levels at typical distances from roads near the airport site using the 'Calculation of road traffic noise' procedure (CoRTN). CoRTN was developed by the United Kingdom Department of the Environment in 1988 and has been modified for Australian conditions and is extensively used for similar types of assessments.

11.3 Existing environments

Ambient noise levels in the vicinity of the airport site are reflective of the mostly rural residential character of the area, with dominant existing noise sources including road traffic and industry. Understanding the background noise environment is important as this is used to determine criteria against which the potential impacts associated with the construction and operation of the proposed airport can be assessed.

Background noise measurements were carried out at 11 locations selected to represent potentially affected areas over the period Monday 23 March to Thursday 2 April 2015. Additional measurements were conducted at Luddenham during March 2016. The background noise measurements were carried out in accordance with AS1055:1997 and are presented in Appendix E2 (Volume 4).

From the measurement data, the Rating Background Level (RBL) as defined in the NSW Industrial Noise Policy was determined for the selected locations. The respective RBL values are presented in Table 11–1.

Table 11–1 Rating background levels

Location	Measurement duration	Rating background level (dBA)		
		Day (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
9 Harold Bentley Way, Glenmore Park	Mon 23/3/15 – Thu 2/4/15	39	42	38
16 Park Avenue, Springwood	Wed 25/3/15 – Thu 2/4/15	29	32	24
17 Blue Ridge Place, Orchard Hills	Mon 23/3/15 – Tue 31/3/15	34	38	36
25 Peter Pan Avenue, Wallacia	Mon 23/3/15 – Thu 2/4/15	37	34	28
27 Dwyer Road, Bringelly	Mon 23/3/15 – Thu 2/4/15	33	38	35
35 Ramsay Road, Rossmore	Fri 27/3/15 – Thu 2/4/15	35	37	35
54 Ridgehaven Road, Silverdale	Thu 26/3/15 – Thu 2/4/15	36	36	31
114 Mount Vernon Road, Mount Vernon	Mon 23/3/15 – Thu 2/4/15	34	35	33
120 Vincent Avenue, Mulgoa	Mon 23/3/15 – Tue 31/3/15	38	42	35
Twin Creeks Golf Club, 2 Twin Creeks Drive, Luddenham	Thu 26/3/15 – Thu 2/4/15	34	38	33
8 Wade Close, Luddenham	Mon 7/3/16 – Wed 16/3/16	35	36	34

According to the NSW Industrial Noise Policy, where the RBL has been measured as less than 30 dBA, it should be assumed to be 30 dBA for the purpose of setting noise criteria. This applies to the RBL at the Springwood and Wallacia locations.

Noise-sensitive receivers in the area around the proposed airport include residences, schools and other educational facilities, hospitals and other health care facilities. The identified sensitive receivers are shown in Figure 11–2.

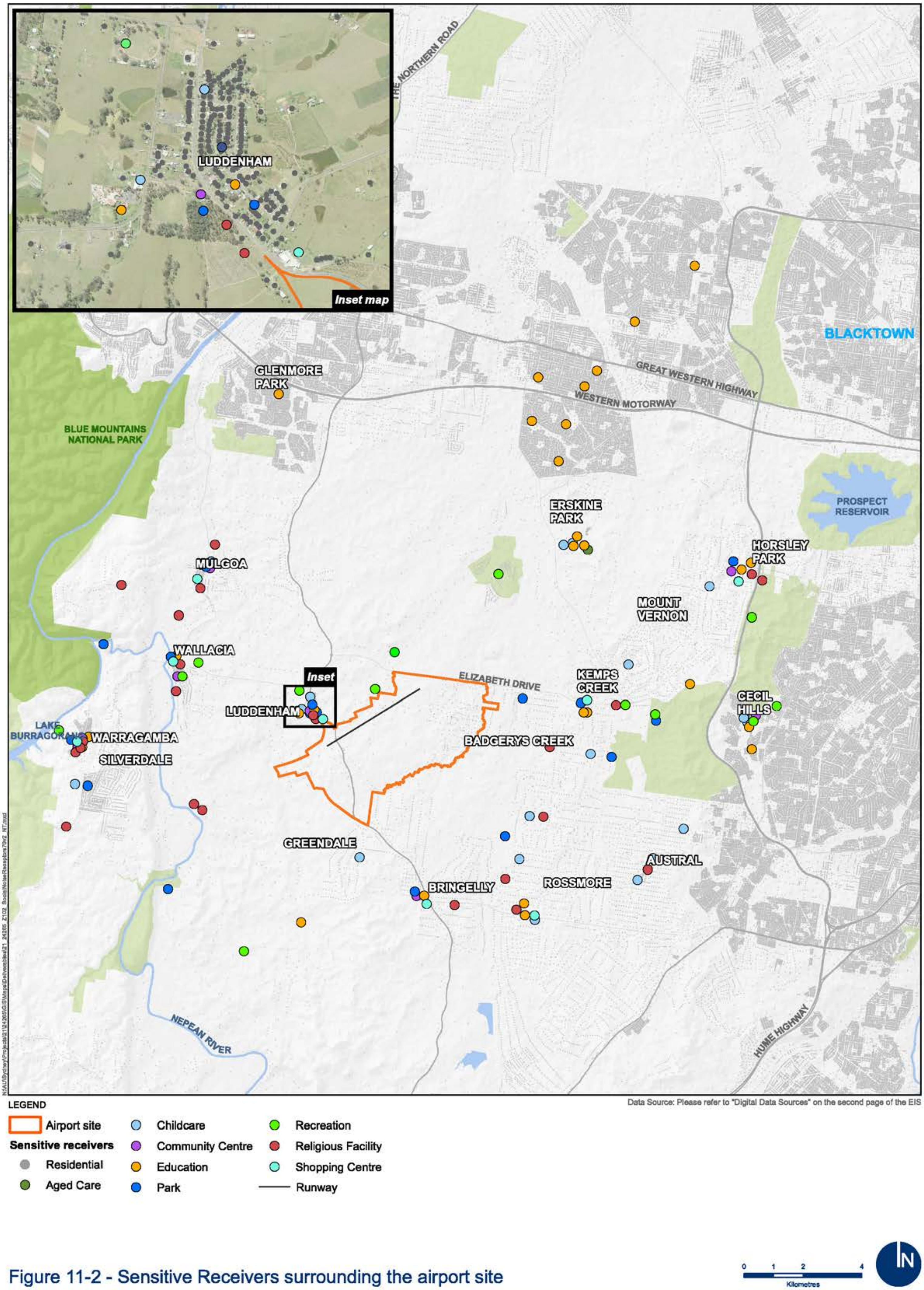


Figure 11-2 - Sensitive Receivers surrounding the airport site

11.4 Regulatory framework, guidelines and criteria

11.4.1 Airports (Environment Protection) Regulations 1997

The Airports (Environment Protection) Regulations provide the regulatory framework for noise generated at an airport site other than noise generated by aircraft in flight, landing, taking-off or taxiing. The regulations provide for appointment of an airport environment officer at each airport to oversight the operation of the regulations.

Under the regulations, operators of an undertaking at an airport have a duty to take all reasonable and practicable measures to prevent the generation of ‘offensive noise’ or if prevention is not reasonable or practicable, to minimise the generation of offensive noise from the undertaking. Noise is considered ‘offensive’ if the noise is generated at a volume, in a way, or under a circumstance that, in the opinion of an airport environment officer, offensively intrudes on individual, community or commercial amenity. The regulations set out certain factors that an airport environment officer must take into account in forming this opinion. These factors include the volume, tonality and ‘impulsive character’ of the noise, the time of day and duration of the noise, background noise levels when the noise is generated, and the location of sensitive receptors (or commercial receptors if there is no affected sensitive receptor) in relation to the noise.

In forming this opinion, airport environment officers must also take into account the excessive noise guidelines in the regulations. The excessive noise guidelines set out specific indicators of excessive noise in relation to specific types of noise, such as noise from construction, road traffic and rail traffic.

In relation to ground-based engine running, there are no specific indicators; however, the regulations provide that noise should be generated consistently with the master plan for the airport (see below). Noise levels are to be determined using AS 1055.

In relation to other airport activities such as aircraft refuelling, aircraft repairs, operation of plant and machinery, embarkation or disembarkation of passengers and operation of audible alarms and warning systems, the guidelines provide that noise should not exceed background noise levels at the sensitive receptor site between 7.00 am and 10.00 pm by more than 5 dBA and between 10.00 pm and 7.00 am by more than 3 dBA.

The question of whether the measures taken by operators to prevent or minimise the generation of offensive noise are ‘reasonable and practicable’ is a judgment to be made by an airport environment officer. In making this judgment, the officer must have regard to the circumstances in which the noise is generated, the state of technical knowledge about preventing or minimising noise from the relevant kind of undertaking, and all measures that might practicably be used to prevent or minimise the noise.

11.4.1.1 Environment protection orders

Airport environment officers have the power to enforce compliance with the duty to avoid excessive noise by issuing an environment protection order. If an airport environment officer finds that an operator is in breach of the duty, the officer may make an environment protection order directing the operator to comply with the duty by taking particular action to prevent or minimise the excessive noise. Failure to comply with an environment protection order is a breach of the Regulations and an offence under the *Airports Act 1996*.

11.4.1.2 Monitoring

Under the regulations, the ALC is required to monitor the level of noise generated at the airport, in accordance with the environment strategy in the airport master plan. If monitoring discloses excessive noise, the ALC must give to the airport environment officer a written report about the excessive noise and the details of any remedial action being taken.

11.4.1.3 Master plan environment strategy obligations

The ALC will be required to include an environment strategy in its first draft master plan. The environment strategy must detail the sources of environmental impact associated with civil aviation operations at the airport; the monitoring to be carried out in connection with the environmental impact; and the measures to be carried out to prevent, control or reduce this impact. It is required to include the proposed systems of testing, measuring and sampling to be carried out for possible or suspected excessive noise. Procedures in relation to how and when engine run-ups can be undertaken would be established under the environment strategy. Each master plan, including the environment strategy, is subject to a public consultation process and requires approval from the Infrastructure Minister.

Table 11–2 includes key requirements from the Airports (Environment Protection) Regulations relevant to ground operations.

Table 11–2 Relevant Airports (Environment Protection) Regulations 1997 requirements

Reference	Subject	Provision
2.04	What is offensive noise	1. Noise that is offensive occurs when noise is generated at a volume, or in a way, or under a circumstance, that, in the opinion of an airport environment officer, offensively intrudes on individual, community or commercial amenity. 2. In forming an opinion, an airport environment officer must have regard to: a. the volume, tonality and impulsive character (if any) of the noise; and b. the time of day, and duration, of the noise; and c. background noise levels at the time the noise is generated; and d. the location, in relation to the source of the noise, of: i. sensitive receptors; or ii. if there is no affected sensitive receptor — commercial receptors; and e. the excessive noise guidelines in Schedule 4 of the regulations (see below).
4.06	General duty to prevent offensive noise occurring	3. The operator of an undertaking at an airport must take all reasonable and practicable measures: a. to prevent the generation of offensive noise from the undertaking; or b. if prevention is not reasonable or practicable — to minimise the generation of offensive noise from the undertaking An operator of an undertaking at an airport is complying with that duty if the noise meets the guidelines in Schedule 4 of the regulations (or any local standard set by or authorisation given by the Minister).
Schedule 4 – 2.02	Noise from construction, etc.	Noise generated from construction, maintenance or demolition of a building or other structure at an airport should not exceed 75 dB(A) at the site of a sensitive receptor.

Reference	Subject	Provision
Schedule 4 – 2.03	Noise from road traffic	Noise generated from road traffic should not exceed: a. 60 dB(A), calculated as the equivalent continuous A−weighted sound pressure level for a 24 hour period of measurement; and b. 55 dB(A), calculated as the equivalent continuous A−weighted sound pressure level for an 8 hour period of measurement from 22:00 hours on a particular day to 06:00 hours on the following day.
Schedule 4 – 2.05	Noise from ground−based aircraft operations	For ground−based aircraft operations, there are no indicators of noise that is excessive, but a number of considerations apply in determining whether noise is excessive. The environment strategy included in the master plan is required to identify sources of environmental impacts including noise and address measures to be carried out by the ALC for the purposes of preventing, controlling or reducing those impacts. The regulations identify specific considerations in relation to ground-based aircraft operations including: a. the distance between the source of the noise and the site of the sensitive receptor; and b. the background noise level; c. the time of day when the noise occurs; and d. if the noise source is an aircraft engine — the power setting of the engine.
Schedule 4 – 2.06	Noise from other airport operations	Noise generated from any of the following activities: a. aircraft refuelling; b. activities in connection with aircraft that do not involve the operating of an aircraft engine (for example, moving, maintaining or repairing aircraft); c. operation of plant or machinery; d. assembling of passengers or goods in connection with embarkation or disembarkation of aircraft; and e. operation of fixed audible alarm or warning systems. Noise generated from an activity should not exceed the background noise level at the sensitive receptor site: a. between the hours of 07:00 and 22:00 — by more than 5 dB(A); and b. between 22:00 hours of a day and 07:00 hours of the next day — by more than 3 dB(A).

11.4.1.4 Aircraft taxiing noise

Part 6 of the Airports Act and the Airports (Environment Protection) Regulations set out the framework which would regulate the generation of noise at the proposed airport, other than noise generated by aircraft in flight (including when landing, taking off or taxiing at the airport). While for noise assessment purposes taxiing is addressed in this chapter, it is not considered to be part of the ground-based noise regulatory framework established under the Regulations. This reflects the general division of responsibility for noise management between Airservices Australia and the ALC.

For aircraft taxiing, it is relevant to note that aircraft operating in Australia must meet noise standards specified in the Air Navigation (Aircraft Noise) Regulations 1984. As discussed in Section 10.2.5, these regulations ensure that aircraft using airports in Australia including the proposed Western Sydney Airport – whether in flight or on the ground – are compliant with internationally accepted noise standards and practices.

Although not consistent with the regulatory framework for this activity, considering aircraft taxiing as a ground-based noise source for assessment purposes provides a way of isolating and evaluating noise generated by taxiing, particularly given that taxiing operations have not been taken into account in the aircraft overflight assessment and associated noise exposure modelling (Chapter 10 and Appendix E1 (Volume 4)).

11.4.2 Construction noise criteria

As noted in Table 11–2, the Airports (Environment Protection) Regulations provide a guideline level of 75 dBA for construction noise measured at a sensitive receptor (see Schedule 4 – 2.02).

The NSW Department of Environment and Climate Change (DECC) Interim Construction Noise Guideline (DECC 2009) was also used for the purposes of this assessment. The Guideline recommends *noise management levels* to assist the management of noise on construction sites both during and outside standard construction hours (Monday to Friday, 7.00 am to 6.00 pm and Saturday 8.00 am to 1.00 pm). Where noise at sensitive receivers is expected to exceed noise management levels, implementation of reasonable and feasible noise mitigation is recommended and consultation with affected people is encouraged.

For works during standard construction hours, the noise management level is background plus 10 dBA for residential locations. For works outside of normal construction hours, the noise management level is background plus 5 dBA.

Based on the daytime background noise levels shown in Table 11–1, the residential noise management level for standard construction hours would be between 39 dBA and 49 dBA. For assessment of construction noise, a noise management level of 45 dBA may reasonably be adopted for all residential receivers. A noise management level of 40 dBA has been adopted for weekend works and early morning works (outside standard construction hours).

11.4.3 Construction vibration criteria

To protect buildings from vibration damage the most stringent vibration standard typically used in Australia is German Standard DIN 4150-3: *Structural Vibration: Effects of Vibration on Structures*. This standard recommends frequency based guideline values and the lowest and most conservative values are normally adopted, as shown in Table 11–3.

Table 11–3 Vibration damage guideline values (DIN 4150-3)

Type of structure	Guideline value, peak particle velocity (mm/s)
Dwellings and buildings of similar design	5
Vibration sensitive buildings (heritage)	3

11.4.4 Blasting criteria

During construction of the proposed Stage 1 development, it is possible that blasting may be carried out at particular locations where hard rock is encountered. During blasting, vibration is generated in the ground and may propagate to surrounding areas. Airblast is the pressure wave generated as the energy from a blast is released into the atmosphere. Both ground vibration and airblast may cause effects at nearby buildings.

The Australian and New Zealand Environment Conservation Council (ANZECC) guideline – *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZECC 1990) – recommends residential criteria for the assessment of vibration and airblast from blasting. These criteria are designed to protect the comfort of occupants of residential buildings. Table 11–4 summarises the criteria recommended by ANZECC.

Table 11–4 ANZECC recommended vibration and airblast criteria

Issue	Measure	Criterion for 95% of blasts	Criterion for 100% of blasts
Vibration	mm/s PPV	5	10
Airblast	dBL Peak	115	120

11.4.5 Ground operations noise criteria

The Airports (Environment Protection) Regulations provide a regulatory approach for ground-based operational noise. However, these regulations are not intended to provide a basis for the assessment of the impact caused by such noise and they do not set specific criteria for aircraft engine noise. As a consequence, this analysis uses the *NSW Industrial Noise Policy* (EPA 2000) as a basis for identifying noise assessment criteria. It is important to recognise in setting these criteria that the character of noise from ground-based activities at an airport is different to the character of noise from many other developments, such as industrial developments, which are regulated by the *NSW Industrial Noise Policy*. It is not intended that these criteria would be used for future regulation of the activities considered in this assessment.

11.4.5.1 Criteria for taxiing noise

The *NSW Industrial Noise Policy* intrusiveness criteria for residences apply to relatively continuous noise such as that produced by aircraft taxiing. The intrusiveness noise criteria used in relation to residential land uses were determined by adding 5 dBA to the measured background noise levels shown in Table 11–1. The criteria are presented in Table 11–5.

Table 11–5 Industrial Noise Policy intrusiveness criteria for residential locations relevant to aircraft taxiing noise

Location	$L_{Aeq,15\ min}$ noise criteria (dBA)		
	Day (7am–6pm)	Evening (6pm–10pm)	Night (10pm–7am)
9 Harold Bentley Way, Glenmore Park	44	47	43
16 Park Avenue, Springwood	35	37	35
17 Blue Ridge Place, Orchard Hills	39	43	41
25 Peter Pan Avenue, Wallacia	42	39	35
27 Dwyer Road, Bringelly	38	43	40
35 Ramsay Road, Rossmore	40	42	40
54 Ridgehaven Road, Silverdale	41	41	36
114 Mount Vernon Road, Mount Vernon	39	40	38
120 Vincent Avenue, Mulgoa	43	47	40
Twin Creeks Golf Club, 2 Twin Creeks Drive, Luddenham	39	43	38
8 Wade Close, Luddenham	40	41	39

By the time the proposed airport becomes operational, background noise levels in the surrounding area would have increased due to various factors including increased road traffic as well as associated residential and commercial development. This would, in turn, raise the value of the appropriate noise criteria for the assessment of airport operations noise. For this reason, and to allow easy interpretation of the operational noise contours, an overall intrusiveness noise criterion of 40 dBA averaged over 15-minute intervals ($L_{Aeq,15\ min}$) has been adopted as appropriate for residential locations in this assessment. Adopting a single, overall noise criterion will be conservative for some locations but is also consistent with the broad approach taken for similar EIS reports.

For other land uses, the taxiing noise criteria were determined by reference to the amenity criteria in the *NSW Industrial Noise Policy*. Table 11–6 provides the adopted noise criteria for taxiing.

Table 11–6 Noise criteria taxiing

Receiver type	Measure	Criterion dB(A)
Residential	$L_{Aeq,15min}$	40
School	$L_{Aeq,15min}$	50
Hospital	$L_{Aeq,15min}$	55
Place of worship	$L_{Aeq,15min}$	55
Passive recreation	$L_{Aeq,15min}$	55
Active recreation	$L_{Aeq,15min}$	60

11.4.5.2 Criteria for engine run-up noise

Engine run-up noise would be intermittent and subject to limitations during the night. It has been assumed that high power engine run-ups would occur for less than five minutes on any night. In this context, the night time residential criterion for these activities has been set as 5 dBA above the general *NSW Industrial Noise Policy* night time criterion for residential receivers. The criteria for other land uses have also been set at 5 dBA above the relevant amenity criteria. Table 11–7 provides the adopted noise criteria for engine run-ups.

Table 11–7 Noise criteria for aircraft engine run-up

Receiver type	Measure	Criterion dB(A)
Residential	$L_{Aeq,15min}$	45
School	$L_{Aeq,15min}$	55
Hospital	$L_{Aeq,15min}$	60
Place of worship	$L_{Aeq,15min}$	60
Passive recreation	$L_{Aeq,15min}$	60
Active recreation	$L_{Aeq,15min}$	65

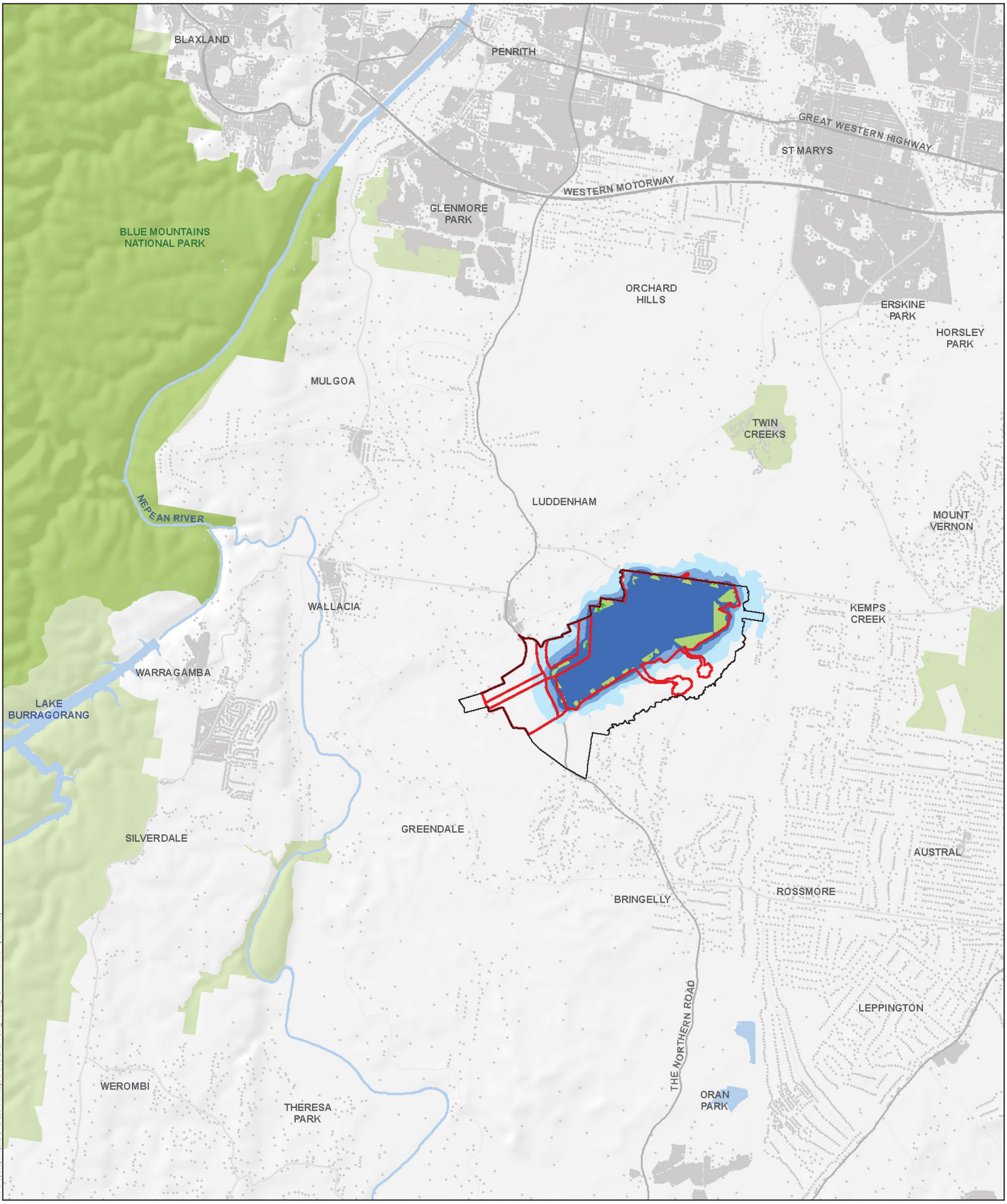
11.4.6 Road traffic noise criteria

The *NSW Road Noise Policy* (DECCW 2011) recommends noise assessment criteria for residential and non-residential land uses affected by traffic generating developments. The policy indicates that an increase of up to 2 dBA represents a minor impact that is considered barely perceptible to the average person. This has been used as the reference point for the assessment of potential construction and operational road traffic noise.

11.5 Assessment of impacts during construction

11.5.1 Noise from construction works

Figure 11–3 to Figure 11–6 show the predicted worst case construction noise contours for construction sectors (east, north, north-west and south-west). These figures show the worst weather condition that may occur, represented by a temperature inversion early in the morning in winter. A still, isothermal weather condition was also modelled to represent the rest of a typical day. Construction noise contours for isothermal conditions are more confined to the airport site (see Appendix E2 (Volume 4)).



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

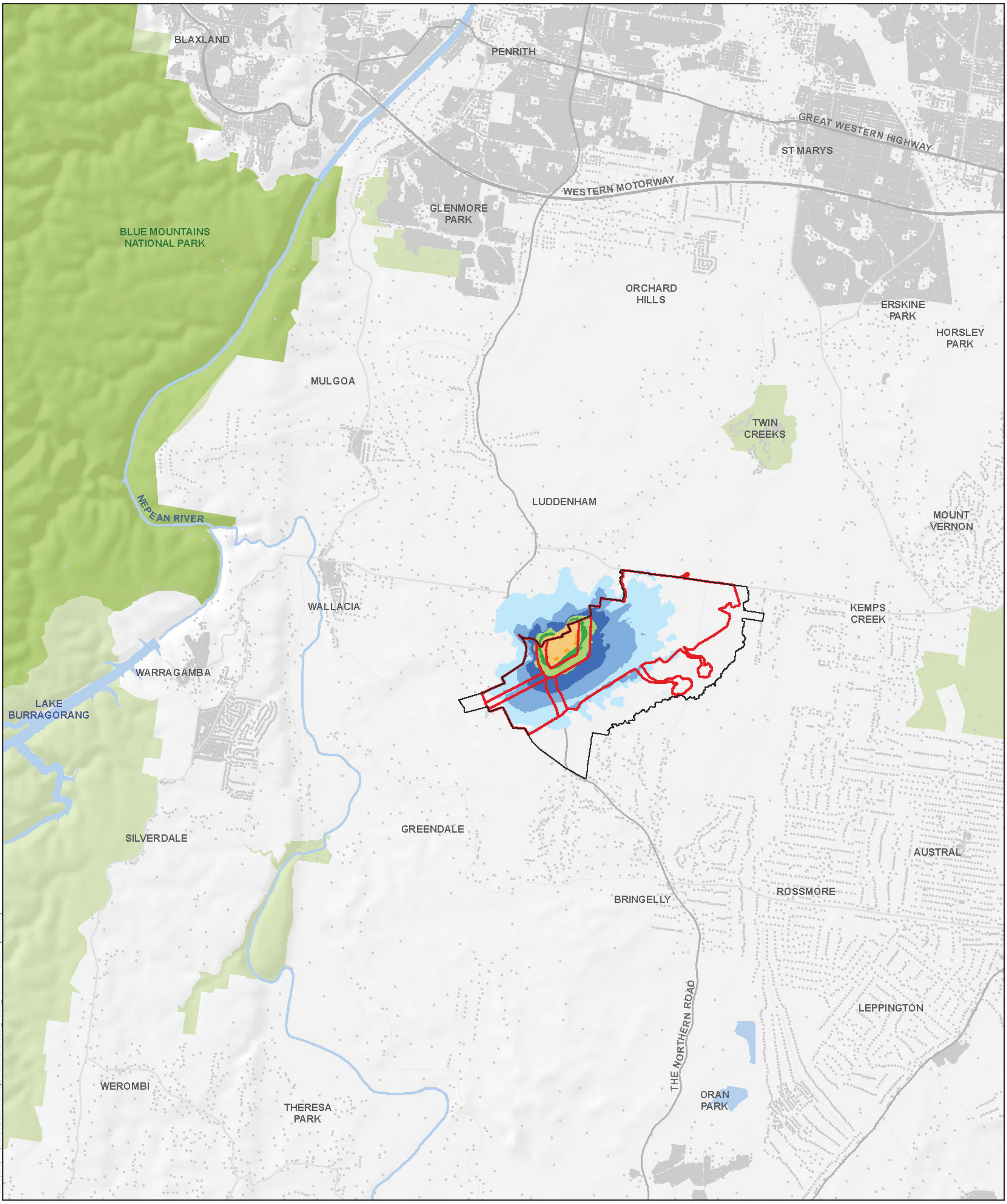
Western Sydney Airport	
Buildings	
Greater Blue Mountains World Heritage Area	
Parks and reserves	
Construction areas	

LAeq, 15 min

- 40-45 dBA
- 45-50 dBA
- 50-55 dBA
- 55-60 dBA
- >60 dBA

0 0.75 1.5 3
Kilometres

Figure 11-3 - East Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

Western Sydney Airport
Buildings
Greater Blue Mountains World Heritage Area
Parks and reserves
Construction areas

LAeq, 15 min
40-45 dBA
45-50 dBA
50-55 dBA
55-60 dBA
60-65 dBA
65-70 dBA
>70 dBA

0 0.75 1.5 3
Kilometres

Figure 11-4 - North Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion

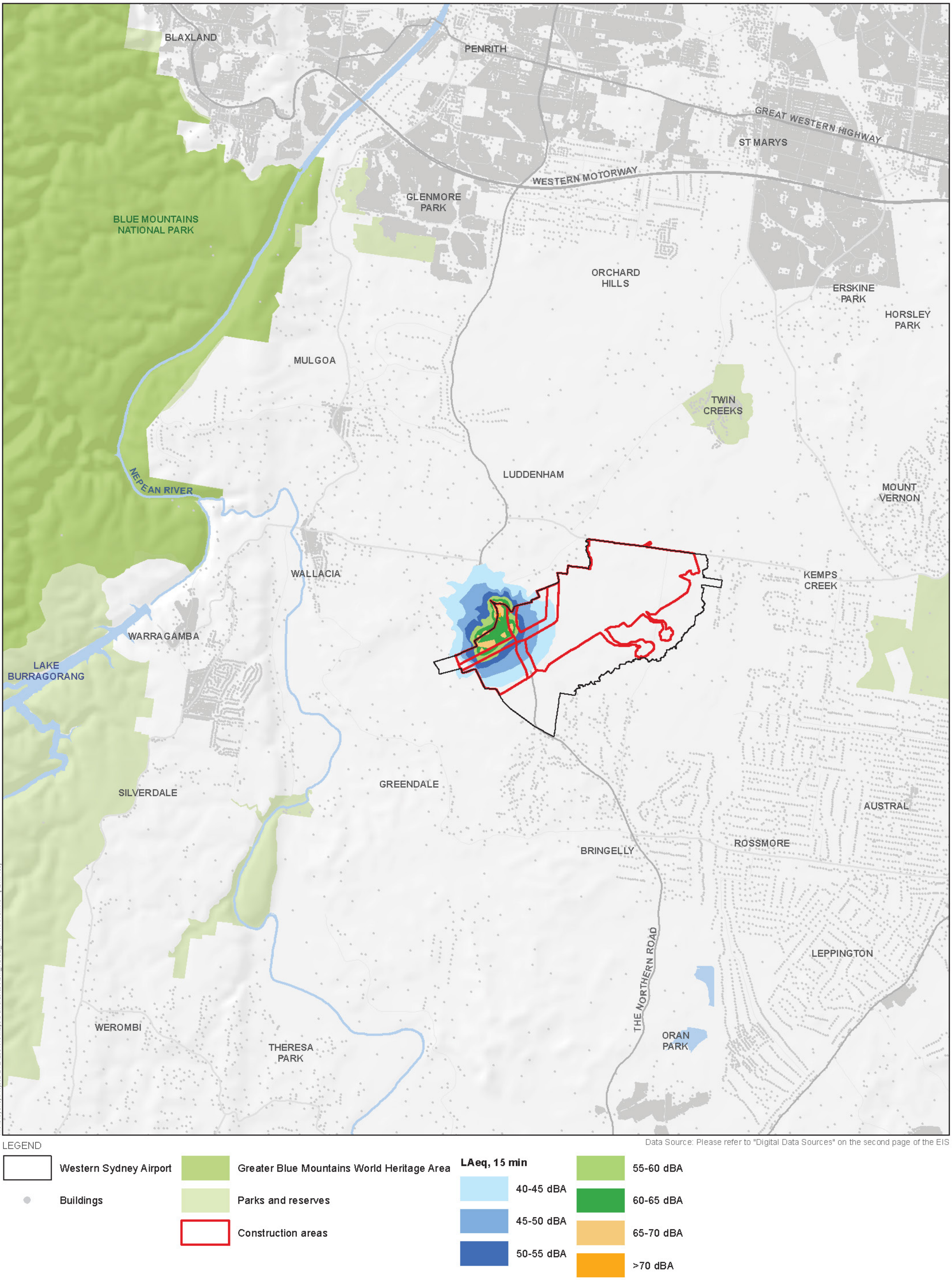
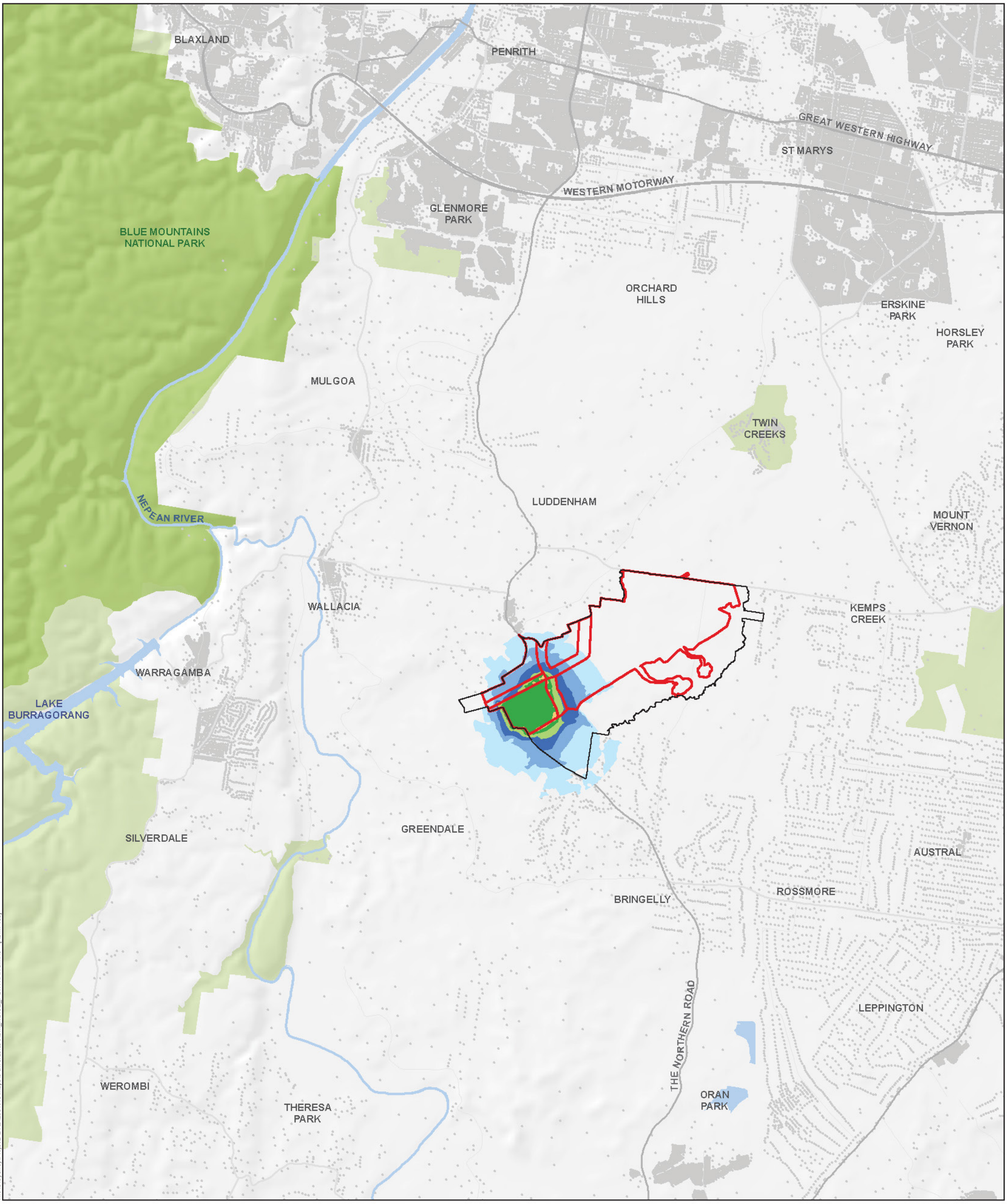


Figure 11-5 - North West Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Western Sydney Airport
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- Construction areas

LAeq, 15 min

- 40-45 dBA
- 45-50 dBA
- 50-55 dBA
- 55-60 dBA
- 60-65 dBA
- >65 dBA

0 0.75 1.5 3
Kilometres

Figure 11-6 - South West Sector Bulk Earthworks LAeq,15min Contours Temperature Inversion

The estimated population likely to be affected by noise levels above the adopted noise management level during standard hours is shown in Table 11–8.

Table 11–8 Estimated residential population affected by levels above noise management level – standard construction hours (worst case temperature inversion)

Location	Noise management level	Estimated residential population affected above criterion
East section	45 dBA	0
North section	45 dBA	103
North-west section	45 dBA	199
South-west section	45 dBA	14

The estimated population likely to be affected by noise levels above the adopted noise management level outside standard hours is shown in Table 11–9.

Table 11–9 Estimated residential population affected by levels above noise management level – outside standard construction hours (worst case temperature inversion)

Location	Noise management level	Estimated residential population affected above criterion
East section	40 dBA	48
North section	40 dBA	527
North-west section	40 dBA	531
South-west section	40 dBA	140

Under worst case conditions, noise emissions arising from construction activities would be predominantly limited to the airport site and immediate surrounds. The airport site covers a broad area, and a range of management measures such as the placement of temporary noise barriers or exclusion buffers within the airport site may be adopted as required to mitigate disturbance to nearby receivers, particularly for construction activity outside of standard construction hours. It should be noted that the construction noise guideline level of 75 dBA in the Airports (Environment Protection) Regulations 1997 is met at all surrounding receivers.

11.5.2 Construction traffic noise

Construction traffic would use the nearby road network, with most traffic expected to access the site via Elizabeth Drive. Table 11–10 presents predicted noise increases along Elizabeth Drive as a result of construction traffic. Along all sections of Elizabeth Drive, the predicted increase in noise from construction traffic is less than 2 dBA. This change in noise level is unlikely to be perceptible.

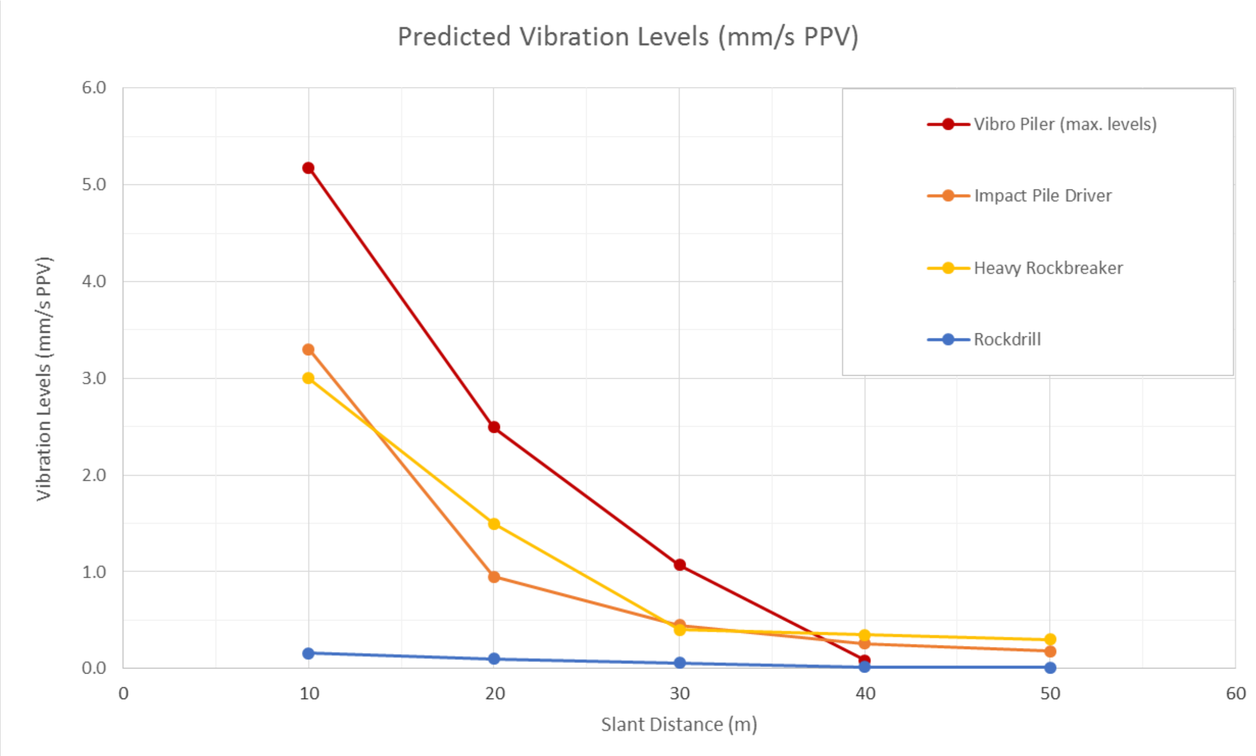
Table 11–10 Predicted construction traffic noise increases on Elizabeth Drive

Road	Location	Noise level increase (dB)	
		Day	Night
Elizabeth Drive	West of Mamre Road	0.6	1.1
	West of Devonshire Road	0.9	0.5
	West of Lawson Road	0.9	0.6

11.5.3 Construction vibration assessment

Vibration would be generated by specific construction plant as part of the proposed construction works. As a very conservative approach, and in the absence of an applicable Australian Standard, the most stringent vibration standard, the German Standard DIN 4150-3:1999 was used to assess building vibration damage. For this assessment, the lower guideline value applying to vibration sensitive buildings (3 mm/s) has been adopted as the threshold of damage from construction vibration.

Figure 11–7 shows vibration levels previously measured on construction sites at a range of distances for key vibration-generating plant. The vibration levels from impact piling during the construction works would likely generate the highest vibration levels.



Source: (Wilkinson Murray)

Figure 11–7 Previously measured vibration levels

The graph indicates that the 3 mm/s threshold value would not be exceeded beyond a distance of 20 metres from a vibration source, even when considering the piling method that would likely generate the highest vibration levels from the anticipated construction plant. Given that piling is expected to be used only for the construction of buildings at locations well within the proposed airport boundary, there would be no risk of damage from vibration occurring outside of the airport site.

Vibration may also be generated by the ripping of rock, but again the 3 mm/s guideline value is likely to be complied with inside the airport boundary and there is no risk of damage outside the airport boundary.

11.5.4 Blast vibration and airblast

Preliminary site investigations indicate that the Bringelly shale and Luddenham dyke at the airport site can be ripped. However, there are some thicker sandstone deposits throughout the site that may need to be blasted.

For an assumed sandstone thickness of up to 5 metres, an indicative blast design has been assumed for the purposes of assessment. The closest residential receiver would be approximately 150 metres from a potential blast site and has been used in the analysis to determine the worst case potential impact.

The vibration level from blasting depends upon the distance from the blast as well as the charge, measured as the maximum instantaneous charge (MIC). Historical blasting vibration measurements in sandstone have been used to develop a vibration prediction graph which is sufficient to allow an indicative analysis for the airport construction. Figure 11–8 shows the results of analysis of blasting vibration in sandstone rock which allows prediction of the upper end of vibration levels which may be expected.

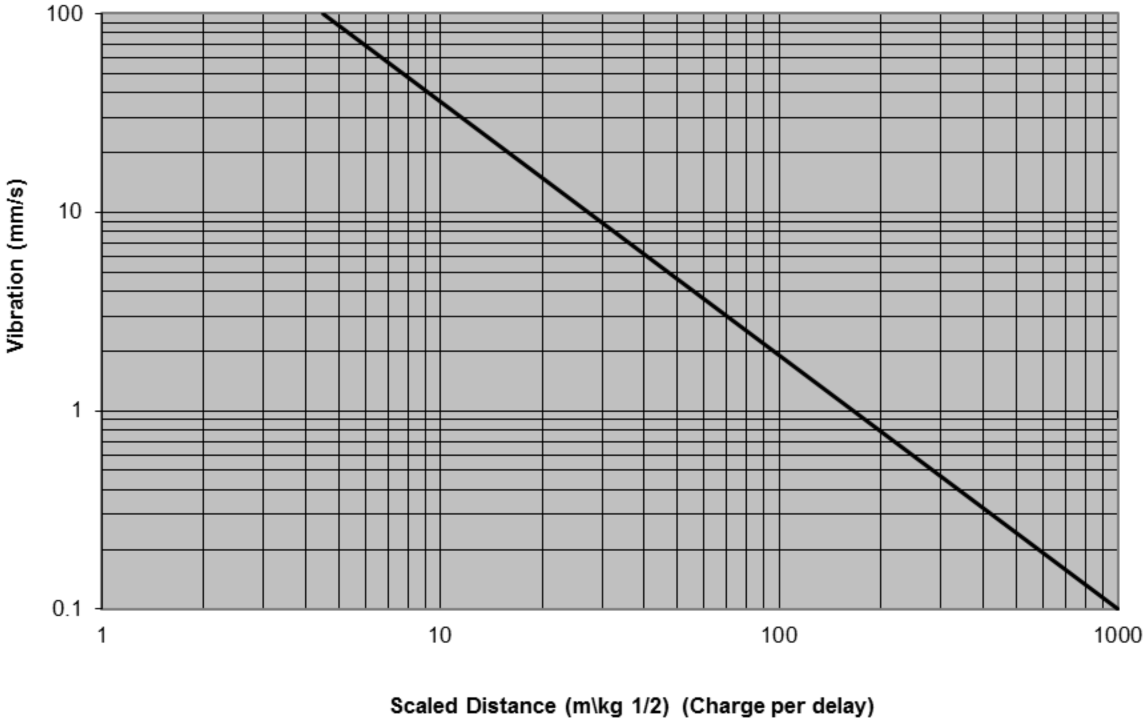


Figure 11–8 Vibration prediction curve for blasting in sandstone

Based on the graph, a vibration level of 3.5 mm/s is predicted 150 metres away at the nearest residence, based on an MIC of 5 kg (scaled distance 67 m/kg$^{0.5}$). It is concluded that to meet the ANZECC 95 per cent vibration criterion, a limitation to blast one hole per delay or to limit the MIC to 5 kg would be required. At distances greater than 150 m, these limitations could be relaxed.

Blasting delay (often called millisecond delay) is the interval of time between the ignition of two consecutive blasting charges. Delays are often used in blasting to ensure that all separate charges in the blast are not ignited simultaneously.

The airblast level depends on the distance from the blast and also the maximum charge fired at any instant in time (MIC). However, it also depends on the degree to which the charge is confined by the rock being blasted. If the charge is fully exposed, the blast will easily escape to the atmosphere, but if it is confined, it will be restrained in escaping. The degree of confinement is related to the depth of the charge below the surface (stemming depth) and the distance from the rock face to the charge (burden). Similar to the vibration prediction, historical blast monitoring and testing conducted has allowed the airblast prediction curve shown in Figure 11–9 to be developed. This shows the airblast level as a function of distance, MIC and burden.

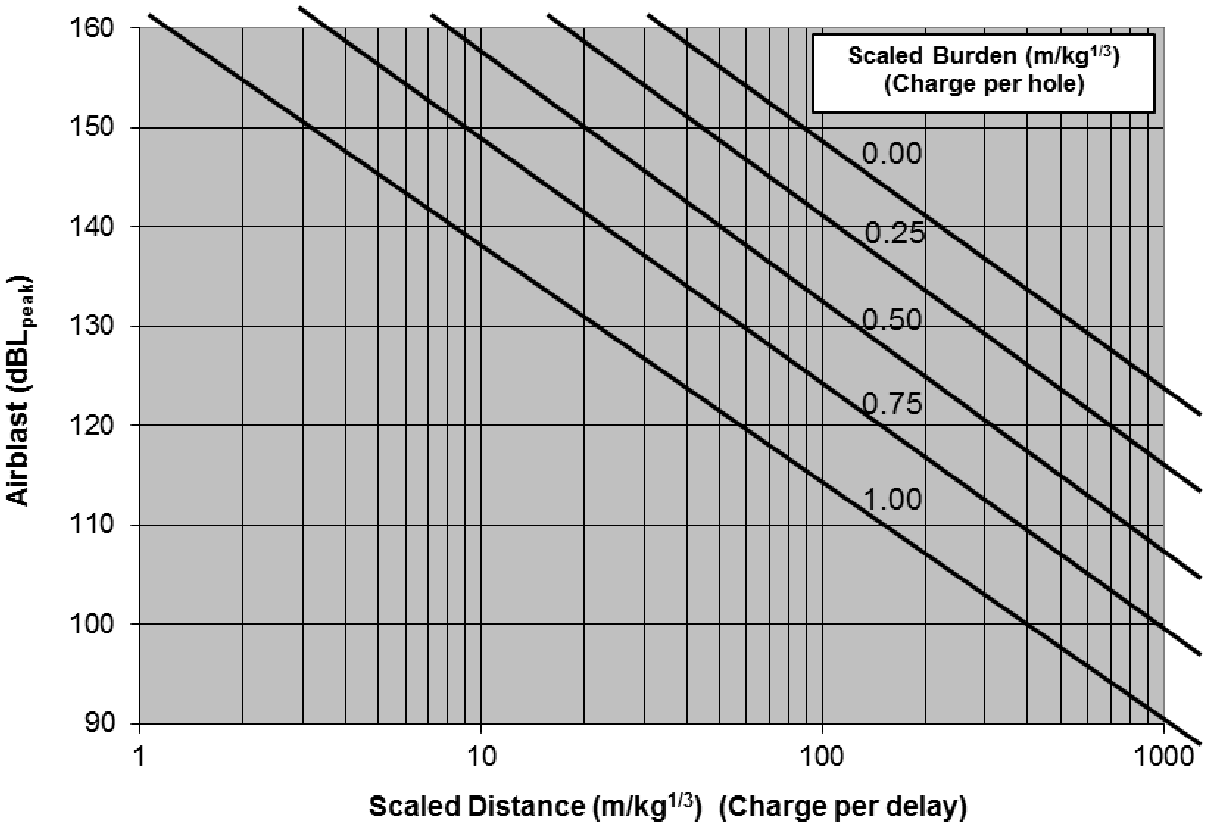


Figure 11–9 Airblast prediction curve for blasting

Based on the assumed blast design, an airblast level of 113 dBL is predicted at a distance of 150 m, representing the distance to the closest residential receiver. This indicates that the 115 dBL ANZECC 95% criterion can be complied with if the MIC is limited to 5 kg. However, it would also be necessary to ensure that the burden and stemming were maintained at no less than 2 m. Decibels linear (dBL) is a value representing the loudness of a sound at a specific time across all sound frequencies. This level is unweighted and is useful in measuring low frequency sound.

11.6 Assessment of impacts during operation

11.6.1 Ground-based operations noise

Figure 11–10 and Figure 11–11 show predicted noise exposure contours associated with engine run-up and taxiing activities. These figures have been updated based on new noise modelling conducted since release of the draft EIS. As outlined in Section 11.2, use of the Concawe prediction algorithm results in the effects of ground absorption being more accurately represented.

The contours indicate that under worst case conditions and in the absence of operational controls (e.g. restriction of engine run-ups), ground-based operations noise has the potential to extend over a large area surrounding the airport site. Table 11–11 shows the estimated population predicted to be affected by noise above the adopted assessment criteria.

Table 11–11 Estimated residential population affected by ground-based operations noise

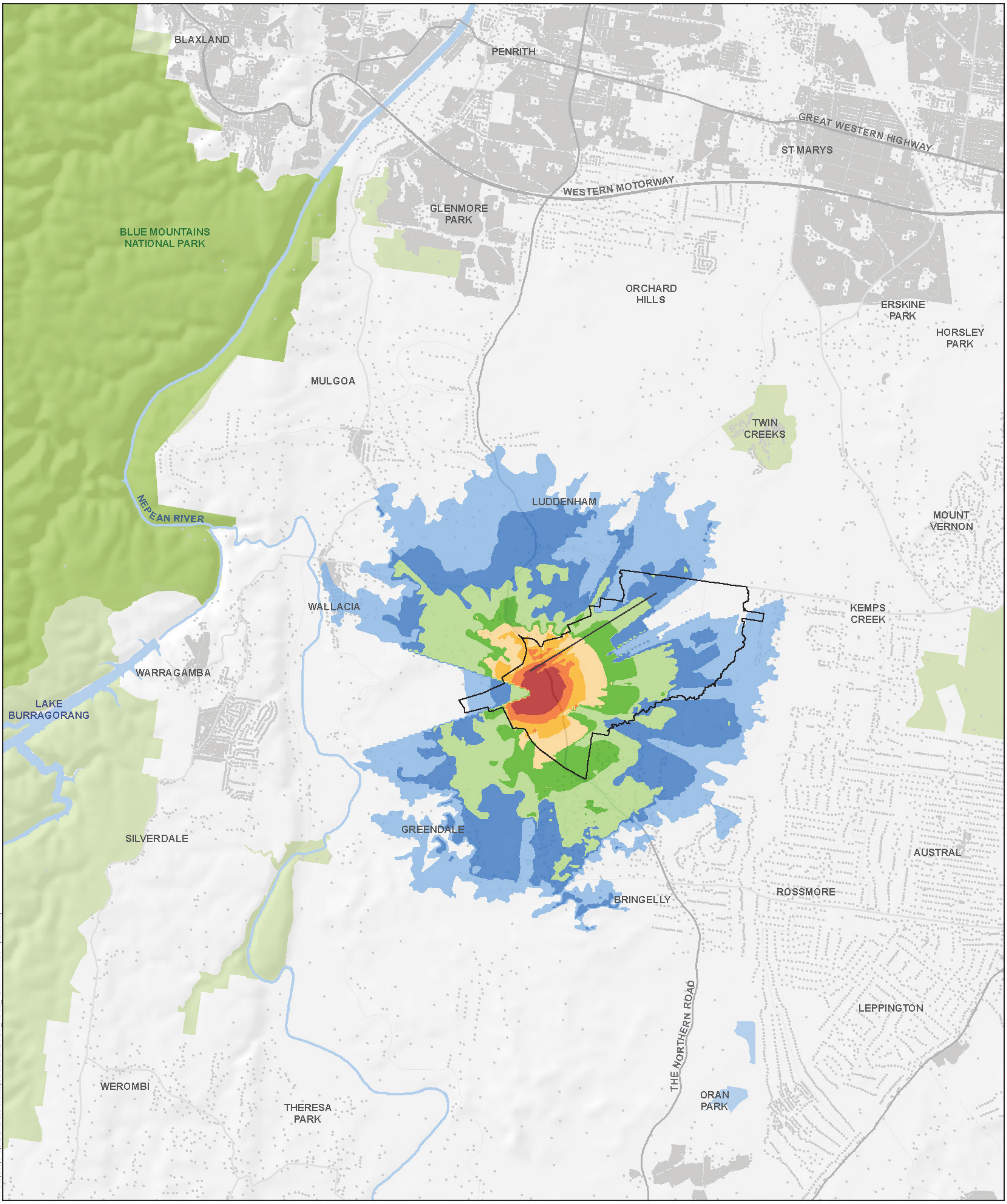
Noise type	Noise criterion	Estimated residential population affected above criterion
Engine run-up	45 dBA	4,471
Taxiing	40 dBA	1,610

Under worst case meteorological conditions, noise associated with engine maintenance testing has the potential to affect Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale.
Figure 11–10 shows the effect of shielding to the west of the airport site by an aircraft maintenance building, the size and location of which are taken from the revised draft Airport Plan. The predicted noise exposure from aircraft taxiing extends over a much smaller area and would primarily affect Luddenham.

The predicted impact of ground-based operations noise on other noise sensitive uses surrounding the airport site is summarised in Table 11–12.

Table 11–12 Noise impact of ground-based operations on other uses

Noise type	Building/land use type	Criterion	Number affected (above criterion)
Engine run-up	Educational institutions	55 dBA	5
	Hospitals	60 dBA	0
	Places of worship	60 dBA	3
	Passive recreation	60 dBA	2
	Active recreation	65 dBA	1
Taxiing	Educational institutions	50 dBA	0
	Hospitals	55 dBA	0
	Places of worship	55 dBA	0
	Passive recreation	55 dBA	0
	Active recreation	60 dBA	0



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Western Sydney Airport
- Runway
- Buildings
- Greater Blue Mountains World Heritage Area
- Parks and reserves

LAeq, 15min

- 45-50 dBA
- 50-55 dBA
- 55-60 dBA
- 60-65 dBA
- 65-70 dBA
- 70-75 dBA
- 75-80 dBA
- >80 dBA

0 0.75 1.5 3
Kilometres

Figure 11-10 - Engine run-up noise contours - worst case Stage 1 operations

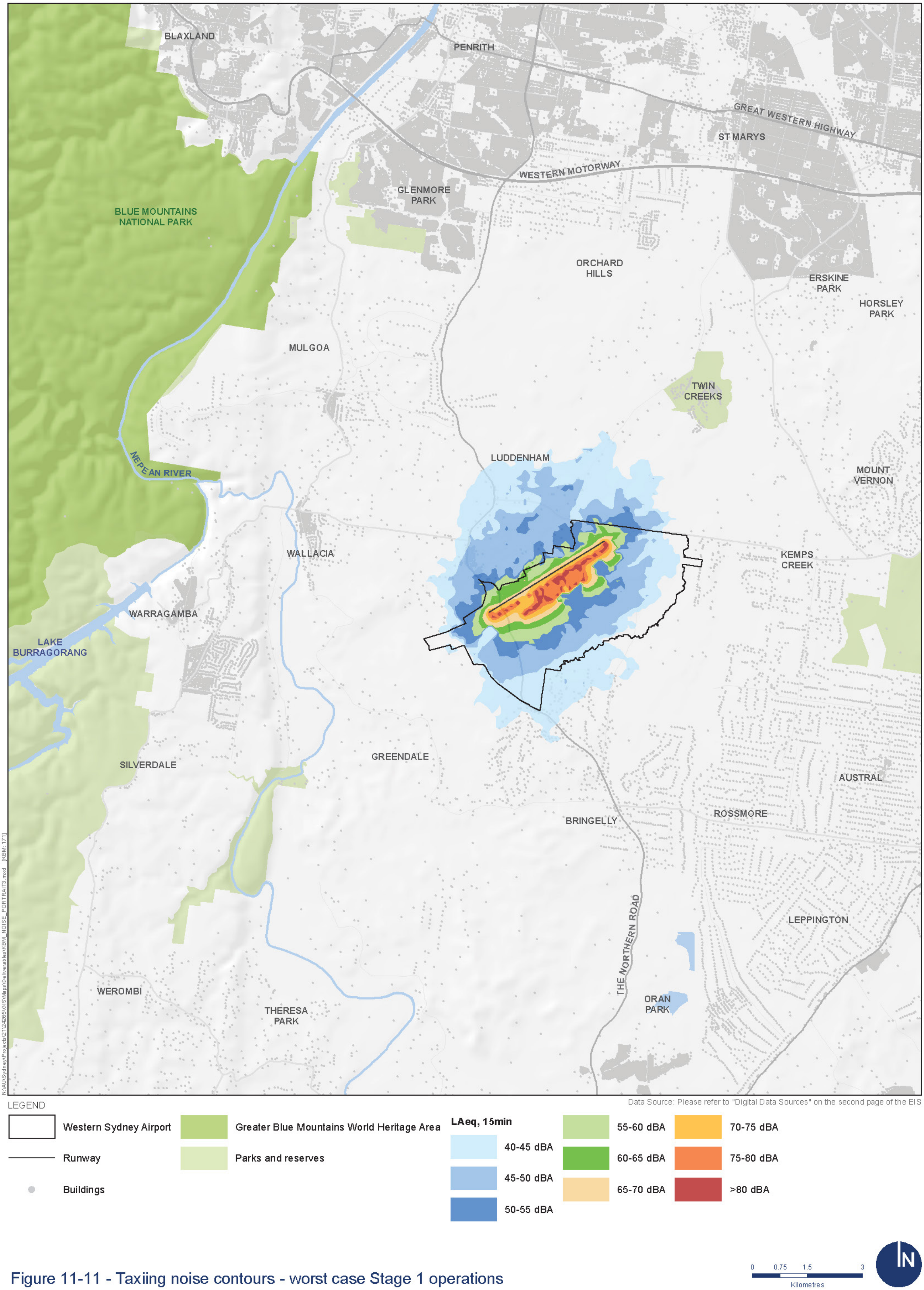


Figure 11-11 - Taxiing noise contours - worst case Stage 1 operations

11.6.2 Road traffic noise

As explained in Section 11.2.3, road traffic noise levels for the road network around the airport site were calculated using the traffic projections discussed in Chapter 15 and the CoRTN procedure.

Table 11–13 shows the change in noise level expected as a result of airport traffic on surrounding roads. In general, the noise level increase is less than 2 dBA except during the night time on Elizabeth Drive (west of Lawson Road) and a section of the M12 (west of Mamre Road). However, given the nature of development setbacks from these roads, in the order of 75 metres, the predicted noise level increases at residential dwellings will still be low.

Table 11–13 Road traffic noise level increases due to proposed airport

Road	Location	Noise level increase (dB)	
		Day	Night
Mamre Road	North of Elizabeth Drive	1.2	0.4
	North of Mount Vernon Road	0.4	-0.4
	North of Abbotts Road	0.6	-0.4
	North of Bakers Lane	0.4	-0.4
	North of Erskine Park Road	0.5	-0.4
	North of Luddenham Road	0.6	-0.3
	North of Banks Drive	0.0	0.0
Luddenham Road	South of South Creek	0.2	0.1
	South of Twin Creeks Golf Club	0.7	-0.5
Elizabeth Drive	West of Mamre Road	0.5	0.1
	West of Devonshire Road	0.7	0.3
	West of Lawson Road	1.9	2.1
	West of Badgerys Creek Road	0.7	0.3
	West of Adams Road	0.7	0.3
	West of The Luddenham Road	0.4	-0.2
Camden Valley Way	West of M7	0.2	-0.2
	West of Croatia Avenue	0.2	-0.2
	West of Talana Drive	0.1	-0.2
	South of Bringelly Road	0.6	-0.3
Bringelly Road	West of Cowpasture Road	0.2	-0.2
	Bringelly Road east of Edmondson Avenue	0.2	-0.2
	Bringelly Road west of Fourth Avenue	0.1	-0.2
	Bringelly Road west of King Street	0.1	-0.2

Road	Location	Noise level increase (dB)	
		Day	Night
	West of Allenby Road	0.1	-0.2
	West of Kelvin Park Drive	0.1	-0.2
Adams Road	South of Elizabeth Drive	0.3	-0.2
	West of Anton Road	0.3	-0.2
	West of Jamison Street	0.3	-0.1
Erskine Park Road	North of Explorers Way	0.2	-0.2
	North of Bennet Road	0.3	-0.2
	North of Lenore Drive	0.3	-0.2
	East of Mamre Road	0.4	-0.3
The Northern Road	North of Homestead Road	0.0	-0.1
	South of Glenmore Parkway	0.1	0.0
	North of Kings Hill Road	0.2	-0.1
	North of Littlefields Road	0.2	0.0
	North of Elizabeth Drive	0.1	0.2
	North of Park Road	0.2	-0.1
	North of Adams Road	-0.7	-0.8
	North of Badgerys Creek Road	0.5	-0.3
	North of Bringelly Road	0.4	-0.3
	North of Carrington Road	0.1	0.0
	North of Northern Road	0.3	-0.2
	North of Cobbity Road	0.2	-0.2
	North of Hillside Drive	0.3	-0.2
	North of The Old Northen Road	0.3	-0.3
	North of Camden Valley Way	1.2	-0.5
Narellan Road	West of Hume Highway	0.3	-0.4
	West of Hartley Road	0.2	-0.4
	West of Camden Bypass	0.4	-0.4
	East of Camden Valley Way	0.4	-0.4
Wallgrove Road	North of Wonderland Drive	0.6	-0.4
	North of Old Wallgrove Road	0.2	-0.2
	North of Redmayne Road	0.1	0.0

Road	Location	Noise level increase (dB)	
		Day	Night
	North of Horsley Drive	0.1	-0.1
	North of Elizabeth Drive	0.3	-0.3
M7	South of M4	1.9	0.1
	South of Old Wallgrove Road	1.6	0.2
	North of Redmayne Road	0.8	0.0
	North of Elizabeth Drive	1.4	0.0
	North of Cowpasture Road	1.3	0.0
	North of Hoxton Park Road	1.5	0.1
	North of Kurrajong Road	1.6	0.2
	North of Camden Valley Way	1.6	0.2
	North of Brooks Road	1.2	0.0
	North of Campbelltown Road	0.9	0.0
M31	North of Narellan Road	0.9	0.0
M4	West of M7	0.9	-0.1
	West of Roper Road	0.6	-0.2
	West of Mamre Road	0.5	-0.2
	East of The Northern Road	0.6	-0.3
	West of The Northern Road	0.5	-0.3
M12	West of M7	0.0	1.0
	West of Mamre Road	0.6	2.4
	West of Airport Access	0.3	1.9

11.7 Mitigation and management measures

Table 11–13 outlines the broad mitigation and management measures that are proposed to address noise associated with ground operations, airport construction and airport generated road traffic. These mitigation measures will be addressed as part of the Construction Environmental Management Plan (CEMP) to be approved prior to Main Construction Works and the Operational Environmental Management Plan (OEMP) to be approved prior to commencement of operations as described in Chapter 28 (Volume 2b).

All major airports have procedures which restrict the time and location for engine run-ups to limit noise impacts and ensure they are conducted safely. The proposed airport is expected to have similar procedures which would limit the circumstances and manner in which night time engine runs would be conducted. Restricting the amount of high power engine runs at night would substantially reduce the impact of engine ground running noise. Alternate locations for the run-up facility may also be considered during detailed design.

It may also be practicable to construct barriers near the run-up area, or design surrounding buildings to provide greater noise shielding from these activities. As described in Appendix E2 (Volume 4), reductions of around 10 dBA could be achieved with provision of a purpose-built ground running enclosure at least 10 metres high, but moderate residual impacts would still occur under worst case meteorological conditions. Night time high power engine run-ups occur infrequently at major airports in Australia. The provision of an enclosure for conducting engine runs is not currently proposed, but could be further considered if noise from this activity results in unacceptable night time noise impacts based on operational experience.

Table 11–14 Mitigation and management measures – aircraft ground operations, airport construction and airport road traffic noise

Issue	Mitigation/management measure	Timing
Construction Noise and Vibration CEMP	A Noise and Vibration CEMP will be approved prior to commencement of Main Construction Works for the proposed airport. The Noise and Vibration CEMP will: • ensure, where feasible, that noise emissions comply with the construction noise guidelines in Schedule 4 of the AEPR; • identify construction activities which are predicted to exceed any noise management levels set for the proposed airport and develop proposed actions, such as notification of affected receivers; • ensure that vibration and airblast from rock blasting and other construction activities comply with relevant vibration damage guideline values in German Standard DIN 4150-3 and vibration and airblast criteria in ANZECC 1990, to protect the amenity of local residents and avoid building damage; • determine noise and vibration monitoring, reporting and response procedures; • describe specific mitigation treatments, management methods and procedures to be implemented to control noise and vibration during construction; • describe construction timetabling to minimise noise impacts, including time and duration restrictions, respite periods and frequency; • describe procedures for notifying residents of construction activities likely to affect their amenity through noise and vibration; and • define contingency procedures to be implemented in the event of non-compliance and/or noise complaints.	Pre-construction Construction

Issue	Mitigation/management measure	Timing
Operations ground-based noise	A Noise OEMP will be prepared and implemented for managing ground-based aircraft and other noise. The Noise OEMP will at a minimum: • record the noise abatement procedures and noise management measures developed for the airport through the airspace and flight path design process as a baseline for these procedures and measures; • identify noise mitigation measures proposed to be implemented for ground-based noise generating activities, including: ▪ aircraft engine ground running rules, including any proposed restrictions on the timing, location and power intensity of engine runs, and any related safety requirements; ▪ opportunities to refine the location and design of airport features to reduce noise impact; and ▪ other measures to address excessive noise where noise mitigation by physical features (e.g. noise barriers) is deemed ineffective. • provide the outcomes of additional noise modelling and assessment conducted during the detailed airport design phase to: ▪ update and refine the noise exposure modelling undertaken for this EIS; ▪ inform the development of additional noise mitigation measures; and ▪ test the effectiveness of any proposed noise mitigation measures and identify any residual excessive noise levels in areas surrounding the airport site. • describe the measures taken to minimise the use of auxiliary power units (APUs), including the provision of fixed electrical ground power units and preconditioned air at aircraft gates and any measures to minimise APU use by stationary aircraft at other locations on the airport; • detail how noise emissions will be taken into account when considering onsite development proposals, both for the construction and operational phases of those developments; • detail any noise amelioration actions proposed to mitigate offsite noise exposure that cannot be managed appropriately by operational and other onsite mitigation measures; • describe stakeholder engagement undertaken with affected residences and other stakeholders regarding potential noise impacts, and potential mitigation and amelioration measures; • describe the procedures for managing enquiries and complaints about noise impacts from ground-based airport activities; and • describe the procedures for monitoring and managing observed breaches in ground running rules, including those for registering, investigating, reporting, instigating and responding to such incidents.	Pre-operation Operation

11.8 Conclusion

Noise during the construction of the proposed airport would be largely confined within the airport boundary, although there would be some impacts on the Luddenham and Badgerys Creek areas. While heavy and light vehicles would need to access the airport site during the construction stage, the resulting increase in traffic noise would not be significant. Vibration generated by the use of typical construction plant would not cause building damage.

Preliminary assessment results indicate that if blasting is to be carried out within 150 metres of residences, the maximum charge should be restricted to no more than 5 kg and the charge confined so that it does not easily escape to the atmosphere. Further more detailed analysis of blast vibration and airblast would be required prior to the commencement of blasting to ensure appropriate blasting management measures are adopted to protect residential amenity and building integrity.

Noise from ground-based operations would be generated primarily by aircraft engine run-ups and taxiing. Modelling conducted for this EIS using the Concawe algorithms shows that under worst case meteorological conditions, noise associated with engine runs has the potential to affect residences and other sensitive receivers in Luddenham, Badgerys Creek, Bringelly, Wallacia and Greendale. The impact of noise from taxiing is predicted to extend over a much smaller area and would primarily affect Luddenham.

During operation of the proposed airport, road traffic noise level increases in the surrounding area from airport-generated traffic are predicted to be insignificant for the majority of roads; however, an increase greater than 2 dBA is predicted for a section of Elizabeth Drive and a section of the proposed M12 Motorway. Any major new road construction or realignments associated with the Western Sydney Infrastructure Plan would be subject to separate applications and approvals by the relevant authorities, including any noise mitigation required.

Mitigation and management measures have been proposed to address noise associated with ground operations, construction and airport-generated road traffic.

12 Air quality and greenhouse gases

The air quality and greenhouse gas assessment included a review of climatic data obtained from the airport site and an analysis of ambient air quality data collected at monitoring stations in the vicinity of the airport site. Air quality impacts associated with the construction of the proposed airport (particularly construction dust) were modelled as were emissions and air quality impacts associated with operation of the proposed airport. Other air quality parameters that were assessed included odour, regional air quality impacts (ozone) and greenhouse gas emissions.

Construction would result in dust emissions generated during both the bulk earthworks and the construction of aviation infrastructure. The results of the air dispersion modelling show that the predicted dust impacts during construction would be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant is also predicted to be below the relevant criteria at all sensitive residential receptors and would be largely contained within the airport site.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide (NO_2), particulate matter (quantified as PM_{10} and $PM_{2.5}$), carbon monoxide (CO), sulfur dioxide (SO_2) and air toxics. There would also be odour emissions from exhaust and from the onsite wastewater treatment plant. The highest offsite concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and north-east of the airport site.

Background traffic, associated with the broader urbanisation of Western Sydney, on surrounding road infrastructure was found to be a significant contributor to offsite ground level concentrations, particularly for those receptors located close to proposed roadways. The dispersion modelling found that there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. Predicted $PM_{2.5}$ does exceed a future NEPM-AAQ objective for 2025 at a number of sensitive receptors, however this is primarily attributable to background concentrations. The modelling also predicted an exceedance of the 99.9th percentile one-hour maximum for formaldehyde shown at a receptor on the airport site. This exceedance is principally governed by the contribution from external roads as opposed to activities of the proposed airport. Predicted offsite odour concentrations were expected to be below detection limits for both aircraft exhaust emissions and odours from the onsite wastewater treatment plant.

Predicted ozone concentrations were found to exceed the relevant air quality criteria. However, the contribution of the Stage 1 development was found to be marginal in the context of predicted background regional ozone levels.

Scope 1 and Scope 2 greenhouse gas emissions from the Stage 1 development have been estimated to comprise about 0.13 Mt CO_2-e/annum, with the majority of emissions associated with the consumption of purchased electricity. These greenhouse gas emissions would represent approximately 0.11 per cent of Australia's projected 2030 transport-related greenhouse gas emission inventory. For this reason, it can be concluded that the greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory. Although not typically included in greenhouse gas inventories due to potential for double counting, Scope 3 emissions from burning of fuel in aircraft were also quantified at around 2.5 Mt CO_2-e/annum.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the Stage 1 development. In particular, a dust management plan would be developed and implemented as part of an Air Quality Construction Environmental Management Plan to address potential impacts during construction. Air quality monitoring would also be undertaken at the airport site during operations as part of an Air Quality Operational Environmental Management Plan. Even though greenhouse gas emissions from the proposed airport would not be material in terms of the national inventory, a number of mitigation measures would also be implemented during operations to reduce these emissions.

12.1 Introduction

This chapter provides a review of the local and regional air quality impacts of the proposed airport. This chapter draws on a comprehensive local air quality and greenhouse gas assessment (included as Appendix F1 (Volume 4)) and a regional air quality assessment (included as Appendix F2 (Volume 4)).

The local air quality assessment considered primary emissions from the construction and operation of the proposed airport, such as nitrogen dioxide (NO_2), particulate matter (quantified as PM_{10} and $PM_{2.5}$), carbon monoxide (CO) and sulfur dioxide (SO_2). The regional assessment considered formation of ozone (O_3) through reactions involving primary emissions.

The potential impacts of the proposed Stage 1 development on local and regional air quality and the anticipated greenhouse gas emissions from the construction and operation of the Stage 1 development are considered and appropriate mitigation and management measures have been identified to reduce potential impacts.

The local air quality and greenhouse gas assessment and the regional air quality assessment have been prepared in consultation with the Australian Government Department of the Environment and Energy and have been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines).

12.2 Methodology

The air quality and greenhouse gas assessment draws on a local air quality and greenhouse gas assessment (see Appendix F1 (Volume 4)) and regional air quality assessment (see Appendix F2 (Volume 4)). Both assessments involved the development of an emissions inventory, a profile of existing air quality and meteorology, selection of representative sensitive receptors and dispersion modelling to understand how emissions from the proposed airport would disperse through the atmosphere. The results of the modelling were then compared against relevant air quality criteria for the protection of human health and the environment to identify exceedances. Measures were then identified where necessary to mitigate and manage emissions and exceedances.

The local and regional air quality assessments were undertaken in accordance with relevant regulatory guidelines, namely the EIS Guidelines, NSW Environment Protection Authority's Approved Methods for the Modelling and Assessment of Air Pollutants and the tiered procedure for ozone assessment. The assessments also utilised industry standard models including AERMOD, The Air Pollution Model (TAPM) and Comprehensive Air Quality Model with extensions (CAMx).

Both assessments were undertaken at a spatial scale appropriate to the emissions being assessed and the spatial extent over which impacts would be evident. Air emissions in the local air quality assessment were modelled up to around five kilometres from the airport site, while ozone was modelled for the NSW Greater Metropolitan Region equalling about 55,000 square kilometres.

Methodologies for the local air quality and greenhouse gas assessment and regional air quality assessment are summarised here and provided in Appendix F1 and Appendix F2 (Volume 4).

12.2.1 Local air quality

12.2.1.1 Emissions inventory

The construction and operation emissions inventories were derived using emissions factors that quantify each type of emission based on planned activities and equipment.

The construction emissions inventory was based primarily on the planned construction activities as outlined in Chapter 6 (Volume 1), including bulk earthworks and operation of machinery. It is expected that some construction activities could occur simultaneously. Therefore, the assessment of construction impacts adopted a worst case scenario to quantify emissions in which various construction activities are assumed to occur simultaneously.

The operation emissions inventory was based primarily on the indicative airport layout as outlined in Chapter 5 (Volume 1) and planned aircraft movements during the operation of the Stage 1 development. The main activities predicted to generate air emissions are listed in Table 12–1.

Emissions from road traffic were also quantified for construction and operation. Traffic projections were sourced from the traffic, transport and access assessment presented in Appendix J (Volume 4). It is noted that the projections also included predicted increases in background traffic associated with the broader urbanisation of Western Sydney predicted to occur over coming decades.

The majority of the adopted emissions factors are incorporated in the US Federal Aviation Administration Emissions Dispersion Modelling System utilised in the assessment, incorporating emissions factors from other sources such as the US Environmental Protection Authority and the International Civil Aviation Organization.

This approach is an industry standard that has been utilised in several similar assessments in Australia, including environmental assessments of Sydney Airport and Adelaide Airport.

Table 12–1 Summary of activities generating atmospheric emissions at the proposed airport

NPI source type		Description
Emissions directly from aircraft	Aircraft main engine	Main engines of aircraft ranging from start-up to shut-down.
	Auxiliary power unit	Auxiliary power unit located on-board aircraft providing electricity and pre-conditioned air while on the ground and bleed air for main engine start.
Aircraft handling emissions	Ground support equipment	Ground support equipment necessary to handle the aircraft during the turnaround at the stand, including ground power units, air climate units, aircraft tugs, conveyor belts, passenger stairs, fork lifts, tractors, cargo loaders, etc.
	Airside traffic	Service vehicle and machinery traffic, including sweepers, trucks (catering, fuel, sewage), cars, vans, buses etc. that circulate on service roads within the airport perimeter and typically within the restricted area.
	Aircraft refuelling	Evaporation through aircraft fuel tanks (vents) and from fuel trucks or pipeline systems during fuelling operations.
Stationary/ infrastructure sources	Power/heat generating plant	Facilities that produce energy for the airport infrastructure, namely boiler houses, heating/cooling plants, co-generators.

NPI source type		Description
	Emergency power generator	Diesel or other generators for emergency operations (e.g. for buildings or for runway lights).
	Aircraft maintenance	All activities and facilities for maintenance of aircraft, i.e. washing, cleaning, paint shop, engine test beds, etc.
	Airport maintenance	All activities and facilities for maintenance of airport facilities, including cleaning operations.
	Fuel	Fuel storage, distribution and handling.
	Construction and demolition activities	All construction and demolition activities involved in airport operation and development, including the resurfacing of roads and runways.
	Fire training	Activities for fire training with different fuels (e.g. kerosene, butane, propane, wood).
	Wastewater treatment	All activities and facilities for the collection, storage and treatment of wastewater onsite.
Landside traffic	Vehicle traffic	Cars, vans, trucks, buses, motorbikes etc. associated with the proposed airport on access roads, drop-off areas and parking lots. Emissions include tailpipe and evaporative releases.

12.2.1.2 Existing air quality and meteorology

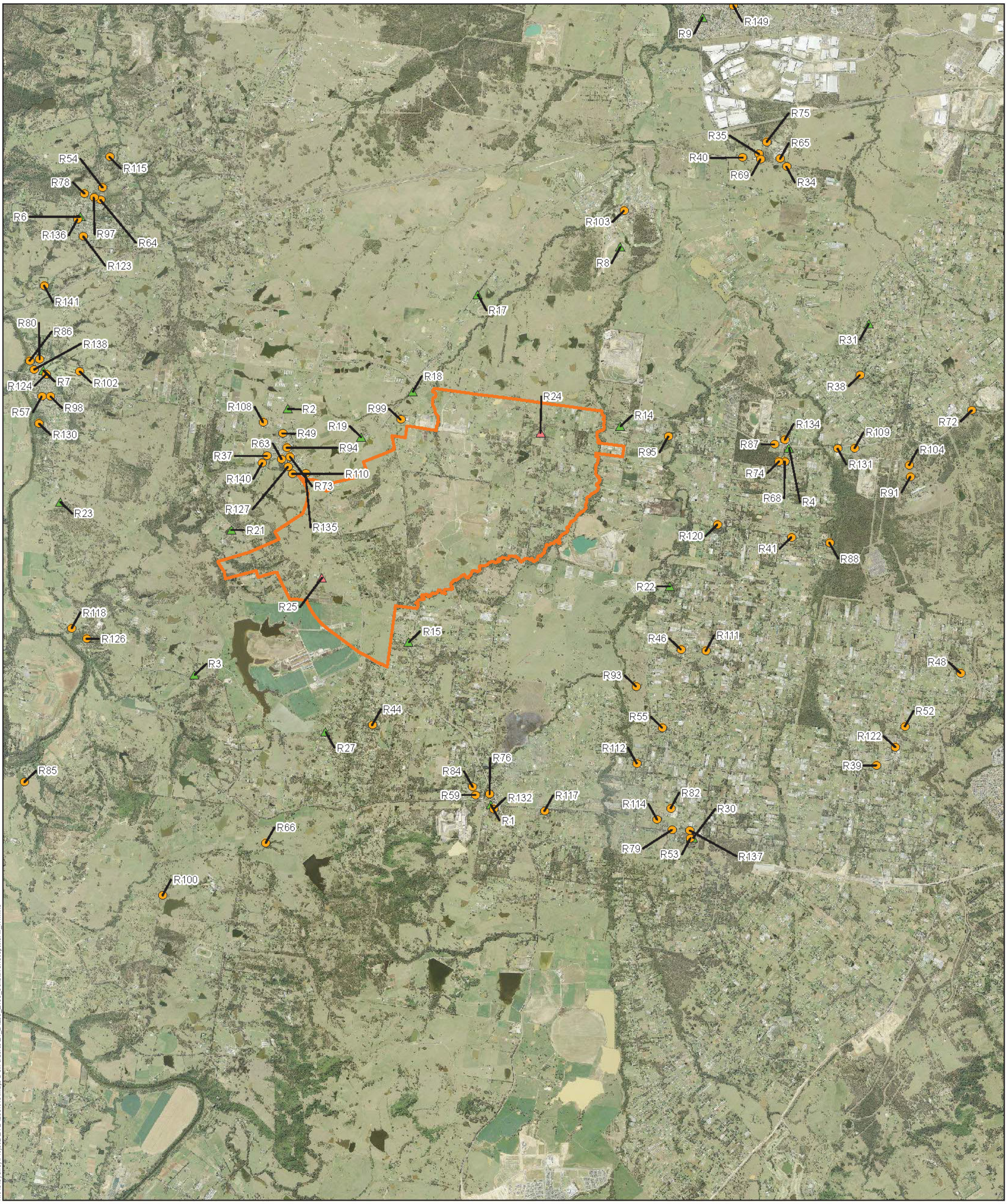
Existing air quality was characterised from air quality monitoring data collected over ten years (2005–2014) at monitoring stations operated by the NSW Office of Environment and Heritage. Monitoring stations included Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond. Parameters recorded included nitrogen dioxide, particulate matter, sulfur dioxide and ozone.

Existing meteorology was characterised from climatic data collected over five years (2010–2014) at an automatic weather station situated at Badgerys Creek operated by the Bureau of Meteorology. Parameters recorded included temperature, rainfall, humidity, wind speed and wind direction at hourly intervals. The data were a key input into the dispersion model discussed in Section 12.2.1.2.

12.2.1.3 Sensitive receptors

Sensitive receptors are defined as places typically occupied by people that are susceptible to environmental impacts. Sensitive receptors were identified within about 5 kilometres of the airport site for the purpose of assessing the potential impacts of air emissions at these locations.

Given the density of sensitive receptors in the vicinity of the airport site, a representative selection comprising 152 of these sensitive receptors was made. The selection included a range of sensitive receptor types including residences, schools, churches and other community infrastructure. The selection also included sensitive receptors from suburbs surrounding the airport site at varying distances. Two receptors were also selected within the airport site for the purpose of assessing potential impacts of air emissions on airport workers and patrons during operation of the Stage 1 development. The locations of the identified sensitive receptors are shown in Figure 12–1.



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LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

- Airport site
- Community
- Residential
- Airport site

0 0.5 1 2
Kilometres

Figure 12-1 - Location of sensitive receptors in the vicinity of the airport site

12.2.1.4 Dispersion modelling

Dispersion modelling of construction and operation emissions was undertaken using the AERMOD Modelling System (US EPA 2004), incorporating the emissions inventory (see Section 12.2.1.1) and existing air quality and meteorology (see Section 12.2.1.2).

AERMOD simulated the dispersion of key pollutants quantified in the emissions inventory including nitrogen dioxide (NO_2), particulate matter (quantified as PM_{10} and $PM_{2.5}$), carbon monoxide (CO) and sulfur oxides (SO_x) within the modelling domain about five kilometres around the airport site.

The results of the AERMOD simulation were then reviewed to identify predicted concentrations of air emissions at identified sensitive receptors. The predicted concentrations were then compared to the relevant criteria set under the *Approved Methods for the Modelling and Assessment of Air Pollutants* and the *National Environment Protection (Ambient Air Quality) Measure*.

12.2.1.5 Odour

The local air quality assessment also considered the potential for odour to be generated. The approach taken was to apply a conversation factor of odour units to relevant emissions and then assess the potential for odour to occur at sensitive receptors.

A conversion factor was applied to emissions incorporating organic compounds including aircraft exhaust, auxiliary power units and ground support equipment (Winther et al. 2005). Concentrations of emissions at sensitive receptors were identified from dispersion modelling (see Section 12.2.1.4) and compared to the recognised odour performance criterion of two odour units.

The potential for odour to be generated by wastewater treatment at the airport site was assessed by conducting odour sampling at two similar facilities. The results of the sampling informed odour emissions rates that were incorporated into dispersion modelling.

12.2.2 Regional air quality

12.2.2.1 Emissions inventory

The operations emissions inventory developed for the local air quality assessment was adopted for the regional air quality assessment (see Section 12.2.1.1).

12.2.2.2 Existing air quality and meteorology

Existing air quality was characterised with reference to air quality monitoring data and emissions source data for 2008–2009. This time period was selected as it includes the greatest number of ozone exceedances recorded over the past decade.

The existing air quality data were then increased in proportion to emissions projections developed by the NSW Environment Protection Authority. This was necessary in order to predict existing air quality in 2030 against which the operation of the Stage 1 development would be assessed. The projections consider economic growth, including additional traffic, and other future developments such as improvements in emissions standards and regulation.

Existing regional meteorology was characterised from climatic data collected from all suitable weather stations operated by the Bureau of Meteorology or Office of Environment and Heritage. A complete list of the 28 weather stations utilised in the assessment is provided in Appendix F2 (Volume 4).

Existing regional meteorology was also simulated in the model TAPM to produce a more detailed characterisation for use in dispersion modelling. The model outputs were validated against the climatic data, which showed a good correlation.

12.2.2.3 Dispersion modelling

Ozone formation and dispersion was modelled using the model CAMx, incorporating the emissions inventory (see Section 12.2.1.1), air quality data and meteorology data (see Section 12.4.1).

CAMx simulated the formation of ozone through reactions involving primary emissions from the proposed airport including nitrogen oxides, volatile organic compounds and carbon monoxide.

The model then simulated the dispersion of this ozone throughout the modelling domain across the NSW Greater Metropolitan Region equalling about 55,000 square kilometres. The model simulates the dispersion of ozone across 25 defined vertical levels at up to 8,000 metres elevation.

A number of scenarios were modelled in CAMx, including:

- a 2008/2009 base case based on historic emissions data;
- a 2030 base case assuming the proposed airport is not developed; and
- a 2030 Stage 1 development case assuming the proposed airport is developed.

Under each scenario, a number of days were simulated. The days were selected from historic weather data proven to be conducive to peak ozone formation.

The 2008/2009 base case was modelled to assess model performance. The results of the base case model were validated against actual air quality data. The validation exercise indicated a good degree of correlation between predicted and actual ozone concentrations.

12.2.3 Greenhouse gases

The local air quality assessment also included the development of a greenhouse gas inventory for the construction and operation of the Stage 1 development.

The greenhouse gas assessment was guided by:

- the *Greenhouse Gas Protocol,* developed by the World Resources Institute and the World Business Council on Sustainable Development;
- the *National Greenhouse and Energy Reporting Act 2007* (Cth)*;*
- the National Greenhouse and Energy Reporting Regulations 2008 (Cth);
- the *National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2015* (Cth)*;* and
- the *Technical guidelines for the estimation of greenhouse gas emissions by facilities in Australia*, developed by the Australian Government Department of the Environment*.*

Greenhouse gas emissions are defined as Scope 1, Scope 2 or Scope 3. The distinction between these emissions categories is depicted in Figure 12–2.

Scope 1 emissions are those directly emitted by the reporting entity (in this case the airport developer or operator), and include exhaust from operational vehicles or carbon dioxide from the decay of cleared vegetation. Scope 2 emissions are those indirectly created by the reporting entity through the purchase of energy. Scope 3 emissions are facilitated by the reporting entity but controlled by other entities, and would include exhaust from aircraft controlled by airline companies utilising the proposed airport. Scope 3 emissions are not typically included in greenhouse gas inventories for accounting purposes given their liability to be double counted, particularly as they would likely also be reported as Scope 1 emissions by the entity with direct operational control.

In accordance with industry standard practice the inventory focussed on Scope 1 and Scope 2 emissions. Some consideration was also given to aircraft fuel burning, which is anticipated to be the major source of Scope 3 emissions for the proposed airport but would largely be under the direct operational control of airline companies utilising the proposed airport.

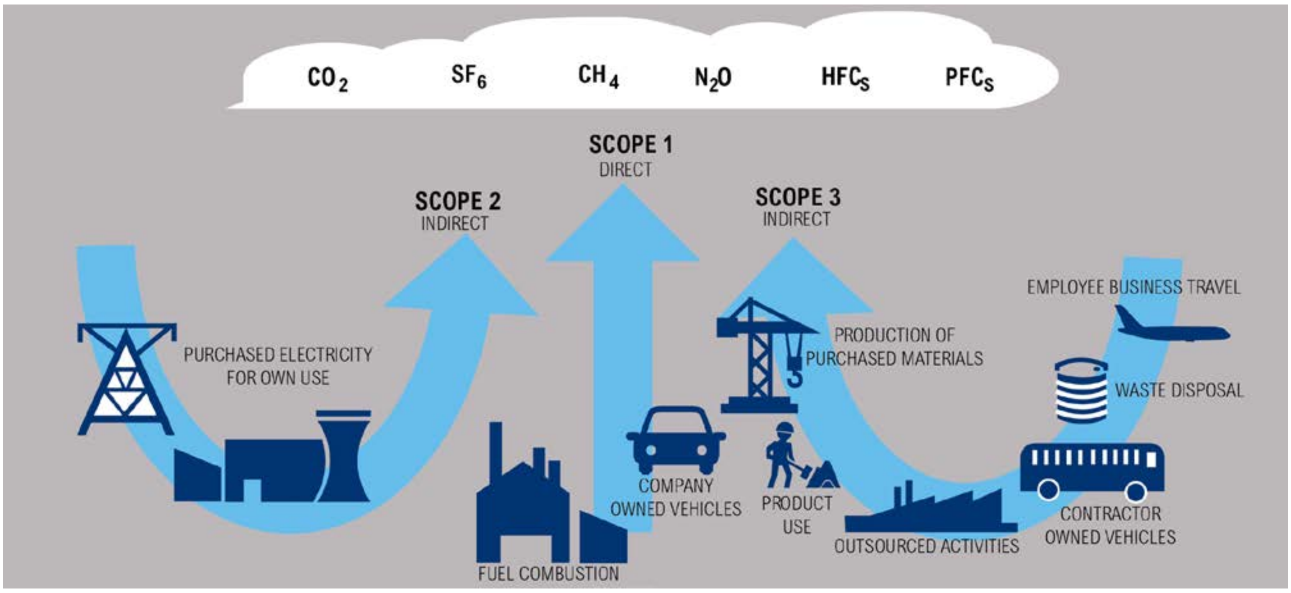


Figure 12–2 Overview of the three scopes and emissions sources across a reporting entity

Greenhouse gas emissions were quantified in the Emissions Dispersion Modelling System (see Section 12.2.1.4) and expressed terms of their equivalence in tonnes of carbon dioxide (t CO_2-e).

Greenhouse gas emissions are typically calculated from emissions factors as follows:

$$Emission_i = Activity\ data \times EF_i$$

In this equation, the estimated emissions of a greenhouse gas (i) is the product of the Activity data (for example, the amount of fuel combusted for energy generation) and the emissions factor appropriate to the activity and emission type (EF_i).

12.3 Air quality criteria

12.3.1 Gaseous pollutants and particulate matter performance criteria

Legislation, guidelines and standards governing air pollutant emissions and ambient air quality have been introduced at the Commonwealth and State government levels. Legislation, guidelines and other standards which have been considered for this assessment are summarised in Table 12–2.

Regulated air pollutants are divided into 'criteria' pollutants and 'air toxics'. Criteria pollutants tend to be ubiquitous and emitted in relatively large quantities, and their health effects have been studied in some detail. Air toxics are gaseous or particulate organic pollutants that are present in the air in low concentrations and have characteristics hazardous to human, plant or animal life. The main sources of pollutants investigated in the local air quality and greenhouse gas assessment are summarised in Appendix G (Volume 4).

Table 12–2 Emissions and air quality legislation

Legislating body	Legislation/measures	Summary
Ambient air quality		
Australian Government	*Airports Act 1996*	Promotes the sound development of civil aviation in Australia. It contains an obligation on airport lessee companies to develop a master plan every five years including a detailed environmental strategy which is required to address amongst other things continuous improvement in the environmental consequences of activities at the airport; progressive reduction in extant pollution at the airport and development and adoption of a comprehensive environmental management system for the proposed airport that maintains consistency with relevant Australian and international standards. The Airports Act also contains a number of offences related to pollution at airports. An Airport Plan is required to authorise the construction and operation of the Stage 1 development.
	Airports (Environment Protection) Regulations 1997 (AEPR)	Imposes a general duty to prevent or minimise environmental pollution once an airport lease is granted. Promotes improved environmental management practices at airports. Includes provisions setting out definitions, acceptable limits and objectives for air quality, as well as monitoring and reporting requirements.
	Air Navigation (Aircraft Engine Emissions) Regulations Chicago Convention Annex 16	The regulations make it an offence to fly certain aircraft if they do not meet relevant emissions standards including the standards set out in Annex 16 to the Chicago Convention.
	National Environment Protection (Ambient Air Quality) Measure (NEPM-AAQ)	Sets the national health-based air quality standards for six air pollutants (carbon monoxide, nitrogen dioxide, sulfur doxide, lead, ozone and PM_{10}) and includes advisory reporting standards for $PM_{2.5}$.
	National Environment Protection (Air Toxics) Measure (NEPM-AT)	Sets a nationally consistent approach to monitoring (by reference to 'investigation levels') for five air toxics: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). These are not compliance standards but are for use in assessing the significance of the monitored levels of air toxics with respect to the protection of human health.

Legislating body	Legislation/measures	Summary
NSW Government	*Protection of the Environment Operations Act 1997* (POEO Act), and the Protection of the Environment Operations (General) Regulation 2009	The POEO Act provides a range of controls with regard to air quality including requirements to maintain plant and equipment in proper and efficient condition and to operate plant and equipment in a proper and efficient manner. This includes the means of processing, handling, moving, storage and disposal of materials.
Emissions of air quality criteria pollutants		
Australian Government	*National Environment Protection (National Pollutant Inventory) Measure*	The primary goals are to: (a) collect a broad base of information on emissions and transfers of substances and (b) disseminate information to all sectors of the community. This NEPM covers a variety of air pollutants.
NSW Government	*Protection of the Environment Operations Act* (2007) (POEO Act) and Protection of the Environment Operations (Clean Air) Regulation (2010) (Clean Air Regulation)	The object of the POEO Act is to achieve the protection, restoration and enhancement of the quality of the NSW environment having regard to the need to maintain ecologically sustainable development. The Clean Air Regulation prescribe standards for certain groups of plant and premises to regulate industry's air emissions and impose requirements on the control, storage and transport of volatile organic liquids.
	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA Approved Methods)	This policy document lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. It is referred to in Part 5: Air impurities from emitted activities and plant of the Clean Air Regulation. It also prescribes the air pollutants and averaging periods that an airport's emissions are to be assessed against.
Emissions of greenhouse gases		
Australian Government	*National Greenhouse and Energy Reporting Act (2007)*	An airport lessee company (ALC) is required to register and report its operational greenhouse gas emissions attributable to the activities over which it has operational control. This is because it is expected that its emissions will exceed relevant thresholds. This may also apply to the construction contractor and other contractors or users of the airport (e.g. airlines).
Ozone-depleting substances		
Australian Government	*Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and the Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995	This Act and these Regulations impose controls on the manufacture, import, export and management of substances that deplete ozone in the atmosphere including CFCs 11, 12, 113, 114 and halons 1211, 1301 and 2402.
NSW Government	*Ozone Protection Act 1989*	This Act regulates or prohibits the manufacture, sale, distribution, conveyance, storage, possession and use of ozone-depleting substances in NSW.

The air quality criteria adopted for use in the air quality assessment are principally those defined in thins EPA Approved Methods. The NSW EPA Approved Methods account for various pollutant criteria and averaging periods from multiple sources, including the NEPM-AAQ.

In some cases, the NSW EPA Approved Methods mirror the NEPM-AAQ. In other cases, where no similar criteria are stated in the Approved Methods, criteria outlined in the NEPM-AAQ have been adopted in the assessment. Examples of the latter are average annual PM_{10} and $PM_{2.5}$.

A summary of the adopted criteria and their source is provided in Table 12–3. In each case, where several performance criteria are available, the more stringent criterion has been used.

In 2016, the National Environment Protection Council approved a variation to the NEPM-AAQ for particulate matter to reflect the latest scientific understanding of health risk. The variation includes new or revised standard for $PM_{2.5}$ and PM_{10}. Whilst the NSW EPA Approved Methods have not yet been updated to reflect the changes, the new standards have been adopted in this assessment.

Table 12–3 Air quality criteria applicable to the airport

Pollutant	Criterion[a]	Averaging period	Source[b]
Carbon monoxide (CO)	87 ppm or 100 mg/m^3	15 minutes	NSW EPA
	25 ppm or 30 mg/m^3	1 hour	NSW EPA
	9 ppm or 10 mg/m^3	8 hours	NSW EPA, AEPR (b)
Nitrogen dioxide (NO_2)	16 pphm or 320 µg/m^3	1 hour	AEPR
	12 pphm or 246 µg/m^3	1 hour	NSW EPA
	3 pphm or 62 µg/m^3	1 year	NSW EPA
Total suspended particulate matter (TSP)	90 µg/m^3	1 year	NSW EPA, AEPR
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24 hours(c)	NSW EPA, NEPM-AAQ
	25 µg/m^3	1 year	NSW EPA, NEPM-AAQ
Particulate matter < 2.5 µm ($PM_{2.5}$)	25 µg/m^3	24 hours	NEPM-AAQ
	20 µg/m^3 (by 2025)	24 hours	NEPM-AAQ
	8 µg/m^3	1 year	NEPM-AAQ
	7 µg/m^3 (by 2025)	1 year	NEPM-AAQ
Deposited dust – Incremental	2 g/m^2/month	Annual	NERDDC
Deposited dust – Cumulative	4 g/m^2/month	Annual	NERDDC
Lead (Pb)	1.5 ppm	3 months	AEPR
	0.5 µg/m^3	1 year	NSW EPA
Photochemical oxidants (as ozone (O_3))	0.10 ppm or 210 µg/m^3	1 hour	NSW EPA(d), AEPR
	0.08 ppm or 170 µg/m^3	4 hours	NSW EPA(e), AEPR
Sulfur dioxide (SO_2)	25 pphm or 710 µg/m^3	10 minutes	NSW EPA(f), AEPR
	20 pphm or 570 µg/m^3	1 hour	NSW EPA, AEPR
	8 pphm or 228 µg/m^3	1 day	NSW EPA
	2 pphm or 60 µg/m^3	1 year	NSW EPA, AEPR
Benzene	0.009 ppm or 29 µg/m^3	99.9th one-hour max	NSW EPA
Toluene	0.09 ppm or 360 µg/m^3	99.9th one-hour max	NSW EPA
Xylene	0.004 ppm or 180 µg/m^3	99.9th one-hour max	NSW EPA
Formaldehyde	0.18 ppm or 20 µg/m^3	99.9th one-hour max	NSW EPA
Benzo[a]pyrene	0.4 µg/m^3	99.9th one-hour max	NSW EPA

(a) ppm = parts per million; pphm = parts per hundred million; µg/m^3 = micrograms per cubic metre; mg/m^3 = milligrams per cubic metre.

(b) NSW EPA = Approved Methods for the Modelling and Assessment of Air Pollutants in NSW; AEPR = Airports (Environment Protection) Regulations 1997.

(c) Up to 5 exceedances allowed per year in NEPM-AAQ.

(d) Given as 214 µg/m^3 in Approved Methods.

(e) Given as 171 µg/m^3 in Approved Methods.

(f) Given as 712 µg/m^3 in Approved Methods.

In recognition of the potential health issues that may arise from exposure to air toxics, 'investigation levels' have been set for five pollutants in ambient air under the NEPM-AT. These investigation levels are listed in Table 12–4.

Table 12–4 Advisory standard air toxic investigation levels applicable to the proposed airport

Pollutant	Criterion[a]		Averaging period	Source
Benzene	0.003	ppm	1 year[d]	Air Toxics NEPM, investigation levels
PAHs[b] (as B[a]P)[c]	0.3	ng/m^3	1 year[d]	Air Toxics NEPM, investigation levels
Formaldehyde	0.04	ppm	24 hours	Air Toxics NEPM, investigation levels
Toluene	1.0	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.1	ppm	1 year[d]	Air Toxics NEPM, investigation levels
Xylenes	0.25	ppm	24 hours	Air Toxics NEPM, investigation levels
	0.20	ppm	1 year[d]	Air Toxics NEPM, investigation levels

(a) ng/m^3 – nanograms per cubic metre.

(b) PAH – polycyclic aromatic hydrocarbons.

(c) B[a]P – benzo[a]pyrene, the most widely studied PAH and used as an indicator compound.

(d) Mean 24-hour monitoring results.

12.3.1.1 Odour performance criteria

The NSW EPA Approved Methods also include ground-level concentration criteria for complex mixtures of odorous air pollutants, taking account of population density in a given area. Table 12–5 lists the odour criteria to be exceeded not more than one per cent of the time, across different population densities. The two odour unit criterion applies to the airport site as an urban area.

Table 12–5 Odour performance criteria for the assessment of odour

Population of affected community	Criterion for complex mixtures of odorous air pollutants (odour units) 99th percentile
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

12.3.1.2 Greenhouse gases

The National Greenhouse and Energy Reporting Scheme (NGER Scheme) comprise legislation, regulations and technical guidelines for the reporting of greenhouse gas emissions and energy consumption data. The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) establishes a mandatory obligation on corporations which exceed defined thresholds to report greenhouse gas emissions, energy consumption and other related information. Methods and criteria for calculating greenhouse gas emissions under the NGER Act are provided in the *National Greenhouse and Energy Reporting (Measurement) Determination 2008*.

Corporate and facility reporting thresholds for greenhouse gas emissions and energy consumption per financial year are provided in Table 12–6. Emissions are measured in terms of tonnes of carbon dioxide equivalent (CO_2-e) which is a value representing the normalisation of different types of greenhouse gases to their equivalent global warming potential of carbon dioxide.

Table 12–6 NGER reporting thresholds

Corporate threshold		Facility threshold	
Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)	Greenhouse gas emissions (kt CO_2-e)	Energy usage (TJ)
50	200	25	100

Source: DCCEE, 2007.

As the proposed airport (once operational) is anticipated to have combined Scope 1 and Scope 2 emissions greater than 25 kilotonnes carbon dioxide equivalent (kt CO_2-e) in a financial year, emissions are expected to be required to be reported under the NGER Scheme.

If a corporation has operational control over facilities whose greenhouse gas emissions or energy use in a given reporting year:

- individually exceed the relevant facilities threshold; or
- when combined with other facilities under the corporation’s operational control, exceed the relevant corporate thresholds, that corporation must report its greenhouse gas emissions or energy use (as the case may be) for that year under the NGER Act.

This definition may encompass the Airport Lessee Company (ALC), a construction company, various other contractors and airlines. A preliminary assessment of greenhouse emissions and energy use for the Stage 1 development is presented in Section 12.7.

12.3.1.3 Regional air quality (ozone)

The NEPM-AAQ standards for ozone are summarised in Table 12–7 and expressed as parts per million by volume. The NEPM-AAQ standards are identical to the impact assessment criteria prescribed in the NSW EPA Approved Methods, with the impact assessment criteria in the NSW EPA Approved Methods expressed as parts per hundred million and in micrograms per cubic metre of air (see Table 12–8). The NEPM-AAQ standard, like the NSW EPA criteria, also allows for the goal to be exceeded for one day a year.

The ambient ozone monitoring data and ozone modelling results presented in this chapter use parts per billion as the preferred reporting unit. A concentration of 100 parts per billion for one-hour ozone is equivalent to the NEPM-AAQ standard of 0.10 parts per million and the NSW EPA Approved Methods criterion of 10 parts per hundred million, while a concentration of 80 parts per billion for four-hour ozone is equivalent to the NEPM-AAQ standard of 0.08 parts per million and the NSW EPA Approved Methods criterion of eight parts per hundred million.

Table 12–7 National standards for ozone (NEPM-AAQ)

Averaging period	Maximum concentration	Maximum allowable exceedances
1 hour	0.10 ppm	1 day a year
4 hours	0.08 ppm	1 day a year

Table 12–8 Impact Assessment criteria for ozone (NSW EPA)

Averaging period	Concentration	
	Parts per hundred million	µg/m³a
1 hour	10	214
4 hours	8	171

12.4 Existing environment

This section describes the meteorological conditions (wind speed and direction, temperature, rainfall and humidity) at the airport site. The existing, ambient air quality in the vicinity of the airport site is also described.

12.4.1 Meteorology

Air quality is influenced by meteorological conditions. Wind speed, wind direction, temperature and relative humidity all affect the potential dispersion and transport of emissions and are basic input requirements for dispersion modelling.

Climatic data was reviewed for five consecutive years (2010-14). Summary statistics are provided in Appendix F1 (Volume 4). These data were used to describe the local meteorology at Badgerys Creek.

12.4.1.1 Wind speed and direction

The average wind speed across the five-year period was 2.6 metres per second. The percentage of calm periods with winds less than 0.5 metres per second across the period was nine per cent.

An analysis of the climatic data suggests that there is no strong relationship between the time of year and the monthly average wind speed, although the monthly average wind speeds are generally less during autumn as shown on Figure 12–3.

There is also little variation in average wind speed between years. The highest annual average wind speed of 2.9 metres per second was recorded in 2010 and the lowest annual average wind speed of 2.4 metres per second was recorded in 2012.

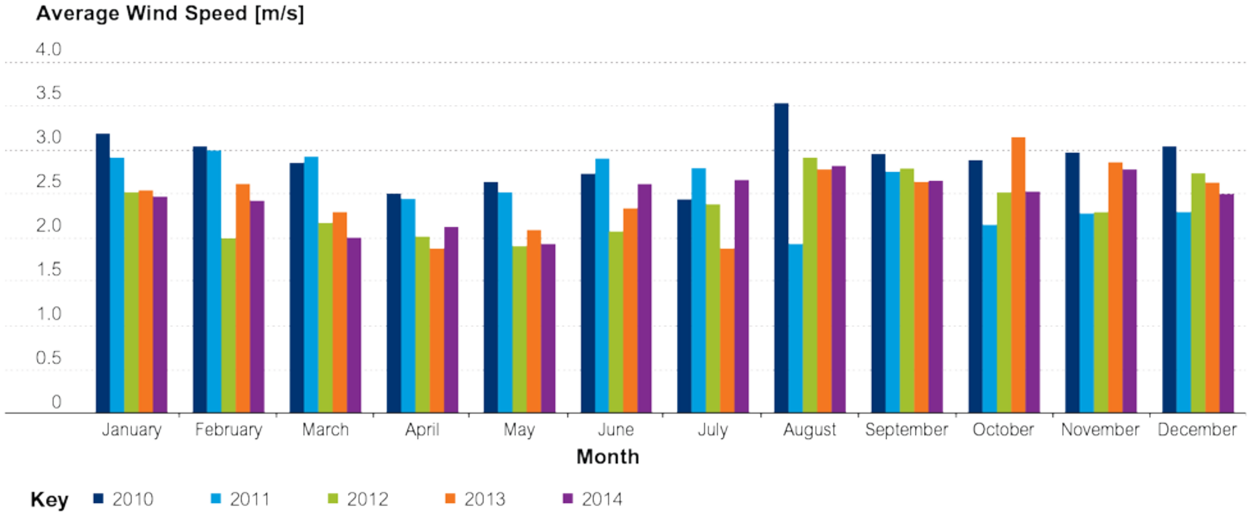


Figure 12–3 Monthly average wind speed at Badgerys Creek (2010-2014)

On an annual basis, the predominant winds at Badgerys Creek originate from the south-west, followed by the south-south-west and north. Very few winds originate from the north-west. The prevailing winds vary across the seasons with the characteristic south-westerly wind less prominent during summer where winds from the north-east become more frequent. During winter, the majority of winds originate from the south-west. There is a consistent seasonal pattern across all years. Annual and seasonal wind roses for 2010 to 2014 are presented in Appendix F1 (Volume 4).

12.4.1.2 Temperature, rainfall and humidity

Key temperature, rainfall and humidity statistics at Badgerys Creek are provided in Table 12–9.

There is a strong seasonal variation in temperature at Badgerys Creek. The annual average temperature between 2010 and 2014 was 17 degrees Celsius. On average, January was the hottest month, with an average monthly temperature of 23 degrees Celsius and maximum of 45 degrees Celsius. June and July were the coldest months for the five-year period, with average temperatures of 11 degrees Celsius and 10 degrees Celsius, respectively. The minimum temperatures for these months were -2 degrees Celsius and -1 degrees Celsius, respectively.

The rainfall data collected at Badgerys Creek indicate that February is the wettest month, with an average rainfall of 114 millimetres while July is the driest month, with an average rainfall of 30 millimetres. The average monthly rainfall for all years was 68 millimetres.

The annual average relative humidity reading at Badgerys Creek was 73 per cent. The month with the highest relative humidity on average was June, with an average of 79 per cent. The months with the lowest relative humidity were September and October.

Table 12–9 Temperature, rainfall and humidity statistics at Badgerys Creek

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean temperature (°C)	23	22	20	17	13	11	10	12	15	17	20	21	17
Minimum temperature (°C)	10	11	9	5	1	-2	-1	0	1	5	7	8	-2
Maximum temperature (°C)	45	41	35	30	27	21	24	28	33	36	41	40	45
Mean rainfall (mm)	76	114	106	62	37	80	30	42	35	47	101	85	68
Mean relative humidity (%)	71	76	76	77	76	79	76	69	67	67	73	71	73

12.4.1.3 Vertical profile

A vertical profile describes wind speed at various elevations through the atmosphere. Vertical profile measurements of the lower atmosphere are made daily at Sydney Airport. No other regular measurements of this kind are made within the Sydney region. The wind speed and wind direction measurements are made using a radiosonde, typically up to 7,000 metres above ground level. The vertical profile measurements of wind speed between 2010 and 2014 are shown in Figure 12–4. As shown, wind speeds peak around 3,000-4,000 feet in the order of 20-30 metres per second, with incidences of even higher wind speeds.

The measurements of wind speed indicate that in the lower few hundred metres of the atmosphere, the wind speeds are generally relatively low, up to eight metres per second. Layers of high wind speeds are observed between 800 metres and 1,000 metres and again between 3,500 metres and 4,500 metres. The highest observed wind speed was 116 metres per second.

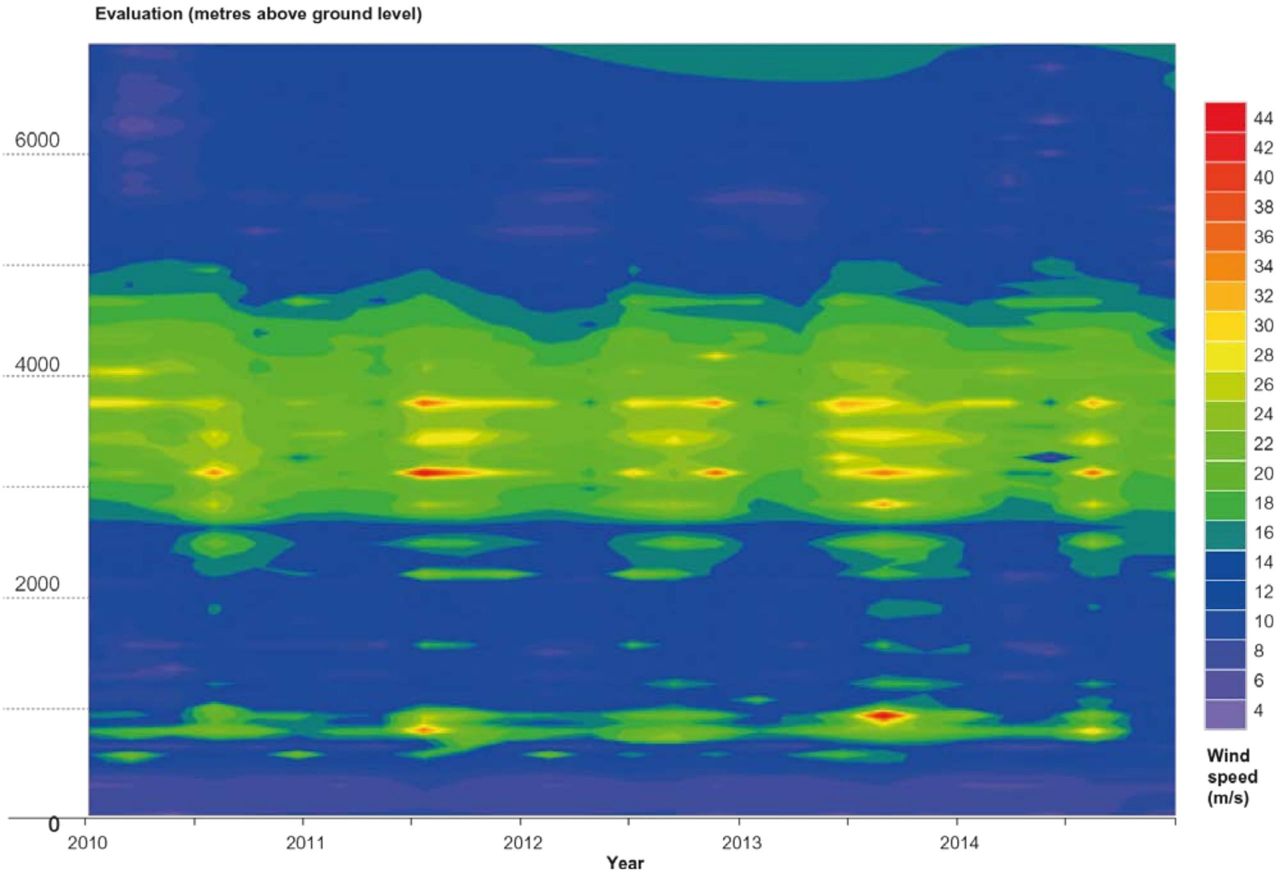


Figure 12–4 Vertical profile of wind speed at Sydney Airport (2010-14)

12.4.2 Local ambient air quality

To assess the potential impacts of the proposed airport against the relevant air quality assessment criteria described in Section 12.3, it is necessary to have information on background concentrations of pollutants so that the cumulative (ambient conditions plus project incremental emissions) impact may be evaluated.

Air quality monitoring data collected between 2005 and 2014 from the NSW OEH monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond were used to describe the existing air quality in Badgerys Creek. The data was compared with the criteria given in Table 12–3 and Table 12–4.

A summary of the available air quality data is provided below with further information provided in Appendix F1 (Volume 4). Generally, air quality for the local area is good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires. Uncontrolled combustion events such as bushfires will influence regional observations of PM_{10} and $PM_{2.5}$, and to a lesser extent, nitrogen oxides.

12.4.2.1 Nitrogen dioxide (NO_2)

The main oxides of nitrogen present in the atmosphere are nitric oxide, nitrogen dioxide and nitrous oxide. The major human activity which generates oxides of nitrogen is fuel combustion, mainly in motor vehicles. Oxides of nitrogen form in the air when fuel is burnt at high temperatures. This is mostly in the form of nitric oxide with usually less than 10 per cent in the form of nitrogen dioxide. Once emitted, nitric oxide combines with oxygen ('oxidises') to form nitrogen dioxide, especially in warm sunny conditions. These oxides of nitrogen may remain in the atmosphere for several days, during which chemical processes may generate nitric acid, and nitrates and nitrites as particles. These oxides of nitrogen play a major role in the chemical reactions that generate photochemical smog (OEH 2014a).

Data for nitrogen dioxide were obtained from the monitoring station at Bringelly. The data is presented in Table 12–10. There were no exceedances of the nitrogen dioxide one-hour average criteria of 246 micrograms per cubic metre (the one-hour maximum concentration ranged between 51 micrograms per cubic metre and 92 micrograms per cubic metre). There were also no exceedances of the annual average criteria of 62 micrograms per cubic metre (the annual average concentrations ranged between 9 micrograms per cubic metre and 13 micrograms per cubic metre).

There is a strong seasonal influence on nitrogen dioxide concentrations, peaking during the winter months. This trend is attributed to the more stable atmospheric conditions during winter that leads to reduced dispersion as well as the limited photochemical processes that react with nitrogen dioxide during the summer months.

Further analysis of the data shows that the greatest concentrations of nitrogen dioxide originate from the east and are associated with the key local nitrogen oxides sources, such as vehicle emissions from the M7 motorway which is located to the east of the Bringelly monitoring station.

Table 12–10 Maximum one-hour and annual average nitrogen dioxide concentrations at Bringelly

Year	One-hour maximum (µg/m³)	Annual average (µg/m³)	Exceedances of one-hour standard (days per year)
EPA criterion	246	62	n/a
2005	92	13	No exceedances
2006	82	13	No exceedances
2007	90	12	No exceedances
2008	68	10	No exceedances
2009	70	9	No exceedances
2010	76	12	No exceedances
2011	60	10	No exceedances
2012	78	11	No exceedances
2013	76	10	No exceedances
2014	51	10	No exceedances

12.4.2.2 Particulate matter

Particulate matter is solid or liquid particles that are suspended in air that may reduce visual amenity or adversely impact health. It is measured as PM_{10} (particles less than 10 micrometres in diameter) and $PM_{2.5}$ (particles less than 2.5 micrometres in diameter). Examples of particles in the air include dust, smoke, plant spores, bacteria and salt. Particulate matter may be a primary pollutant, such as smoke particles, or a secondary pollutant formed from the chemical reaction of gaseous pollutants. Human activities resulting in particulate matter in the air include mining; burning of fossil fuels; transportation; agricultural and hazard reduction burning; the use of incinerators; and the use of solid fuel for cooking and heating (OEH 2014a).

Data for PM_{10} was obtained from the monitoring station at Bringelly. The data are presented in Table 12–11. The maximum concentrations of 24-hour average PM_{10} have been fairly constant over the last 10 years, generally ranging between 40 micrograms per cubic metre and 97 micrograms per cubic metre (the exception is 2009, where elevated 24-hour average PM_{10} concentrations were measured on a number of occasions as a result of a series of dust storms). There have been several exceedances of the 24-hour average criterion of 50 micrograms per cubic metre. Aside from 2009, the annual average concentrations appear to be generally decreasing with no exceedances of the criterion of 25 micrograms per cubic metre (the annual average concentrations ranged between 25 micrograms per cubic metre and 15 micrograms per cubic metre).

Further analysis of the data suggests that the greatest concentrations originate from the north-west, and to a lesser extent, from the east, west and south-east. The dominant north-west source is likely to be a function of natural events such as bushfires and dust storms that tend to be associated with the hot dry prevailing winds originating from this direction. To the east and south-west are the densely populated precincts of Liverpool and Campbelltown which encompass a multitude of potential particulate matter sources.

Table 12–11 Maximum 24-hour and annual average PM_{10} concentrations at Bringelly

Year	24-hour maximum (µg/m³)	Annual average (µg/m³)	No. of exceedances of 24-hour standard
EPA criterion	50	25	n/a
2005	55	19	2
2006	72	20	3
2007	51	18	1
2008	63	16	1
2009	1,684	25	6
2010	41	15	No exceedances
2011	86	16	2
2012	40	16	No exceedances
2013	97	17	3
2014	43	17	No exceedances

Data for $PM_{2.5}$ were obtained from the monitoring stations at Liverpool and Richmond. The data are presented in Table 12–12. The data indicate that $PM_{2.5}$ concentrations are higher at Liverpool than Richmond, with combustion emissions from urbanisation anticipated to be a major source of the measured differences. There are a number of days across the monitoring period where the 24-hour average measurements are above the NEPM goal of 25 micrograms per cubic metre. As with the PM_{10} monitoring data, the dust storms from 2009 have also been captured in the data set, recording up to 268 micrograms per cubic metre at Liverpool.

Table 12–12 Maximum 24-hour and annual average $PM_{2.5}$ concentrations at Liverpool and Richmond

Year	24-hour max (µg/m³)		Annual average (µg/m³)		No. of exceedances of 24-hour standard	
	Liverpool	Richmond	Liverpool	Richmond	Liverpool	Richmond
NEPM standard	25 (20[a])		8 (7[a])		n/a	
2005	31	23	8	6	2	0
2006	48	78	9	6	3	1
2007	23	21[b]	7	6[b]	0	0
2008	32	18	6	7	1	0
2009	268	149	8	6	5	2
2010	22	21	6	4	0	0
2011	38	43	6	5	2	2
2012	25	117	9	5	0	2
2013	74	83	9	8	2	14
2014	24	25	9	7	0	0

[a] NEPM-AAQ aim by 2025.

[b] Less than 75% data retrieval for year.

12.4.2.3 Carbon monoxide (CO)

Carbon monoxide is an odourless, colourless gas produced by incomplete oxidation (burning). As well as wildfires, carbon monoxide is produced naturally by oxidation of the oceans and organic decomposition. In cities, the motor vehicle is by far the largest human source, although any combustion process may produce it (OEH 2014a).

Data for carbon monoxide were obtained from the monitoring station at Macarthur and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data are presented in Table 12–13.

The one-hour maximum concentrations of carbon monoxide show a reasonably stable trend through the years with a slight decrease after 2006. The eight-hour maximum concentrations also show a slight decrease that occurred after 2007. There have been no exceedances of one-hour or eight-hour carbon monoxide criteria at Macarthur.

Table 12–13 Minute, one-hour and eight-hour average carbon monoxide concentrations at Macarthur and Campbelltown West

Year	15-minute maximum (mg/m^3)		One-hour maximum (mg/m^3)		Eight-hour maximum (mg/m^3)	
	Macarthur	Campbelltown West	Macarthur	Campbelltown West	Macarthur	Campbelltown West
EPA criterion	100	100	30	30	10	10
2005	-	-	2.3 [(a)]	-	1.2 [(a)]	-
2006	-	-	2.5	-	2.3	-
2007	-	-	2.4	-	2.2	-
2008	-	-	1.5	-	1.1	-
2009	-	-	1.6	-	0.9	-
2010	-	-	2.0	-	1.1	-
2011	-	-	2.1	-	1.3	-
2012	-	-	1.1 [(a)]	1.1 [(a)]	0.8 [(a)]	0.8 [(a)]
2013	-	-	-	10.5	-	8.6
2014	-	2.1	-	1.5	-	1.2

[a] Less than 75 per cent data retrieval for year

12.4.2.4 Sulfur dioxide (SO_2)

Sulfur dioxide in the atmosphere arises from both natural and human activities. Natural processes which release sulfur compounds include decomposition and combustion of organic matter; spray from the sea; and volcanic eruptions. The main human activities producing sulfur dioxide are the smelting of mineral ores containing sulfur and the combustion of fossil fuels (OEH 2014a).

Data for sulfur dioxide were obtained from the monitoring stations at Bringelly and Campbelltown West, though only a short data set is available from the monitoring station at Campbelltown West. The data are presented in Table 12–14. There have been no exceedances of the criteria for any of the required averaging periods.

The data show one-hour maximum concentrations of sulfur dioxide fluctuating over the past 10 years. In 2007 and 2008, one-hour maximum concentrations of sulfur dioxide rose by 50 per cent from the 2006 level. Concentrations then decreased during 2010 and 2011 and subsequently rose in 2011.

The 24-hour concentrations follow a similar trend to the one-hour maximums with a significant drop in 2010 and subsequent increase in 2011. Annual average sulfur dioxide concentrations appear to have decreased from 2010 to 2011 but then increased again in 2012 and 2013.

Further analysis of the data suggests that the greatest concentrations of sulfur dioxide originate from the east, and are most likely associated with vehicle emissions and industry located in this direction. Fluctuations may be caused by variations in meteorology or the intensity of activity.

Table 12–14 Maximum 15-minute, one-hour, eight-hour and annual average sulfur dioxide concentrations at Bringelly and Campbelltown West

Year	10 minute maximum (µg/m³)	One-hour maximum (µg/m³)		24-hour maximum (µg/m³)		Annual average (µg/m³)	
	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West	Bringelly	Campbelltown West
EPA criterion	712	570	570	228	228	60	60
2004	-	43	-	6.8	-	0.6	-
2005	-	26	-	7.5	-	0.7	-
2006	-	26	-	6.3	-	1.0	-
2007	-	49	-	8.2	-	1.2	-
2008	-	54	-	7.5	-	0.3	-
2009	-	34	-	9.2	-	-0.8	-
2010	-	23	-	5.7	-	0.7	-
2011	-	31	-	5.2	-	0.3	-
2012	-	43	23 (a)	5.1	5.7 (a)	0.5	1.4 (a)
2013	-	31	26	7.0	6.8	0.7	1.3
2014 (b)	80(c)	26	34	8.5	9.9	0.7	1.2

[a] Less than 75 per cent data retrieval for the year.

[b] Calibration issue with the instrument between January and May 2014. The data have been included for completeness.

[c] High resolution data were available for Campbelltown West only.

12.4.2.5 Air toxics

Air toxics include volatile organic compounds like benzene, dioxins, lead and other metals that are typically present in ambient air in low concentrations and are hazardous to human health or the environment. Major sources of these toxics include motor vehicle exhaust and some commercial and industrial processes. Knowledge of the health effects of air toxics is far from complete, but studies indicate that very small amounts of air toxics may present a risk to human health and the environment (OEH 2014a).

Continuous monitoring of air toxics is not measured as part of the OEH air quality monitoring network or under any other program at present. However, between 1996 and 2001, the NSW Environment Protection Authority (EPA) (then Department of Environment and Conservation (DEC)) conducted the Air Toxics Monitoring Project which investigated concentrations of the NEPM air toxics (benzene, toluene, xylene and polyaromatic hydrocarbons such as benzo[a]pyrene) for 24-hour periods at numerous locations across Sydney and NSW (DEC 2004a, DEC 2004b). In addition, the Ambient Air Quality Monitoring and Fuel Quality Testing Project collected 24-hour concentrations of formaldehyde at Rozelle and Turrella for a one year period from October 2008 to October 2009. The results of this monitoring have been published as part of the EPA's Current Air Quality in New South Wales technical paper (DECCW 2010).

The Air Toxics Monitoring Project found ambient concentrations of most tested substances were well below international ambient air quality goals at the time. The Ambient Air Quality Monitoring and Fuel Quality Testing Project also found low concentrations of all chemical pollutants, with many observations below the detection limit of the method.

12.4.2.6 Ozone

Near the ground, ozone is a colourless, gaseous secondary pollutant. It is formed by chemical reactions between reactive organic gases and oxides of nitrogen in the presence of sunlight – triggering a photochemical reaction. Ozone is one of the irritant secondary pollutants in photochemical smog and is often used as a measure of it (OEH 2014a).

Data for ozone in the vicinity of the airport site were obtained from the monitoring station at Bringelly. The data are presented in Table 12–15 and further analysis of regional ozone is presented in Section 12.4.5. There have been multiple exceedances of both the one-hour maximum criteria of 214 micrograms per cubic metre and the four-hour maximum criteria of 171 micrograms per cubic metre over the past 10 years. The one-hour maximum concentrations ranged between 188 micrograms per cubic metre and 268 micrograms per cubic metre and the four-hour maximum concentrations ranged between 149 micrograms per cubic metre and 235 micrograms per cubic metre.

Ozone concentrations vary based on the time of day and also time of year, with peak ozone concentrations occurring in the mid-afternoon and also during the summer months. The seasonal variability is associated with the availability of sunlight, with the increase in sunlight in the summer months driving the photochemical activity that generates ozone.

Table 12–15 Maximum one-hour and four-hour average ozone concentrations at Bringelly

Year	One-hour maximum (µg/m³)	Four-hour maximum (µg/m³)	Exceedances of one-hour standard (days per year)	Exceedances of four-hour standard (days per year)
EPA criterion (NEPM goal)	214	171	(1)	(1)
2005	261	235	8	5
2006	240	218	6	3
2007	255	219	10	5
2008	199	155	0	0
2009	257	232	7	3
2010	223	179	2	1
2011	268	226	5	2
2012	188	149	0	0
2013	231	207	3	1
2014	265	237	4	3

12.4.3 Odour

The airport site is mostly isolated from other industry activities that have the potential to be odorous. The exception is the poultry industry with a number of broiler and egg-laying farms in the vicinity, particularly to the east of the airport site. Multiple sources of odour are typically only treated cumulatively when similar in character and, as such, the consideration of background odour has not been included as part of this assessment.

12.4.4 Adopted local background concentrations

The background concentrations adopted for the local air quality assessment are presented in Table 12–16.

Table 12–16 Summary of assumed background concentrations

Pollutant	Averaging period	Year	Background	Location
Carbon monoxide (CO)	15 minutes	2014	2.1 mg/m³	Campbelltown West
	One-hour	2014	1.5 mg/m³	Campbelltown West
	Eight hours	2014	1.2 mg/m³	Campbelltown West
Nitrogen dioxide (NO_2)	One-hour	2014	Varied	Bringelly
	One year	2014	10 µg/m³	Bringelly
Particulate matter < 10 µm (PM_{10})	24 hours	2014	Varied	Bringelly
	One year	2014	17 µg/m³	Bringelly
Particulate matter < 2.5 µm ($PM_{2.5}$)	24 hours	2014	Varied	Bringelly[b]
	One year	2014	7 µg/m³	Bringelly[b]
Deposited dust	One year	n/a	2 g/m2/month	n/a
Sulfur dioxide (SO_2)	10 minutes	2014	80 µg/m³	Campbelltown West
	One-hour	2014	34 µg/m³	Campbelltown West
	24 hours	2014	9.9 µg/m³	Campbelltown West
	One year	2014	1.2 µg/m³	Campbelltown West
Benzene	One year	2008-09	1.0 µg/m³	Rozelle
Toluene[a]	24 hours	2008-09	15.3 µg/m³	Rozelle
	One year	2008-09	3.7 µg/m³	Rozelle
Xylenes[a]	24 hours	2008-09	16.6 µg/m³	Rozelle
	One year	2008-09	2.4 µg/m³	Rozelle
Formaldehyde	24 hours	2008-09	4.3 µg/m³	Rozelle
Benzo[a]pyrene	One year	2008-09	0.2 ng/m³	Blacktown

[a] 24-hour average value has been pro-rated based on the 1996-2001 data from Table 4–10 in Appendix F1 (Volume 4).

[b] Based on 2014 $PM_{2.5}$ / PM_{10} ratio of 0.31 at Liverpool and Richmond.

12.4.5 Regional air quality (ozone)

Regional air quality considers the formation of ozone through photochemical reactions from primary emissions of precursor gases including nitrogen oxides, volatile organic compounds and carbon monoxide.

Regional ozone is affected both by local formation and the transport of ozone and its precursor gases from upwind areas. As a secondary pollutant, ozone concentrations are generally more regionally homogeneous than concentrations of primary pollutants (USEPA 2013).

Meteorology and seasonality also play an important role in ozone formation. Peak ozone concentrations in Sydney tend to occur in the afternoon and during summer months due to the availability of sunlight and higher temperatures.

Elevated ground-level ozone concentrations are also associated with slow moving high pressure systems during the warmer seasons, often involving generally cloudless skies, light winds and the development of stable conditions near the surface that reduce the vertical mixing of the precursor gases. The combination of reduced mixing and light winds minimises the dispersal of pollutants, allowing their concentrations to build up (USEPA 2014).

There are a range of precursor gas emission sources which contribute to regional ozone generation. Sources include industrial, commercial, off-road mobile and on-road mobile emissions together with biogenic sources such as emissions of volatile organic compounds from areas of existing vegetation such as the Blue Mountains.

The relationship between ozone formation and emissions of precursor gases is not linear. For example, nitrogen oxides emissions can lead to both formation and destruction of ozone, depending on the local quantities of nitrogen oxides, volatile organic compounds and sunlight (USEPA 2014).

Ozone is currently measured at 15 Sydney monitoring sites, operated by the OEH. The maximum one-hour and four-hour average ozone concentrations for the most recent five years of monitoring data at these sites are presented in Table 12–17 and Table 12–18. The average across the five years is taken and the maximum five-year average is compared against the acceptance limits of 82 parts per billion (one-hour) and 65.2 parts per billion (four-hour). It is clear from the analysis that all areas of the Sydney region are currently classified as non-attainment.

The NSW EPA tiered procedure for ozone assessment requires classification of areas of Sydney as either attainment or non-attainment. An area is classified as attainment if ozone meets the acceptance limit, otherwise it is classified as non-attainment. As shown in Table 12–17 and Table 12–18 all areas within the Sydney region are classified as non-attainment.

Table 12–17 Classification of ozone nonattainment based on one-hour average ozone concentrations

Stations	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	84	73	66	75	66	73
Rozelle	73	93	69	73	67	75
Lindfield	82	86	73	81	85	81
Chullora	83	114	80	105	79	92
Earlwood	85	99	82	101	69	87
Maximum five year average – Sydney central-east (non-attainment)						92
Richmond	89	116	85	95	90	95
St Marys	95	136	85	110	100	105
Vineyard	90	94	80	105	112	96
Prospect	104	126	80	111	103	105
Maximum five year average – Sydney north-west (non-attainment)						105
Liverpool	91	103	79	117	103	99
Bringelly	104	125	88	108	124	110
Bargo	110	126	91	95	105	105
Macarthur	119	131				
Oakdale	99	126	89	95	110	104
Campbelltown west				94	124	
Camden				110	123	
Maximum five year average – Sydney south-west (non-attainment)						110

Table 12–18 Classification of ozone nonattainment based on four-hour average ozone concentrations

Station	Maximum ozone concentration (parts per billion)					Average
	2010	2011	2012	2013	2014	
Randwick	77	69	63	67	61	67
Rozelle	67	80	54	63	60	65
Lindfield	79	84	71	74	75	77
Chullora	72	96	68	94	73	81
Earlwood	74	88	68	82	65	75
Maximum – Sydney central-east (non-attainment)						**81**
Richmond	82	88	70	76	73	78
St Marys	83	121	72	101	85	92
Vineyard	79	75	70	90	75	78
Prospect	97	114	73	104	97	97
Maximum – Sydney north-west (non-attainment)						**97**
Liverpool	81	95	71	110	87	89
Bringelly	89	118	72	102	113	99
Bargo	86	98	83	82	93	88
Macarthur	103	122				
Oakdale	88	98	81	81	88	87
Campbelltown west				82	111	
Camden				90	110	
Maximum – Sydney south-west (non-attainment)						**99**

Exceedances of the ambient ozone standards in Sydney are generally limited to the summer months (December to February). In some years, exceedances occur in the months of October, November and March, however outside the core summer periods, exceedances often coincide with bushfires events (for example November 2009 and October 2013).

A review of the most recent 10 years of monitoring data reveals exceedances of the one-hour and four-hour ozone standard in eight of the previous 10 years at Bringelly. Analysis of long term trends indicates that there is some evidence of decreasing monthly maximum ozone concentrations at Bringelly, near the airport site, as well as in other areas of Sydney.

12.5 Assessment of impacts during construction

12.5.1 Overview

Construction of the proposed Stage 1 development would result in dust emissions being generated during both the bulk earthworks and the construction of aviation infrastructure. Dust emissions during the bulk earthworks would result from:

- dozers;
- scrapers;
- the loading and unloading of material;
- hauling on paved and unpaved roads;
- wind erosion; and
- grading.

Dust emissions during the construction of aviation infrastructure would be generated by:

- the working crew (similar to the equipment used during bulk earthworks);
- the asphalt plant; and
- the concrete batching plant.

In addition to the above, there would also be diesel particulate matter emissions (comprising $PM_{2.5}$ only) from the onsite equipment as well as odour emissions from the asphalt plant.

This section describes the results of the air dispersion modelling for the construction of the Stage 1 development. The concentrations of PM_{10}, $PM_{2.5}$, dust deposition and odour were determined for 18 residential receptors and 75 community receptors in the vicinity of the airport site.

Only the residential receptors are discussed below as they were considered representative of the community receptors. The tabulated results for all receptors, including the community receptors, are provided in Appendix F1 (Volume 4).

Contour plots for each of the pollutants and relevant averaging periods are also provided in Appendix F1 (Volume 4).

12.5.2 Bulk earthworks

Table 12–19 presents a summary of the maximum 24-hour average and annual average particulate matter and dust deposition concentrations due to the onsite construction activities. Table 12–20 summarises the cumulative results including other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1 (Volume 4).

The results show that the predicted dust impacts during the bulk earthworks would be at or below the air quality assessment criteria for each of the reported air quality parameters both incrementally as a result of the project and cumulatively when assessed with background concentrations and modelled inputs of other projects.

The contour plots show the spatial extent of particulate matter and the predicted concentrations across the local area (see Appendix F1 (Volume 4)). While the predicted concentrations remain low at all offsite residential receptors, the nature of the plume spread for the 24-hour and annual averaging periods is highest to the north-east and south-west of the airport site, consistent with the prevailing winds measured at Badgerys Creek (see Section 12.4.1).

Table 12–19 Predicted incremental particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*25*	*25 (20[a])*	*8 (7[a])*	*2*
R1	Bringelly	1.0	0.1	0.4	<0.1	1 x10^{-5}
R2	Luddenham	2.1	0.3	0.5	0.1	7 x10^{-5}
R3	Greendale, Greendale Road	2.7	0.1	1.4	0.1	2 x10^{-5}
R4	Kemps Creek	1.3	0.1	0.8	<0.1	2 x10^{-5}
R6	Mulgoa	0.4	0.1	0.2	<0.1	1 x10^{-5}
R7	Wallacia	0.6	0.1	0.3	<0.1	1 x10^{-5}
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	2.0	0.3	0.7	0.1	5 x10^{-5}
R14	Badgerys Creek, Lawson Road	4.8	0.6	2.0	0.2	1 x10^{-4}
R15	Greendale, Mersey Road	3.3	0.4	1.2	0.1	5 x10^{-5}
R17	Luddenham Road	2.2	0.3	0.6	0.1	6 x10^{-5}
R18	Corner of Adams and Elizabeth Drive	6.5	1.0	1.8	0.2	2 x10^{-4}
R19	Corner of Adams and Anton Road	7.2	0.9	2.1	0.2	2 x10^{-4}
R21	Corner of Willowdene Avenue and Vicar Park Lane	2.9	0.5	0.7	0.1	1 x10^{-4}
R22	Rossmore, Victor Avenue	1.4	0.1	0.7	<0.1	2 x10^{-5}
R23	Wallacia, Greendale Road	0.8	0.1	0.3	<0.1	2 x10^{-5}
R27	Greendale, Dwyer Road	1.2	0.2	0.4	<0.1	3 x10^{-5}
R30	Rossmore residential	0.7	0.1	0.3	<0.1	7 x10^{-6}
R31	Mount Vernon residential	1.8	0.1	1.0	<0.1	2 x10^{-5}

Table 12–20 Predicted cumulative particulate matter and dust deposition results during bulk earthworks

Receptor	Receptor description	PM_{10} (µg/m^3)		$PM_{2.5}$ (µg/m^3)		Dust deposition (g/m^2/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*25*	*25 (20[a])*	*8 (7[a])*	*4*
R1	Bringelly	43.0	17.1	13.5	7.0	2.0
R2	Luddenham	42.7	17.3	13.3	7.1	2.0
R3	Greendale, Greendale Road	42.7	17.1	13.3	7.1	2.0
R4	Kemps Creek	42.6	17.1	13.3	7.0	2.0
R6	Mulgoa	42.6	17.1	13.3	7.0	2.0
R7	Wallacia	42.6	17.1	13.3	7.0	2.0
R8	Twin Creeks, corner of Twin Creeks Drive and Humewood Place	43.4	17.3	13.5	7.1	2.0
R14	Badgerys Creek, Lawson Road	43.0	17.6	13.4	7.2	2.0
R15	Greendale, Mersey Rd	44.6	17.4	14.0	7.1	2.0
R17	Luddenham Road	44.2	17.3	13.7	7.1	2.0
R18	Corner Adams and Elizabeth Drive	44.2	18.0	13.7	7.2	2.0
R19	Corner of Adams and Anton Road	43.9	17.9	13.6	7.2	2.0
R21	Corner of Willowdene Avenue and Vicar Park Lane	42.9	17.5	13.4	7.1	2.0
R22	Rossmore, Victor Avenue	42.7	17.1	13.3	7.0	2.0
R23	Wallacia, Greendale Road	42.6	17.1	13.3	7.0	2.0
R27	Greendale, Dwyer Road	43.0	17.2	13.4	7.0	2.0
R30	Rossmore residential	42.7	17.1	13.4	7.0	2.0
R31	Mt Vernon residential	42.6	17.1	13.3	7.0	2.0

[a]NEPM-AAQ aim by 2025

12.5.3 Construction of aviation infrastructure

Table 12–21 presents a summary of the maximum 24-hour average and annual average particulate matter and dust deposition concentrations at each of the 20 residential receptors, due to the construction of aviation infrastructure. Table 12–22 summarises the results cumulatively with other sources/background predictions. The predicted dust impacts at the community receptors are provided in Appendix F1 (Volume 4).

The results show that the predicted dust impacts during construction are forecast to be below the air quality assessment criteria for each of the reported air quality parameters. Dust impacts would be below the assessment criteria for both incremental impacts as a result of the project and cumulative impacts when assessed with the background concentrations and modelled inputs of other projects.

The contour plots show a similar trend to those described for the bulk earthworks, with maximum offsite concentrations predicted to the north-east and south-west of the airport site (see Appendix F1 (Volume 4)).

Table 12–21 Predicted incremental results during construction of aviation infrastructure

Receptor	Receptor description	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		Dust deposition (g/m²/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*25*	*25 (20[a])*	*8 (7[a])*	*2*
R1	Bringelly	2.7	0.2	2.3	0.2	7 $\times10^{-6}$
R2	Luddenham	2.7	0.4	2.4	0.3	4 $\times10^{-5}$
R3	Greendale, Greendale Road	8.0	0.3	5.4	0.2	2 $\times10^{-5}$
R4	Kemps Creek	11.0	0.2	2.8	0.2	1 $\times10^{-5}$
R6	Mulgoa	1.3	0.1	0.7	0.1	7 $\times10^{-6}$
R7	Wallacia	1.7	0.1	0.9	0.1	1 $\times10^{-5}$
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	4.0	0.4	3.3	0.3	2 $\times10^{-5}$
R14	Badgerys Creek, Lawson Road	25.4	1.2	6.6	0.7	5 $\times10^{-5}$
R15	Greendale, Mersey Road	7.3	0.6	5.9	0.5	3 $\times10^{-5}$
R17	Luddenham Road	5.3	0.4	2.4	0.3	3 $\times10^{-5}$
R18	Corner of Adams and Elizabeth Drive	11.0	1.1	7.8	1.0	1 $\times10^{-4}$
R19	Corner of Adams and Anton Road	8.7	1.1	7.0	1.1	1 $\times10^{-4}$
R21	Corner of Willowdene Avenue and Vicar Park Lane	4.6	0.7	3.9	0.7	1 $\times10^{-4}$
R22	Rossmore, Victor Avenue	6.6	0.3	2.2	0.2	1 $\times10^{-5}$
R23	Wallacia, Greendale Road	2.1	0.2	1.2	0.2	1 $\times10^{-5}$
R27	Greendale, Dwyer Road	2.6	0.2	2.9	0.2	2 $\times10^{-5}$
R30	Rossmore residential	2.3	0.1	1.5	0.1	4 $\times10^{-6}$
R31	Mt Vernon residential	5.9	0.2	2.9	0.2	1 $\times10^{-5}$

Table 12–22 Predicted cumulative results during construction of aviation infrastructure

Receptor	Receptor description	PM_{10} (µg/m³)		$PM_{2.5}$ (µg/m³)		Dust deposition (g/m²/month)
		24 hour	Annual	24 hour	Annual	Annual
Assessment criteria		*50*	*25*	*25 (20[a])*	*8 (7[a])*	*4*
R1	Bringelly	45	17	14	7	2
R2	Luddenham	43	17	13	7	2
R3	Greendale, Greendale Road	43	17	13	7	2
R4	Kemps Creek	43	17	13	7	2
R6	Mulgoa	43	17	13	7	2
R7	Wallacia	43	17	13	7	2
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	47	17	14	7	2
R14	Badgerys Creek, Lawson Road,	50	18	14	8	2
R15	Greendale, Mersey Road	46	18	17	8	2
R17	Luddenham Road	44	17	15	7	2
R18	Corner of Adams and Elizabeth Drive	45	18	15	8	2
R19	Corner of Adams and Anton Road	44	18	15	8	2
R21	Corner of Willowdene Avenue and Vicar Park Lane	43	18	14	8	2
R22	Rossmore, Victor Avenue	43	17	13	7	2
R23	Wallacia, Greendale Road	43	17	13	7	2
R27	Greendale, Dwyer Road	43	17	14	7	2
R30	Rossmore residential	43	17	14	7	2
R31	Mt Vernon residential	43	17	13	7	2

[a]NEPM-AAQ aim by 2025.

12.5.4 Asphalt batching plant

The 99th percentile one-hour odour predictions for emissions from the asphalt batching plant are presented in Table 12–23. Odour from the asphalt plant would be below the relevant criteria at all sensitive residential receptors. The contour plot shows that the highest odour concentrations would be largely limited to within the airport site (see Appendix F1 (Volume 4)). The two odour unit contour (the adopted impact assessment criterion) spreads outside of the airport site a relatively short distance to the north. This area is currently unoccupied and, therefore, it is expected that there would be no adverse odour impacts to sensitive receptors from the asphalt batching plant.

Table 12–23 Predicted 99th percentile odour concentration from asphalt batching plant

Receptor	Receptor description	One-hour 99th percentile (odour units)
Assessment criteria		2
R1	Bringelly	<0.1
R2	Luddenham	<0.1
R3	Greendale, Greendale Road	<0.1
R4	Kemps Creek	0.1
R6	Mulgoa	<0.1
R7	Wallacia	<0.1
R8	Twin Creeks, corner of Twin Creek Drive and Humewood Place	0.3
R14	Badgerys Creek, Lawson Road	1.7
R15	Greendale, Mersey Road	0.1
R17	Luddenham Road	0.4
R18	Corner of Adams and Elizabeth Drive	0.5
R19	Corner of Adams and Anton Road	0.1
R21	Corner of Willowdene Avenue and Vicar Park Lane	<0.1
R22	Rossmore, Victor Avenue	0.2
R23	Wallacia, Greendale Road	<0.1
R27	Greendale, Dwyer Road	<0.1
R30	Rossmore residential	<0.1
R31	Mt Vernon residential	0.2

12.6 Assessment of impacts during operation

This section describes the results of the emission calculations and air dispersion modelling for the operation of the proposed Stage 1 development.

12.6.1 Emissions

The emissions of criteria pollutants from the Stage 1 development are presented in Figure 12–5. Incremental emissions are generated by sources solely associated with the airport operations. These include emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative emissions include the respective airport sources in addition to emissions from vehicles on external roadways, which is comprised of airport traffic and background traffic, as characterised within the surface transport and access technical report (see Chapter 15 and Appendix J (Volume 4)).

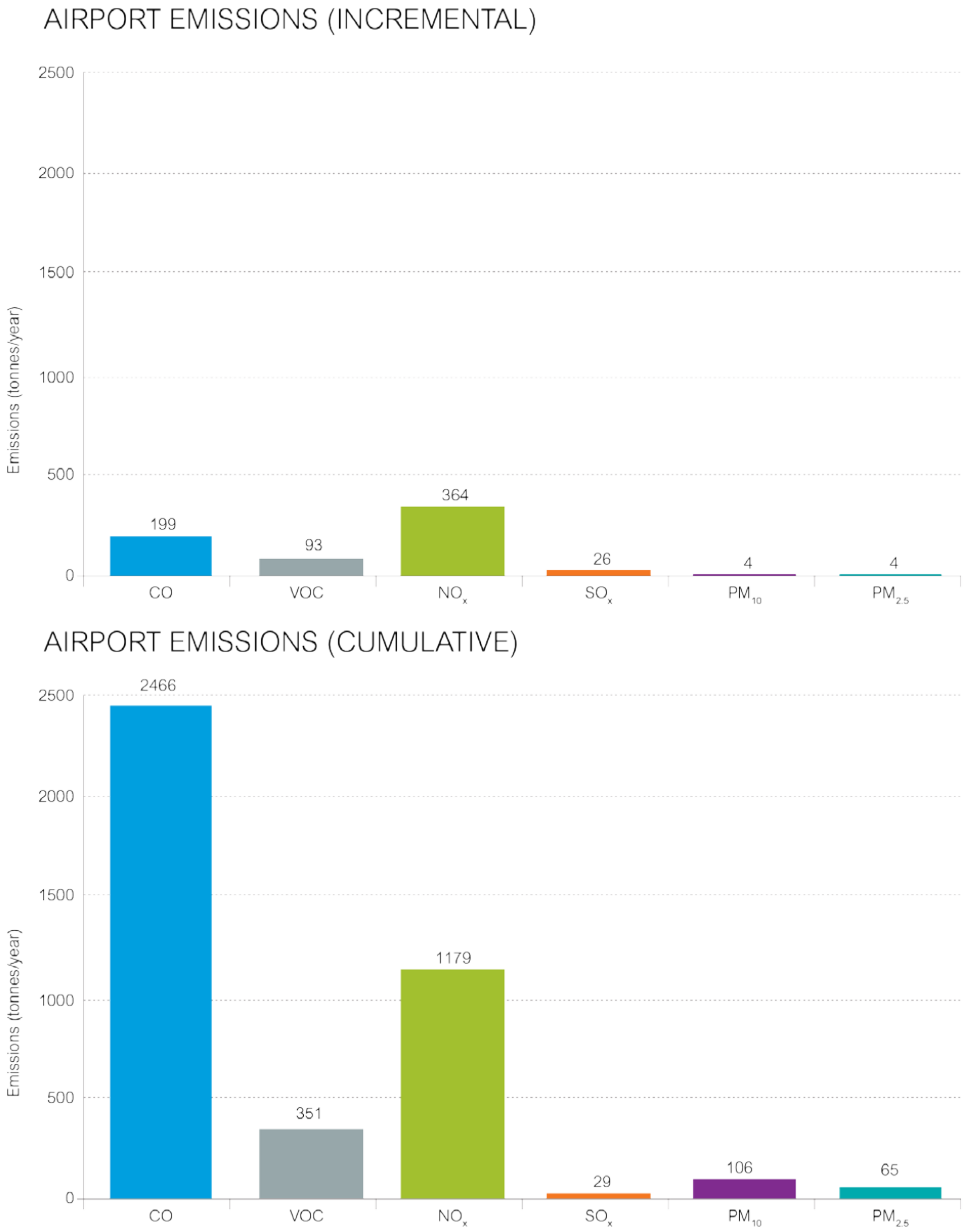


Figure 12–5 Estimated incremental and cumulative emissions for criteria pollutants

The emission inventory for the Stage 1 development is presented by source type in Table 12–24. The percentage contribution of each source to the full inventory for each pollutant is shown alongside the emission value.

Background traffic on the external road network is the largest overall source of emissions during the Stage 1 development. As such, the proposed airport represents a relatively small part of the full emissions inventory in the context of these background emissions.

The volume of emissions from background traffic can be attributed to the increased number of vehicles predicted to be using the road network at the time of operation of the Stage 1 development. Some of these vehicles would be accessing the airport, however the increase would largely be the result of significant urban development occurring in the region.

Review of the incremental emissions (that is, those emissions from the proposed airport in isolation) shows that aircraft engines are by far the most significant source for emissions at the airport site. The operation of auxiliary power units, ground support equipment, parking facilities and terminal traffic were also substantial sources of emissions.

Another significant component of incremental emissions are volatile organic compounds. Stationary sources and fuel tanks are the biggest contributor to these emissions. Evaporative losses from jet fuel at the onsite fuel farm are calculated to account for over 99 per cent of all fuel losses including diesel and petroleum reflecting the volatility of jet fuel.

Table 12–24 Airport emission inventory for criteria pollutants

Category	Emissions (tonnes per year)											
	CO		VOC		NO_x		SO_2		PM_{10}		$PM_{2.5}$	
Proposed airport	199	8%	93	26%	364	31%	26	88%	4	4%	4	7%
Aircraft engines	127	63%	27	29%	336	92%	23	91%	2	41%	2	42%
Ground support equipment	48.6	24%	2.0	2%	4.5	1%	0.5	2%	0.3	7%	0.3	7%
Auxiliary power units	4.7	2%	0.5	1%	17.3	5%	1.6	6%	1.1	24%	1.1	25%
Parking facilities	9.4	5%	1.0	1%	0.4	0%	0.0	0%	0.0	1%	0.0	0%
Terminal traffic	4.9	2%	0.5	0%	1.2	0%	0.0	0%	0.2	4%	0.1	2%
Stationary sources	2.4	1%	62.0	67%	4.4	1%	0.1	1%	0.3	7%	0.3	7%
Boilers	1.9	1%	0.1	0%	2.4	1%	0.0	0%	0.2	4%	0.2	4%
Engine tests	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Fuel tanks	0.0	0%	54.5	59%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Generators	0.4	0%	0.1	0%	2.0	1%	0.1	1%	0.1	3%	0.1	3%
Paint and Solvent	0.0	0%	7.2	8%	0.0	0%	0.0	0%	0.0	0%	0.0	0%
Training Fires	3.1	2%	0.1	0%	0.0	0%	0.0	0%	0.7	16%	0.7	16%
Airport traffic on road network	107	4%	12	3%	16	1%	0	0%	4	3%	2	3%
Background traffic on road network	2,159	88%	246	70%	800	68%	4	12%	98	92%	58	90%
Total	2,468	100%	351	100%	1,179	100%	29	100%	106	100%	65	100%

CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides,
SO_2 = Sulfur dioxide, PM_{10} and $PM_{2.5}$ = Particulate matter

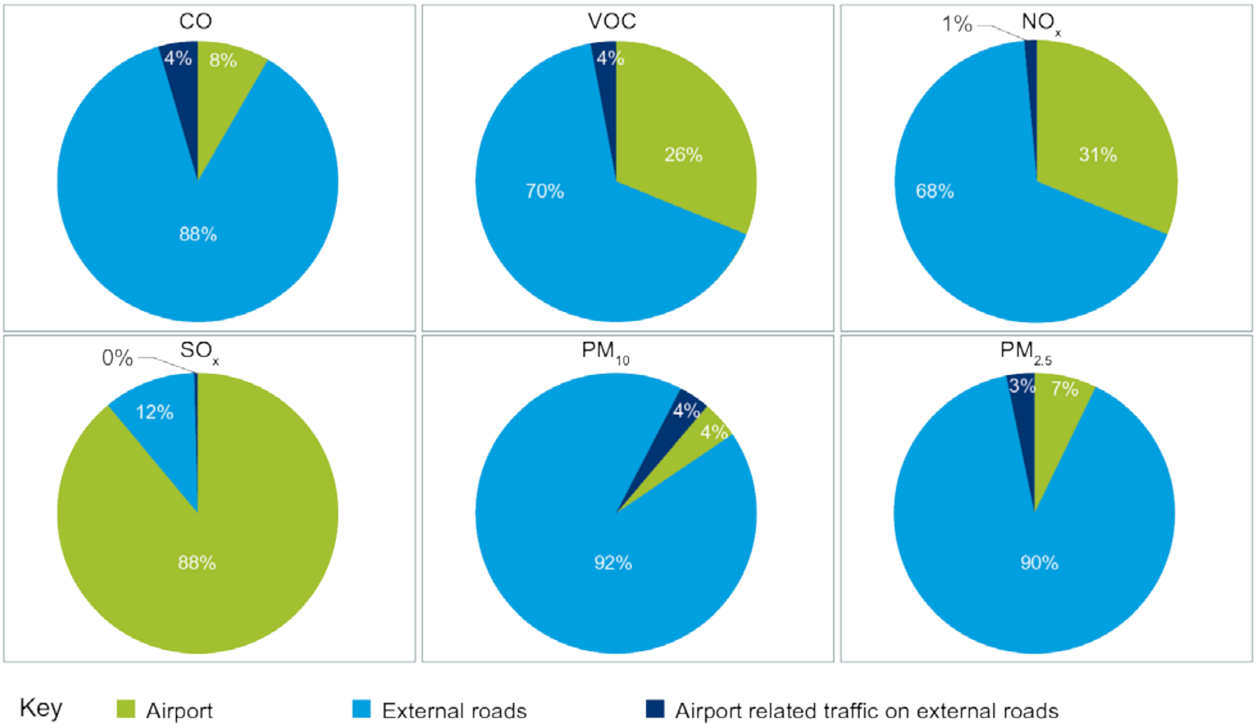


Figure 12–6 Estimated airport and external roads emissions as a percentage of total modelled for criteria pollutants

Forecast emissions from the proposed airport have also been considered in the context of the Sydney airshed. Projected emissions data for the Sydney airshed were prepared by the NSW EPA (2012) for the years 2016, 2021, 2026, 2031 and 2036. The projected emissions for 2031 have been compared with the incremental emissions from the proposed airport and are shown in Table 12–25. As the Sydney airshed forecast emissions are not available for 2030, it has been assumed that they would be substantially the same as 2031.

The comparison shows that incremental emissions from the Stage 1 development would represent a marginal share of total emissions in the Sydney airshed in 2030. In particular, the proposed airport would represent approximately 0.7 per cent of total anthropogenic emissions of nitrogen oxides within the Sydney airshed, with even smaller shares of sulfur dioxide and volatile organic compounds (0.2 per cent each), carbon monoxide (0.1 per cent) and particulate matter (less than 0.1 per cent).

Table 12–25 Forecast Sydney airshed emissions compared with forecast airport emissions

Pollutant	Forecast Sydney airshed emissions in 2031 (tonnes/year)	Forecast airport emissions in 2030 (tonnes/year)	Forecast airport emissions compared with Sydney airshed in 2030 (%)
CO	166,802	199	0.1%
VOC	98,369	93	0.1%
NOx	51,452	364	0.7%
SO_2	18,522	29	0.2%
PM_{10}	10,446	4	<0.1%
$PM_{2.5}$	12,834	4	<0.1%

Source: Forecast 2031 Sydney Airshed emissions (EPA 2012a).

Forecast airport emissions do not include contributions from external roadways.

CO = Carbon monoxide, VOC = Volatile organic compounds, NO_x = Nitrogen oxides, SO_2 = Sulfur dioxide, PM_{10} and $PM_{2.5}$ = Particulate matter

12.6.2 Dispersion modelling results

The concentrations of the criteria pollutants (carbon monoxide, nitrogen dioxide, sulfur dioxide, PM_{10}, $PM_{2.5}$ and volatile organic compounds) were determined for residential, onsite and community receptors in the local area. As the residential receptors are generally located in similar areas to the community receptors, only the residential and onsite receptors are discussed below. The results for all receptors, including the community receptors, are provided in Appendix F1 (Volume 4). Contour plots that show the spatial distribution of each pollutant are provided in Appendix F1 (Volume 4).

The incremental emissions comprise emissions from aircraft, auxiliary power units, ground support equipment, parking facilities, terminal traffic, stationary sources and training fires. Cumulative predictions include the airport sources as well as emissions from the external roadways and background contributions.

The dispersion modelling results are generally broken down into three categories.

- Airport – the incremental emissions from the operation of the proposed airport in isolation;
- External roads – emissions from traffic on roads surrounding the airport site, accounting for traffic due to the broader urbanisation of Western Sydney (including the proposed airport); and
- Cumulative – the total of emissions from the operation of the proposed airport, traffic on roads surrounding the airport site, and background concentrations recorded in the vicinity of the proposed airport (see Section 12.2.1.2) which would capture other major emissions sources in the region such as industrial developments.

12.6.2.1 Nitrogen dioxide (NO_2)

The dispersion modelling results for maximum one-hour and annual average nitrogen dioxide are presented in Table 12–26. The results of the dispersion modelling show predicted nitrogen dioxide concentrations to be below the air quality assessment criteria at all residential receptors when considering the airport both in isolation (incremental) and combined with the external roadways and background sources (cumulative).

The highest one-hour nitrogen dioxide concentrations are predicted to occur at sensitive receptors R3 and R25, where the cumulative concentration is predicted to reach about 70 per cent of the one-hour air quality criteria (320 µg/m^3). Sensitive receptor R25 is on the airport site and will not be residential.

The cumulative contributions from external roadways are shown to have negligible effects for some receptors and greater effects for others such as R22 at Rossmore.

Table 12–26 Predicted incremental and cumulative NO_2 concentrations

Receptor	Receptor description	Airport (µg/m^3)		Cumulative[a] (µg/m^3)	
		One-hour	Annual	One-hour	Annual
Assessment criteria		*320*	*62*	*320*	*62*
R1	Bringelly	84	11	145	19
R2	Luddenham	91	13	192	15
R3	Greendale, Greendale Road	194	12	213	13
R4	Kemps Creek	76	11	109	17
R6	Mulgoa	84	12	85	13
R7	Wallacia	90	11	92	13
R8	Twin Creeks, corner Twin Creeks Drive & Humewood Place	86	13	91	17
R14	Badgerys Creek, Lawson Road	147	13	153	18
R15	Greendale, Mersey Road	130	13	135	16
R17	Luddenham Road	96	13	103	17
R18	Corner Adams and Elizabeth Drive	107	17	108	21
R19	Corner Adams and Anton Road	111	19	112	23
R21	Corner Willowdene Avenue and Vicar Park Lane	171	13	177	15
R22	Rossmore, Victor Avenue	68	11	104	15
R23	Wallacia, Greendale Road	87	11	101	12
R24	Badgerys Creek 1 NE	166	18	169	26
R25	Badgerys Creek 2 SW	104	12	215	26
R27	Greendale, Dwyer Road	80	11	108	12
R30	Rossmore residential	66	11	126	18
R31	Mt Vernon residential	142	12	142	16

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.

12.6.2.2 Particulate matter (PM_{10})

The dispersion modelling results for maximum 24-hour average and annual average PM_{10} are presented in Table 12–27. The results of the dispersion modelling show predicted PM_{10} concentrations to be below the air quality assessment criteria (50 µg/m^3 over 24 hours and 25 µg/m^3 annually) at all assessed sensitive receptors.

As shown, the inclusion of traffic on external roadways increases the predicted concentrations at most assessed sensitive receptors. This is due to the relatively large proportion of the emissions inventory attributable to traffic as well as the broader spatial extent of these emissions sources.

Table 12–27 Predicted incremental and cumulative PM_{10} concentrations

Receptor	Receptor description	Airport (µg/m^3)		Airport + external roads (µg/m^3)		Cumulative[a] (µg/m^3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		n/a	n/a	n/a	n/a	*50*	*25*
R1	Bringelly	0.5	<0.1	7.3	1.0	44	18
R2	Luddenham	0.5	<0.1	1.7	0.3	43	17
R3	Greendale, Greendale Road	1.0	<0.1	2.5	0.2	43	17
R4	Kemps Creek	0.6	<0.1	4.4	0.8	44	18
R6	Mulgoa	0.5	<0.1	1.5	0.2	43	17
R7	Wallacia	0.4	<0.1	1.4	0.2	43	17
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	2.6	0.5	44	18
R14	Badgerys Creek, Lawson Road	1.5	0.1	6.0	0.8	44	18
R15	Greendale, Mersey Road	1.1	0.1	2.1	0.5	44	17
R17	Luddenham Road	0.7	<0.1	2.9	0.5	43	18
R18	Corner Adams and Elizabeth Drive	0.7	0.1	3.2	0.7	44	18
R19	Corner Adams and Anton Road	2.0	0.2	3.1	0.7	44	18
R21	Corner Willowdene Avenue and Vicar Park Lane	0.9	<0.1	3.4	0.4	43	17
R22	Rossmore, Victor Avenue	0.9	<0.1	3.4	0.5	44	18
R23	Wallacia, Greendale Road	0.6	<0.1	2.0	0.2	43	17
R24	Badgerys Creek 1 NE	4.1	0.4	5.9	1.5	44	18
R25	Badgerys Creek 2 SW	0.6	<0.1	18.6	1.9	47	19
R27	Greendale, Dwyer Road	0.1	<0.1	1.7	0.2	43	17
R30	Rossmore residential	0.3	<0.1	6.0	1.1	44	18
R31	Mt Vernon residential	0.9	<0.1	4.0	0.5	43	18

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.
n/a – the criterion do not apply to this assessment scenario

12.6.2.3 Particulate matter ($PM_{2.5}$)

The dispersion modelling results for maximum 24-hour average and annual average $PM_{2.5}$ are presented in Table 12–28. The dispersion modelling shows predicted $PM_{2.5}$ concentrations to be below the current air quality assessment criteria (25 µg/m^3 over 24 hours and 8 µg/m^3 annually) at all assessed sensitive receptors.

Predicted $PM_{2.5}$ does exceed a future NEPM-AAQ objective for 2025 (7 µg/m^3 annually) at a number of sensitive receptors, however this is primarily attributable to background concentrations. As shown, the inclusion of traffic on external roadways increases the predicted concentrations at most assessed sensitive receptors. This is due to the relatively large proportion of the emissions inventory attributable to traffic as well as the broader spatial extent of these emissions sources.

Table 12–28 Predicted incremental and cumulative $PM_{2.5}$ concentrations

Receptor	Receptor description	Airport (µg/m^3)		Airport + external roads (µg/m^3)		Cumulative[a] (µg/m^3)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*25 (20[b])*	*8 (7[b])*
R1	Bringelly	0.5	<0.1	4.3	0.6	14	8
R2	Luddenham	0.5	<0.1	1.1	0.2	14	7
R3	Greendale, Greendale Road	1.0	<0.1	1.9	0.1	13	7
R4	Kemps Creek	0.6	<0.1	2.6	0.5	14	7
R6	Mulgoa	0.5	<0.1	1.0	0.1	13	7
R7	Wallacia	0.4	<0.1	0.9	0.1	13	7
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.6	<0.1	1.5	0.3	14	7
R14	Badgerys Creek, Lawson Road	1.4	0.1	4.1	0.5	14	7
R15	Greendale, Mersey Road	1.0	0.1	1.5	0.3	14	7
R17	Luddenham Road	0.7	<0.1	1.7	0.3	14	7
R18	Corner Adams and Elizabeth Drive	0.7	0.1	2.0	0.4	14	7
R19	Corner Adams and Anton Road	1.9	0.2	2.5	0.5	14	7
R21	Corner Willowdene Avenue and Vicar Park Lane	0.8	<0.1	2.1	0.2	14	7
R22	Rossmore, Victor Avenue	0.9	<0.1	2.0	0.3	14	7
R23	Wallacia, Greendale Road	0.6	<0.1	1.2	0.1	13	7
R24	Badgerys Creek 1 NE	3.9	0.3	4.3	0.9	14	8
R25	Badgerys Creek 2 SW	0.6	<0.1	11.1	1.1	18	8

R27	Greendale, Dwyer Road	0.1	<0.1	1.0	0.1	13	7
R30	Rossmore residential	0.3	<0.1	3.5	0.6	14	8
R31	Mt Vernon residential	0.9	<0.1	2.4	0.3	14	7

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.
[b] NEPM-AAQ aim by 2025.
n/a – the criterion do not apply to this assessment scenario

12.6.2.4 Carbon monoxide (CO)

The dispersion modelling results for maximum 15-minute, one-hour and eight-hour carbon monoxide are presented in Table 12-29. The results of the dispersion modelling show predicted carbon monoxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

Table 12–29 Predicted incremental and cumulative CO concentrations

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
Assessment criteria		n/a	n/a	n/a	n/a	n/a	n/a	100	30	10
R1	Bringelly	0.6	0.4	0.1	3.8	2.9	0.4	5.9	4.4	1.6
R2	Luddenham	0.5	0.4	0.1	0.5	0.4	0.1	2.6	1.9	1.3
R3	Greendale, Greendale Road	0.9	0.7	0.1	1.4	1.0	0.2	3.5	2.5	1.4
R4	Kemps Creek	0.7	0.5	0.1	1.9	1.5	0.3	4.0	3.0	1.5
R6	Mulgoa	0.7	0.5	0.1	0.9	0.6	0.1	3.0	2.1	1.3
R7	Wallacia	0.3	0.2	0.0	0.9	0.7	0.1	3.0	2.2	1.3
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	0.9	0.7	0.1	1.2	0.9	0.1	3.3	2.4	1.3
R14	Badgerys Creek, Lawson Road	1.8	1.4	0.2	2.2	1.7	0.3	4.3	3.2	1.5
R15	Greendale, Mersey Road	1.1	0.8	0.2	1.3	1.0	0.2	3.4	2.5	1.4
R17	Luddenham Road	0.5	0.4	0.1	1.0	0.7	0.1	3.1	2.2	1.3
R18	Corner Adams and Elizabeth Drive	0.7	0.5	0.1	1.6	1.2	0.3	3.7	2.7	1.5
R19	Corner Adams and Anton Road	2.3	1.7	0.3	2.4	1.8	0.3	4.5	3.3	1.5
R21	Corner Willowdene Avenue and Vicar Park Lane	1.1	0.8	0.2	1.7	1.3	0.2	3.8	2.8	1.4

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		15-min	1-hour	8-hour	15-min	1-hour	8-hour	15-min	1-hour	8-hour
R22	Rossmore, Victor Avenue	1.0	0.8	0.1	1.1	0.8	0.2	3.2	2.3	1.4
R23	Wallacia, Greendale Road	0.4	0.3	0.1	0.5	0.4	0.1	2.6	1.9	1.3
R24	Badgerys Creek 1 NE	3.1	2.3	0.5	4.6	3.4	0.6	6.7	4.9	1.8
R25	Badgerys Creek 2 SW	0.5	0.4	0.1	4.8	3.6	0.9	6.9	5.1	2.1
R27	Greendale, Dwyer Road	0.2	0.1	0.0	0.8	0.6	0.1	2.9	2.1	1.3
R30	Rossmore residential	0.4	0.3	0.1	3.1	2.3	0.3	5.2	3.8	1.5
R31	Mt Vernon residential	0.8	0.6	0.1	0.8	0.6	0.2	2.9	2.1	1.4

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.
n/a – the criterion do not apply to this assessment scenario

12.6.2.5 Sulfur dioxide (SO_2)

The dispersion modelling results for maximum 10-minute, one-hour, 24-hour and annual average sulfur dioxide, are presented in Table 12–30 (10-minute and one-hour averaging periods) and Table 12–31 (24-hour and annual averaging periods). The results of the dispersion modelling show predicted sulfur dioxide concentrations to be well below the air quality assessment criteria at all residential receptors for all averaging periods.

Table 12–30 Predicted incremental and cumulative maximum 10 minute and one-hour sulfur dioxide concentrations

Receptor	Receptor description	Airport (µg/m³)		Airport + external roadways (µg/m³)		Cumulative[a] (µg/m³)	
		10-min	1-hour	10-min	1-hour	10-min	1-hour
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*700*	*570*
R1	Bringelly	28	19	29	19	109	53
R2	Luddenham	18	12	25	16	105	50
R3	Greendale, Greendale Road	63	42	83	55	163	89
R4	Kemps Creek	24	16	54	36	134	70
R6	Mulgoa	122	81	52	34	132	68
R7	Wallacia	66	44	32	21	112	55
R8	Twin Creeks, corner Twin Creeks Drive and Humewood Place	64	42	64	43	144	77

Receptor	Receptor description	Airport (µg/m³)		Airport + external roadways (µg/m³)		Cumulative[a] (µg/m³)	
		10-min	1-hour	10-min	1-hour	10-min	1-hour
R14	Badgerys Creek, Lawson Road	85	56	122	81	202	115
R15	Greendale, Mersey Road	49	32	66	44	146	78
R17	Luddenham Road	133	88	54	35	134	69
R18	Corner Adams and Elizabeth Drive	39	26	36	24	116	58
R19	Corner Adams and Anton Road	102	67	102	68	182	102
R21	Corner Willowdene Avenue and Vicar Park Lane	51	34	86	57	166	91
R22	Rossmore, Victor Avenue	25	16	49	32	129	66
R23	Wallacia, Greendale Road	83	55	43	29	123	63
R24	Badgerys Creek 1 NE	87	57	133	88	213	122
R25	Badgerys Creek 2 SW	84	56	40	27	120	61
R27	Greendale, Dwyer Road	16	11	16	11	96	45
R30	Rossmore residential	24	16	29	19	109	53
R31	Mt Vernon residential	90	59	90	59	170	93

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.
n/a – the criterion do not apply to this assessment scenario

Table 12–31 Predicted incremental and cumulative maximum 24-hour and annual average SO_2 concentrations

Receptor	Receptor description	Airport (µg/m³)		Airport + external roads (µg/m³)		Cumulative[a] (µg/m³)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Assessment criteria		*n/a*	*n/a*	*n/a*	*n/a*	*228*	*60*
R1	Bringelly	1.8	0.1	2.0	0.1	11.9	1.3
R2	Luddenham	1.4	0.2	1.4	0.2	11.3	1.4
R3	Greendale, Greendale Road	4.6	0.2	4.6	0.2	14.5	1.4
R4	Kemps Creek	2.2	0.1	2.3	0.1	12.2	1.3
R6	Mulgoa	2.4	0.1	2.4	0.1	12.3	1.3
R7	Wallacia	1.5	0.1	1.5	0.1	11.4	1.3
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	2.2	0.2	2.2	0.2	12.1	1.4
R14	Badgerys Creek, Lawson Road	4.6	0.3	4.8	0.3	14.7	1.5
R15	Greendale, Mersey Road	3.9	0.3	3.9	0.3	13.8	1.5
R17	Luddenham Road	2.7	0.2	2.8	0.2	12.7	1.4

Receptor	Receptor description	Airport (µg/m³)		Airport + external roads (µg/m³)		Cumulative[a] (µg/m³)	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
R18	Corner Adams and Elizabeth Drive	2.5	0.6	2.5	0.6	12.4	1.8
R19	Corner Adams and Anton Road	4.4	0.8	4.4	0.8	14.3	2.0
R21	Corner Willowdene Avenue and Vicar Park Lane	3.8	0.2	3.8	0.2	13.7	1.4
R22	Rossmore, Victor Avenue	2.4	0.1	2.5	0.1	12.4	1.3
R23	Wallacia, Greendale Road	2.8	0.1	2.9	0.1	12.8	1.3
R24	Badgerys Creek 1 NE	7.4	0.7	7.4	0.7	17.3	1.9
R25	Badgerys Creek 2 SW	2.2	0.1	2.3	0.2	12.2	1.4
R27	Greendale, Dwyer Road	0.6	0.1	0.7	0.1	10.6	1.3
R30	Rossmore residential	1.7	0.1	1.9	0.1	11.8	1.3
R31	Mt Vernon residential	4.2	0.1	4.3	0.2	14.2	1.4

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.
n/a – the criterion do not apply to this assessment scenario

12.6.2.6 *Air toxics*

The relevant dispersion modelling results for the four air toxics evaluated in this assessment (benzene, toluene, xylene and formaldehyde) are presented in Table 12–32 (99.9th percentile), Table 12–33 (24-hour averaging period) and Table 12–34 (annual averaging period). The results of the dispersion modelling show the predicted concentrations of air toxics to be well below the air quality assessment criteria for the 99.9th percentile. The exception was formaldehyde with an exceedance shown at onsite receptor R24 (see Table 12–32).

The 24-hour and annual average concentrations of benzene, toluene and xylenes were predicted to be orders of magnitude lower than the air quality assessment criteria. The concentration of formaldehyde was also less than 18 per cent of the criteria.

Table 12–32 Predicted incremental and cumulative 99.9th percentile one-hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)				Airport + external roads (µg/m³)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
Assessment criteria		*29*	*360*	*180*	*20*	*29*	*360*	*180*	*20*
R1	Bringelly	0.1	<0.1	<0.1	0.7	1.5	0.6	0.4	11.1
R2	Luddenham	0.2	0.1	0.1	1.5	1.3	0.5	0.3	9.2
R3	Greendale, Greendale Road	0.2	0.1	<0.1	1.2	1.0	0.4	0.3	7.4
R4	Kemps Creek	0.1	<0.1	<0.1	0.9	1.3	0.5	0.4	9.8

Receptor	Receptor description	Airport (µg/m³)				Airport + external roads (µg/m³)			
		Benzene	Toluene	Xylene	Formaldehyde	Benzene	Toluene	Xylene	Formaldehyde
R6	Mulgoa	0.1	<0.1	<0.1	0.7	0.7	0.3	0.2	5.3
R7	Wallacia	0.1	<0.1	<0.1	0.7	0.6	0.2	0.2	4.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.1	<0.1	<0.1	0.8	0.9	0.3	0.2	6.3
R14	Badgerys Creek, Lawson Road	0.3	0.1	0.1	2.2	1.5	0.6	0.4	10.7
R15	Greendale, Mersey Road	0.3	0.1	0.1	1.8	1.4	0.5	0.4	10.5
R17	Luddenham Road	0.1	0.1	<0.1	1.0	0.9	0.3	0.2	6.6
R18	Corner Adams and Elizabeth Drive	0.2	0.1	<0.1	1.4	1.4	0.5	0.4	10.0
R19	Corner Adams and Anton Road	0.4	0.1	0.1	2.6	2.1	0.8	0.6	15.6
R21	Corner Willowdene Avenue and Vicar Park Lane	0.2	0.1	0.1	1.5	1.3	0.5	0.4	9.7
R22	Rossmore, Victor Avenue	0.2	0.1	<0.1	1.1	0.9	0.4	0.2	6.8
R23	Wallacia, Greendale Road	0.1	<0.1	<0.1	0.9	0.6	0.2	0.2	4.3
R24	Badgerys Creek 1 NE	0.6	0.2	0.2	4.2	3.2	1.2	0.8	23.2
R25	Badgerys Creek 2 SW	0.3	0.1	0.1	2.0	2.6	1.0	0.7	18.8
R27	Greendale, Dwyer Road	0.1	0.1	<0.1	1.0	1.1	0.4	0.3	7.9
R30	Rossmore residential	0.1	<0.1	<0.1	0.5	1.5	0.6	0.4	11.1
R31	Mt Vernon residential	0.2	0.1	0.1	1.4	1.1	0.4	0.3	8.3

Note Bold indicates exceedance of criterion

Table 12–33 Predicted incremental and cumulative 24-hour average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde	Toluene	Xylene	Formaldehyde
Assessment criteria		*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*	*4,160*	*1,170*	*53*
R1	Bringelly	<0.1	<0.1	0.9	0.1	0.1	2.2	15.4	16.7	6.5
R2	Luddenham	0.1	0.1	1.6	0.1	0.1	1.5	15.4	16.7	5.8
R3	Greendale, Greendale Road	0.1	0.1	1.5	0.1	0.1	1.5	15.4	16.7	5.8
R4	Kemps Creek	0.1	<0.1	1.1	0.1	0.1	1.7	15.4	16.7	6.0
R6	Mulgoa	<0.1	<0.1	0.8	0.0	0.0	0.9	15.3	16.6	5.2
R7	Wallacia	<0.1	<0.1	0.8	0.0	0.0	0.9	15.3	16.6	5.2
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<0.1	<0.1	0.8	0.1	0.0	1.1	15.4	16.6	5.4
R14	Badgerys Creek, Lawson Road	0.1	0.1	2.4	0.1	0.1	2.6	15.4	16.7	6.9
R15	Greendale, Mersey Road	0.1	0.1	2.0	0.1	0.1	1.7	15.4	16.7	6.0
R17	Luddenham Road	0.1	<0.1	1.1	0.1	0.0	1.1	15.4	16.6	5.4
R18	Corner Adams and Elizabeth Drive	0.1	0.1	1.5	0.1	0.0	1.3	15.4	16.6	5.6
R19	Corner Adams and Anton Road	0.1	0.1	2.7	0.2	0.1	3.0	15.5	16.7	7.3
R21	Corner Willowdene Avenue and Vicar Park Lane	0.1	0.1	1.7	0.1	0.1	1.4	15.4	16.7	5.7
R22	Rossmore, Victor Avenue	0.1	<0.1	1.2	0.1	0.0	1.3	15.4	16.6	5.6
R23	Wallacia, Greendale Road	0.1	<0.1	1.1	0.1	0.0	1.1	15.4	16.6	5.4
R24	Badgerys Creek 1 NE	0.2	0.2	4.6	0.3	0.2	4.9	15.6	16.8	9.2
R25	Badgerys Creek 2 SW	0.1	0.1	2.1	0.3	0.2	5.0	15.6	16.8	9.3
R27	Greendale,	0.1	<0.1	1.0	0.1	0.0	1.3	15.4	16.6	5.6

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde	Toluene	Xylene	Formald-ehyde
	Dwyer Road									
R30	Rossmore residential	<0.1	<0.1	0.5	0.1	0.1	1.9	15.4	16.7	6.2
R31	Mt Vernon residential	0.1	0.1	1.4	0.1	0.1	1.5	15.4	16.7	5.8

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.

Table 12–34 Predicted incremental and cumulative annual average air toxic concentrations

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		Benzene	Toluene	Xylene	Benzene	Toluene	Xylene	Benzene	Toluene	Xylene
Assessment criteria		*10*	*406*	*935*	*10*	*406*	*935*	*10*	*406*	*935*
R1	Bringelly	0.01	<0.01	<0.01	0.05	0.02	0.01	1.1	3.7	2.4
R2	Luddenham	0.02	0.01	0.01	0.03	0.01	0.01	1.0	3.7	2.4
R3	Greendale, Greendale Road	0.01	<0.01	<0.01	0.02	0.01	<0.01	1.0	3.7	2.4
R4	Kemps Creek	0.01	<0.01	<0.01	0.04	0.02	0.01	1.0	3.7	2.4
R6	Mulgoa	0.01	<0.01	<0.01	0.02	0.01	<0.01	1.0	3.7	2.4
R7	Wallacia	0.01	<0.01	<0.01	0.01	0.01	<0.01	1.0	3.7	2.4
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	0.01	0.01	<0.01	0.04	0.01	0.01	1.0	3.7	2.4
R14	Badgerys Creek, Lawson Road	0.02	0.01	<0.01	0.05	0.02	0.01	1.1	3.7	2.4
R15	Greendale, Mersey Road	0.01	0.01	<0.01	0.03	0.01	0.01	1.0	3.7	2.4
R17	Luddenham Road	0.01	0.01	<0.01	0.04	0.01	0.01	1.0	3.7	2.4
R18	Corner Adams and Elizabeth Drive	0.03	0.01	0.01	0.06	0.02	0.01	1.1	3.7	2.4
R19	Corner Adams and Anton Road	0.04	0.02	0.01	0.07	0.02	0.02	1.1	3.7	2.4
R21	Corner Willowdene Avenue and Vicar Park Lane	0.01	<0.01	<0.01	0.03	0.01	0.01	1.0	3.7	2.4

Receptor	Receptor description	Airport (µg/m³)			Airport + external roads (µg/m³)			Cumulative[a] (µg/m³)		
		Benzene	Toluene	Xylene	Benzene	Toluene	Xylene	Benzene	Toluene	Xylene
R22	Rossmore, Victor Avenue	0.01	<0.01	<0.01	0.03	0.01	0.01	1.0	3.7	2.4
R23	Wallacia, Greendale Road	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	1.0	3.7	2.4
R24	Badgerys Creek 1 NE	0.06	0.02	0.02	0.12	0.05	0.03	1.1	3.7	2.4
R25	Badgerys Creek 2 SW	0.02	0.01	<0.01	0.11	0.04	0.03	1.1	3.7	2.4
R27	Greendale, Dwyer Road	0.01	<0.01	<0.01	0.02	0.01	<0.01	1.0	3.7	2.4
R30	Rossmore residential	<0.01	<0.01	<0.01	0.06	0.02	0.01	1.1	3.7	2.4
R31	Mt Vernon residential	0.01	<0.01	<0.01	0.03	0.01	0.01	1.0	3.7	2.4

[a] The combined total of background air quality, emissions from external roadways and emissions from the proposed airport.

12.6.3 Odour

12.6.3.1 Aircraft exhaust

The modelling results for the 99th percentile one-hour odour emissions from aircraft exhaust are presented in Table 12–35. The modelling shows predicted odour concentrations to be below the threshold detection level of one odour unit at all but one of the residential receptors. At R24, the predicted odour concentration is one odour unit, indicating when a receptor is located in this area, they may detect odour from aircraft exhausts. This is, however, less than the NSW EPA odour performance criterion of two odour units.

The contour plots show that the highest odour concentrations would be largely limited to within the airport site (see Appendix F1 (Volume 4)).

Table 12–35 Predicted 99th percentile odour concentrations from aircraft exhaust

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1

Receptor	Receptor description	One hour 99th percentile
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1
R18	Corner Adams and Elizabeth Drive	1
R19	Corner Adams and Anton Road	1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.3.2 Wastewater treatment plant

The modelling results for the 99th percentile one-hour odour emissions from the onsite wastewater treatment plant are presented in Table 12–36. The modelling shows predicted odour concentrations to be below the relevant air quality criteria of two odours units as well as the threshold of detection at one odour unit at all assessed receptors.

Table 12–36 Predicted 99th percentile odour concentrations from wastewater treatment plant

Receptor	Receptor description	One hour 99th percentile
Assessment criteria		*2*
R1	Bringelly	<1
R2	Luddenham	<1
R3	Greendale, Greendale Road	<1
R4	Kemps Creek	<1
R6	Mulgoa	<1
R7	Wallacia	<1
R8	Twin Creeks, Corner Twin Creeks Drive and Humewood Place	<1
R14	Badgerys Creek, Lawson Road	<1
R15	Greendale, Mersey Road	<1
R17	Luddenham Road	<1

Receptor	Receptor description	One hour 99th percentile
R18	Corner Adams and Elizabeth Drive	<1
R19	Corner Adams and Anton Road	<1
R21	Corner Willowdene Avenue and Vicar Park Lane	<1
R22	Rossmore, Victor Avenue	<1
R23	Wallacia, Greendale Road	<1
R24	Badgerys Creek 1 NE	<1
R25	Badgerys Creek 2 SW	<1
R27	Greendale, Dwyer Road	<1
R30	Rossmore residential	<1
R31	Mt Vernon residential	<1

12.6.4 Emergency fuel jettisoning

Emergency fuel jettisoning refers to an emergency situation where an aircraft must jettison fuel in order to land safely – typically an emergency landing. Emergency fuel jettisoning is not a standard procedure and furthermore most domestic aircraft are incapable of doing it.

It is mandatory for fuel jettisoning events to be reported. In Australian airspace in 2014, there were 10 reported instances of civilian aircraft dumping fuel from 698,856 domestic air traffic movements and 31,345 international air traffic movements. This equates to approximately 0.001 per cent of all air traffic movements.

Notwithstanding the rarity of fuel jettisoning events, the potential impacts on local air quality would be further limited by the rules in place for fuel jettisoning to occur. These rules demand that pilots take reasonable precautions to ensure the safety of people and property and, where possible, conduct a controlled jettison at an altitude of above 6,000 feet.

Given the rarity of fuel jettisoning globally, the known low occurrence in Australian airspace, and the standards in place along with 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 environmental or social impacts.

The operational conditions for emergency fuel jettisoning are discussed further in Chapter 7 (Volume 1).

12.6.5 Regional air quality

International studies have shown that emissions from airport operations are small when viewed in the context of regional emissions inventories (Ratliff et al. 2009). This is supported by data presented in the Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (NSW EPA 2012) which shows that emissions from existing airport operations in Sydney are less than three per cent of total emissions for the Sydney region.

The daily maximum predicted one-hour ozone concentrations are presented in Table 12–37. Results are presented as peak concentrations for the 2030 future base case (no airport), the 2030 airport case (airport emissions plus the 2030 future base case) and the largest difference in daily maximums (the 2030 airport case minus the 2030 future base case). The largest difference represents the maximum change in daily maximum ozone concentration, as a result of the additional emissions from the Stage 1 development.

Table 12–37 Maximum daily predicted one-hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	149.1	149.1	0.4
07/01/2009	129.8	129.8	5.5
14/01/2009	106.6	106.6	1.3
29/01/2009	124.1	124.1	0.3
30/01/2009	107.4	107.4	0.6
31/01/2009	109.4	109.4	0.6
04/02/2009	103.8	103.8	1.2
05/02/2009	119.6	119.6	0.3
06/02/2009	112.5	112.5	0.8
07/02/2009	133.7	133.7	0.3
08/02/2009	148.6	148.6	0.6
20/02/2009	98.3	98.3	1.0

The results of the regional air quality analysis show that for each day of analysis, the peak predicted one-hour ozone concentrations were unchanged between the 2030 future base case and the 2030 airport case. This is because the predicted ozone concentrations from the proposed airport occur in different locations to where ozone peaks occur. Both the 2030 future base case and the 2030 airport case were above the NEPM-AAQ criterion of 100 parts per billion for all but one day of analysis.

To provide context, the predicted peak ozone concentrations presented in Table 12–37 can be compared with measured peak one-hour ozone concentrations at Bringelly. During 2014, there were two days when the maximum daily one-hour ozone concentration at Bringelly was above the NEPM-AAQ standard, with a peak concentration of 124 parts per billion measured in November 2014. It is noted that the modelled peak values are expected to be higher than observed peak values because monitoring networks never achieve full coverage of an airshed. In other words, modelling can predict higher peak ozone for areas not covered by monitoring networks.

The largest difference in daily maximum one-hour ozone concentrations, from the addition of airport emissions, was 5.5 parts per billion. However, the second highest was significantly lower at 1.3 parts per billion. This highlights that reliance on a single model result (for example, focussing on the largest ozone change) could accentuate the influence of uncertainties in the model's input data or model formulation. Therefore, the average of the 2nd to 4th highest ozone change (1.2 parts per billion) is used to describe ozone impacts. This approach is similar to the use of a 99th percentile to describe maximum ozone impacts. When compared to the maximum allowable increment level of one part per billion, prescribed by the NSW EPA tiered procedure for ozone assessment, a marginal impact is predicted from the 2030 airport case.

The peak predicted four-hour ozone concentration were unchanged between the 2030 airport case and the 2030 future base case on eight days and increased on four days, by a maximum of 0.1 parts per billion as shown in Table 12–38.

Table 12–38 Maximum daily predicted four-hour ozone concentration (parts per billion)

Date	2030 future base case peak value	2030 airport case peak value	2030 airport case – 2030 future base case largest difference
06/01/2009	126.2	126.3	0.3
07/01/2009	115.3	115.4	2.4
14/01/2009	98.7	98.8	0.7
29/01/2009	95.9	95.9	0.5
30/01/2009	78.2	78.2	0.6
31/01/2009	99.9	99.9	0.5
04/02/2009	97.3	97.3	0.7
05/02/2009	108.7	108.7	0.4
06/02/2009	92.4	92.4	0.4
07/02/2009	121.0	121.0	0.7
08/02/2009	129.9	129.9	0.6
20/02/2009	83.9	84.0	1.3

The highest change in daily maximum four-hour ozone concentration, from the addition of airport emissions, was 2.4 parts per billion, while the second highest was 1.3 parts per billion. The average of the 2nd to 4th highest change in daily maximum four-hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one part per billion.

Increases in ozone are predicted to occur downwind of the airport site, usually to the south given prevailing winds. Spatial variation of ozone increases and decreases is presented in the spatial plots included in Appendix F2 (Volume 4).

A spatial analysis of ozone concentrations with and without the proposed airport shows some decreases in the vicinity of the proposed airport. Such decreases are attributable to ozone suppression by nitrogen oxides emissions.

The use of historical dates may appear counterintuitive for the modelling of future emissions. However, these dates represent the meteorological conditions that have historically led to peak ozone formation and therefore form a suitable basis for assessment of future scenarios.

12.7 Greenhouse gas assessment

This section presents the results of the greenhouse gas assessment which quantifies the greenhouse gas emissions in tonnes of carbon dioxide equivalent (CO_2-e) for construction and operation of the Stage 1 development.

Climate change generally refers to a rise in global temperatures attributable to greenhouse gas emissions from human activity. Climate change is also associated with other alterations in weather patterns including increased occurrence and intensity of severe weather events such as storms, floods, bushfires and droughts. The increase in global temperatures is also predicted to result in warming ocean temperatures and sea level rise. These effects have an impact on both humans and the environment.

According to the National Greenhouse Gas Inventory, Australia's civil aviation contributed a total of 17.7 million tonnes of CO_2-e in 2011, of which 60 per cent was attributed to international aircraft and the remainder to domestic aircraft. This contribution equals approximately 3.1 per cent of Australia's total emissions in that year (DIRD 2014).

12.7.1 Construction emission estimates

Greenhouse gas emissions generated during construction of the Stage 1 development are presented in Table 12–39. The two main sources of greenhouse gas emissions would be the operation of construction equipment and vegetation clearing. A conservative approach was applied when calculating the emissions. For example, it was assumed that the equipment used during construction of the aviation infrastructure would use as much fuel as the equipment used during the bulk earthworks. It was also assumed that construction equipment would be used for six working days a week. Public holidays and bad weather were also factored into the calculations. In addition, it was assumed that 50 per cent of the vegetation cleared was carbon and that 3.67 tonnes of CO_2-e is generated per tonne of carbon cleared (AGO 1999, 2000, 2002 and 2003).

Table 12–39 Summary of greenhouse gas emissions during construction

Scope	Source	Fuel type	Quantity	Emissions (t CO_2-e)
1	Equipment	Transport diesel oil	162 ML	286,111
1	Vegetation clearing	N/A	73.5 kt	134,873
				420,983

12.7.2 Operations emission estimates

Greenhouse gas emissions forecast to be generated during operation of the proposed Stage 1 development are presented in Table 12–40. As shown in Table 12–40, electricity consumption would account for the vast majority of greenhouse gas emissions (approximately 83 per cent). Electricity is a Scope 2 emission. Scope 1 emissions would account for the remaining 17 per cent of greenhouse gas emissions from the airport site. Greenhouse gas emissions from auxiliary power units would be the biggest contributor to Scope 1 emissions.

Table 12–40 Summary of estimated annual Scope 1 and 2 greenhouse gas emissions

Scope	Source	Fuel type	Annual quantity	Units	Annual emissions (t CO_2-e)
1	Ground support equipment	Transport diesel oil	0.85	ML	2,292
		Transport gasoline	2	ML	4,776
1	Auxiliary power unit	Stationary gasoline (jet fuel)	5	ML	10,975
1	Boilers	Stationary natural gas	1,489,809	m^3	3,005
1	Generators	Stationary diesel oil	0.04	ML	113
1	Fire training	Stationary Kerosene (jet fuel)	0.01	ML	14
1	Wastewater treatment plant	N/A	1,935	ML	1,204
1	Fugitive emissions	Transport gasoline (jet fuel)	985	ML	104
1	Fugitive emissions	Transport diesel oil	0.85	ML	0.1
1	Fugitive emissions	Transport gasoline	2	ML	0.2
2	Electricity	N/A	124,392,000	kWh	106,977
				TOTAL	129,462

Fuel Type reflects the categories in DoE (2014b)

Assumptions made within the greenhouse gas calculations are provided within Appendix F1 (Volume 4).

As an emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

As mentioned in Section 12.2.2, it is not commonplace to report Scope 3 emissions due to the potential of double counting greenhouse gas emissions. Nevertheless, as they are considered significant for the proposed airport, the most probable primary contributor (combustion of aircraft fuel) has been quantified in Table 12–41. As shown, the combustion of aircraft fuel would generate about 2.5 Mt CO_2-e per annum. It must be noted that this assessment accounts for the greenhouse gas emissions being emitted during the entire flight of departing planes only. This method assumes the arriving planes' emissions are accounted for by the airport from which the planes departed. This method is common overseas and has been recommended by the Airport Cooperative Research Program (ACRP) (ACRP 2009).

Table 12–41 Summary of estimated annual Scope 3 greenhouse gas emissions

Scope	Source	Fuel type	Quantity	Emissions (t CO_2-e)
3	In flight aviation fuel	Transport gasoline (jet fuel)	986	2,524,504

Note: An emissions factor was not available for jet fuel, emissions have been assumed to be the same as Avgas.

Table 12–42 compares the Stage 1 development's estimated greenhouse gas emissions to NSW's total anthropogenic emissions in 2011–12. It shows that the annual Scope 1 and Scope 2 emissions from the Stage 1 development would be around 0.13 Mt CO_2-e, representing less than 0.1 per cent of NSW's total emissions for 2011–12.

Table 12–42 Comparison of greenhouse gas emissions

Location	Source coverage	Reference year	Emissions Mt CO_2-e
Stage 1 development	Scope 1 and 2	2030	0.13
NSW	Total	2011-12	154.7

Source: DoE (2014) and CER (2015).

Table 12–43 summarises Australia's current and forecast sectoral breakdown of greenhouse gas emissions for the 2013–14 financial year and 2029-30 financial year respectively.

As aviation is considered a part of 'transport' it can be concluded that the Stage 1 development would account for approximately 0.11 per cent of the total 'transport' greenhouse gas emissions throughout Australia around the time of operation.

Table 12–43 Australian sectoral breakdown of 2014–15 projection results to 2029–30

Sector	2013-14 Mt CO_2-e	2029-30 Mt CO_2-e
Electricity	180	224
Direct combustion	93	129
Transport	92	115
Fugitives	41	68
Industrial processes	32	39
Agriculture	82	92
Waste	13	16
Land use, land use change and forestry	14	41
Total	548	724

Source: DoE (2015)

12.8 Mitigation and management measures

Mitigation and management measures proposed to minimise the construction related impacts on local and regional air quality for the Stage 1 development are listed in Table 12–44. Measures, sub-plans and procedures to reduce greenhouse gas emissions during the operation of the proposed airport are also listed in Table 12–44. These measures would be incorporated in the Air Quality Construction Environmental Management Plan (CEMP) to be approved prior to commencement of Main Construction Works and the Operational Environmental Management Plan (OEMP), to be approved prior to commencement of operations, which are discussed further in Chapter 28 (Volume 2b).

These measures stated in Table 12–44 will build upon existing air quality management obligations, including monitoring, reporting and auditing requirements, for airports under the AEPR.

Table 12–44 Mitigation and management measures (air quality and greenhouse gases)

Issue	Mitigation/management measure	Timing
Dust management Plan	As part of the Air Quality CEMP, a dust management plan will be developed to mitigate the impacts of dust during construction. The plan will involve: • avoiding site runoff of water or mud to reduce the potential for track-out dust emissions; • only using cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays; • ensuring adequate water will be made available on the site for effective dust and particulate matter suppression and mitigation, using non-potable water where possible; • using enclosed chutes and conveyors and covered skips; • minimising drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment, and using fine water sprays on such equipment wherever appropriate; • making equipment readily available on-site to clean up spillages as soon as reasonably practicable after the event; • measures to reduce dust impacts from earthworks and other works as outlined elsewhere in this table; and • measures to reduce dust track out as outlined elsewhere in this table.	Pre-construction Construction
Dust impacts from bulk earthworks	Measures to address impacts from bulk earthworks will include: • minimise exposed areas as far as is practical; • re-vegetate earthworks and exposed areas or soil stockpiles to stabilise surfaces as soon as practicable; and • use of hessian, mulches or tackifiers to cover exposed areas as soon as possible after completion of earthworks where it is not possible to re-vegetate or cover with topsoil.	Construction
Dust impacts from other Main Construction Works	Measures to mitigate dust impacts associated with other Main Construction Works include: • avoiding scrabbling (roughening of concrete surfaces) where practicable; • storing sand and other aggregates in bunded areas and not allowing them to dry out unless required for particular processes. If they are required for particular purposes, appropriate additional control measures would need to be in place; • delivering bulk cement and other fine powder materials in enclosed tankers and storing them in silos with suitable emission control systems to prevent escape of material and overfilling during delivery; and • sealing and appropriately storing bags of any fine powder materials to prevent dust generation.	Construction

Issue	Mitigation/management measure	Timing
Dust track out	Mitigating the impacts associated with track out dust will involve: • using water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper to be continuously in use; • avoiding dry sweeping of large areas; • sealing high use haul roads and regularly inspecting and making necessary repairs to the surface as soon as reasonably practicable; • recording all inspections of haul routes and any subsequent action in a site log book; • regularly cleaning and damping down hard surfaced haul routes with fixed or mobile sprinkler systems or mobile water bowsers; • implementing a wheel washing system (with rumble grids to dislodge accumulated dust and mud) prior to leaving the site; • providing an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits; and • locating site access points as far as practicable from sensitive receptors.	Construction
Vehicle and equipment emissions	A vehicle and equipment emissions plan will be developed and implemented as part of the Air Quality CEMP to mitigate the impacts associated with vehicle and equipment emissions. The plan will involve: • requiring vehicle operators to switch off engines when not in use; • avoiding the use of diesel or petrol powered generators and instead using mains electricity or battery powered equipment, where practicable; • considering appropriate vehicle speeds on sealed and unsealed roads; • developing and implementing a construction logistics plan to manage the sustainable delivery of goods and materials to the airport site; and • implementing measures to support and encourage sustainable travel for construction workers to and from the airport site, including public transport, shuttle busses, cycling, walking, and car-sharing (as also outlined in the Traffic and Access CEMP).	Construction
Dust monitoring	Additional monitoring requirements include that: • suitable locations for dust deposition, dust flux, or real-time PM_{10} continuous monitoring will be determined in consultation with the NSW Environment Protection Authority; • baseline monitoring will commence at least three months before Main Construction Works commence; • regular site inspections will be undertaken to monitor compliance with the dust management plan. Inspection results will be recorded and the inspection log made available to the Department of Infrastructure and Regional Development upon request; and • more frequent site inspections by the person accountable for air quality and dust issues will be conducted onsite when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Pre-construction / Construction

Issue	Mitigation/management measure	Timing
Air quality OEMP	The Air Quality OEMP will include the following measures to reduce air emissions and the potential for ground level ozone formation: • using ground support equipment powered by electric, hydrogen, compressed natural gas or compressed air, including belt loaders, pushback tractors, bag tugs, and cargo loaders, where appropriate; • providing remote ground power facilities for remote aircraft parking positions, where practicable; • installing co-generation or tri-generation in-lieu of traditional gas fired boilers or solar hot water systems to replace gas fired boilers; • where possible, avoiding certain activities, such as training fires, and maintenance (spray painting) during the ozone seasons; • using underground fuel hydrant systems and/or vapour recovery systems for refuelling and fuel storage; and • promoting the use of public transport to the airport for workers, passengers and other airport users.	Operation
Greenhouse gases – Scope 1 and Scope 2 emissions	The following measures will be implemented to minimise Scope 1 and Scope 2 greenhouse gas emissions: • using ground support equipment powered by electric, hydrogen, compressed natural gas or compressed air, including belt loaders, pushback tractors, bag tugs, and cargo loaders, where appropriate; • training ground support equipment drivers in techniques to conserve fuel and implementing a no-idling policy; • considering in the detailed design process ways to minimise greenhouse gas emissions through the design of the runway, taxiways, gates and terminals to minimise aircraft and ground support equipment travel distances without limiting long term aeronautical capacity at the airport; • promoting aircraft management procedures that achieve reduced fuel use as far as practicable; • using fixed electrical ground power and preconditioned air supply to aircraft and avoiding the use of auxiliary power units by stationary aircraft where possible; • using high efficiency power, heating and cooling plants on the airport site; and • making use of renewable energy sources where practicable for the generation, use or purchase of electricity, heating and cooling.	Operation
Greenhouse gases – Scope 3 emissions	The following measures will be implemented to minimise Scope 3 greenhouse gas emissions: • promoting the use of public transport to the airport for workers, passengers and other airport users; • developing the waste and resource OEMP in accordance with Table 28-28 (Volume 2b), to implement waste saving initiatives such as composting and recycling; and • installing tenant energy sub-metering systems.	Operation
Air quality monitoring	The ALC is required to monitor air pollution under the AEPR. An air quality monitoring station will be installed at the airport site to monitor NO_X, NO, NO_2, CO, O_3, PM_{10}, $PM_{2.5}$ and VOCs and record ambient air quality data prior to operations commencing to establish baseline air quality conditions.	Pre-operation / Operation

12.9 Conclusion

Construction of the proposed Stage 1 development would generate dust emissions during both the bulk earthworks and the construction of aviation infrastructure. The asphalt batching plant would also generate some odour during construction. The results of the air dispersion modelling show that the dust impacts during construction are expected to be below the air quality assessment criteria at all sensitive residential receptors. Odour from the asphalt plant would also be below the relevant criteria at all sensitive residential receptors and largely contained within the airport site. Some odour may be detected outside of the airport boundary to the north, however, this area is currently unoccupied and, as such, it is not expected to impact on sensitive receptors.

Operation of the proposed Stage 1 development would result in an increase in emissions of nitrogen dioxide, particulate matter, carbon monoxide, sulfur dioxide and air toxics. There would also be odour emissions from exhaust and from the onsite wastewater treatment plant. The highest offsite concentrations of the air quality metrics evaluated were generally predicted to occur at the receptors located to the north and north-east of the proposed airport. This is anticipated to be a function of the prevalence of south-westerly winds and the proximity of these receptors to activities at the proposed airport.

Background traffic, associated with the broader urban development of Western Sydney, on surrounding road infrastructure was found to be a significant contributor to predicted offsite ground level concentrations, particularly for those receptors located close to proposed roadways.

The dispersion modelling found that there were almost no predicted exceedances of the air quality assessment criteria at any of the sensitive residential receptors investigated as part of the assessment of the Stage 1 development. Predicted $PM_{2.5}$ would exceed a future NEPM-AAQ objective for 2025 at a number of sensitive receptors, however this is primarily attributable to background concentrations. The modelling also predicted an exceedance of the 99.9th percentile one-hour maximum for formaldehyde shown at one receptor on the airport site. Predicted offsite odour concentrations were below odour detection limits for both aircraft exhaust emissions and odours from the onsite wastewater treatment plant.

The maximum predicted one-hour ozone concentration remained unchanged following the implementation of the airport and four-hour ozone concentrations increased by a maximum of 0.1 parts per billion. Both predicted base case and the Stage 1 development were generally above the NEPM criteria. The average change in daily maximum four-hour ozone was 0.9 parts per billion, which is below the maximum allowable increment of one part per billion.

Scope 1 and Scope 2 greenhouse gas emissions from the Stage 1 development have been estimated to comprise 0.13 Mt CO_2-e/annum, with the majority of emissions associated with purchased electricity. The Scope 1 and Scope 2 greenhouse gas emissions estimated for the proposed Stage 1 development represent approximately 0.11 per cent of Australia’s projected transport-related greenhouse gas emission inventory in the 2029-2030 financial year. While not typically included in greenhouse gas inventories due to potential for double counting, Scope 3 emissions from burning of fuel in aircraft using the proposed airport were also quantified at around 2.5 Mt CO_2-e/annum.

Mitigation and management measures would be implemented to reduce potential air quality impacts during both construction and operation of the proposed Stage 1 development. In particular, a dust management plan would be developed and implemented to address potential impacts from dust generated during construction. Air quality monitoring would also be undertaken at the airport site during operations. These measures will build upon existing air quality management obligations, including monitoring, reporting and auditing requirements, for airports under the AEPR.

13 Human health

The health risk assessment has considered the risks associated with construction and operation of the Stage 1 development on the health of the community. The assessment focuses on the chronic health risks associated with changes to air quality, noise, and surface and groundwater through a comparison with existing conditions. These issues were identified as the most likely pathways of potential impact to community health from the Stage 1 development. Other perceived and non-chronic health effects, such as anxiety associated with the airport, are considered as part of the social impact assessment in Chapter 23.

The air quality health risk assessment evaluated the predicted health risks associated with the emission of particulate matter, nitrogen dioxide, sulfur dioxide, air toxics (benzene, toluene, xylenes and formaldehydes), diesel, and ozone. The noise health risk assessment considered both aircraft overflight and ground-based operations sources. The water quality health risk assessment considered water contaminants to surface water and groundwater including petroleum hydrocarbons, heavy metals, polyaromatic hydrocarbons, chlorinated hydrocarbons and perflourinated compounds. In all cases, the relevant EIS technical studies were drawn upon to provide the exposure and impact level data used in the risk assessment. Criteria used for the health risk assessment included the National Environmental Protection Measure (NEPM), as well as national and international guideslines from the National Health and Medical Research Council, NSW Health and the World Health Organization (WHO).

During construction, health risks are generally predicted to be low and within acceptable limits. Emission of particulates would be less than the NEPM criteria for both PM_{10} and $PM_{2.5}$. Construction noise levels would be confined mostly to the airport site and risks to local water quality are typical of most major construction projects. Standard precautionary measures are considered to be appropriate to address these issues. Due to the relatively short period over which construction will take place, it is unlikely that any of the potential health risks will be realised.

The air quality health risk assessment identified that the predicted health risks from the Stage 1 operations would generally be within or at the upper bound of national and international standards of acceptability, with the exception of NO_2. As noted in the air quality assessment in Chapter 12, a significantly large contributor to air quality impacts, and therefore health risks, are background emissions from urban development and road vehicles external to the airport site. Overall, air quality impacts are predicted to increase the risk of mortality, hospital admissions and emergency department attendances. However, these risks are very small when compared to health impacts from existing air pollution in Sydney.

Overall, the risk posed by noise to the health of exposed communities is generally low and within acceptable limits. The results of the noise health risk assessment indicate that noise from aircraft overflight and ground-based operations may lead to a small increase in sleep disturbance for communities around the airport site. The noise health risk assessment also found that there is no predicted risk for increases in cardiovascular disease and the risk to learning and cognitive development in children is largely within acceptable limits. During Stage 1 operations, Luddenham is predicted to experience the highest risks associated with noise due to its proximity to the airport site.

The water quality health risk assessment found that potential impacts to Sydney's drinking water supplies, in reservoirs at Warragamba and Prospect, is unlikely due to their distance from the airport site and low predicted levels of particulates at these locations. Similarly, the health risk assessment did not find evidence to suggest that private rainwater tanks would be adversely affected by airport operations. Comprehensive surface and groundwater baseline data will be collected throughout construction and operation of the Stage 1 development to better inform the future assessment of potential water contamination.

Having regard to the identified risks outlined above, and that for some pollutants there is no defined 'safe' level below which exposure will not result in adverse health effects, the health risk assessment includes reference to mitigation and management measures in other chapters in the EIS which will reduce the health risks of the proposed airport. It is expected that following implementation of these measures, the identified health risks of the Stage 1 development will be reduced.

It is acknowledged that just over half of the representative communities analysed in the health risk assessment had a SEIFA index (socio-economic index for areas) less than the Sydney average. This indicates that populations in these localities may be vulnerable to the effects of air, noise and water pollution from the proposed airport.

13.1 Introduction

This chapter considers the risks associated with the construction and operation of the Stage 1 development on the health of the community. It draws on the specialist health risk assessment (see Appendix G (Volume 4)) undertaken during the preparation of the EIS which considered the risks associated with noise, air and surface/ground water emissions from the proposed airport.

The health risk assessment considers the baseline health profile of the region and identifies key health risks from the construction and operation of the Stage 1 development. The implementation of mitigation measures associated with noise, air quality and water quality described in the relevant chapters of this EIS would reduce the predicted risks.

13.2 Methodology

The health risk assessment was undertaken in accordance with the Australian Government Guidelines for Health Risk Assessment (enHealth 2012), the National Health and Medical Research Council Approach to Hazard Assessment for Air Quality (NHMRC 2006), WHO Guidelines for Community Noise (WHO 2000), the WHO Night Noise Guidelines for Europe (WHO 2009) and the WHO Guidelines for Drinking Water Quality (2011).

The health risk assessment uses information about pollutants to estimate a theoretical level of risk for people who might be exposed to defined pollutant levels. Health statistics for Sydney have been used as a baseline in the assessment, with information on the health risks of pollutants being drawn from scientific studies. Data on existing pollutant levels come from ambient monitoring stations in Western Sydney operated by the NSW Office of Environment and Heritage and the NSW Environment Protection Authority.

The risk assessment process comprises five stages: issue identification, hazard (or toxicity) assessment, exposure assessment, risk characterisation and uncertainty assessment. Through the issues identification stage, it was determined that the primary pathways by which the proposed airport could pose a risk to human health were exposure to air pollutants, noise, and surface water pollutants and groundwater pollutants.

The health risk assessment is based upon the findings of the local air quality, regional air quality, aircraft overflight noise, ground-based noise and water quality technical studies undertaken as part of the preparation of the EIS. The potential health effects of airport operations have been considered in the assessment, as well as the health impacts associated with emissions from background sources associated with road traffic and urbanisation in the broader region. The potential health risk from construction activities has also been assessed.

The results of the risk assessment are typically presented in terms of the number of ‘attributable cases’ relevant to each aspect considered. For example, health risk assessments for pollutants draw on population studies typically undertaken across an entire society or a specified section of society. Accordingly, references to the number of hospital admissions for respiratory disease are intended to identify a change in the number of hospital admissions across a specified population resulting from exposure to the pollutant compared to the baseline level.

13.2.1 Air quality

13.2.1.1 Pollutants

The health effects resulting from exposure to particulate matter of 10 micrometres or less (PM_{10}), particulate matter of 2.5 micrometres or less ($PM_{2.5}$), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO) have been assessed in this health risk assessment. These pollutants have been considered for the potential for any increases in mortality, hospital admissions for respiratory and cardiovascular disease, and emergency department visits for asthma in children, that may be attributable to emissions from the proposed airport.

Baseline health statistics for Sydney have been used in the assessment and the risk has been assessed for localities within five kilometres of the airport boundary. The localities include Bringelly, Luddenham, Greendale, Kemps Creek, Mulgoa, Wallacia, Badgerys Creek, Rossmore and Mount Vernon.

13.2.1.2 Ozone

The regional air quality assessment follows the NSW EPA guidelines and identifies peak ozone periods with potential exceedances of air quality standards. The assessment has considered the potential risk that ozone may have on mortality and emergency department visits for asthma in children that may be attributable to emissions from the proposed airport.

The assessment is based on a small sample of days when exceedances of the standards are predicted and when there is a good correlation between the model outputs and existing monitoring data obtained from NSW EPA monitoring stations. Given there is only a limited ozone prediction dataset available, a full risk characterisation is not possible. The approach adopted focuses on the potential increase in risk due to changes in ozone only on the days where exceedances are predicted. However, this is considered to be a reasonable approach because the likelihood of health impacts arising in circumstances where there are no or very few relevant exceedances of ozone is very small.

13.2.1.3 Air toxics

A number of air toxics will be emitted during airport operations. Air dispersion modelling has been conducted for benzene, toluene, xylenes and formaldehyde. The most significant potential health risk is cancer from exposure to benzene. The predicted data for benzene has been used in the health risk assessment for Stage 1 operations.

To enable the potential increased risk of cancer arising from the airport operations to be evaluated, annual average concentrations of benzene have been modelled. The maximum concentration predicted at any location was 0.1 $\mu g/m^3$. This value has been used to calculate the maximum cancer risk from benzene in the surrounding area.

13.2.1.4 Diesel

Diesel emissions associated with the proposed airport would arise from machinery used during construction activities as well as truck movements to, from and on the site. Diesel emissions would also be generated through the use of diesel powered equipment onsite during operations.

In recent years there has been increased community concern about the health effects of diesel. Exposure to diesel exhaust can have immediate health effects. Diesel exhaust can irritate the eyes, nose, throat and lungs, and it can cause coughs, headaches, light headedness and nausea. In studies with human volunteers, exposure to diesel exhaust particles at certain intensities made people with allergies more susceptible to the materials to which they are allergic, such as dust and pollen. Exposure to diesel exhaust at certain intensities also causes inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks. Diesel exhaust and many individual substances contained in it (including arsenic, benzene, formaldehyde and nickel) have the potential to contribute to mutations in cells that can lead to cancer.

13.2.2 Noise

Health risks associated with aircraft overflight noise and airport ground-based noise were predicted for three health outcomes:

- sleep disturbance (measured as awakenings);
- myocardial infarction (heart attacks); and
- impacts on learning and cognitive development in children.

Other impacts associated with noise, such as annoyance and impacts on lifestyle and social amenity are assessed in the social impact assessment (see Chapter 23).

The health risk assessment includes consideration of noise exposure from aircraft overflights as well as airport ground-based sources. Residential areas and schools were identified as sensitive noise receivers in the EIS (see Appendix E (Volume 4)) and are listed in Table 13–1 and shown in Figure 13–1. Although the schools have been identified primarily for assessment of the potential impacts on children’s learning and cognitive development, they are also located in residential areas. Accordingly, the noise levels predicted at these locations would be representative of the exposure to noise for the local community, and have also been used in the assessment of sleep disturbance.

Table 13–1 Representative sensitive noise receivers

Residential areas	
Bringelly	Greendale
Kemps Creek	Silverdale
Erskine Park	Horsley Park
Rossmore	Rooty Hill
St Marys	Prospect
Schools	
Warragamba Preschool	Bringelly Public School
Emmaus Catholic College (Kemps Creek)	Mount Druitt Public School
Horsley Park Public School	St Marys South Public School
Luddenham Public School	Colyton High School
Bennett Road Public School (Colyton)	Banks Public School (St Clair)
St Clair High School	Plumpton High School
Blackwell Public School (St Clair)	

Following the enHealth Health Effects of Environmental Noise other than Hearing Loss (2004) WHO guidelines (2009; 1999), the assessment of the potential impacts of aircraft noise considers the following noise metrics:

- L_{Aeq}: a measure of noise which represents the equivalent-continuous noise level averaged over a specified period;
- $L_{Aeq,11pm\text{-}7am}$ or $L_{night,outside}$: the equivalent-continuous noise level between 11.00 pm and 7:00 am. This metric is used to describe night time noise exposure and assess chronic health impacts associated with noise exposure;
- $L_{Aeq,9am\text{-}3pm}$: the equivalent-continuous noise level between 9.00 am and 3.00 pm. This metric is used to assess the impact of noise on school students and teachers; and
- L_{Amax}: a measure of the maximum noise level during a specified period. This metric is used to assess night time noise impacts from aircraft overflights.

The WHO Night Noise Guidelines for Europe (2009), summarised in Table 13–2, identify the relationship between different night noise levels and health effects. These guidelines were used to inform the assessment of health risks.

Table 13–2 WHO Guidelines (2009) – Effects of different levels of night noise on population health

Average night noise level over a year L_{night} outside	Health effects observed in the population
Up to 30 dB	Although individual sensitivities and circumstances may differ, up to this level no substantial biological effects are observed. A level of 30 dB L_{night} outside is equivalent to the no observed effects level (NOEL) for night noise.
30 to 40 dB	A number of effects on sleep are observed in this range such as body movements, awakening, self-reported sleep disturbance and arousals. The intensity of the effects depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst case, the effects are modest. A level of 40 dB L_{night} outside is equivalent to the lowest observed adverse effects level (LOAEL) for night noise.
40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable portion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

As outlined in Table 13–2, below the level of 30 dB $L_{night,outside}$, no effects on sleep are observed except for a slight increase in the frequency of body movements during sleep due to night noise. There is insufficient evidence that the biological effects observed below 40 dB $L_{night,outside}$ are harmful to health (WHO, 2009). The WHO recommends that for the prevention of subclinical adverse health effects associated with night noise, the population should not be exposed to night noise levels greater than 40 dB $L_{night,outside}$. An interim target of 55 dB was recommended by the WHO in situations where the night noise guideline was not feasible in the short term.

Two approaches have been taken to assess sleep disturbance. The first is to estimate the number of electroencephalography (EEG) awakenings that may be associated with noise and the second is to assess full awakenings. An EEG awakening is not a fully awakened state but is a measure of disturbed sleep. The dose-response curves shown in the European Environment Agency (EEA) Good Practice Guide on Noise Exposure and Potential Health Effects (EEA, 2010) have been used to estimate the number of EEG awakenings due to both aircraft and ground operational sources.

In relation to noise impacts on learning and cognitive development in children, the hazard quotient approach has been used to assess the potential impacts. This involves dividing the predicted levels for daytime noise by the noise guidelines levels to generate a hazard quotient. The relevant noise guidelines used are based on the WHO Guidelines for Community Noise (WHO 2000), summarised in Table 13–3, which establishes a noise guideline of 55 dB for outside noise and 35 dB for inside noise in school environments.

Table 13–3 WHO Guidelines (2000) – Community noise guidelines for school environments

School Environment	Critical Health Effects	L_{Aeq} (dBA)	Time base (hours)
School class rooms and preschools indoors	Speech intelligibility, disturbance of information extraction, message communication	35	During class
School playground, outdoors	Annoyance (external source)	55	During play

If the hazard quotient is less than 1, then no adverse health effects are expected as a result of exposure to the hazard. If the hazard quotient is greater than 1, then adverse health effects are possible. It should be noted that a hazard quotient exceeding 1 does not necessarily mean that adverse effects will occur.

Using the findings from the noise impact assessments, the health risk assessment used these metrics and guidelines to identify the potential for annoyance, sleep disturbance, increased likelihood of cardiovascular disease, and impacts on children's learning and cognitive development. Predicted noise levels were calculated at an external point of the building. Noise levels within a building would be significantly lower, depending on the building fabric and whether windows and doors are opened. To assess inside noise impacts on learning and cognitive development in children, the predicted outside noise levels were reduced by 10 dB, consistent with the aircraft overflight noise report (see Appendix E1 (Volume 4)).

Further information about the methodology used in the health risk assessment can be found in Appendix G (Volume 4). The predicted noise levels were calculated at specific locations (see Figure 13–1), using assumptions and procedures that are described in detail in the noise assessment reports in Appendix E (Volume 4).

13.2.3 Ground and surface water

Groundwater data from samples collected in 1995 and 1998 were compared to groundwater investigation levels from relevant guideline sources. A qualitative evaluation of the risk potential to identified waterbodies under current conditions at the site and in surrounding areas has been conducted.

The ANZECC (2000) guidelines set out key indicators which can be used to measure whether there is a potential risk to each environmental value. Indicators have been selected based on the appropriate level of protection for the waterways at and surrounding the site. These indicators provide a risk-based approach to assessing the potential for impacts to environmental values.

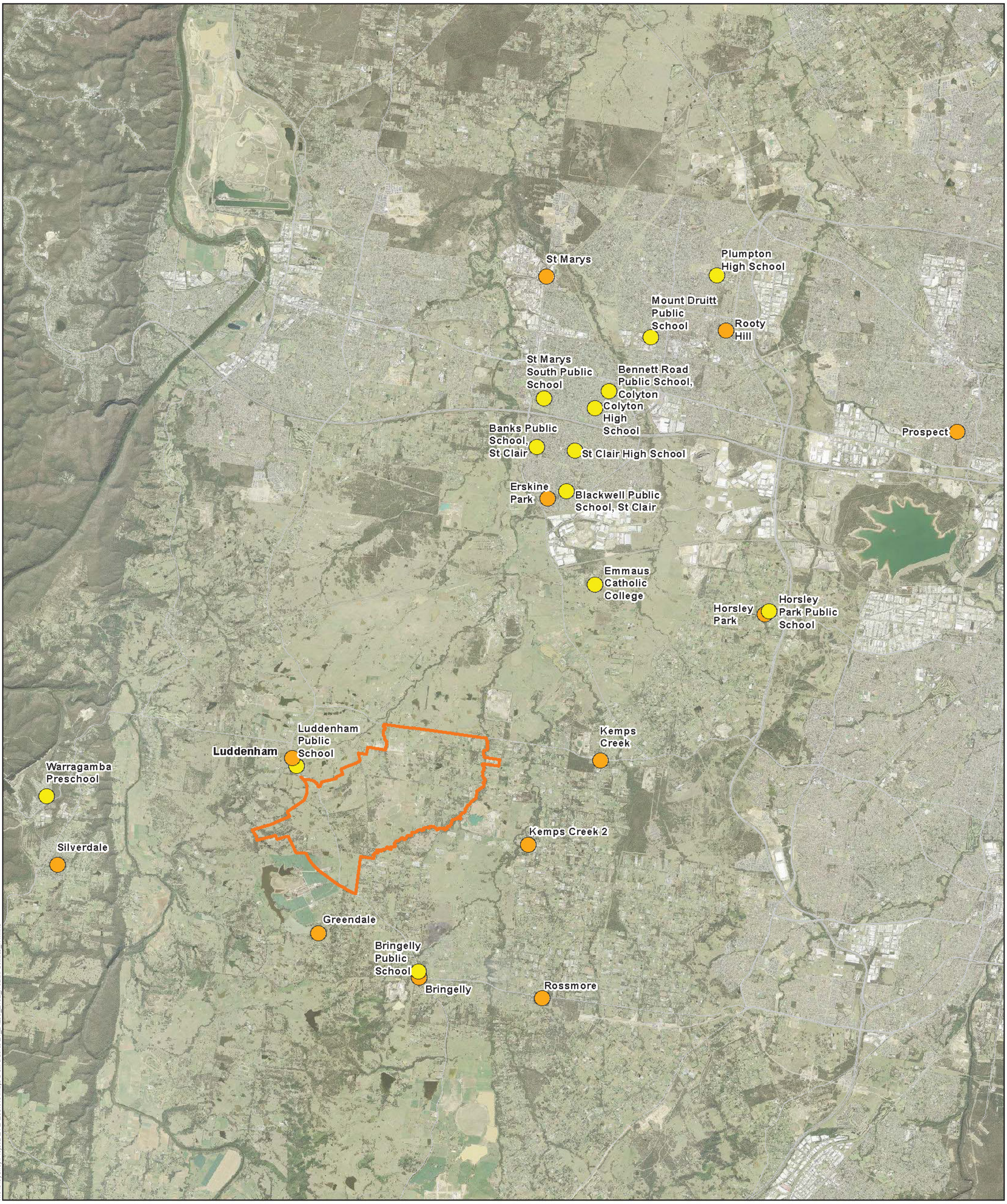
13.3 Existing environment

13.3.1 Airport site

The airport site covers an area of approximately 1,780 hectares located at Badgerys Creek in Western Sydney. The site is located approximately 50 kilometres west of Sydney's central business district and 15 to 20 kilometres from major population centres such as Liverpool, Fairfield, Campbelltown and Penrith.

The Northern Road transects the western end of the airport site and Elizabeth Drive borders the site to the north. Badgerys Creek flows in a north-easterly direction and forms the south-eastern boundary of the airport site. The airport site is located on undulating topography that has been extensively cleared with the exception of stands of remnant vegetation located predominantly along Badgerys Creek and the south-western portion of the site.

Figure 13–1 shows the sensitive receivers selected for the purposes of the health risk assessment.



LEGEND

Airport site

Roads

Education

Residential

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

0 1 2 4
Kilometres

Figure 13-1 - Locations of representative sensitive receptors

13.3.2 Demography

The airport site is located within the Liverpool local government area (LGA). The Liverpool LGA is bounded by Fairfield, Penrith, Camden, Wollondilly and Canterbury-Bankstown LGAs (see Figure 13–2).

Population statistics for the 2011 Census have been obtained from the Australian Bureau of Statistics for each of the localities surrounding the airport which have been considered in the health risk assessment. These statistics are shown in Table 13–2, with the localities sorted in order of increasing population size. It is noted that the stated population of Badgerys Creek would have included tenants on the airport site, however as the majority of these tenants have relocated, the current population would be much lower.

The South West Sydney Local Health District forecasts in its Liverpool Community Health Profile (2014) that the population of Liverpool LGA will increase significantly from 188,088 people in 2011 to 288,959 in 2031. The highest rate of growth is anticipated in the age cohort 45-69.

13.3.3 Socio-economic status

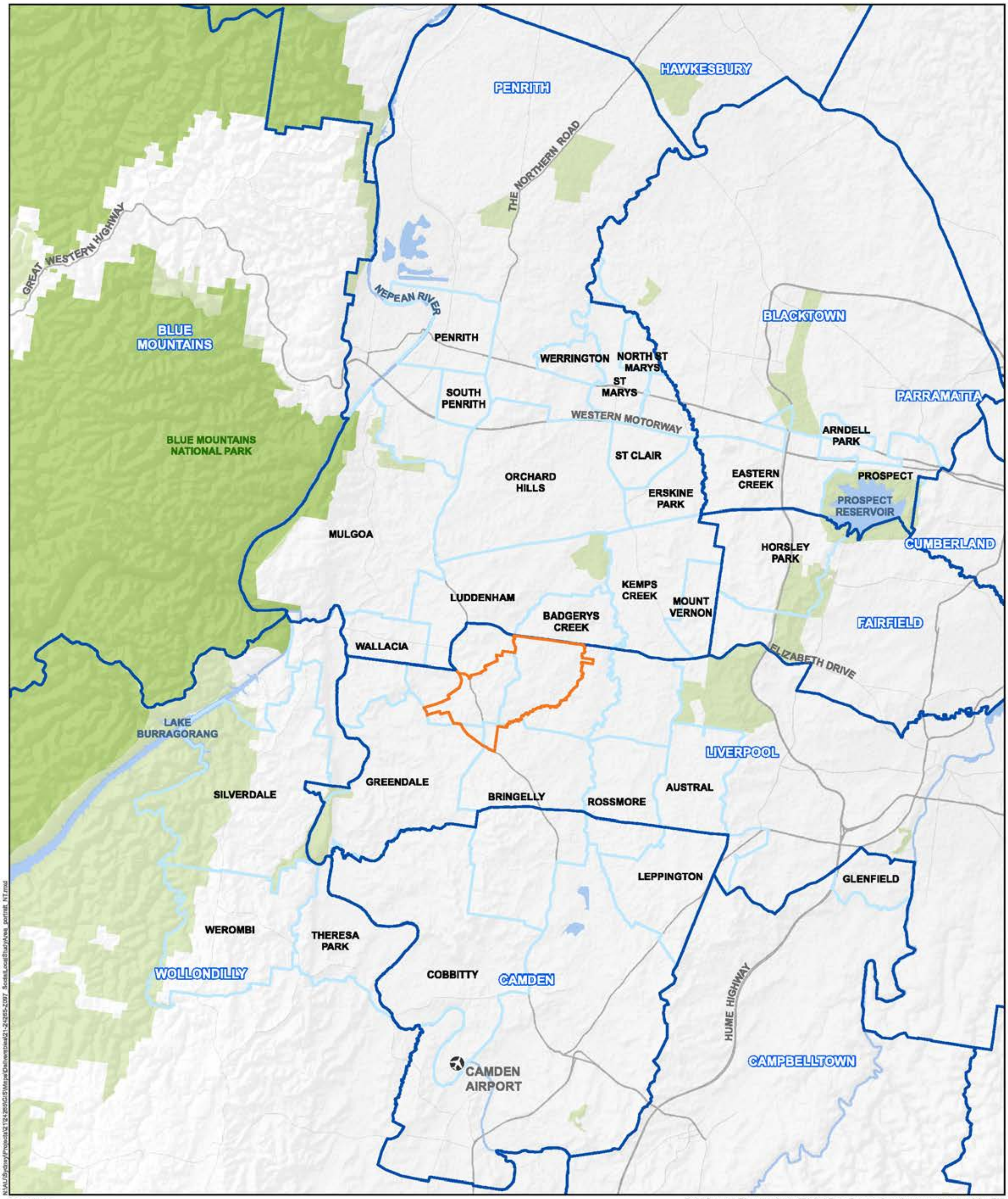
Consistent with assumptions found generally in epidemiological studies, people who are of a low socioeconomic status are identified as a vulnerable group for the effects of air, noise and water pollution for the purposes of a health risk assessment. This is largely due to the fact that people within these groups usually have a poorer health status, may have limited access to medical care, and may live in more affordable areas which generally experience higher rates of pollution (e.g. near major roads or industry).

The health risk assessment adopts the Socioeconomic Indexes for Areas (SEIFA) as a measure of relative social disadvantage. This measure takes into account 20 variables (including income levels, educational attainment, unemployment and vocational skills).

SEIFA scores in Table 13–4 indicate that there are areas within the vicinity of the proposed airport with a lower socioeconomic status than the Australian average (SEIFA score of 1,000) or Sydney as a whole (SEIFA score of 1,025). The localities of Badgerys Creek, St Marys, Mount Druitt, Rooty Hill, Colyton and Warragamba all have low SEIFA scores indicating that the populations in these localities may be vulnerable to the effects of air, noise and water pollution from the proposed airport.

13.3.4 Health baseline

A baseline health status of the Liverpool LGA was prepared by the South West Sydney Local Health District as part of their 2014 Community Health Profile (see Table 13–3). This table summarises the key indicators for hospitalisations and mortality in the Liverpool LGA, compared to the average for NSW over the same period. Whilst Liverpool experiences a relatively higher number of coronary heart disease, diabetes, and fall related hospitalisations, it is generally comparable to the NSW health profile, having regard to the full range of measured health indicators for the population.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Local government areas
- Social local study area
- Greater Blue Mountains World Heritage Area
- Parks and reserves
- Airfields

0 1 2 4
Kilometres

Figure 13-2 - Airport site and social local study area

Table 13–4 Demographic profile of localities surrounding the airport site (ABS 2011)

Locality	Approximate distance to the airport (km)	Total population	Proportion of population older than 65 years of age (%)	Proportion of population younger than 15 years of age (%)	SEIFA index
Australia (average)	-	-	14	19	1,000
Sydney (average)	-	-	13	19	1,025
Greendale	8	352	11	22	986
Badgerys Creek*	3	455*	12	20	913
Mt Vernon	8	1,036	11	20	1,102
Warragamba	11	1,236	12	22	914
Luddenham	3	1,496	12	22	1,034
Wallacia	8	1,700	10	21	1,032
Mulgoa	8.5	1,792	12	20	1,065
Horsley Park	13	1,936	16	18	1,007
Kemps Creek	6	2,309	15	19	993
Bringelly	6	2,387	10	21	1,036
Rossmore	8	2,412	13	22	997
Silverdale	11	3,439	7	24	1,077
Prospect	21	4,621	9	21	1,031
Erskine Park	11.5	6,668	4	23	1,041
Colyton	13	7,993	11	22	930
Plumpton	18.5	8,244	6	25	999
St Marys	14	10,961	14	21	881
Mt Druitt	16	15,764	8	26	895
Rooty Hill	17	13,377	12	22	970
St Clair	12	19,837	6	21	1,013

*The population of Badgerys Creek includes tenants on the proposed airport site; however, at the time the airport becomes operational, these tenants will no longer be occupying the site and therefore the population would be expected to be much lower.

Table 13–5 Liverpool LGA baseline health status

Indicator	Liverpool LGA	Proportion of NSW average (%)
Hospitalisations		
Hospitalisations (2009/10 to 2010/11) per year	58,010	99.9
Potentially preventable hospitalisations per year (2010/11 to 2011/12)	3,850	95.4
Alcohol attributable hospitalisations per year (2010/11 to 2011/12)	934	81.8
Smoking attributable hospitalisations per year (2010/11 to 2011/12)	905	100.5
High body mass index attributable hospitalisations per year (2010/11 to 2011/12)	719	101
Coronary heart disease hospitalisations per year (2009/10 to 2010/11)	821	91.2
Chronic obstructive pulmonary disease hospitalisations (persons aged over 65) per year (2009/10 to 2010/11)	262	112.9
Diabetes hospitalisations per year (2009/10 to 2010/11)	515	132.1
Fall-related injury overnight hospitalisations (persons aged 65 years and over) per year (2010/2011 to 2011/12)	572	116.9
Stroke hospitalisations per year (2010/11 to 2011/12)	196	97.6
Deaths		
Potentially avoidable deaths (persons aged under 75 years) per year (2006 to 2007)	211	99.5
Potentially avoidable deaths from preventable causes (persons aged under 75 years) (2006 to 2007)	122	96.6
Potentially avoidable deaths from causes amenable to health care (persons aged under 75 years) per year (2006 to 2007)	84	97.8
High body mass index attributable deaths (2006 to 2007)	46	91.1
Alcohol attributable deaths per year (2006 to 2007)	23	94.6
Smoking attributable deaths per year (2006 to 2007)	79	99.2

Over the period 2005 to 2007, Liverpool LGA had a higher mortality ratio of 107.3 (NSW baselined at 100). The life expectancy for both males (79.5) and females (83.4) was less than the NSW averages (males 79.6 and females 84.3).

According to the Liverpool Community Health Profile (SWSLHD), the asthma prevalence rate in people over 16 years of age in the area is 6.3 per cent. This is lower than the NSW average for the same age group.

In 2006, a Parliamentary Inquiry into the health impacts of air pollution in the Sydney basin found that despite evidence that air pollution had improved over the last 30 years, these improvements were offset by Sydney's growing population, particularly in the south-west and western areas of Sydney. An increasing reliance on private motor vehicles, made worse by inadequate public transport was noted as a major challenge. Evidence provided by NSW Health at that time estimated that in Sydney there was between 600 and 1,400 deaths per year due to air pollution in the Sydney basin.

13.3.5 Air quality

Air quality monitoring data collected between 2005 and 2014 from the NSW Office of Environment and Heritage monitoring stations in Bringelly, Macarthur/Campbelltown West, Liverpool and Richmond was used to describe the existing air quality in Badgerys Creek. A detailed outline of the available air quality data is provided in Appendix F1 (Volume 4). Generally, air quality for the local area is good, with the exception of isolated high pollution days or extreme events such as dust storms and bushfires. Uncontrolled combustion events such as bushfires will influence regional measurements of PM_{10}, $PM_{2.5}$ and to a lesser extent, NO_X.

13.3.6 Groundwater

Groundwater at the airport site is generally poor quality with limited beneficial use or environmental value. The aquifers at the airport site include:

- an unconfined aquifer in the shallow alluvium of the main watercourses at the airport site;
- an intermittent aquifer in weathered clays overlying the Bringelly Shale;
- a confined aquifer within the Bringelly Shale; and
- a confined aquifer within the Hawkesbury Sandstone.

Groundwater within the alluvium has been measured at depths between 0.7 and 4.7 metres. Within the Bringelly Shale, groundwater has been measured at depths between 3.0 and 11.7 metres, and at depths between 2.4 and 4 metres in the overlying weathered material (PPK 1997; Coffey & Partners 1991). Groundwater within the Hawkesbury Sandstone is significantly deeper because the aquifer is 100 metres below ground level.

Groundwater quality data indicates elevated concentrations of lead, zinc, copper, nitrogen and phosphorous above the values in the ANZECC freshwater guidelines. Nitrate and sulphate exceeded guideline values at some locations. Groundwater was found to be saline with an average electrical conductivity equalling 21,474 µS/cm and exceeding the 2,200 µS/cm guideline (PPK 1997), indicating a low beneficial reuse potential.

The shallower alluvial aquifer at the airport site is understood to discharge at Badgerys Creek, Cosgroves Creek and Duncans Creek. However, surface discharges from the Bringelly Shale aquifer and overlying weathered material are likely to be limited by low connectivity and hydraulic conductivity. Groundwater salinity is an order of magnitude higher on average than surface water salinity at the airport site, which is further evidence of the limited groundwater discharge.

A number of surface water dams are present across the site. These features are expected to have been developed initially to capture surface water runoff and are therefore primarily reliant on surface water inputs rather than groundwater. The low permeability clays in which these dams have been developed would limit the connection with surrounding groundwater.

A total of 42 groundwater bores are registered in the vicinity of the airport site. The groundwater bores are recorded as being constructed to significant depths and are understood to generally target the Hawkesbury Sandstone aquifer, which is known to be of higher beneficial use value. It is likely that the Hawkesbury Sandstone is preferentially targeted because of the relatively poor quality of Bringelly Shale groundwater.

13.3.7 Surface water

Two main catchments drain the site: the South Creek Catchment and the Nepean River Catchment. There are several waterways that are within, or in the vicinity of, the airport site:

- Duncans Creek is located to the south-west of the site and drains to the Nepean River west of the airport site;
- Oaky Creek flows through the central and northern area of the airport site and then drains to Cosgroves Creek;
- Cosgroves Creek flows along to the north-west and north of the airport site, before draining into South Creek to the north-east of the site;
- Badgerys Creek flows along the southern and south-eastern boundary of the airport site and then drains to South Creek to the north-east of the airport site; and
- Thompsons Creek is located to the south-east of the airport site and drains to South Creek to the south-east of the airport site.

Each of the above listed waterways has a number of small tributaries which drain the airport site and areas in the vicinity. Many of the creeks which drain the airport site and surrounding area may not flow continuously. During dry periods, only intermittent pools of water may remain along the creek beds.

Warragamba Dam is located approximately 11 kilometres west of the airport site and is one of Sydney's major drinking water supply dams. Prospect Reservoir is located approximately 16 kilometres north-east of the site. Prospect Reservoir is a potable water supply which is used during periods of high demand. The airport site is not located within the catchment area for either the dam or the reservoir. There are also numerous farm storage dams on and surrounding the airport site, as well as rain water tanks on properties around the site used for potable water.

Surface water quality sampling has been undertaken for the EIS and is outlined in Appendix L2 (Volume 4). The results indicate that the nutrient loads are generally well above both the Airports (Environment Protection) Regulations 1997 (AEPR) accepted limits and the default values in the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines. Turbidity and total suspended solids were found to be within acceptable levels, while dissolved oxygen levels were found to be relatively low. The data also indicate that conductivity levels were high, and above those for typical lowland rivers. Some exceedances of chromium, copper and zinc were also detected. The results are generally consistent with prior sampling conducted in 1997 and more recently in 2014, and demonstrates the limited change to land uses in the intervening period.

The water quality sampling results indicate that both the airport and downstream catchments are fairly degraded, particularly in terms of nutrients. The existing water quality does not typically satisfy the AEPR limits or default ANZECC guideline criteria for the protection of aquatic ecosystems, primary and secondary contact recreation, as well as irrigation water use for food and non-food crops.

13.4 Assessment of impacts during operation

13.4.1 Particulate matter

The local air quality assessment found that Stage 1 operations would result in the emission of particulate matter (PM_{10} and $PM_{2.5}$). Background emissions from road vehicles using roads external to the airport site would account for approximately 92 per cent of total PM_{10} emissions and approximately 90 per cent of total $PM_{2.5}$ emissions. Activities on the airport site itself would amount to approximately 7 per cent of total PM_{10} emissions and approximately 10 per cent of total $PM_{2.5}$ emissions, with the remaining balance coming from road traffic accessing the airport site. The main source of PM_{10} and $PM_{2.5}$ onsite would be aircraft engines, followed by the operation of auxiliary power units (APUs) and ground support equipment (GSE).

Annual average and 24-hour emissions for particulate matter have been modelled as part of the local air quality assessment. The average 24-hour NEPM Ambient Air Quality (NEPM-AAQ) standard for PM_{10} and $PM_{2.5}$ are 50 $\mu g/m^3$ and 25 $\mu g/m^3$ respectively and all predictions of emissions from the Stage 1 development are below these levels. A revised NEPM-AAQ standard will reduce the acceptable levels for 24-hour $PM_{2.5}$ to 20 $\mu g/m^3$ however all predictions for $PM_{2.5}$ emissions are also below this standard. The highest predicted 24-hour average PM_{10} and $PM_{2.5}$ concentrations are predicted at Badgerys Creek, Bringelly and Rossmore.

The health effects of particle matter linked to ambient exposures have been well studied and reviewed by international agencies. An overview of the literature related to the health effects of particulate matter is provided in Appendix G (Volume 4). Most information comes from population-based epidemiological studies that find increases in mortality, increases in hospital admissions and emergency room attendances, and exacerbation of asthma associated with daily changes in ambient particle levels. In recent years, there has been an increasing focus on the association between exposure to particles and cardiovascular outcomes. In addition to studies on the various size metrics for particles, recent research has also investigated the role of particle composition in the observed health effects.

The predicted number of attributable cases due to PM_{10} during operations is low. The highest risk is for all-cause mortality from long term exposures with between four additional deaths per 1,000 years and six additional deaths per 100 years attributable to PM_{10}. The highest risk is predicted for Bringelly and Rossmore with an additional six deaths per 100 years predicted. All other risks are lower than that predicted for these outcomes.

Similar to PM_{10}, the numbers of cases attributable to $PM_{2.5}$ are low. The highest risk is for all-cause mortality and cardiopulmonary mortality from long term exposures with between two additional deaths per 1,000 years and six additional deaths per 100 years. The highest risks are predicted for Bringelly and Rossmore. All other risks are lower than that predicted for these outcomes.

13.4.2 Nitrogen dioxide

The local air quality assessment found that Stage 1 operations would result in the emission of nitrogen oxides (NO_x), which includes nitrogen dioxide (NO_2). Background emissions from road vehicles using the external road infrastructure would account for approximately 68 per cent of total NO_x emissions. Activities on the airport site itself would amount to approximately 31 per cent of total NO_x emissions, with the remaining balance coming from road traffic accessing the airport site. The majority of NO_x emissions generated onsite would come from aircraft engines, with some emissions generated from the operation of APUs and GSE.

Although the predicted NO_x levels meet the NEPM-AAQ standards, it is recognised that there is no threshold for these pollutants below which adverse health effects are not observed. This means that even meeting the air quality standards means that there remains a level of risk associated with exposure.

The daily maximum 1-hour nitrogen dioxide concentrations at residential receivers are predicted to be low. The local air quality assessment identified that for all relevant averaging periods, the nitrogen dioxide levels due to airport operations are below the current NEPM-AAQ standards. The levels predicted at all residential locations are similar, with slightly higher levels at Greendale.

An overview of the literature related to the health effects of NO_2 is provided in Appendix G (Volume 4). Recent studies of both long term and short-term exposure to NO_2 have concluded that short-term exposure to NO_2 is associated with increases in mortality, hospital admissions and respiratory symptoms. Studies of the long term effects of exposure to NO_2 have also shown associations with both mortality and morbidity outcomes. The effects that have been observed for both long term and short-term exposure are occurring below current WHO air quality guidelines for NO_2 which are lower than the current NEPM standards. The most recent studies have provided evidence that NO_2 has an independent effect from other pollutants. Epidemiological studies of the long term effects of NO_2 exposure on mortality (both respiratory and cardiovascular causes) and with children's respiratory symptoms and lung function also support the conclusion that NO_2 has an independent effect on health.

Based on the modelling data, the highest risk is for long term mortality in people over 30 years of age with between nine additional deaths every 100 years and 1.1 additional deaths every year. This risk relates to the combined emissions from the airport as well as traffic on roads outside the airport site. The highest risks are predicted to occur at Bringelly, Kemps Creek and Rossmore, reflecting the predicted concentration of emissions from background sources external to the airport site.

To enable an assessment of the risk posed by NO_2 emissions from airport operations in isolation of external background emissions, additional modelling was conducted in the absence of traffic on roads outside the airport site. Without traffic emissions, there was a significant reduction in the health risk predicted. When looking at airport operations only, the highest risk associated with NO_2 was for all-cause mortality in people over 30 years of age with a maximum of four additional deaths every 10 years. In this case, the highest risks are predicted to occur in Luddenham, Kemps Creek, Mulgoa and Wallacia.

A recent review of the *Fuel Quality Act 2000* estimated that in Sydney in 2015, NO_2 was responsible for 330 additional deaths per year and an additional 336 and 371 hospital admissions for respiratory disease and cardiovascular disease respectively in people over 65 years of age. The risk predicted for Stage 1 operations is very small within this context.

It should be noted that the health risk assessment predictions also do not take into account the implementation of any mitigation measures proposed in the EIS to reduce nitrous oxide emissions. The implementation of the mitigation measures identified in Chapter 12 will be implanted to reduce community exposure to NO_2 and reduce the predicted health risks associated with NO_2 emissions.

13.4.3 Sulfur dioxide

The local air quality assessment found that Stage 1 operations would result in the emission of sulfur dioxides (SO_2). Activities on the airport site are predicted to account for approximately 88 per cent of total SO_2 emissions. Background emissions from road traffic using the external road system would amount to approximately 12 per cent of total SO_2 emissions. The majority of SO_2 emissions generated onsite would come from aircraft engines, with some emissions generated from the operation of APUs and GSE.

Air dispersion modelling conducted for the local air quality assessment has predicted maximum 1-hour, 24-hour average and annual average sulfur dioxide concentrations for a range of receivers in the vicinity of the airport site. The daily 24-hour sulfur dioxide concentrations at the most affected receivers show that all levels are only a few percent of the current NEPM-AAQ standard of 80 ppb. The levels are highest at receivers in Badgerys Creek, Greendale and Mount Vernon.

The health effects of SO_2 linked to ambient exposures have been well studied and reviewed by international agencies. An overview of the literature related to the health effects of SO_2 is provided in Appendix G (Volume 4). A large number of population-based epidemiological studies have reported a link between short term SO_2 exposure and daily mortality and respiratory and cardiovascular effects. Adverse effects, such as sneezing or shortness of breath occur within the first few minutes after inhalation. The effects are greater when the person is exercising, and are most pronounced in people with asthma and other respiratory conditions and particularly in exercising asthmatics. A large body of epidemiological studies generally report consistent and robust associations between ambient SO_2 concentrations and emergency department visits and hospitalisations for all respiratory causes, particularly among children and older adults (65+ years), and for asthma and chronic obstructive pulmonary disease.

The health risk from exposure to sulfur dioxide from the Stage 1 operations is predicted to be very low. The highest risk is for hospital admissions from respiratory causes for people aged over 65 years, with between seven additional admissions per 1,000 years and seven additional admissions per 100 years. All other risks associated with sulfur dioxide exposure are lower than this. The highest risks are predicted to occur in Luddenham, Mulgoa and Wallacia.

13.4.4 Carbon monoxide

The local air quality assessment found that Stage 1 operations would result in the emission of carbon monoxide (CO). Background emissions from road vehicles using the external road infrastructure would account for approximately 88 per cent of total CO emissions. Activities on the airport site itself would amount to approximately 12 per cent of total CO emissions, with the remaining balance coming from road traffic accessing the airport site. The main source of CO onsite would be aircraft engines, followed by the operation of GSE and vehicles using parking facilities.

The local air quality assessment assessed daily 8-hour maximum CO levels for the worst affected locations in the vicinity of the airport site. The data indicates that the predicted CO levels are higher at Kemps Creek, Bringelly, Rossmore and Badgerys Creek, however all predicted concentrations are well below the NEPM-AAQ standard of 9 ppm.

Carbon monoxide is a toxic gas and, given exposure to sufficient concentrations, may result in cardiovascular morbidity. The health effects of CO are based on the ability of carbon monoxide to remove haemoglobin from the blood forming carboxyhaemoglobin. An overview of the literature related to the health effects of CO is provided in Appendix G (Volume 4). Epidemiological studies of emergency department visits and hospital admissions for ischaemic heart disease report consistent positive associations for an increase in cardiovascular-related mortality. New toxicological evidence suggests that other mechanisms involving altered cellular signalling may play a role in cardiovascular disease outcomes following CO exposure.

The health risk assessment modelling results indicate that the predicted health effects associated with CO emissions from operation of the Stage 1 development are very low. The highest risk is for hospital admissions for cardiovascular disease in people 65 years of age and older with a maximum of an additional four hospital admissions in 1,000 years. This risk is negligible.

13.4.5 Air toxics (benzene)

A number of air toxics including benzene, toluene, xylenes and formaldehyde would be emitted from airport operations and were modelled as part of the local air quality assessment. The most significant potential health risk of these is cancer from exposure to benzene.

For the Stage 1 development, the local air quality assessment estimated that airport operations would contribute approximately 30 per cent of the total air toxics with approximately 70 per cent from vehicles on external roads. Stationary sources and fuel tanks onsite are considered to be the major contributors associated with the airport operations.

The local air quality assessment identified that the annual average concentration of benzene would be an order of magnitude lower than the monitoring investigation level in the Air Toxics NEPM (NEPM-AT) of 0.3 ppb.

Human exposure to benzene has been associated with a range of acute and long term adverse health effects and diseases, including cancer and aplastic anaemia. Acute (short-term) inhalation exposure of humans to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness. Chronic (long term) inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anaemia. An overview of the literature related to the health effects of benzene is provided in Appendix G (Volume 4).

The maximum predicted cancer risk was estimated using a unit risk factor adopted by the California Environmental Protection Agency Office of Environmental Health Hazard Assessment. The modelled maximum annual average concentration was 0.1 $\mu g/m^3$, resulting in an increase in cancer risk of 2.9×10^{-6} (2.9 in a million).

It is generally accepted by national and international regulatory agencies that an increase in risk between 1 x 10^{-6} (one in a million) and 1 x 10^{-5} (one in 100,000) is considered to be a low risk and therefore acceptable. The maximum predicted increase in cancer risk from exposure to benzene associated with operation of the Stage 1 development is within this range and is therefore considered to be acceptable.

13.4.6 Diesel particulates

The local air quality assessment estimated diesel emissions likely to be generated as a result of the proposed airport. Diesel emissions associated with the proposed airport would arise from truck movements and diesel-powered equipment used during operation. The local air quality assessment modelled diesel emissions for the Stage 1 development. The annual average concentrations range from 0.07 to 0.3 µg/m^3.

In recent years, there has been increased community concern about the health effects of diesel emissions. Exposure to diesel exhaust can irritate the eyes, nose, throat and lungs, and it can cause coughs, headaches, light headedness and nausea. In studies with human volunteers, diesel exhaust particles made people with allergies more susceptible to the materials to which they are allergic, such as dust and pollen. Exposure to diesel exhaust also causes inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks. Diesel exhaust and many individual substances contained in it (including arsenic, benzene, formaldehyde and nickel) have the potential to contribute to mutations in cells that can lead to cancer. WHO have classified diesel particles and diesel exhaust as a known human carcinogen. An overview of the literature related to the health effects of diesel is provided in Appendix G (Volume 4).

The unit risk factor from the California Environmental Protection Agency Office of Environmental Health Hazard Assessment has been used in the assessment of the increase in cancer risk associated with diesel particles from the construction and future operations of the airport. The unit risk factor for diesel particles is 3 x 10^{-4} (3 in 10,000) per 1 µg/m^3 increase in diesel particles.

The maximum predicted increase in cancer risk attributable to diesel particles is 2 x 10^{-4} (2 in 10,000) and ranges from 9 x 10^{-5} (9 in 100,000) to 2 x 10^{-4} (2 in 10,000). These risk levels fall at the upper bound of the range generally considered accepted by national and international regulatory agencies. For values between 1 x 10^{-5} (1 in 100,000) and 1 x 10^{-4} (1 in 10,000), mitigation measures should be considered to reduce the risk.

The highest risk level is predicted at the Badgerys Creek location that is within the airport site itself. It is therefore more representative of the exposure of airport workers than the general public. However, other offsite locations at Mulgoa and Wallacia are also at the upper bound of acceptable levels. Modelling conducted for the local air quality assessment that has been used in the health risk assessment has not assumed any improvements to diesel emissions that may occur through changes to motor vehicle regulations or through changes to fuel quality standards over time. Along with the mitigation measures in Chapter 12, such improvements would lead to reductions in diesel particles and a lowering of the risk to exposed communities.

13.4.7 Ozone

The regional air quality assessment provided an assessment of ozone impacts associated with the proposed airport. It found that the operation of the Stage 1 development would lead to the formation of ozone. Increases in ozone from the proposed airport are predicted to occur downwind of the airport site which, on most days, is to the south and south-west. Decreases in daily maximum ozone occur only in the vicinity of the airport site and are attributable to ozone suppression by nitrous oxide emissions from activities on the airport site. The operation of the Stage 1 development would not result in an increase in the peak predicted 1-hour ozone concentrations. This is because the predicted ozone concentrations from the proposed airport occur in different locations to where ozone peaks currently occur.

The regional air quality assessment has found that peak ozone concentrations in 2030 would be above the NEPM-AAQ criterion of 100 ppb for all but one day of the analysis. These exceedances would occur regardless of the airport development and reflect the contribution of background emission activity to ozone concentrations.

Ozone is a secondary pollutant and is formed from precursors such as oxides of nitrogen and volatile organic compounds. Ozone levels are influenced by meteorology and seasonality (i.e. warmer seasons, cloudless skies, stable atmosphere) and bushfires.

The main health effects associated with exposure to ozone are associated with the respiratory tract. Studies have shown that long term exposure to ozone has an impact on people with existing disease, in particular people with chronic obstructive pulmonary disease, diabetes, congestive heart failure and myocardial infarction. Long term exposure to ozone has also been associated with an increase in asthma incidence, asthma severity, hospital care for asthma and lung function growth. Short-term effects associated with daily maximum one-hour and eight-hour ozone concentrations include all cause, cardiovascular and respiratory mortality as well as cardiovascular and respiratory hospital admissions. An overview of the literature related to the health effects of ozone is provided in Appendix G (Volume 4).

The increase in risk from ozone concentrations associated with the Stage 1 development ranges from the lowest risk of 5×10^{-6} (0.5 in 100,000) for respiratory mortality to the highest risk of 4.5×10^{-5} (4.5 in 100,000) for emergency department attendances for asthma in children. Given the nature of ozone formulation, these risks are for the Western Sydney region as a whole and are not broken down to the community level.

There is general agreement by international agencies including the WHO and the US EPA that acceptable risk levels fall between 1×10^{-6} (one in a million) and 1×10^{-5} (one in 100,000). The predicted health risk for emergency department attendances for asthma in children is marginally outside these limits. Noting that international agencies usually consider 1×10^{-4} (1 in 10,000) as the level of risk that is considered as unacceptable, the predicted risk for ozone from Stage 1 operations is considered manageable.

In relation to this finding, it is noted that the regional air quality assessment of ozone relies on a conservative modelling methodology selecting a ‘snapshot’ of days when ozone formation is likely to occur rather than a more comprehensive (annual) dataset which would normally be used to complete a quantitative health risk assessment. The actual occurrence of ozone in these concentrations would also not necessarily result at the airport site itself and the concentrations would vary day to day due to factors such as wind speed and direction as well as other factors.

As noted previously, these risks from ozone include the risks associated with background emissions from other sources. Given the relatively limited impact of the Stage 1 development on ozone concentrations when compared to existing and future background emissions, the ability for a future airport lessee company to reduce ozone impacts and health risks at the regional scale will be very limited.

13.4.8 Aircraft overflight noise

The assessment of health risks associated with aircraft overflight noise from Stage 1 operations are based on the findings of the noise exposure modelling presented in Chapter 10 of this EIS. The predicted risks associated with overflight noise consider the differences associated with potential operating strategies at the proposed airport (i.e. Prefer 05, Prefer 23) and the use of operating modes such as head-to-head. Further information on operating modes and operating strategies can be found in Chapter 10.

For night time aircraft noise during Stage 1 operations, the results indicate that only Luddenham is predicted to experience noise levels above the WHO 40 dB $L_{night,outside}$ criterion for all potential airport operating strategies modelled. All other areas assessed would be below this criterion, which is the level of lowest observed adverse effects to public health. The highest daytime noise levels of between 44-46 dB are also predicted at Luddenham. The noise levels at all other locations are predicted to be below 40 dB. The full table of results are outlined in Appendix G (Volume 4).

13.4.8.1 Sleep disturbance

The health risk assessment found that aircraft overflights associated with the operation of the Stage 1 development would not significantly increase the risk of sleep disturbance. The predicted number of additional EEG awakenings was between zero and 40 per person per year, depending on the community and the operating strategy in use. $L_{night,outside}$ noise results indicate that the Prefer 05 operating strategy results in more EEG awakenings across more localities than the Prefer 23 strategy. Use of the head-to-head mode at night—involving all landings and departures to the south-west of the airport site—could reduce the number of EEG awakenings in some instances compared to both the Prefer 05 strategy and the Prefer 23 strategy.

The area with the highest number of additional EEG awakenings per person per year is Luddenham, which is predicted to experience 40 additional EEG awakenings per person per year no matter which operating strategy is selected. Due to Luddenham's proximity to the airport site, the use of the head-to-head operating mode does not reduce the potential incidence of EEG awakenings as it does at other localities, such as Erskine Park and Kemps Creek, where a similar impact is predicted from the Prefer 05 and Prefer 23 operating strategy, respectively. The full table of results for additional EEG awakenings is provided in Appendix G (Volume 4).

For context, individuals typically exhibit about 24 EEG awakenings per eight hours of sleep (European Environment Agency 2010). The number of additional EEG awakenings per person per year due to aircraft overflight noise is predicted to be between zero and 40 per person per year and would therefore represent an increase of approximately zero to 0.5 per cent over a year. This shows that the predicted number of additional EEG awakenings from aircraft overflight noise during Stage 1 operations would be very low.

Sleep disturbance impacts were also quantified as the increased risk of full awakenings. The health risk assessment found that the number of additional full awakenings would be significantly lower than the predicted number of additional EEG awakenings. The number of additional full awakenings due to aircraft overflight noise is predicted to be between zero and five additional full awakenings per person per year, depending on the community and the operating strategy used. Similar to the analysis of EEG awakenings, the highest risk of additional full awakenings is predicted for Luddenham, which would experience an additional three full awakenings per person per year under the Prefer 05 and Prefer 23 operating strategies and an additional five full awakenings per person per year if the head-to-head operating mode was used at night. The full table of results for additional full awakenings is provided in Appendix G (Volume 4).

13.4.8.2 Cardiovascular effects

The WHO has identified that the noise level for potential increases for myocardial infarction (heart attacks) is 55 dB $L_{night,outside}$. For all receivers assessed for overflight noise impacts, the $L_{night,outside}$ predicted levels are below 55 dB. This was observed for all operating strategies assessed. On the basis of these results, it can be concluded that aircraft noise would not lead to any increased risk in myocardial infarction in communities in the vicinity of the airport site.

13.4.8.3 Learning and cognitive development in children

The health risk assessment determined that hazard quotients for outdoor noise levels were all less than one, indicating that the risk from aircraft overflight noise during Stage 1 operations for each of the proposed operating strategies generally does not pose an unacceptable risk. For indoor noise levels, hazard quotients were also less than one, except at Luddenham, where the WHO 35 dB L_{Aeq} criterion was exceeded by 1 dB at Luddenham Primary School. This does not mean that there will be an impact on children's learning and cognitive development but that there is an increased risk, albeit very low. The full table of results for hazard quotients for outdoor and indoor noise is provided in Appendix G (Volume 4).

13.4.9 Ground-based operations noise

Ground-based operations noise is predicted to have a greater (health) impact than aircraft overflight noise and has the most impact at localities closest to the proposed airport, in particular at Luddenham.

Modelling indicates that only Luddenham would experience noise levels above the WHO 40 dB $L_{night,outside}$ criterion—with a predicted noise level of 47 dB—from ground-based operations noise during operation of the Stage 1 development. All other areas assessed would be below the WHO criterion, which is the level of lowest observed adverse effects to public health.

Luddenham is predicted to also experience the highest daytime noise levels of 50 dB $L_{Aeq,9am\text{-}3pm}$. Greendale would experience a relatively high daytime noise level of 42 dB $L_{Aeq,9am\text{-}3pm}$. These results are below the WHO guideline value of 55 dB $L_{Aeq,9am\text{-}3pm}$. The daytime noise levels at all other locations are predicted to be below 40 dB $L_{Aeq,9am\text{-}3pm}$. The full table of results are outlined in Appendix G (Volume 4).

13.4.9.1 Sleep disturbance

The effects of ground based operations noise are predicted to lead to an additional 0 to 75 EEG awakenings per year per person, depending on the location. Due to their proximity to the airport site, Luddenham and Greendale are predicted to be the most affected locations. Luddenham is predicted to experience an additional 75 EEG awakenings per person per year, Greendale is predicted to experience an additional 37 EEG awakenings and Kemps Creek would experience an additional 20 EEG awakenings per person per year. The full table of results for EEG awakenings is provided in Appendix G (Volume 4).

Based on the fact that individuals typically exhibit about 24 EEG awakenings per eight hours of sleep (European Environment Agency 2010), the additional EEG awakenings associated with ground-based operations noise would represent a relatively modest increase of between 0 and 0.9 per cent per year.

In relation to full awakenings, ground-based operations noise is predicted to result in a relatively small impact. Luddenham is predicted to experience an additional four full awakenings per person per year and Greendale is predicted to experience an additional two full awakenings per person per year. All other locations are predicted to experience no increase in full awakenings due to ground based operations noise. The complete results for full awakenings is provided in Appendix G (Volume 4).

13.4.9.2 Cardiovascular effects

The WHO has identified that the noise level for potential increases for myocardial infarction (heart attacks) is 55 dB $L_{night,outside}$. Similar to aircraft overflight noise, for all receivers assessed, the $L_{night,outside}$ predicted levels for ground based operations noise were below 55 dB. On the basis of these results, it can be concluded that ground-based operations noise would not lead to any increased risk for myocardial infarction in communities in the vicinity of the airport site.

13.4.9.3 Learning and cognitive development in children

In terms of children’s learning and cognitive development, the health risk assessment predicts that hazard quotients for outdoor noise levels will be less than one, which generally indicates that the risk from ground-based operations noise does not pose an unacceptable risk. For indoor noise levels, hazard quotients were also less than one, except at Luddenham where it was 1.1. This is because ground-based operations noise at Luddenham is predicted to exceed the WHO 35 dB $L_{Aeq,9am\text{-}3pm}$ criteria for indoor noise by 5 dB, which represents a significant increase in noise levels. This does not mean that there will be an impact on children’s learning and cognitive development but that there is an increased risk. The full table of results for hazard quotients for outdoor and indoor noise is provided in Appendix G (Volume 4).

13.4.10 Surface and groundwater

A number of activities undertaken during the operation of the proposed airport have the potential to result in the contamination of ground and surface water. These activities include chemical and fuel storage, equipment operation, equipment maintenance and firefighting. Potential contaminants include petroleum hydrocarbons, heavy metals, polyaromatic hydrocarbons, perflourinated compounds and chlorinated hydrocarbons.

Aqueous film-forming foams (AFFF) have historically been used for firefighting purposes at airports, at fuel depots, hangars and for aviation rescue and fire-fighting (for both operational and training purposes). AFFF products historically used on airport sites contain perfluorinated or polyfluorinated compounds, or fluorosurfactants (PFCs). Depending on the type of AFFF used, the principal PFC constituents could have included perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) and fluorotelomers such as 6:2 fluorotelomer sulfonate (6:2FtS) and 8:2 fluorotelomer sulfonate (8:2FtS). AFFF has not been used for aviation rescue and fire-fighting by Airservices Australia since 2010, but continues to be used around fuel depots and hangars at many airports (GHD 2016b).

13.4.10.1 Surface water

The indicative flight paths for the proposed Stage 1 development are located above the catchment areas for Warragamba Dam and Prospect Reservoir. In addition, through consultations there have been concerns raised by parts of the community about the potential for aircraft emissions to impact on the quality of tank water in the area close to the airport site.

A qualitative evaluation was conducted to understand the potential for these activities, and activities at the airport site, to impact on surface water bodies in and around the airport site. The following operational activities were considered for their potential to impact on surface water:

- the accidental spill of stored chemicals or fuels from vehicles, which may be released to nearby surface water environments;
- the release of stored groundwater, which has not been adequately characterised with regard to contamination concentrations, to surface water bodies;
- the deposit of aircraft emissions to nearby surface water bodies which may result in increased contaminant loading to waterways; and
- the very rare event of aircraft fuel jettisoning during emergency incidents as aircraft approach the airport site.

Based on available information, there is considered to be a low risk for operation of the proposed airport to impact on the environmental values of surface water.

In relation to accidental spills and stored groundwater, the health risk assessment found that there was a very low risk of airport operations impacting on nearby surface water bodies. In addition, the mitigation measures outlined in Chapter 17 and Chapter 18 would be implemented to reduce the potential for surface water risks.

For aircraft emissions, there are currently no data available which can be used to assess whether emissions from aircraft operations would result in increased loading of contaminants to surface waters. However, air dispersion modelling was conducted as part of the air quality assessment (see Chapter 12) to predict ground level concentrations of volatile organic compounds (VOCs) and PM_{10} in areas close to the airport site. The maximum predicted concentration of benzene within five kilometres of the airport site is 0.1 µg/m^3 and diesel particles 0.8 µg/m^3. These concentrations are very low and would not impact on the quality of tank water.

As discussed in Chapter 7 (Volume 1), fuel jettisoning for commercial aircraft is very rare (in 2014 only 0.001 per cent of all civilian aircraft movements in Australia) and only occurs during emergency circumstances where an unscheduled landing is required. Based on the information presented in Chapter 7 (Volume 1), it is considered unlikely that the jettisoning of fuel will result in impacts to surface water bodies surrounding the proposed airport site.

13.4.10.2 Groundwater

Based on available information relating to the types of activities which will be conducted during construction and operation of the airport, there is considered to be minor potential for risks to the environmental values of groundwater in the alluvial and Bringelly Shale aquifers.

Groundwater bores are recorded as being constructed to significant depths and are understood to target the underlying Hawkesbury Sandstone aquifer.

The management and mitigation measures identified in Chapter 18 would be implemented to reduce the potential for these risks to occur. It is noted however that the potential for exposure to groundwater contaminants by offsite users of extracted groundwater is minimal as bores draw from the Hawkesbury Sandstone aquifer.

13.5 Assessment of impacts during construction

The health risk assessment assessed the impacts on community health associated with the construction of the Stage 1 development. This was done by quantifying the increased risk of health outcomes for communities around the airport site as a result of impacts on air quality (through particulate matter) and impacts on surface and groundwater quality. Health risks from construction noise have not been assessed as it is a short-term activity and the levels of exposure are lower than those for aircraft overflight and ground-based operations noise.

It should be noted that the construction of Stage 1 development would occur for a period of less than 10 years. Therefore, the predicted risk levels associated with the construction phase are unlikely to be realised as they are predicted to occur over much longer timeframes (100 to 10,000 years).

13.5.1 Particulates

The local air quality assessment modelled the emission of particulate matters (PM_{10} and $PM_{2.5}$) associated with construction of the Stage 1 development. The main sources of emissions during main construction works are bulk earthworks, the construction of aviation infrastructure, the operation of machinery and trucks, and the operation of the concrete batching plant. Details of the modelling and sources considered are provided in the local air quality assessment (see Chapter 12).

13.5.1.1 PM_{10}

The local air quality assessment predicts that 24 hour average PM_{10} levels from bulk earthworks would be well below the current NEPM-AAQ standard of 50 µg/m^3 at all residential locations assessed. The highest concentrations are predicted on the airport site.

The health risk assessment found that the highest predicted risk attributable to PM_{10} during bulk earthworks is for all-cause mortality from long term (annual) exposures with between one additional death per 1,000 years and one additional death per 100 years. The highest risk would be for Luddenham. All other risks would be lower than that predicted for long term mortality.

Similar to bulk earthworks, the predicted PM_{10} concentrations during the construction of aviation infrastructure works are higher than those during bulk earthworks but still below the NEPM-AAQ standard. The highest concentration is predicted on the airport site.

The highest predicted risks attributable to PM_{10} during construction of aviation infrastructure are for all-cause mortality from long term exposures with between two additional deaths per 1,000 years and one additional death per 100 years. The highest impacts are predicted at Luddenham, Bringelly, Kemps Creek and Badgerys Creek.

13.5.1.2 $PM_{2.5}$

The local air quality assessment predicted $PM_{2.5}$ concentrations for bulk earthworks and found them to be low and below the NEPM-AAQ advisory reporting standard of 25 $\mu g/m^3$. The highest concentrations are predicted for Greendale and Badgerys Creek.

The health risk assessment predicted the highest risk attributable to $PM_{2.5}$ during bulk earthworks is for all-cause mortality and cardiopulmonary mortality from long term exposures with between seven additional deaths per 10,000 years and four additional deaths per 1,000 years. The highest risks are predicted at Bringelly and Luddenham.

The predicted $PM_{2.5}$ concentrations during construction of aviation infrastructure are higher than those predicted for bulk earthworks but still in compliance with the NEPM-AAQ advisory reporting standard of 25 $\mu g/m^3$. The highest concentrations are predicted for Badgerys Creek, Greendale and Rossmore.

The highest predicted risks attributable to $PM_{2.5}$ during main construction works are for all-cause mortality and cardiopulmonary mortality from long term (annual) exposures with between three additional deaths per 1,000 years and two additional deaths per 100 years. All other risks are lower than that predicted for these outcomes. The highest risks are predicted to occur at Bringelly and Luddenham.

13.5.2 Local surface waters

The following activities during construction of the proposed airport have the potential to result in impacts on surface water bodies:

- earthmoving activities and/or vegetation clearance resulting in potentially increased sediment loading in surface run-off;
- accidental spills of fuels or chemicals from construction vehicles which may discharge into surface water environments; and
- discharge of collected groundwater to surface water bodies which may contain potential contaminants that have not been adequately assessed prior to discharge.

These risks are typical of most major construction projects and standard precautionary measures are considered to be appropriate to address these issues. The recommended monitoring, management and mitigation measures identified in Chapter 18 are expected to reduce the potential for these risks to be realised during airport construction.

13.5.3 Sydney's drinking water catchment

Construction of the proposed airport is not located within the catchments for Warragamba Dam or Prospect Reservoir. However, there is potential that airborne particles from construction may be deposited within these two waterbodies through dispersion of airborne dust, potentially affecting water quality.

Warragamba Dam is approximately 11 kilometres from the airport site. Dispersion modelling forecasts an annual average deposition rate of 0.02 µg/m^3 at Warragamba due to airport construction. This is unlikely to result in a significant risk to water quality. Prospect Reservoir is located further away, approximately 18 kilometres from the airport site. Airborne particle deposition is therefore also unlikely to be a significant risk for this site, given the separation distance.

Dust suppression mitigation measures outlined for air quality in Chapter 12 would further reduce the risk of these impacts.

13.6 Mitigation and management measures

Potential impacts to human health associated with the construction and operation of the Stage 1 development would be directly related to potential noise, air quality and water quality impacts that are described in the relevant sections of this EIS. The mitigation measures described to manage potential issues associated with these other disciplines would be expected to reduce the potential impacts on community health. These mitigation measures are described in Chapters 10, 11, 12, 17 and 18.

13.7 Conclusion

The health risk assessment considers the likely health impacts of construction and operation of the Stage 1 development. The assessment considers the predicted risk associated with the proposed airport on community health from the most likely contaminant exposure pathways: air quality, noise and surface and groundwater.

Generally, the assessment found that the predicted health risk associated with the Stage 1 development would be low and in line with national and international standards of acceptability. The implementation of proposed mitigation measures associated with noise, air quality and surface and groundwater described in the relevant chapters of this EIS would reduce the predicted community health risks

The modelling used in the various inputs to the health risk assessment have been developed on a conservative basis, meaning that the health risks predicted represented conservative estimates of the predicted impact on human health. Environmental impacts, and by extension health risks, will continue to be regulated under the legislative framework in which the airport development would be developed, including the Airports Act, the formal future process for defining aircraft flight paths and the Environmental Management Framework outlined in Chapter 28 (Volume 2b).

14 Hazard and risk

This assessment considers the key hazards and risks that may arise from construction and operation of the proposed airport.

The analysis was based on a review of relevant project documentation including a number of studies conducted for the EIS and local and international aircraft safety data, a conceptual airspace risk model and a series of workshops with key project stakeholders.

Many aspects of the airport design are preliminary and a number of important considerations will be resolved during detailed design or closer to the commencement of operations. Certification of the aerodrome by the Civil Aviation Safety Authority will also be required before operations can commence, as well as implementation of the requirements of the existing regulatory framework.

Based on the design information currently available, no insurmountable construction or operational risks associated with the Stage 1 development are considered likely. Key issues that need to be finalised prior to operations include:

- resolution of potential offsite safety risks associated with jet fuel storage;
- work with relevant authorities to identify options for a pipeline corridor to secure future fuel supply by means other than road transport;
- additional bird and bat surveys to confirm the preliminary low strike risk identified to date;
- completion of a study to identify high velocity gaseous emissions in the proposed airspace which might pose a risk to aircraft; and
- implementation of development controls on public safety zones outside Commonwealth land.

Prior to operations commencing at the airport, a safety review would need to be undertaken in accordance with the requirements of the applicable work, health and safety legislation.

14.1 Introduction

As part of the development of the EIS, a hazard and risk review of the proposed airport was undertaken and is documented in detail in Appendix H (Volume 4).

The assessment of key risks associated with the construction and operation of the proposed airport adopted a precautionary approach, consistent with the provisions of the *Work Health and Safety Act 2011* (Cth) and *Work, Health and Safety Act 2011* (NSW). Due to the preliminary nature of the design, including indicative flight tracks, airspace and terminal design information, a comprehensive due diligence assessment of the proposed airport was not possible.

A review was therefore considered appropriate for the purposes of the EIS, given that a safety assessment to demonstrate due diligence in accordance with Work, Health and Safety (WHS) legislation would be required before the commencement of operations at the proposed airport. This chapter draws on that study and other work by the Australian Government agencies (such as Airservices Australia), as described in Chapter 7 (Volume 1).

14.2 Methodology

The study methodology comprised:

- documentation review – including the findings of the 1997–99 EIS risk study, current project design documentation, and national and international aviation safety statistics;
- legislative context review – to establish the legislative framework for the proposed airspace and ground operations at the proposed airport;
- development of a conceptual airspace risk model – to provide a framework for a systematic process to identify possible hazards and risks; and
- stakeholder workshops – to discuss identified risks and seek expert opinion on these and any other risks and treatments that should be considered for the proposed airport.

14.2.1 Document review

A number of background documents were reviewed as part of the hazard and risk assessment process, including:

- 1997–1999 Environmental Impact Statement: Technical Paper 10 – Hazards and Risks (PPK 1997);
- Western Sydney Airport: Preliminary Airspace Management Analysis (Airservices Australia 2015);
- Western Sydney Airport Climatological Review (Bureau of Meteorology 2015a);
- Western Sydney Airport Usability Report – Meteorological Impacts (Bureau of Meteorology 2015b); and
- Western Sydney Airport indicative airport layouts.

14.2.2 Legislative context

The following Commonwealth legislation applies to airports and aviation:

- *Civil Aviation Act 1988* (Civil Aviation Act)*;*
- Civil Aviation Regulations 1988;
- Civil Aviation Safety Regulations 1998*;*
- *Air Navigation Act 1920;*
- Airspace Regulations 2007;
- *Airports Act 1996* (the Airports Act)*;*
- Airports (Protection of Airspace) Regulations 1996 (APAR);
- Air Navigation Regulations 1947;
- Airport (Building Control) Regulations 1996;
- Airport (Environment Protection) Regulations 1997;
- Airports Regulations 1997;

- Airports (Control of On-Airports Activities) Regulations 1997;
- Airports (Ownership and Interests in Shares) Regulations 1996;
- *Aviation Transport Security Act 2004; and*
- Aviation Transport Security Regulations 2005.

The Civil Aviation Safety Authority (CASA) has primary responsibility for the safety regulation of civilian aircraft operations in Australia. The Civil Aviation Regulations 1988 and the Civil Aviation Safety Regulations 1998 provide the general regulatory controls for the safety of air navigation. The Regulations enable CASA to issue Manuals of Standards with detailed technical material, which support the regulations. The following Manuals of Standards are relevant to the proposed airport:

- Manual of Standards Part 139 – Aerodromes;
- Manual of Standards Part 139H – Standards Applicable to the Provision of Aerodrome Rescue and Fire Fighting Services;
- Manual of Standards Part 172 – Air Traffic Services;
- Manual of Standards Part 171 – Aeronautical Telecommunication and Radio Navigation Services; and
- Manual of Standards Part 173 – Standards Applicable to Instrument Flight Procedure Design.

Prior to the proposed airport commencing operations, CASA would need to be satisfied that appropriate operating procedures, and necessary infrastructure and personnel are in place to ensure the safety of aircraft operations in accordance with the Civil Aviation Act and the Civil Aviation Safety Regulations. Aircraft operations around the proposed airport would be controlled by the aviation-specific Commonwealth Acts and Regulations outlined above.

14.2.2.1 Airspace protection

The airspace at and around airports is protected under Part 12 of the Airports Act and the APAR. The protected airspace is defined within international standards as the space above two sets of operational surfaces above the ground around an airport, namely the:

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

The OLS is intended to provide protection for aircraft flying into or out of the airport when the pilot is flying by sight. The PANS-OPS surfaces are intended to safeguard an aircraft from collision with obstacles when the aircraft's flight may be guided solely by instruments, in conditions of reduced visibility.

14.2.2.2 Control of development in the vicinity of airports

The National Airports Safeguarding Framework (NASF) is a national land use planning framework, agreed to by Commonwealth, State and Territory Ministers in 2012. The NASF recognises that responsibility for land use planning rests with State and local governments, but that a national approach can assist in improving planning outcomes near airports and under flight paths.

The NASF guidelines provide comprehensive information and recommendations relating to six airport safeguarding matters. The NASF guidelines are:

- Guideline A: Measures for Managing Impacts of Aircraft Noise;
- Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports;
- Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports;
- Guideline D: Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation;
- Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports; and
- Guideline F: Managing the Risk of Intrusions into the Protected Airspace of Airports.

The assessment of proposed development in the vicinity of airports is primarily the responsibility of local government, based on declared airspace arrangements. Once the airspace has been declared for the proposed airport, surrounding councils would be notified and OLS and PANS-OPS requirements would be incorporated into local planning instruments. Developments with the potential to exceed the OLS must be referred to the airport operator and the Department of Infrastructure and Regional Development for review prior to the development being approved to proceed. The OLS applies to both building obstacles (e.g. antennae, masts or tall buildings) and hot or high velocity air emission (e.g. smokestacks, cooling towers) which may cause a potential hazard to aircraft. In addition to OLS, civil aviation regulations also require approval from CASA for the installation of lighting which might cause a distraction, glare or confusion for pilots.

14.2.2.3 Dangerous goods

There is specific legislation related to the management of dangerous goods. NSW WorkCover is the responsible authority for the storage and handling of dangerous goods including jet fuel. Australian Standard *1940-2004: The storage and handling of flammable and combustible liquids* (AS 1940-2004) deals with flammable liquids of dangerous goods classified as Class 3 substances (flammable liquids) in the UN *Recommendations on the Transport of Dangerous Goods – Model Regulations.* The objective of AS 1940-2004 is to promote the safety of persons and property where flammable or combustible liquids are stored or handled, by providing requirements and recommendations that are based on industry best practices.

The NSW Environment Protection Authority (EPA) regulates the transport of dangerous goods under the provisions of the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW). The approval authority for a fuel pipeline would be the NSW Department of Trade and Investment (Resources and Energy) under the provisions of the *Pipelines Act 1967* (NSW).

14.2.2.4 *Hazardous industries*

The NSW Department of Planning and Environment also provides guidelines for the planning and development of hazardous industry in NSW which applies to land outside of the airport site. Relevant guidelines include the NSW *Hazardous Industry Planning and Advisory Paper* (HIPAP) series of guidelines:

- HIPAP 4 – Risk Criteria for Land Use Safety Planning (January 2011); and
- HIPAP 10 – Land Use Safety Planning (January 2011).

14.2.3 Conceptual airspace risk model

In conceptual terms, the airport airspace risk analysis approach considers risks in three parts: the entry (arrival and landing), exit (departure and take-off) and transit through the relevant airport airspace. There are a number of factors that add complexity to an airport's airspace, including:

- terrain and weather;
- the number and variety of airspace activities;
- multiple runway operations (where applicable);
- possible increased traffic density from nearby airspaces;
- potential runway intrusions including animals;
- public and other environmentally sensitive facilities and activities adjacent to the airport that may affect operations (e.g. population centres, especially schools and hospitals);
- speed differentials between aircraft at the airport; and
- pilot experience differentials.

These issues were tested in stakeholder workshops in order to systematically consider possible airspace risks at the proposed airport and identify, in a preliminary manner, existing regulatory and potential other risk treatments.

14.2.4 Stakeholder workshops

Workshops with representative key stakeholders were completed to identify credible risk issues that should be addressed by the hazard and risk assessment.

Workshops or meetings were undertaken with the following stakeholders:

- Department of Infrastructure and Regional Development;
- Civil Aviation Safety Authority, Office of Airspace Regulation;
- Airservices Australia;
- NSW Department of Planning and Environment;
- Australia Federal Police; and
- NSW Rural Fire Service.

14.3 Identified key risks

The risk review process identified a list of key credible hazards that were the subject of analysis and discussion with stakeholders. These can be broadly considered as either airspace or ground-based risks and are outlined in Table 14–1. It should be noted that while each of these risks has a different likelihood of occurrence, they were identified on the basis that each could potentially result in either injury or loss of life to members of the public, airport workers or airline staff.

Table 14–1 Identified key risks

Airspace	Ground-based
Bat and bird strike	Aircraft fire (on the ground)
Drone and model aircraft strike	Building fire
Airspace obstruction	Fuelling fire
Mid-air collision with other aircraft	Grass fire
Military and emergency services operations	Fuel storage fire
High velocity air discharge	Contaminated land (during construction)
Adverse meteorology	Transport of dangerous goods
Aircraft crashes into critical infrastructure	Site flooding
Falling aircraft	Railway safety
Terrorism incidents	Bushfire

For the purposes of the hazard and risk assessment process, these risks were considered separately, as they may have different causes, and mitigation measures would be specific to each risk. For the purposes of the summary below, they have been grouped into broad categories for more general discussion.

14.4 Airspace risk overview

Australia has a good aviation safety record, comparable to other developed countries such as the United States, Canada and the United Kingdom. Statistics collected by the Australian Transport Safety Bureau (ATSB) indicate that the number of reported safety incidents in Australia has risen significantly over the past decade. However, not all incidents result in a physical accident and the growth in incidents reported needs to be considered in light of the continuing increase in aircraft movements. In 2013, among 3.3 million departures of high capacity public transport aircraft, there were 23 serious incidents (occurrences nearly leading to an accident) and two accidents in which serious injury or damage to an aircraft or person occurred.

The 23 aircraft involved in serious incidents in 2013 was the highest rate for this operation type in more than 10 years (ATSB 2014). The most common occurrences reported were wildlife strikes, adverse weather and aircraft system problems. Most accidents and serious incidents involved reduced aircraft separation distance, engine malfunction, or runway excursions.

No fatalities involving high capacity commercial aircraft operations similar to the type assessed for the proposed airport have occurred since 1975 and the number of reported fatal accidents and fatalities declined significantly from 1990 to 2005 to a level considered very low (ATSB 2006a).

14.4.1 Flight paths

Indicative flight paths have been developed by the Airservices Australia to model and assess the impacts of aircraft operations in the EIS. The indicative concept designs demonstrate that the Stage 1 Western Sydney Airport and Sydney Airport could safely operate independently as high capacity airports. A formal flight path design process design process will commence after the Airport Plan is determined. Chapter 7 (Volume 1) provides further detail on the indicative flight path design and the formal flight path design process. However, these indicative flight paths would avoid key infrastructure locations such as Defence Establishment Orchard Hills, the Warragamba Dam wall and Prospect Reservoir.

Commencement of operations of the second runway at the proposed airport would introduce additional complexity to airspace arrangements. Current analysis shows a broader reconfiguration of the Sydney basin airspace would likely be required. However, changes in land and improved navigation technology over time would influence the extent of future reconfiguration necessary.

A rigorous process of airspace design and approval would need to be undertaken prior to commissioning of a second runway. This two runway scenario at the proposed airport is discussed in Chapter 34 (Volume 3).

14.4.2 Navigation systems and air traffic management procedures

A variety of satellite and ground-based navigational aids would provide necessary safety for aircraft approaches and departures in reduced visibility conditions. The required accuracy, operation and availability of these facilities are strictly controlled under the Civil Aviation Safety Regulations. All aircraft that would operate at the proposed airport in reduced visibility conditions would need to be suitably equipped to use the available navigational aids. Radar services would assist air traffic control to manage air traffic in the controlled airspace surrounding the proposed airport under the Civil Aviation Safety Regulations.

A satellite assisted precision landing system, known as a ground based augmentation system (GBAS) is proposed for the airport. The system uses GPS signals to provide aircraft with very precise positioning guidance during the final stages of an approach and landing. Airservices Australia and the International Civil Aviation Organization (ICAO) recognise GBAS as a potential future replacement for current instrument landing systems and adoption of this technology is considered to be a critical component of next-generation air traffic management infrastructure. Each GBAS can precisely guide up to 26 approach flight paths simultaneously from up to 42 kilometres from the runway. The proposed airport would likely include two GBAS – one for each runway.

Another example of emerging technology in the aviation sector is the adoption of automatic dependent surveillance-broadcast for all instrument flight rules (IFR) aircraft. This system allows aircraft to broadcast their position, velocity and other flight details in real time for flight tracking. The technology is currently being rolled out in the Sydney basin. It is anticipated that the proposed airport would similarly adopt emerging technology and that future incidents would decrease.

14.4.3 Bat and bird strike

Birds are attracted to large, open grassed areas which are often found at airports. Such areas provide feeding, resting and nesting areas for many types of birds. Short grass provides protection against predators such as snakes, cats and foxes but may also attract predatory birds in search of rodents and other food sources. Water lying in drains and dams on the airport site may also provide habitat for birds. Large open hangars and other flat roofed buildings can also provide nesting areas for small birds.

The environment surrounding airports can also attract birds. These may be natural habitat areas (e.g. wetlands) or urban features such as landfills. Birds and flying foxes can transit across airports and flight paths while travelling between nesting, roosting and feeding sites.

Modern aircraft engines are designed to deal with bird or bat strike. The key issue is the size and flocking habits of the species in and around an airport. While in the worst case, bird or bat strike can lead to serious aircraft incidents, the more likely consequence is damage to aircraft and associated inconvenience to the travelling public.

A preliminary bird and bat strike report (see Appendix I (Volume 4)) identifies the type and number of species that would be likely in the vicinity of the proposed airport. It concludes that the risk at the proposed airport is comparably low relative to many other Australian airports that are situated in coastal areas where flocking birds are more likely to exist. Standard activities and procedures throughout the design, construction and operational phases including additional surveys and monitoring would be undertaken to confirm these preliminary results and reduce areas of potential habitat of various species before airport operations commence. This would include measures to be adopted both on and off-site, in accordance with the requirements of applicable regulations such as NASF, CASA Advisory Circular 139-26(0) and ICAO requirements.

14.4.4 Airspace obstructions

Airspace obstructions and distractions (e.g. lighting and glare) can be a threat to navigation, but these are controlled through CASA standards and guidelines and through development control procedures of local government. Additional hazards include hot air from discharge points such as smokestacks and cooling towers. Emissions above certain velocities, or chimneys above specified heights, are considered potential hazards in accordance with the APAR.

A preliminary survey for obstacles in and around the proposed airport was undertaken based on the anticipated OLS for both the northern and second runways. Before the start of airport operations, a survey would be required to identify existing industrial emissions that may pose a hazard to aircraft. Any future industrial developments within the declared airspace would need to be referred to the Department of Infrastructure and Regional Development and the Airport Lessee Company for comment prior to the development proceeding.

14.4.5 Adverse meteorology

In aviation terms, adverse meteorology refers to the following conditions:

- aircraft icing (freezing fog);
- crosswind (especially gusts);
- cyclones/tornados;
- fog (visibility);
- lightning (thunderstorm); and
- windshear (especially in the vicinity of the runway threshold).

The likely occurrence of these meteorological conditions at the airport site was investigated by the Bureau of Meteorology (see Appendix D (Volume 4)) and the outcomes are summarised in Chapter 7 (Volume 1). No unusual conditions are likely to exist at the site that would routinely interfere with safe operation of the proposed airport. An on-site automatic weather station would collect comprehensive baseline data of local weather conditions before the start of operations to support further analysis. Provided that appropriate airport operating parameters are established and complied with, operational safety concerns associated with adverse meteorology at the airport would be satisfactorily managed.

14.4.6 Aircraft accidents

Australia has a good aviation safety record comparable to other developed countries. No fatalities involving high capacity commercial aircraft operations similar to the type assessed for the proposed airport have occurred since 1975. The number of reported fatal accidents and fatalities declined significantly from 1990 to 2005 to a level considered to be very low (ATSB 2006a).

Aircraft accidents involving multiple fatalities are a rare occurrence in Australia and worldwide (ATSB 2006b). Figure 14–1 provides a summary of commercial jet aircraft operations, specific to the USA and Canada and the rest of the World combined, between 1959 and 2013 and indicates that over the 54 years of analysis, the annual fatal accident rate has reduced from 40 (1959) to less than 0.5 (2013) per million departures (Boeing 2014).

The Sydney Basin Aeronautical Study undertaken by CASA (CASA 2015) reported an improving safety trend in total airspace related incidents in the Sydney region. An airspace 'incident' includes events such as operational non-compliance with an air traffic control instruction, a missed approach and 'go-around', airspace infringements and non-compliance with aircraft separation standards. The rate of airspace incidents in relation to total recorded basin movements declined consistently over the five-year period between 2008 and 2013. The number of airspace related incidents more than halved (a reduction of 56.4 per cent) over this period.

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

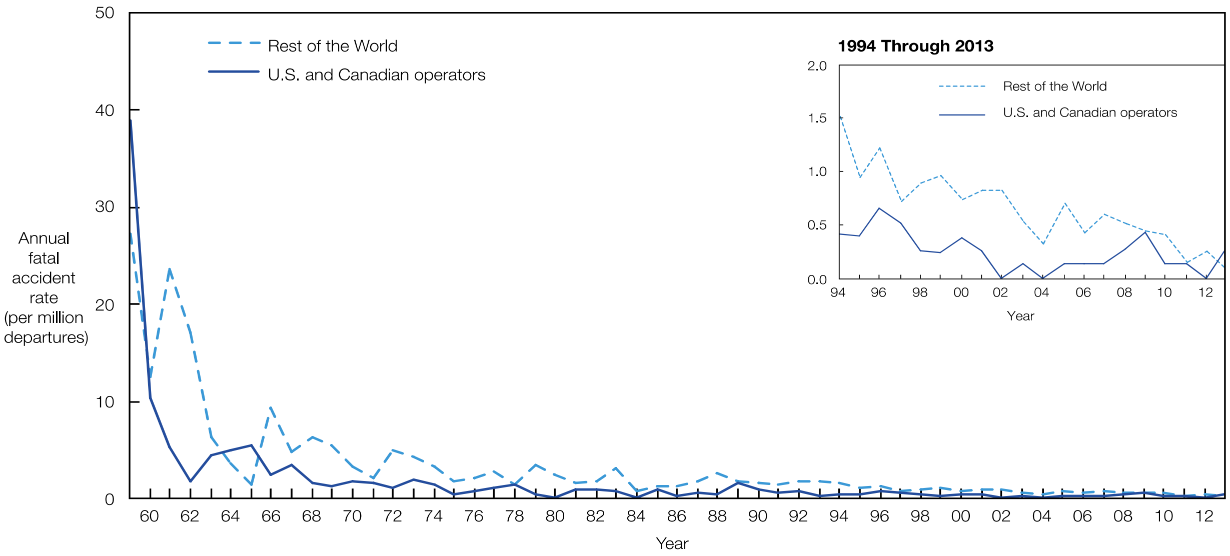


Figure 14–1 Summary of annual fatal accident rate between 1959 and 2013

Figure 14–2 summarises the percentage of fatal accidents by stage of flight which indicates that:

- 10 per cent are likely to occur on the ground during taxiing, loading/unloading, when the plane is being parked or towed;
- 14 per cent are during take-off or initial climb to cruising altitude;
- 10 per cent are during level flight at cruising altitude;
- 11 per cent are during descent and on initial approach to landing; and
- 47 per cent are during final approach or landing.

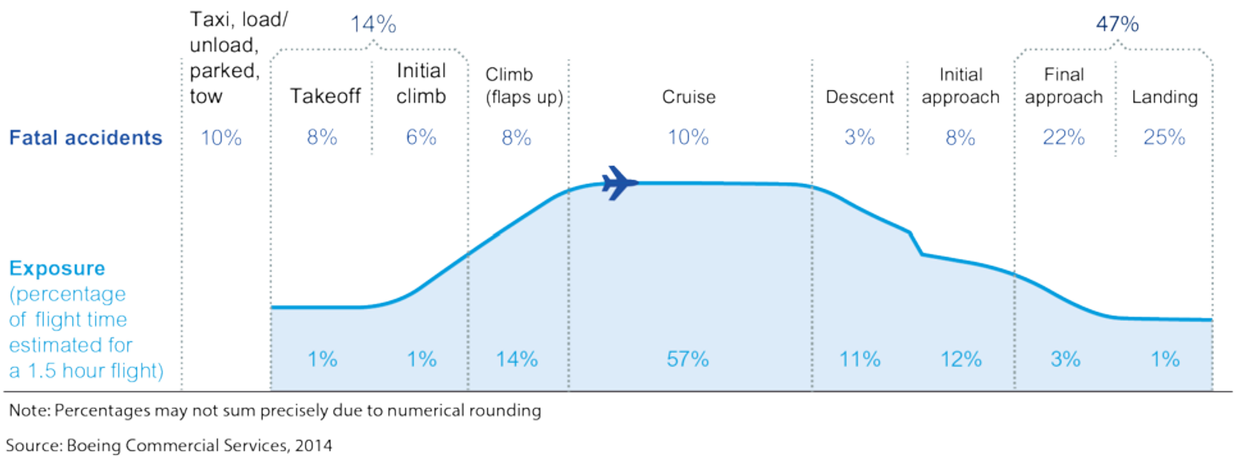


Figure 14–2 Percentage of fatal accidents by flight stage

ICAO reports that most aircraft crashes occur within 1,000 metres of landing and 500 metres of take-off (ICAO 2014). The Australian Government is working with the states and territory governments on the development of a national standard for public safety zones to be incorporated into the NASF. Public safety zones are areas of land at the ends of runways within which development may be restricted in order to control the number of people on the ground at risk of injury or death in the event of an aircraft accident on take-off or landing. While Australia has an excellent aviation safety record, there will always be an inherent risk associated with flying and operation of aircraft at or around airports. The use of public safety zones can further reduce the already low risk of an air transport accident affecting people near airport runways. In the absence of any nationally agreed guidance, a nominal 1,000 metre trapezoid-shaped clearance at the end of the runway threshold has been provided in the proposed airport concept.

An estimate of the likely risk of plane crashes resulting from the proposed airport has been undertaken based on the most recent year of accident data available. In 2013, Boeing reported five major accidents occurred worldwide in their fleet as a result of 25 million departures that year. This equates to an accident likelihood of 0.0000002 per cent per departure. Table 14–2 shows the likelihood of an accident for the proposed Stage 1 development based on forecast total annual air traffic movements and the 2013 accident statistics.

Table 14–2 Predicted likelihood of an accident for Stage 1 development

Total annual air traffic movements (passenger and freight)	Departures (per year)	Likelihood of major accident per departure	Major accidents per year	Years between major accidents	Years between major accidents on final approach or runway
63,000	31,500	0.0000002	0.0063	159	317

As indicated in the table, the accident rate for aircraft assessed for the proposed airport would be in the order of 1 in 150 years for all stages of flight. It should be noted that this estimate is based on forecast air traffic movements at the airport and an accident rate based on current aviation technology and practices around the world. As outlined in Section 14.4.2, aviation procedures and technology are continually improving, particularly in response to ongoing incident investigations, and therefore it is reasonable to expect that improved safety performance would occur with time.

14.4.7 Terrorism

At this preliminary design stage, no specific issues or precautions beyond those in use at Sydney Airport or other similar international facilities are envisaged for the proposed airport. The detailed design of the proposed airport facilities would be reviewed by security experts to ensure that adequate space for security facilities and personnel is provided and additionally, that the design minimises potential vulnerabilities.

14.5 Ground-based issues

14.5.1 Transport of dangerous goods

It is expected that jet fuel would initially be transported to the airport site by B-Double road tankers. Approximately five years after opening, the expected fuel demand would require approximately 43 B-Double fuel deliveries per day. This is not a large number of trucks, relative to road capacity or existing heavy vehicle volumes. This number of deliveries is expected to rise in line with the increased aircraft movements at the airport. However, the actual volumes of fuel required onsite to support aircraft operations will be largely determined by the airlines as a result of aircraft scheduling.

Although it is not currently possible to identify the specific traffic routes likely to be used for fuel deliveries, it is expected the majority of the trip would be by high capacity, arterial roads and/or motorways. It is anticipated that fuel truck movements would comply with relevant legislation and that transportation routes will avoid tunnels in accordance with existing industry practice.

It is expected that a fuel supply pipeline would replace road tanker deliveries, likely before the operation of the second runway. A route for a fuel pipeline will be determined by the entity or organisation responsible for providing fuel to the airport and likely, in consultation with the NSW Government. Arrangements for access to the fuel pipeline, which may involve an easement, would be required along the pipeline corridor alignment for emergency response, maintenance and as a public safety measure. Ensuring such access may require planning controls including restricting development on, and adjacent to, the pipeline.

14.5.2 Fuel storage and other fires

A fuel farm will be located near the north-western boundary of the airport, off Anton Road. During the Stage 1 development, the fuel farm will include up to four fuel tanks providing volume for three days' supply. The design of the fuel storage will include protection bunds and safety buffers.

For the purposes of investigating potential off-site risks from the fuel storage, ignition of a 100 x 100 metre bunded fuel storage area was modelled in a fire dynamics simulation with 20 knot winds blowing towards off-site areas. The assessment was considered worst case given that winds exceeding 20 knots are rare at Badgerys Creek (BOM 2015a).

The results of the simulation are presented in Figure 14–3. The vertical coloured bar on the right hand side indicates the heat at different distances from the simulated fire.

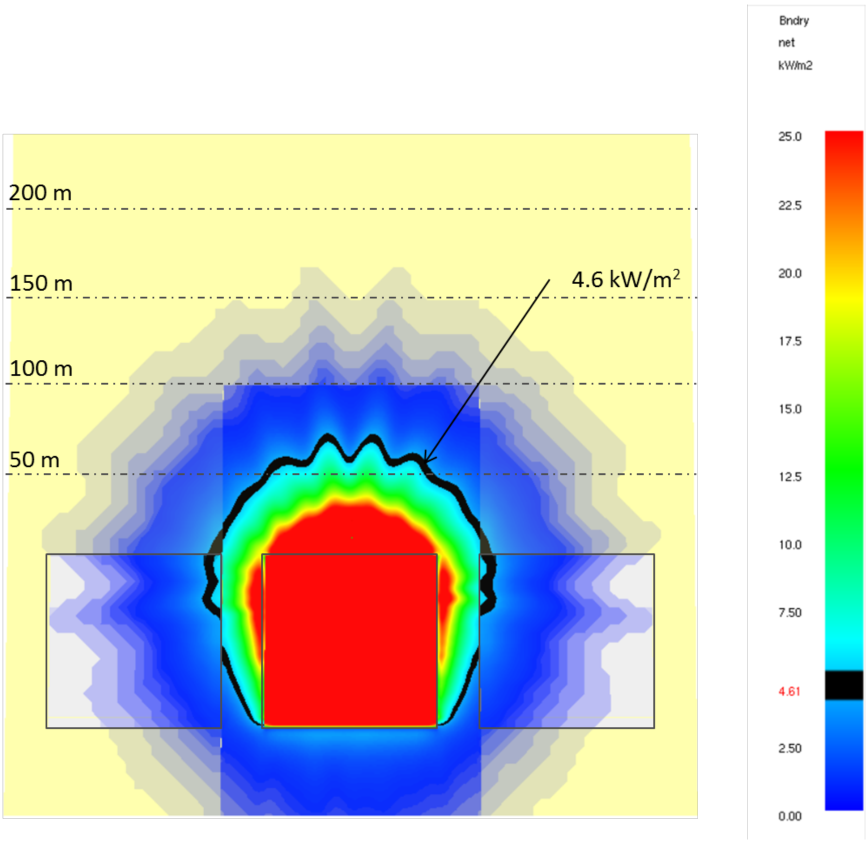


Figure 14–3 Fire dynamic simulation model for a kerosene fire with 20 knot winds

Hazardous Industry Planning Advisory Paper (HIPAP) 4 (Department of Planning and Environment 2011a) outlines the potential consequences of varying levels of heat flux on structures and people, noting that the ultimate effect would depend on the duration of exposure. In general terms, buildings should be located outside of a heat flux level of 12.6 kilowatts per square metre (kW/m^2) which is the point at which timber can ignite after prolonged heat exposure and insulated steel can buckle. Buildings outside the 2.1 kW/m^2 heat flux level would not typically require special fire protection measures to be adopted.

The preliminary fire modelling shows that a buffer of at least 50 metres is required from the edge of the storage bund to all airport site boundaries to avoid a heat flux level of 12.6 kW/m^2. The current conceptual design of the fuel storage facility at the proposed airport would satisfy this requirement by incorporating an 80 metre buffer to the airport site boundary.

The current land use zoning of property neighbouring the fuel storage allows for the development of residential dwellings. However, rezoning of the surrounding area is expected to occur as a result of the airport. In consideration of potential injury to people in these locations, HIPAP 10 indicates that a heat flux level of 4.7 kW/m^2 should not be exceeded at a frequency of more than 50 chances in a million per year. This level represents the possibility of injury for people who are exposed for more than 30 seconds and are unable to be evacuated or seek shelter.

As shown in Figure 14–3, this heat flux level would only be achieved beyond approximately 80 metres from the edge of the storage bund. Therefore, further risk calculations may be required to determine the frequency of such an event to meet the NSW DP&E off-site risk criteria.

Other fires associated with tanker truck discharge, fires in terminal buildings or other areas or aircraft are also possible, but would likely to be smaller. Standard design precautions would be adopted for all infrastructure. Additionally, an aviation rescue fire-fighting station is proposed for the Stage 1 development. A mutual aid agreement with the NSW Rural Fire Service would also be put in place before airport operations commence.

14.5.3 Flooding

The potential for flooding at the proposed airport is assessed in detail in Chapter 18. The concept design for the proposed airport includes a drainage strategy for the site. The airport infrastructure is located outside the 100-year average recurrence interval (ARI) flood extent of Badgerys Creek, Duncans Creek and Oaky Creek. Existing creeks at the airport site would be removed and replaced with an extensive stormwater drainage network including a series of detention basins. These would be created during the construction stage and remain in use during airport operation.

The airport infrastructure has been designed in accordance with the Stormwater Drainage Design Manual, which identifies standards for aerodromes and is consistent with current industry practice. The manual sets minimum flood immunity requirements for airport infrastructure as shown in Table 14–3. Consideration has also been given to Australian Rainfall and Runoff (Engineers Australia 1987) recommendations, including the need to make appropriate allowances in the design for blockage of stormwater structures.

The table shows that, for key infrastructure such as runways and taxiways, flood immunity would be required for a 50 year ARI event as a minimum, with additional restrictions on the duration for which any water can pond nearby.

During construction, the effects of changes to the site topography would be mitigated by a network of flood detention basins. A detailed Soil and Water Construction Environmental Management Plan would be developed to manage the impacts of on-site flooding during the construction period.

Table 14–3 Typical flood criteria for aerodromes

Aerodrome Area	Criterion	Annual recurrence interval
Pavements		
Runways	No ponding	50 years
Taxiways	No ponding	50 years
Apron	No ponding	10 years
Other paved areas	No ponding within 30 metres of buildings	50 years
Grassed areas		
Runway strip	Ponding within 75 metres of runway centreline not to exceed 12 hours	5 years
Taxiway strip and apron flanks	Ponding within 15 metres of pavement edge not to exceed 12 hours	5 years

14.5.4 Railway safety

The Australian Government and NSW Governments are undertaking a Joint Scoping Study on the rail needs for Western Sydney, which includes the proposed airport. The study will consider the best options for future rail links, including decisions about timing and rail service options, both directly to the airport site and within the Western Sydney region.

A specific alignment or station location for the airport rail link is yet to be confirmed, however planning for the airport preserves flexibility to accommodate several possible rail alignments. This would be resolved as part of the future design and planning for the proposed airport in conjunction with Transport for NSW and DP&E. Any such work is expected to be subject to a separate approval process.

Underground trains and stations have special safety and operational considerations which would be taken into account in the railway design and approvals process.

14.5.5 Bushfire

A bushfire risk assessment was conducted as part of the design development of the proposed airport. The proposed airport would be a significant commercial asset, located in a landscape that contains vegetation and landscape features that may represent a bushfire risk. It is noted that over time this risk may reduce as a function of the broader urbanisation of Western Sydney.

The most likely scenario for fire at the airport site would be from a large grass fire starting to the west of the site under hot, dry north-westerly, westerly or south-westerly winds. Construction and operation of the proposed airport also has the potential to provide sources of ignition that, under adverse winds, could allow a fire to escape off site.

A Bushfire Management Plan for the Commonwealth owned land at Badgerys Creek has been prepared and implemented to manage current bushfire risk and identify response actions. The existing plan will be revised and updated by the Department of Infrastructure and Regional Development prior to Main Construction Works for the airport and would contain procedures for how site personnel should respond in the event of a bushfire occurring within or threatening the site. The plans would be prepared in consultation with the NSW Rural Fire Service.

14.5.6 Contaminated land

A range of contaminants associated with prior land uses may be present at the airport site. Previous and current land uses at the airport site that may potentially result in contamination include agriculture, light commercial and building demolition works. Contaminants of potential concern evidenced at the airport site include fuels, lubricants, solvents, acids, asbestos, heavy metals, ash, herbicides, pesticides and pathogens. Furthermore, about half the properties at the airport site are considered to present at least moderate risk of asbestos contamination.

A contaminated land assessment was undertaken at the airport site including a desktop assessment and site investigation. A number of mitigation and management measures are proposed to control risks associated with contamination including an asbestos management plan, remedial action plan and unexpected finds protocol. The assessment and associated mitigation and management measures is documented in Chapter 17.

14.6 Mitigation and management measures

While a number of potential risk issues were identified and analysed by the hazards and risk study, the majority:

- could be satisfactorily resolved through further design and regulatory processes or studies already underway;
- would not require the adoption of project-specific measures or measures that are not already required by existing industry legislation and standards; or
- would be the responsibility of other statutory authorities to implement, in consultation with the Department of Infrastructure and Regional Development and the future Airport Lessee Company.

These issues and the responsible parties are summarised in Table 14–4.

The key remaining mitigation and management measures to be resolved in future design stages are provided in Table 14–5.

Table 14–4 Identified issues and responsible parties

Responsible organisation	Identified risk	Considerations
Department of Infrastructure and Regional Development	Future formal flight path design process	• avoidance of military and emergency services operations from surrounding airfields, existing airspace obstacles, surrounding critical infrastructure and site-specific meteorology; and • consideration of possible future flight paths associated with the long term development and proposed second runway so that changes in surrounding land use over the intervening period can be appropriately managed.
Civil Aviation Safety Authority	Safe operation of aircraft	• aerodrome certification of the proposed airport facilities and equipment are in accordance with the applicable standards and operating procedures make satisfactory provision for the safety of aircraft operations; • regulation of drone and model aircraft; and • specification of new technology/procedures as demonstrated to be effective.

Responsible organisation	Identified risk	Considerations
Airport Lessee Company	Appropriate design and safe operation of the proposed airport and facilities	• preparation of an aerodrome manual; • installation and operation of automatic weather station in consultation with the Bureau of Meteorology; • compliance/adoption of new technology/ procedures specified by CASA; • detailed design of the proposed airport and facilities in accordance with industry standards and regulations e.g. terminal, railway and fuel storage; • provision of necessary safety and contingency procedures and facilities in accordance with guidelines; • ongoing management of wildlife at the airport in accordance with CASA Manuals of Standards and operational management plan; • preparation of an airport master plan in accordance with the Airports Act; • participate in planning coordination forums and community aviation consultation groups; and • conduct a risk and safety study prior to operation of the Stage 1 development in accordance with the requirements of WHS legislation.
Aircraft manufacturers and airline operators	Fuel exhaustion Mechanical failure Pilot error Inflight fire	• continuous improvement and response to identified issues
Local councils	Airspace intrusion	• refer potential conflicts to the Airport Lessee Company and Department of Infrastructure and Regional Development.

A biodiversity land and safety Operational Environment Management Plan (OEMP) detailed in Chapter 28 (Volume 2b) will incorporate these mitigation and management measures in Table 14–5. A biodiversity OEMP will be approved prior to commencement of operation of the proposed airport.

Table 14–5 Mitigation measures to be resolved in future design stages

Issue	Mitigation and management measure	Timing
Wildlife hazard management plan	To manage the risk of fauna hazard and bird and bat strike a wildlife hazard management plan will be developed and implemented. The plan will include the following measures: • the conduct of additional surveys to study and monitor for changes in species and movement patterns. The surveys will be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species; • the review of detailed design documentation to identify potential bird and bat attractants; • liaison with local government in relation to plans for proposed developments within 13 kilometres of the airport site that are likely to increase the bird and bat strike risk; • active management of bird and bat presence at the airport site six months prior to the commencement of airport operations; and • the outcomes of bird and bat strike monitoring will be reviewed by a wildlife strike expert and the results taken into account in any audit of the airport's impacts on wildlife in and around the airport site.	Pre-operation Operation

Issue	Mitigation and management measure	Timing
Fauna hazard	To minimise bird and bat strike risk and terrestrial fauna strike risk, the design of the proposed airport will seek to minimise the attractiveness of the airport site to fauna. To achieve this, the following measures will be incorporated into the detailed design process: • drains, water basins and other airfield components that minimise the availability and attractiveness of water and other potential roosting, nesting or foraging habitat; • an appropriate fence to restrict terrestrial animal access to the airfield; and • airside access roads to facilitate active wildlife management.	Pre-operation
Fuel storage	To reduce the risk of hazardous incidents and ensure compliance with relevant offsite risk criteria the fuel farm will be managed having regard to any further hazard investigations undertaken and operating procedures establish during detailed design.	Pre-operation Operation

14.7 Conclusion

At this preliminary design stage of the proposed airport, adequate precautions have been identified to resolve safety and risk issues. Ongoing design processes would further consider these issues and future regulatory approvals would need to be achieved before operations could commence. This includes the future formal airspace design process to be led by the Department of Infrastructure and Regional Development in close collaboration with Airservices Australia and CASA, the detailed design of the airport in accordance with the approved Airport Plan (including any conditions in the Airport Plan arising out of the EIS and made by the Environment Minister) and the aerodrome certificate from CASA.

The recommended mitigation measures would reduce hazards and risk during construction and operation of the airport, both for airspace and ground-based activities.

15 Traffic, transport and access

The road network in the vicinity of the airport site is currently relatively uncongested, with only sections of The Northern Road, Narellan Road, Elizabeth Drive and Mamre Road experiencing congested conditions in peak periods. This is a result of these being relatively high capacity arterial roads and the existing low density land uses in the area. While there is currently spare capacity on much of the network near the airport site, there is congestion on the broader strategic network including the M4 Motorway, M5 Motorway, M7 Motorway and M31 Hume Highway.

Significant road improvement works are underway as part of the Western Sydney Infrastructure Plan announced in 2015 by the Australian and NSW governments. These improvements will relieve existing bottlenecks and provide additional network capacity over the next decade, while also connecting the airport site to the broader road network.

The peak construction period for the proposed Stage 1 development would generate an estimated 1,254 additional vehicle movements per day on the surrounding road network. This equates to around 150-160 vehicle movements during the AM and PM peak periods. In the context of the capacity of the arterial roads and motorways in Western Sydney, these additional movements would not result in additional congestion. Movements of oversized vehicles or plant and equipment may at times require temporary road closures or escorts to the site but these would generally be conducted outside of peak hours.

A community awareness programme would be implemented during construction to ensure that the local community and road users are kept informed about construction activities and the potential for delays. A Traffic and Access Construction Environmental Management Plan would be implemented to ensure that the movement of construction traffic (including any oversize vehicles) is appropriately managed. The plan would be prepared in consultation with Councils and NSW Roads and Maritime Services.

Stage 1 operations are expected to result in approximately 21,562 vehicles entering the airport site and 21,556 vehicles leaving the airport site each day. The Stage 1 development would generate additional traffic volumes on: Elizabeth Drive, the M12, The Northern Road, Luddenham Road and Mamre Road. However, considering road improvements included as part of the Western Sydney Infrastructure Plan, including the introduction of the M12 Motorway, this volume of additional traffic would not substantially impact the operation of the surrounding road network.

Modelling indicates that Stage 1 operations are predicted to result in:

- an increase in congestion:
  - on the M7 southbound, south of the M4;
  - on sections of the M12, noting that the M12 is still well within capacity;
  - on Elizabeth Drive, east and west of the M7, noting that the Stage 1 development exacerbates existing congestion levels that already exist at these locations;
  - on The Northern Road, north of Elizabeth Drive; and
- a small decrease in congestion on Mamre Road northbound, north of Elizabeth drive.

The public transport, walking and cycling infrastructure proposed by the NSW Government and local councils would also be planned and implemented to cater for the expected airport passenger and employee demand at the proposed airport.

The Australian and NSW governments are undertaking a joint scoping study into Western Sydney's rail needs, which will help to determine the need, cost, timing and route of a future rail connection to the airport site.

15.1 Introduction

This chapter provides a review of the expected traffic and transport impacts associated with the construction and operation of the Stage 1 development. It draws on a comprehensive surface transport and access study (see Appendix J (Volume 4)), summarising the study's main findings and identifying mitigation measures to address potential impacts. This chapter also presents the results of updated traffic modelling completed following exhibition of the draft EIS as a result of a more recent version of the Strategic Travel Model being provided by the NSW Government. The STM3 update included revised forecasts of future population and development projects in Sydney.

The assessment addresses the requirements of the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Australian Government Department of the Environment. The EIS Guidelines include a requirement to assess all relevant impacts including specific consideration of changes in traffic movements during construction and operation (associated with both passenger movements and workers).

15.2 Methodology

15.2.1 Assessment approach

Assessment of the potential traffic, transport and access impacts has considered both the construction and operation of the proposed Stage 1 development.

For the construction phase, the assessment focuses on traffic impacts that would be associated with the haulage of materials, plant and equipment, as well as the traffic generated by construction workers at the airport site. For the purpose of analysing the potential construction impacts, 2021 was selected as representative of the peak construction year, during which the highest number of construction vehicle movements are likely to be generated.

For the operation phase, the assessment focuses on the impact of the proposed airport on wider transport networks in the Western Sydney region. Two modelling 'scenarios' were developed for the purpose of this assessment:

- 'without airport' which represents the likely transport network improvements and likely population and employment size and distribution, without consideration of the expected additional demand generated by the proposed airport; and
- 'with airport' which includes consideration of the expected additional demand generated by the proposed airport.

The operational assessment involved:

- determination of the trips expected to be generated by the proposed airport;
- analysis of how those trips are likely to be distributed across the transport system;
- assessment of the resulting impacts on the transport system; and
- identification of appropriate mitigation measures to alleviate the impacts.

For the purposes of this assessment, no rail line has been assumed to be provided for the Stage 1 development. Rail access to the airport is included in the assessment of the long term development (see Chapter 33 (Volume 3)).

15.2.2 Transport modelling and analysis

15.2.2.1 Strategic Travel Model

The potential impacts of constructing and operating the proposed Stage 1 development were assessed using the STM (Version 3). The STM is a tool, provided by the NSW Bureau of Statistics and Analytics for projecting travel patterns in the Sydney Greater Metropolitan Area (GMA) under different land use and transport scenarios. The model is typically used to test alternative settlement, employment and transport policies, identify likely future capacity constraints, or determine potential usage levels of proposed new transport infrastructure or services.

The STM is programmed in five-yearly increments to account for expected urban development and background traffic conditions. Commencing in 2011, the years included in the model are 2011, 2016, 2021, 2026, 2031 and 2036. The year 2031 has been adopted for the operational traffic assessment because it is broadly consistent with the other EIS assessments undertaken (which adopt 2030 as the year of assessment) and it avoids the need to extrapolate from other time periods in the traffic model. It also provides a consistent basis for comparing outputs from this assessment with other studies using the STM3 model.

15.2.2.2 Airport passenger demand

Airport passenger demand was based on a synthetic aircraft flight schedule provided for the year 2030. The adoption of the 2030 reference year does not affect the general conclusions about the proposed airport's impacts on travel volumes and road capacities.

15.2.2.3 Modelling process

Transport modelling typically comprises four main stages:

1. determination of trip generation, or travel frequency (how many trips would occur to and from a nominated travel zone with regard to the demographics and land uses of that zone);
2. trip distribution (where these trips are likely to go);
3. assignment of travel mode choice (car, bus, rail or a combination); and
4. assignment of route (chosen for each trip and mode, and between each origin and destination). This stage provides the detail for the number of vehicles on each road and people on each public transport service.

For the purposes of this assessment, the following adjustments to the model were necessary:

- removal of trips destined for airport travel zones. This allows assessment of a scenario that includes other proposed development in Western Sydney but does not include the proposed airport (the 'without airport' scenario). This scenario can subsequently be used to identify the specific impact of the proposed airport when added into the model;
- changes to the number of trips to and from the airport site for cars, light goods, rigid and articulated vehicles. This represents construction traffic in 2021 and traffic associated with Stage 1 operations;

- inclusion of additional road infrastructure in the form of the proposed M12 Motorway. This project is currently in the planning phase. The proposed M12 Motorway is expected to run generally parallel to Elizabeth Drive and provide direct motorway-grade access to the proposed airport. The M12 project and any associated environmental assessment and approval requirements are the responsibility of NSW Roads and Maritime Services (Roads and Maritime). The M12 is planned to be operational when the proposed airport opens and is therefore included in all ‘without airport’ and ‘with airport’ model scenarios.

The proposed corridor for the Outer Sydney Orbital has not yet been defined and was therefore not included in the modelling and assessment undertaken for the proposed Stage 1 development.

Following these model alterations, the revised travel demand was reassigned to the road network. This was done for the STM AM peak period (7.00 am to 9.00 am), the PM peak period (3.00 pm to 6.00 pm), the period between these peaks (interpeak period) (9.00 am to 3.00 pm), and the evening period (6.00 pm to 7.00 am). Only the AM peak and PM peak are reported in this assessment because these are the periods during which the capacity of the road network is most constrained.

15.2.2.4 Trip generation and modelling assumptions

For the assessment of construction impacts, daily light vehicle numbers were estimated using the assumption that 80 per cent of construction personnel would drive to and from the airport site on any given day, and that the remainder would either use public transport or car-pooling. Heavy vehicle volumes were estimated following an analysis of the indicative construction schedule described in Section 6.2.1 (Volume 1) of this EIS.

Trip generation and traffic generation associated with Stage 1 operations were estimated using the Sydney Airport Land Transport Model (SALTM). This model describes the types of trips to Sydney Airport and is based on surveys completed in 2008.

The modelling process utilised SALTM but has also taken into account recent developments in airport operations, such as self-check-in and bag drop-off as well as notification of security clearance times, which generally allow people to arrive at the airport closer to their flight departure time.

15.2.2.5 Assessment criteria

Assessment of the potential traffic, transport and access impacts has been undertaken with reference to the *Guide to Traffic Generating Developments* (RTA 2002). This guideline is commonly used in NSW and is therefore likely to be familiar to NSW stakeholders and the community. The operational traffic assessment process outlined in the guidelines stipulates that the operating characteristics need to be compared with agreed performance criteria as described below.

Mid-block capacity

The capacity of urban roads is generally determined by the capacity of the intersections or the ‘mid-block’ capacity (the sections of roads between intersections). The mid-block capacities for roads can be estimated and compared to the existing traffic volumes in terms of volume to capacity ratios (VCR).

The VCR is a measure of the amount of traffic carried by a section of road compared to its nominal capacity. As VCR nears one, the speed on the link decreases and both the likelihood and the duration of flow breakdowns increase.

The Austroads *Guide to Traffic Management*[5] outlines Level of Service (LoS) criteria for mid-block sections of road based on the VCR. A summary of LoS criteria is presented in Table 15–1.

Table 15–1 Level of Service descriptions for roads

Level of Service (LoS)	Uninterrupted flow facilities (motorways)	Uninterrupted flow facilities (arterial and collector roads)	Volume/capacity ratio
A	Free flow conditions in which individual drivers are unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.	Primarily free flow operations at average travel speeds, usually about 90% of the free flow speed (FFS) for the given street class. Vehicles are completely unimpeded in their ability to manoeuvre within the traffic stream. Control delay at signalised intersections is minimal.	0.00 to 0.34
B	Zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is less than with LoS A.	Reasonably unimpeded operations at average travel speeds, usually about 70% of the FFS for the street class. The ability to manoeuvre within the traffic stream is only slightly restricted and control delays at signalised intersections are not significant.	0.35 to 0.50
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.	Stable operations, however, ability to manoeuvre and change lanes in mid-block locations may be more restricted than at LoS B, and longer queues, adverse signal coordination or both may contribute to lower average travel speeds of about 50% of the FFS for the street class.	0.51 to 0.74
D	Close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.	A range in which small increases in flow may cause substantial increases in delay and decreases in travel speed. LoS D may be due to adverse signal progression, inappropriate signal timing, high volumes or a combination of these factors. Average travel speeds are about 40% of FFS.	0.75 to 0.89
E	Occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.	Characterised by significant delays and average travel speeds of 33% of the FFS or less. Such operations are caused by a combination of adverse progression, high signal density, high volumes, extensive delays at critical intersections and inappropriate signal timing.	0.90 to 0.99

[5] *Part 3: Traffic Studies and Analysis (2009)*

Level of Service (LoS)	Uninterrupted flow facilities (motorways)	Uninterrupted flow facilities (arterial and collector roads)	Volume/capacity ratio
F	In the zone of forced flow. With LoS F, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result.	Characterised by urban street flow at extremely low speeds, typically 25% to 33% of the FFS. Intersection congestion is likely at critical signalised locations, with high delays, high volumes and extensive queuing.	1.0 or greater

Source: Adapted from Austroads Guide to Traffic Management – Part 3: Traffic Studies and Analysis.

15.3 Existing environment

15.3.1 Existing road network

Roads and Maritime define four levels in a typical functional road hierarchy, ranging from high mobility and low accessibility, to high accessibility and low mobility. These road classes are:

- Arterial Roads – controlled by Roads and Maritime, they typically exhibit no limit in flow and are designed to carry vehicles long distances between regional centres;
- Sub-Arterial Roads – can be managed either by council or by Roads and Maritime under a joint agreement. Typically, their operating capacity ranges between 10,000 and 20,000 vehicles per day. Their aim is to carry through-traffic between specific areas in a sub region, or provide connectivity from arterial road routes (regional links);
- Collector Roads – provide connectivity between local sites and the arterial road network, and typically carry between 2,000 and 10,000 vehicles per day; and
- Local Roads – provide direct access to properties and the collector road system and typically carry between 500 and 4,000 vehicles per day.

A description of the roads within and servicing the airport site, including their functional category is provided in Table 15–2. The location of these roads and the broader land use context are shown in Figure 15–1. The areas surrounding the airport site are mostly rural residential properties with a few residential areas adjacent to The Northern Road and Park Road intersection and further south of The Northern Road.

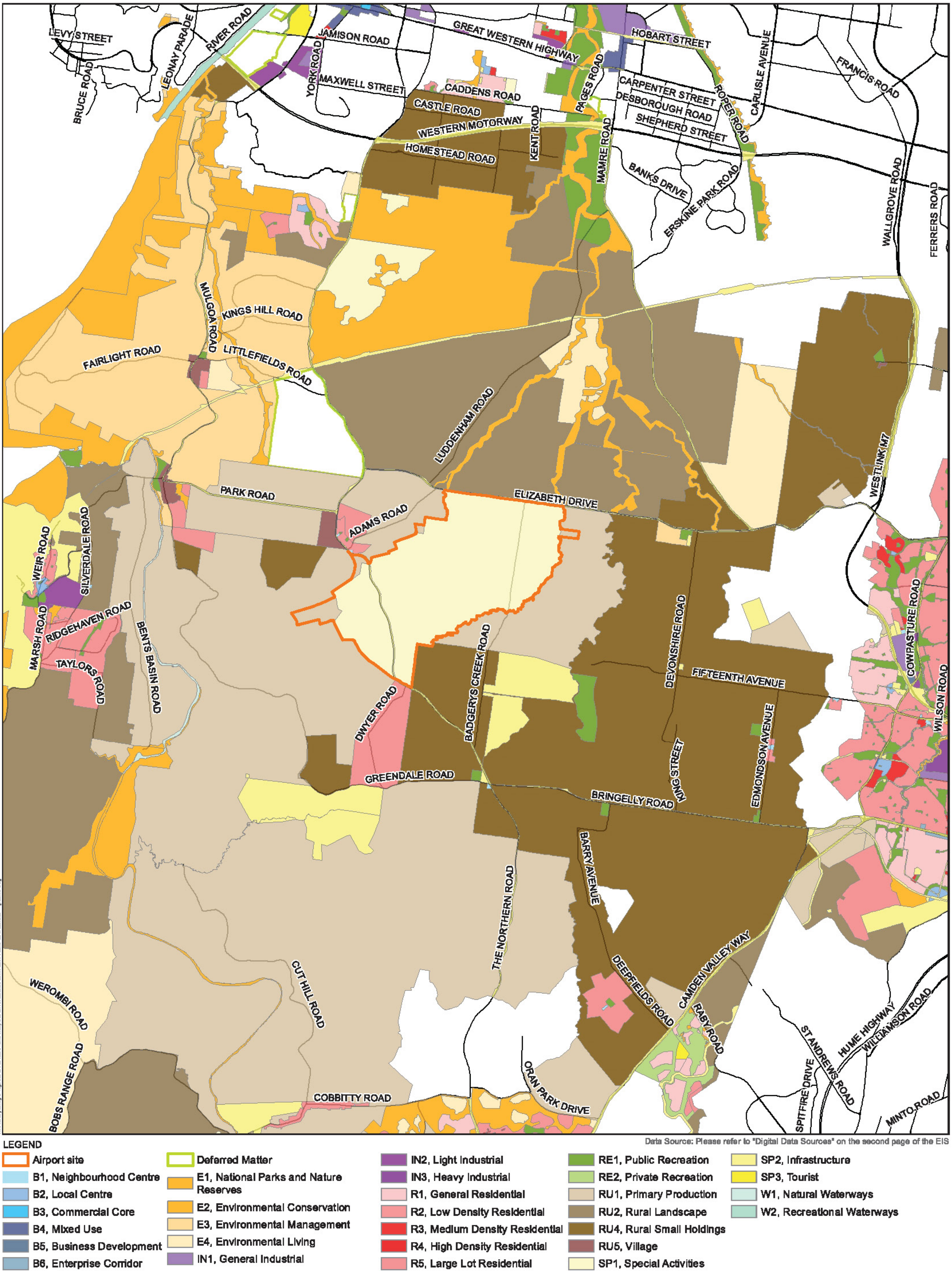


Figure 15.1 - Existing road network and land use

Table 15–2 Existing roads servicing the airport site

Road	Functional category	Description
Westlink M7 Motorway	Arterial	The M7 Motorway connects Western Sydney with the broader road network and Sydney CBD by providing an uninterrupted journey between the M2, M4 and M5 motorways. It is a fully electronic toll road that uses a distance based tolling system with no toll booths. In the vicinity of Elizabeth Drive, the M7 has two lanes in each direction separated by a grass median around 14 metres wide. The M7 provides for travel at variable speeds up to 100 kilometres per hour. An off-road shared cycle / pedestrian pathway traverses the motorway and connects with the Sydney Cycleway network.
The Northern Road	Arterial	The Northern Road connects Narellan in the south-west to the Great Western Highway in Penrith. In the vicinity of Luddenham, The Northern Road has an undivided carriageway with one lane in each direction and a sign posted speed limit of 80 kilometres per hour.
Elizabeth Drive	Arterial	Elizabeth Drive connects The Northern Road at its western end, and the M7 Motorway at its eastern end. Between The Northern Road and the Mamre Road roundabout, Elizabeth Drive has an undivided carriageway with one lane in each direction and a sign posted speed limit of 80 kilometres per hour. Elizabeth Drive between Mamre Road and the M7 has two eastbound lanes and one westbound lane. In the vicinity of Wallgrove Road, Elizabeth Drive carries around 26,000 vehicles per day.
Bringelly Road	Collector	Bringelly Road connects to The Northern Road at Bringelly and to Camden Valley Way at Horningsea Park. Bringelly Road is around 10 kilometres in length and has an undivided carriageway with one lane in each direction, unsealed shoulders and a sign posted speed limit of 80 kilometres per hour for the majority of its length.
Badgerys Creek Road	Collector	Badgerys Creek Road connects The Northern Road at a roundabout to the north of Bringelly to Elizabeth Drive, and is around seven kilometres in length. The carriageway is undivided with one lane in each direction, unsealed shoulders and a sign posted speed limit of 80 kilometres per hour. The component of Badgerys Creek Road within the airport site was compulsorily acquired by the Australian Government.
Adams Road	Collector	Adams Road connects The Northern Road at Luddenham to Elizabeth Drive. The carriageway is undivided with one lane in each direction and a sign posted speed limit of 70 kilometres per hour.
Mamre Road	Arterial	Mamre Road connects the Great Western Highway in St Marys to Elizabeth Drive. Mamre Road has an undivided carriageway with one lane in each direction and a sign posted speed limit of 80 kilometres per hour.
Luddenham Road	Collector	Luddenham Road connects Elizabeth Drive at Luddenham to Mamre Road. The carriageway is undivided with one lane in each direction and a sign posted speed limit of 80 kilometres per hour.
Local roads within the airport site	Local	The following local roads are located within the airport site: Ferndale Road; Fuller Street; Gardiner Road; Jackson Road; Jagelman Road; Leggo Street; Longleys Road; Pitt Street; Taylors Road; Vicar Park Lane; and Winston Close. These roads were compulsorily acquired by the Australian Government in July 1991 and are currently maintained by Liverpool City Council under an agreement with the Australian Government. These roads will be progressively closed when they are no longer required.

15.3.2 Traffic volumes and profile

Daily traffic volumes recorded for roads within the vicinity of the proposed airport are provided in Table 15–3. Data presented are for 2005 (the last year these counters were in operation) and represent a combination of vehicle counts and axle pair counts. An axle pair is the equivalent of a passenger car (passenger car unit) with two axles and is a standard method of determining the volume of traffic passing a counting location. A correction factor is applied to the axle spacing to determine a volume for heavy vehicles.

Table 15–3 Average annual daily traffic 2005

Location	Average annual daily traffic	Count type
The Northern Road north of Bringelly Road	16,944	Vehicle
The Northern Road north of Elizabeth Drive	16,654	Vehicle
Elizabeth Drive east of The Northern Road	7,311	Axle pairs
Mamre Road south of Erskine Park Road	13,793	Vehicle
Bringelly Road west of Camden Valley Way	8,900	Axle pairs
Bringelly Road east of The Northern Road	6,212	Axle pairs

Roads and Maritime have permanent counting stations on Elizabeth Drive at Cecil Hills and Bonnyrigg. Recent results from these counters and the percentage growth per annum are presented in Table 15–4.

Table 15–4 Elizabeth Drive traffic volumes and growth rate

Location	Direction	2008	2008 combined	2014	2014 combined	% growth per annum compounding
Elizabeth Drive at Cecil Hills	Westbound	10,927	22,523	12,923	26,598	38,121
	Eastbound	11,596		13,675		
Elizabeth Drive at Bonnyrigg	Westbound	16,726	35,600	17,989	2.8%	1.2%
	Eastbound	18,874		20,132		

Table 15–5 provides a summary of the 2015 traffic counts undertaken by RMS for The Northern Road and Bringelly Road.

Table 15–5 Existing daily traffic volumes 2015

Location	Vehicles per day (weekday)	Vehicles per day (weekend)	Vehicles per day (7 day average)
The Northern Road north of Bringelly Road	16,916	12,286	15,593
The Northern Road south of Bringelly Road	14,745	11,100	13,704
Bringelly Road east of The Northern Road	6,462	4,908	6,018

15.3.3 Existing road network performance

The STM provides a mechanism for assessing the impact of land use and transport infrastructure changes. The 2011 base year model in the STM has been analysed to provide an insight into the prevailing peak period performance in the area surrounding the airport site. No changes were made to the 2011 model for this analysis. The 2016 base year model in the STM only contains a forecast of future traffic and land use development patterns which is periodically updated and will not be finalised until sometime in 2017. It was therefore considered preferable to use the next most recent year, 2011, which does not rely on forecast or incomplete data.

Modelling indicates that the road network in the vicinity of the airport site is currently relatively uncongested (2011 base model), with only sections of Narellan Road and Camden Valley Way showing a level of service (LoS) of D or worse in either the AM or PM peak periods.

While there has been residential and commercial development in the area since 2011, including in the Western Sydney Employment Area, the Western Sydney Priority Growth Area and the South West Priority Growth Area, there remains spare capacity on much of the network near the airport site. Figure 15–2 and Figure 15–3 show the existing (2011) network conditions.

While roads near the airport site are relatively unconstrained, there are constraints on the broader strategic motorway network (2011 base model). For the AM peak, the model shows capacity constraints on the following motorways:

M4 Motorway:

- LoS F eastbound to the west of the M7; and
- LoS E eastbound to the east of the M7.

M7 Motorway:

- LoS E in both directions south of the M4; and
- LoS E southbound to the north of the M4.

M5 Motorway:

- LoS F eastbound, east of the M7; and

Narellan Road:

- LoS E south-east-bound towards the M31 (Hume Highway).

In the PM peak, capacity constraints are generally less acute; however, the model still shows constraints for the following motorways;

M5 Motorway:

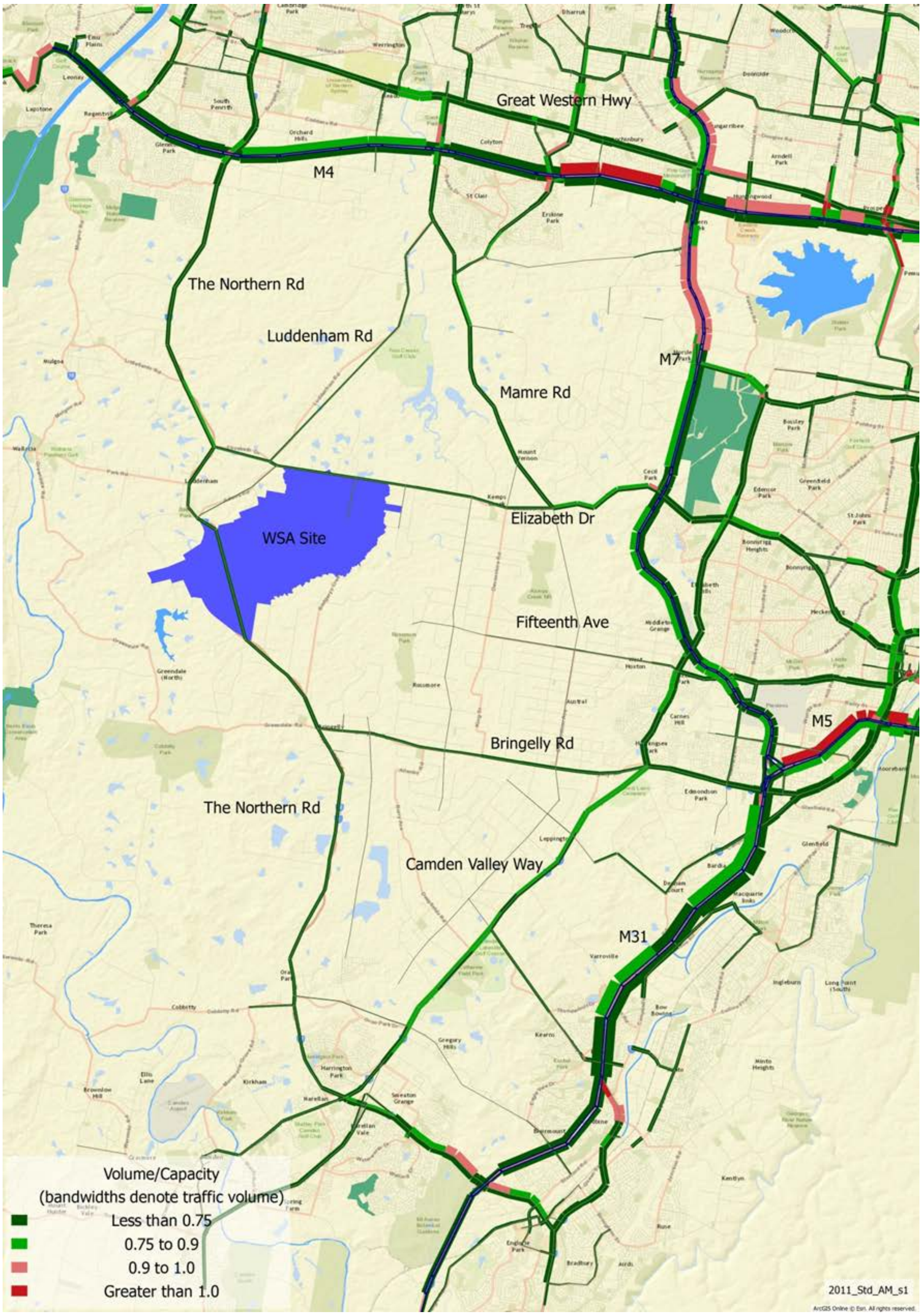
- LoS E, westbound, east of the M7.

M4 Motorway:

- LoS D, westbound along much of the length of the motorway.

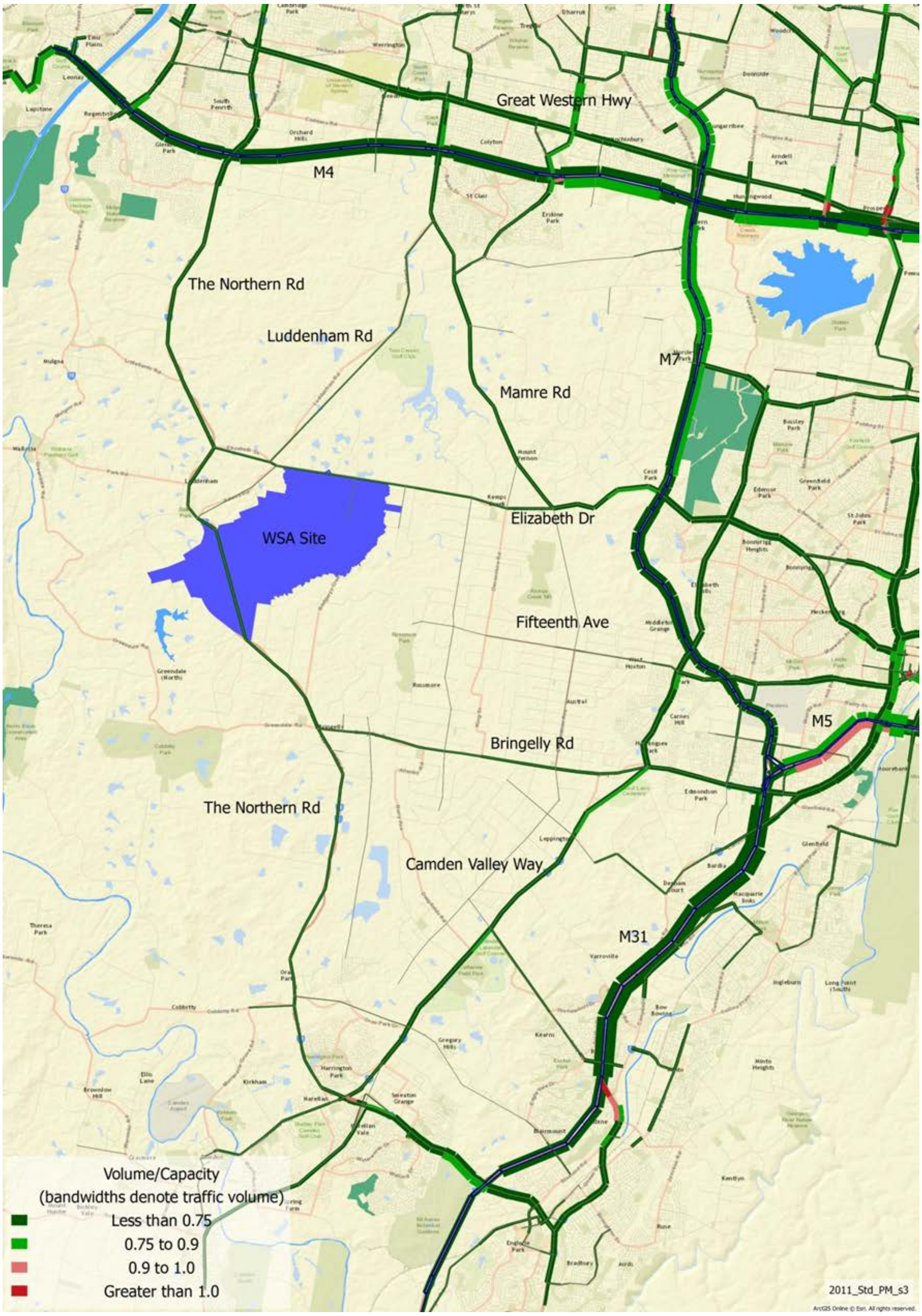
M7 Motorway:

- LoS D in both directions, particularly close to the M4 intersection.



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–2 2011 AM peak volume/capacity − existing conditions



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–3 2011 PM peak volume/capacity – existing conditions

15.3.4 Road safety and crash history

RMS crash data were available for the major roads in the vicinity of the proposed airport. They indicate that the numbers of crashes are generally consistent with the high traffic volumes carried by these roads. The data are summarised in Table 15–6.

Table 15–6 Crash data for key roads near the airport site

Location	Period	Crashes	% resulting in injury (fatality)
The Northern Road – between Maxwell Street and Mersey Street	January 2009 to December 2013	304	43% (1%)
The Northern Road – between Badgerys Creek Road and Mersey Street	July 2009 to June 2014	16	38% (6%)
Bringelly Road – between The Northern Road and Camden Valley Way	July 2009 to June 2014	113	54% (2%)
Elizabeth Drive – between The Northern Road and M7 Motorway	July 2009 to June 2014	157	48% (1%)
Mamre Road – between Elizabeth Drive and M4 Motorway	July 2009 to June 2014	159	50% (1%)
Badgerys Creek Road – between Elizabeth Drive and The Northern Road	July 2009 to June 2014	24	9% (0%)
Adams Road – between Elizabeth Drive and The Northern Road	July 2009 to June 2014	6	67% (0%)

15.3.5 Public transport

There are currently four bus routes that traverse the airport site and/or service the immediate surrounds:

- Route 789 - Penrith Interchange to Luddenham;
- Route 801 - Liverpool Interchange to Badgerys Creek Road;
- Route 855 - Austral to Liverpool via Prestons and Churchill Gardens; and
- Route 856 - Bringelly to Liverpool via Prestons and Churchill Gardens.

The following train interchanges are closest to the airport site:

- T1 Western Line – Penrith Interchange;
- T2 Inner West and South Line – Liverpool Interchange; and
- South West Rail Link – Leppington.

Penrith and Leppington railway stations are around 15 kilometres from the site and Liverpool station is around 21 kilometres from the site.

15.3.6 Pedestrians and cyclists

Pedestrian and cycling infrastructure in the area is currently limited, reflecting the predominantly rural character of the area.

As the Western Sydney Priority Growth Area and South West Priority Growth Area develop, additional cycleway links will be provided and integrated within the Liverpool cycleway network. By 2018, the expected Bringelly Road Stage 1 and Stage 2 upgrades described in the Western Sydney Infrastructure Plan will deliver more than 10 kilometres of shared pedestrian and cyclist paths between Leppington and The Northern Road.

According to the Western Sydney Infrastructure Plan, The Northern Road is expected to have shared pedestrian and cyclist paths between Narellan and the M4 Motorway by 2019. The M12 is also expected to include an off-road shared path for pedestrians and cyclists.

15.4 Assessment of impacts during construction

15.4.1 Construction traffic volumes and distribution

Construction vehicles would access the site via Elizabeth Drive, Anton Road, The Northern Road and Badgerys Creek Road. Construction vehicle generation would be expected to reach its peak in 2021. Table 15–7 provides the expected traffic volumes by period and vehicle type.

Table 15–7 Peak construction vehicle generation

Vehicles	Direction	AM peak 07.00 – 09.00	Interpeak 09.00 – 15.00	PM peak 15.00 – 18.00	Evening 18.00 – 07.00	Total (vtpd)
Light vehicles	In	264	88	0	88	440
	Out	0	66	220	154	440
Semi-trailers	In	4	11	5	2	22
	Out	4	11	5	2	22
B-Double and Truck and Dog	In	21	63	31	50	165
	Out	21	63	31	50	165
Total		314	302	292	346	1,254

The following vehicle distribution assumptions were made for the purposes of this assessment:

- the majority of light vehicles would arrive and depart the site between 5.00 am and 7.00 pm; and
- heavy vehicles would operate to and from the site 24 hours per day during main construction activities.

The geographic distribution of light vehicles was assumed to be consistent with existing vehicle movements in this area derived from the existing 2021 STM.

Detailed information on a probable distribution for heavy vehicles was not available, however for the purpose of the EIS, the following assumptions are considered reasonable:

- 50 per cent of trips to and from the M31 Hume Motorway;
- 20 per cent of trips to and from the M5;
- 10 per cent of trips to and from the M4 (east);
- 10 per cent of trips to and from the M4 (west); and
- 10 per cent of trips to and from the M7 (north).

15.4.2 Effect on road network performance

The expected distribution and volume of construction traffic discussed in Section 15.4.1 suggests there would be approximately 160 additional vehicle movements per hour (to and from the airport site) on Elizabeth Drive during the AM peak and approximately 150 additional vehicle movements per hour (to and from the airport site) on Elizabeth Drive during the PM peak. The forecast AM peak traffic volume equates to about an 8 per cent increase in traffic on this road.

Modelling indicates that this level of additional traffic volume would not result in operating conditions worse than LoS C on Elizabeth Drive in the vicinity of the airport site.

There would be capacity constraints on the wider network, principally on the M4, M5 and M7 motorways; however:

- these constraints currently exist;
- the LoS does not deteriorate when construction traffic is included, with the exception of a minor increase from LoS C to D on Cowpasture Road and from LoS B to C on Luddenham Drive during the PM peak; and
- the proportion of construction traffic compared to overall traffic reduces with distance from the airport site and therefore the impact of construction is reduced with distance from the site.

The types and volumes of vehicle movements associated with the construction of the proposed airport are not expected to substantially impact on the surrounding transport system, with the exception of potential oversized vehicle movements required for the delivery of large construction equipment. These movements may require temporary road closures or escorts.

A community awareness programme would be implemented during construction to ensure that the local community and road users are kept informed about construction activities and the potential for delays. A Traffic and Access Construction Environmental Management Plan would also be implemented to ensure that the staging and movement of construction traffic (including any oversize vehicles) are appropriately managed. The plan would be prepared in consultation with local councils, emergency services and Roads and Maritime.

15.5 Assessment of impacts during operation

To assess the potential transport network impacts of Stage 1 operations, consideration was given to the travel demand associated with passengers, airport employees and freight. The expected trip generation for each of these is outlined in Section 15.5.2, Section 15.5.3 and Section 15.5.4 respectively. The consequential transport network impacts are discussed in Section 15.5.6. Road infrastructure providing access to the proposed airport is described in Chapter 5 (see Section 5.9 (Volume 1)).

The assessment has not considered traffic associated with future commercial development. While the land use plan in the revised draft Aiport Plan includes areas identified for future non-aeronautical commercial development, the details of such development would be developed by the ALC and would be subject to separate authorisation under the Airports Act.

15.5.1 Future transport network

15.5.1.1 Road network

As part of the Western Sydney Infrastructure Plan, the Australian and New South Wales governments have committed $3.6 billion over 10 years in major road infrastructure upgrades in Western Sydney. These upgrades would relieve pressure on existing infrastructure and provide connectivity to the proposed airport and surrounding areas before the airport begins operation. The key projects which comprise the Western Sydney Infrastructure Plan are listed in Table 15–8.

Table 15–8 Key Western Sydney Infrastructure Plan projects

Initiative	Description
The Northern Road	Upgrade to a minimum of four lanes from Narellan to Jamison Road, Penrith.
M12 Motorway	Construction of a new four-lane motorway between the M7 Motorway and The Northern Road.
Bringelly Road	Upgrade to a minimum of four lanes from Camden Valley Way to The Northern Road.
Werrington Arterial	Construction of the Werrington Arterial by upgrading Kent Road and Gipps Street to four lanes between the Great Western Highway and the M4 Motorway.
Ross Street, Glenbrook	Upgrade of the intersection of Ross Street and the Great Western Highway to reduce congestion.
Local roads	$200 million package for local road upgrades.

15.5.1.2 Public transport network

There are three additional bus routes identified by Transport for NSW to service the proposed airport. These routes are:

- Liverpool-Badgerys Creek-Penrith (suburban);
- Campbelltown-Oran Park-Badgerys Creek (suburban); and
- Leppington-Badgerys Creek-Mt Druitt (local).

The service frequencies would be determined based on the demand for travel to the proposed airport.

15.5.1.3 *Rail*

While no rail connection to the proposed airport is currently confirmed for the Stage 1 development, planning for the proposed airport preserves flexibility for several possible rail alignments including a potential express service. As described in Section 5.8.4 of Volume 1, the Australian and NSW governments are undertaking a Joint Scoping Study into Western Sydney's rail needs, which will help to determine the need, cost, timing and route of a future rail connection to the airport site. A final alignment would be determined in consultation with the NSW Government.

15.5.2 Passenger trip generation

During Stage 1 operations, it is estimated that the proposed airport would be handling approximately 10 million passengers per year. In order to understand the transport impact these passenger movements may have, they need to be translated into 'trips' and assigned to the surrounding road network using the STM. This process is illustrated in Figure 15–4.

While this generalised figure shows rail as a mode of transport, the Stage 1 development does not currently include a rail service.

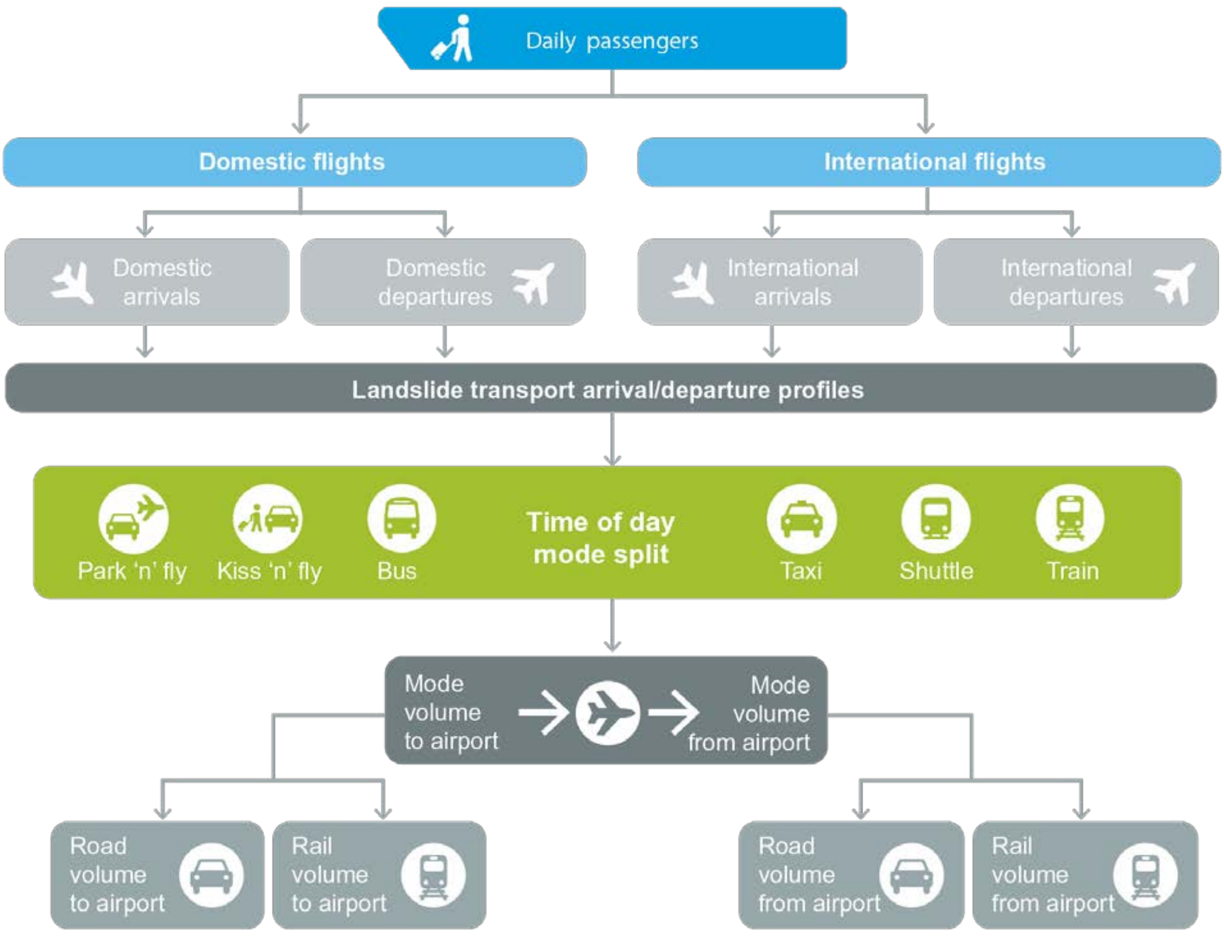


Figure 15–4 Process for determining passenger trip generation

15.5.2.1 Flight movements

A synthetic passenger flight profile for Stage 1 operations was developed for the Airport Plan and is shown in Figure 15–5.

Figure 15–5 Flight arrivals/departures profile - Stage 1 operations

On a typical busy day during Stage 1 operations, a total of 170 passenger flights would be expected, of which 144 flights are assumed to be domestic and 26 international. During the peak hour, anticipated to be between 7:00 am and 8:00 am, there are predicted to be 19 passenger flights, comprising nine arrivals and 10 departures (for both domestic and international sectors).

15.5.2.2 Passenger movements

For each domestic and international flight, a profile for the passengers entering and exiting the airport was determined based on the Sydney Airport Land Transport Model, as explained in Section 15.2.2. The following assumptions were made for the purposes of calculating passenger volumes:

- for each domestic aircraft, an average capacity of 180 passengers with an average flight occupancy of 93 per cent; and
- for each international aircraft, an average capacity of 400 passengers with an average flight occupancy of 95 per cent.

Using the passenger profile and the above assumptions, a passenger arrival/departure profile was developed in order to determine the associated demand for ground transport services. The resulting profile is illustrated in Figure 15–6.

Figure 15–6 Ground transport demand per hour – Stage 1 operations

15.5.2.3 Transport mode split

The Sydney Airport Land Transport Model (and its assumed mode split) was used to assign the calculated ground transport demand to the modes listed in Table 15–9.

Table 15–9 Stage 1 operations assumed mode split

Mode	Stage 1 operations assumed mode split			
	Domestic		International	
	Drop-off	Pick-up	Drop-off	Pick-up
Kiss and fly	30%	30%	40%	40%
Park and fly	35%	35%	30%	30%
Taxi	20%	20%	20%	20%
Shuttles	5%	5%	5%	5%
Bus	10%	10%	5%	5%

Rail was not included in the assumed mode split because rail has been assumed to service the proposed airport some time after the Stage 1 development. Walking and cycling to the airport (by passengers) was assumed to be minimal.

Suitable dwell times for each mode were then applied (with, for example, longer times assumed for international kiss and fly passengers when compared to their domestic counterparts).

Figure 15–7 shows the number of expected passenger arrivals via ground transport at the proposed airport. Figure 15–8 shows the total departures expected via ground transport from the proposed airport.

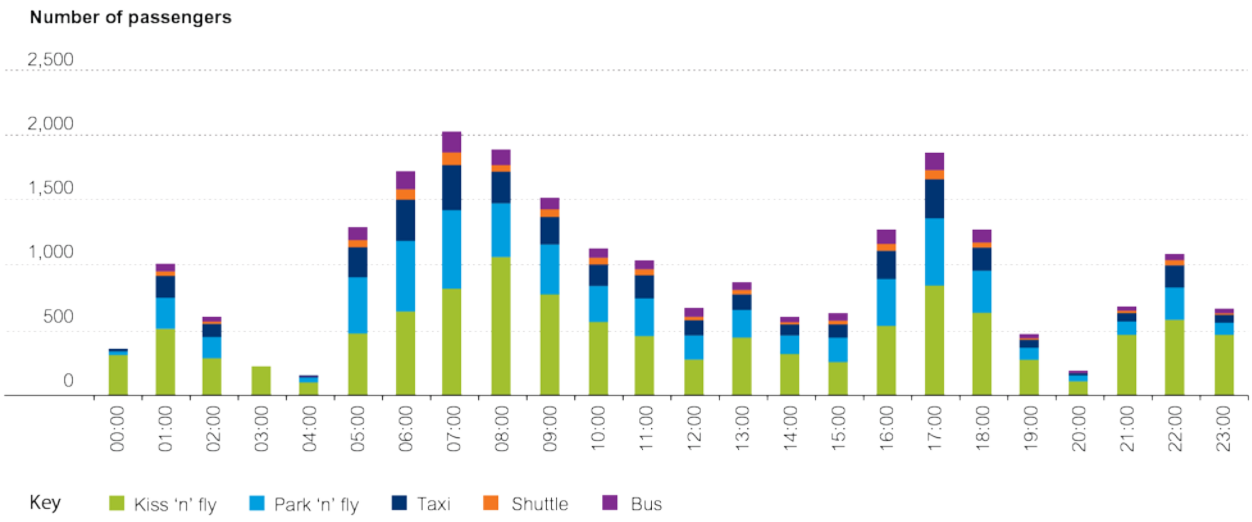


Figure 15–7 Total passenger arrivals at the proposed airport via ground transport - Stage 1 operations

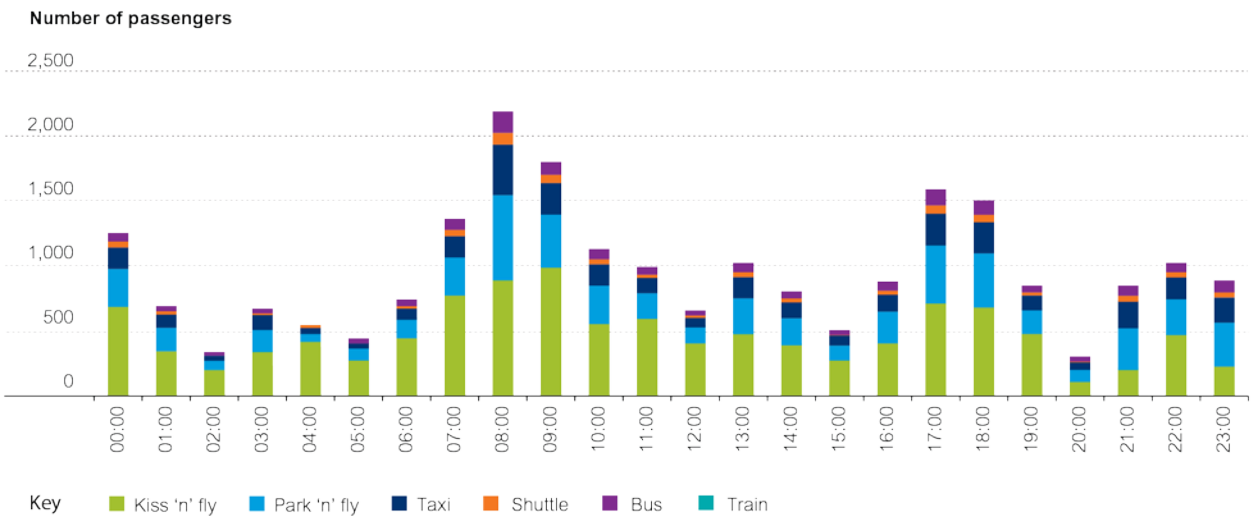


Figure 15–8 Total passenger departures from the proposed airport via ground transport - Stage 1 operations

The trips (by mode) shown in Figure 15–7 and Figure 15–8 were assigned to vehicles entering and exiting the airport site to determine the passenger-related traffic generation (excluding vehicle movements that only circulate internally within the airport site, such as some taxi movements).

Figure 15–9 shows that for Stage 1 operations, 1,419 vehicles would be expected to enter the airport site during the AM peak hour (7.00 am to 8.00 am) and 1,346 vehicles would be expected to enter the airport site during the PM peak hour (5.00 pm to 6.00 pm).

Figure 15–10 shows that for Stage 1 operations, 1,481 vehicles would be expected to leave the airport during the AM peak hour (8.00 am to 9.00 am) and 1,183 would be expected to leave the airport during the PM peak hour (5.00 pm to 6.00 pm).

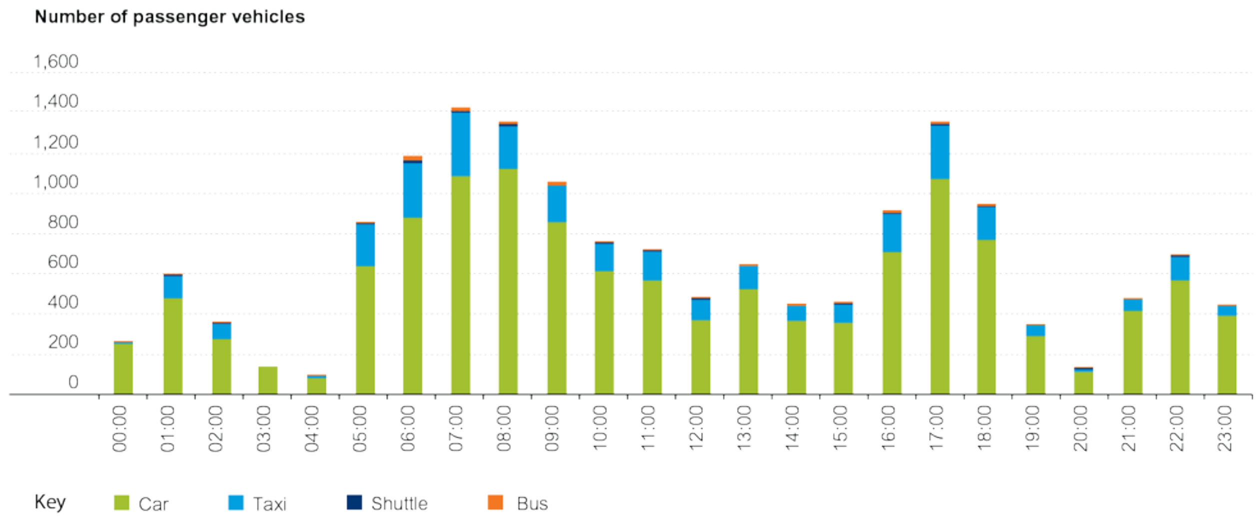


Figure 15–9 Passenger vehicles entering the proposed airport site - Stage 1 operations

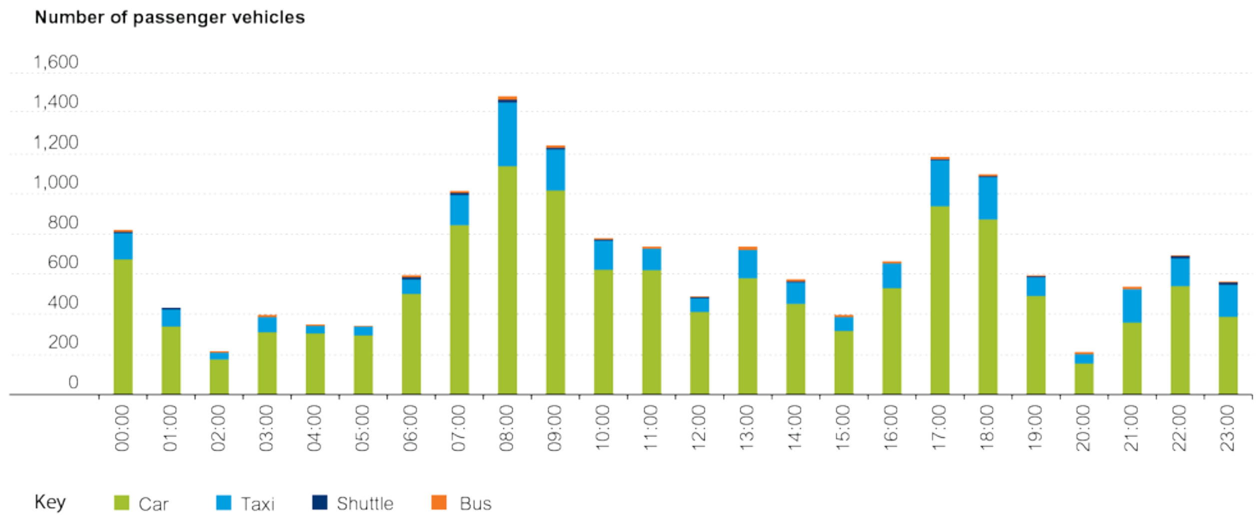


Figure 15–10 Passenger vehicles leaving the proposed airport site - Stage 1 operations

15.5.3 Employee trips

Airfield, terminal and airside employment estimates are directly related to the volume of passengers expected to pass through the proposed airport. Appendix P3 (Volume 4) contains the results of an international benchmarking analysis conducted at 20 selected airports. Characteristics such as an airport's scale, operating model and surrounding community can each have a significant effect on the employees required to service passenger movements. Consistent with the results of this analysis, a ratio of 750 employees per one million annual passengers has been used as the basis on which to estimate the number of full time employees at the airport.

In order to determine the expected number of trips generated by these employees, they were allocated into shifts across the proposed 24-hour operation of the airport and then assigned to a transport mode. Figure 15–11 illustrates the process.

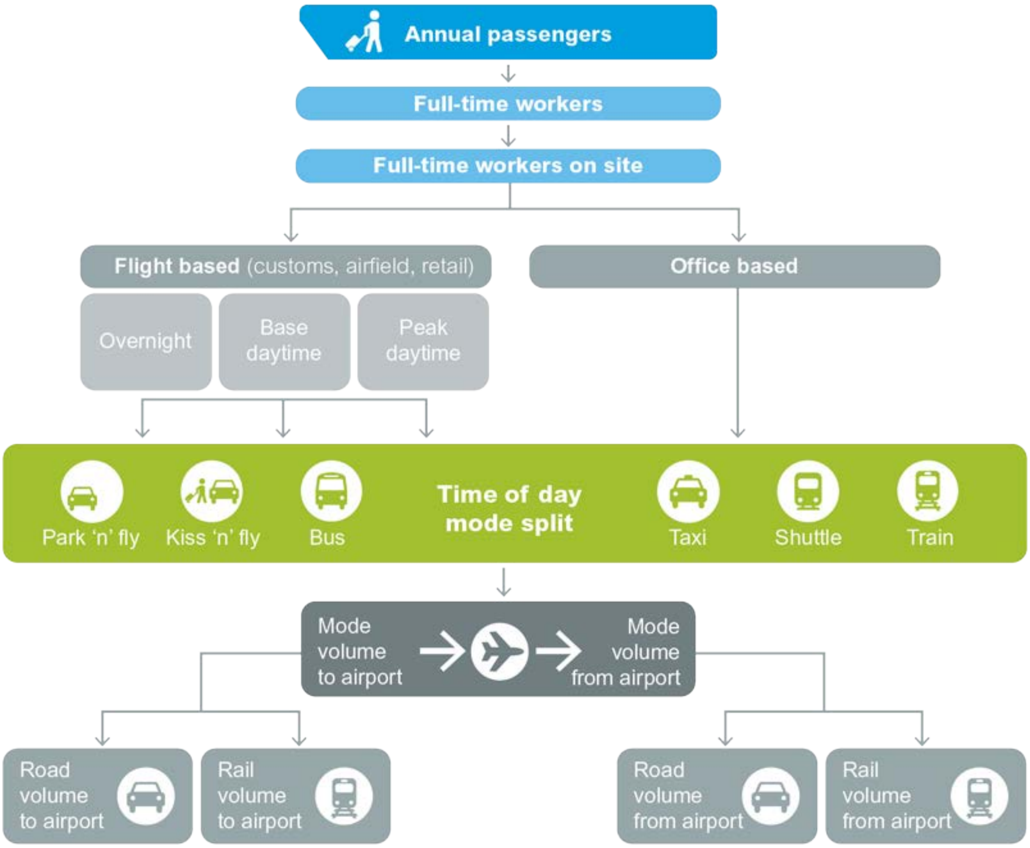


Figure 15–11 Employee trip generation

15.5.3.1 Employees and shifts

During Stage 1 operations, up to 8,730 employees are expected to service the proposed airport. Consistent with the experience at Sydney Airport and other international airports, it was assumed that up to 80 per cent of employees (6,984) would be onsite on any given day.

The airport employees were categorised as follows:

- airfield operations (three shifts of 8.5 hours);
- terminal support (two shifts of 7 hours plus two split-shifts of four hours); and
- office workers (two shifts of nine hours, offset by one hour).

15.5.3.2 Employee arrival and departure profiles

A profile for employee arrivals and departures prior to and after their shifts was developed and is shown in Figure 15–12. The profile acknowledges that some employees would arrive in the hour before their shift starts and/or leave in the hour after their shift finishes.

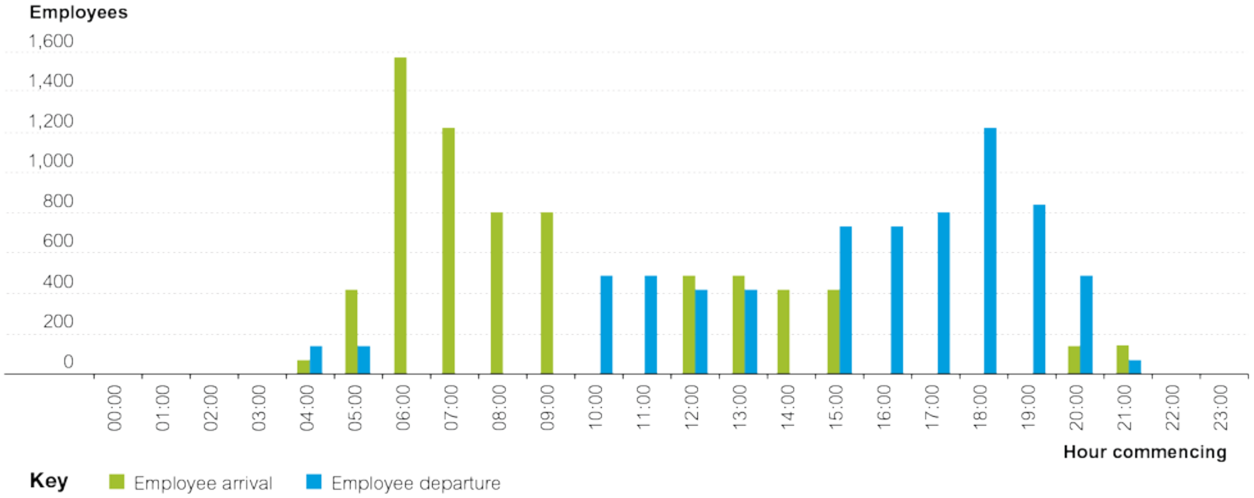


Figure 15–12 Employee arrival and departure profile – Stage 1 operations

Figure 15–12 shows that the AM peak hourly arrival rate is expected to be around 1,571 employees (between 6.00 am and 7.00 am) and the PM peak hourly departure rate for employees (between 6.00 pm and 7.00 pm) is 1,222 employees.

15.5.3.3 Mode split

The employee mode split has been determined using the Sydney Airport overall mode splits for journey to work, but reassigning the 11 per cent of trips taken by train (to Sydney Airport) to car based modes for the proposed airport.

Additionally, it was assumed that no employees would use public transport during early morning hours due to likely service limitations.

Figure 15–13 and Figure 15–14 show the expected distribution of arrivals and departures by mode. Both figures show the largest proportion of arrivals and departures are by private transport given the limited availability of public transport services, although public transport usage is likely to be higher in the peak periods.

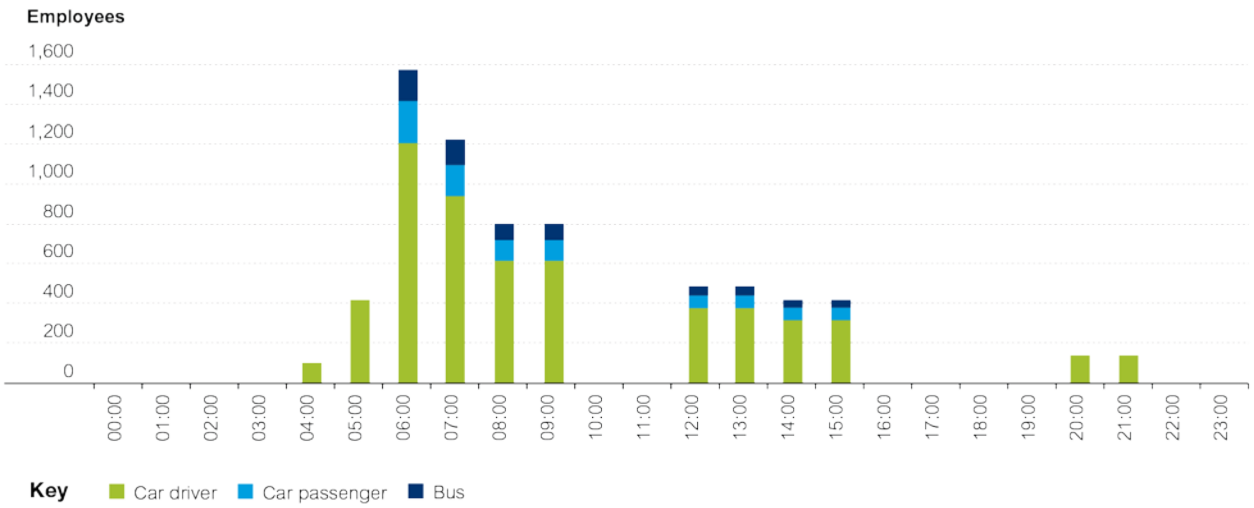


Figure 15–13 Employee arrivals by mode and time of day – Stage 1 operations

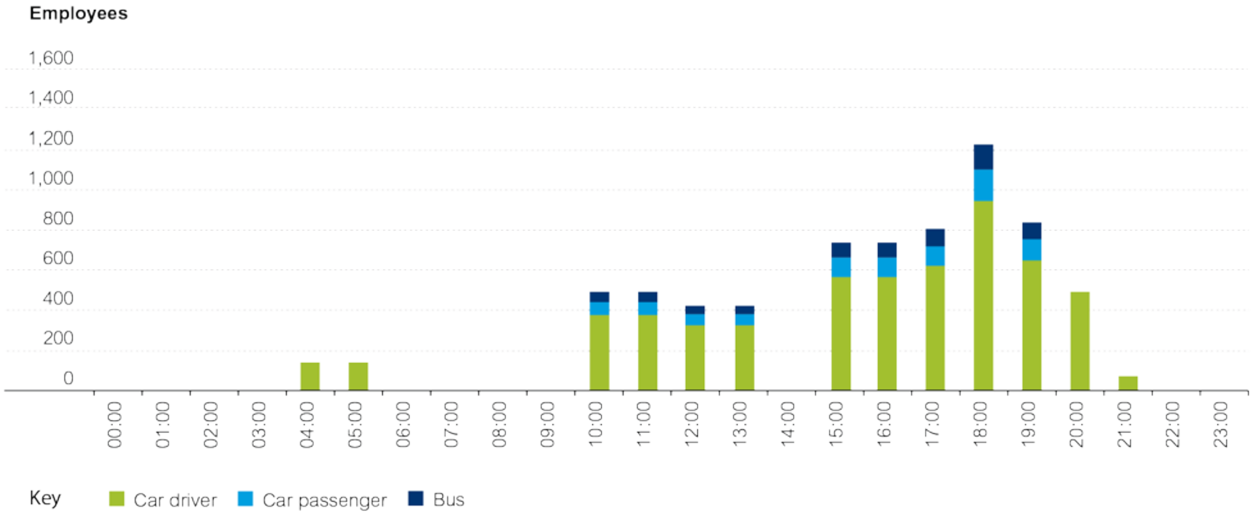


Figure 15–14 Employee departures by mode and time of day – Stage 1 operations

15.5.3.4 Traffic generation

The calculated employee arrivals and departures were assigned to vehicles to determine the number of vehicles entering and leaving the airport site throughout the 24-hour operational period. The results are shown in Figure 15–15 for arrivals and Figure 15–16 for departures. The figures show that the employee traffic generation peaks would be expected to be outside the nominal main traffic peak periods (7.00−9.00 am and 4.00−6.00 pm as used in STM3) for both the arrival and departure of employees.

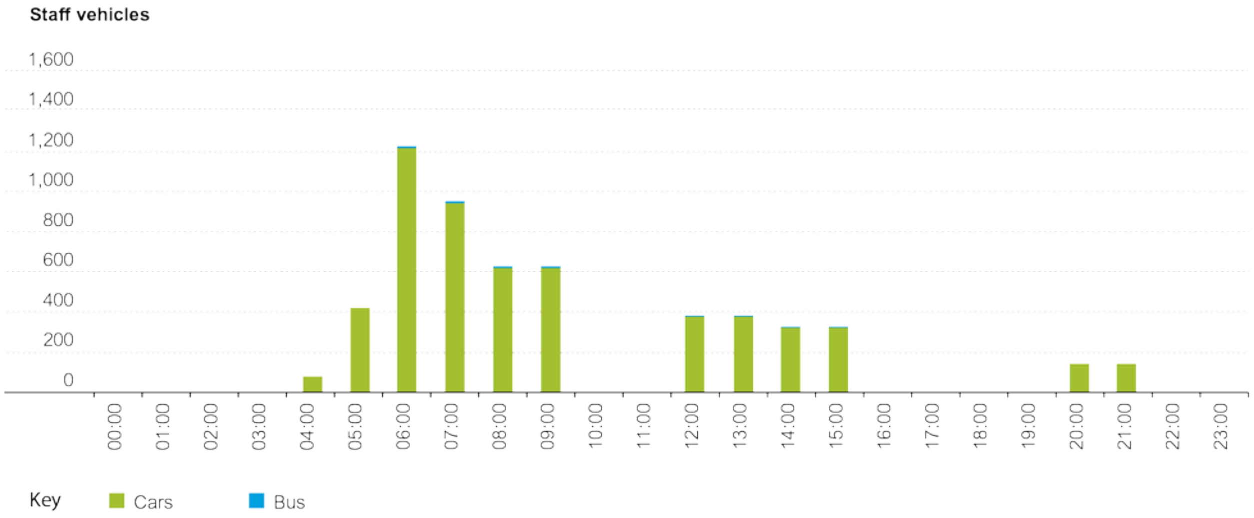


Figure 15–15 Employee vehicle arrivals by mode – Stage 1 operations

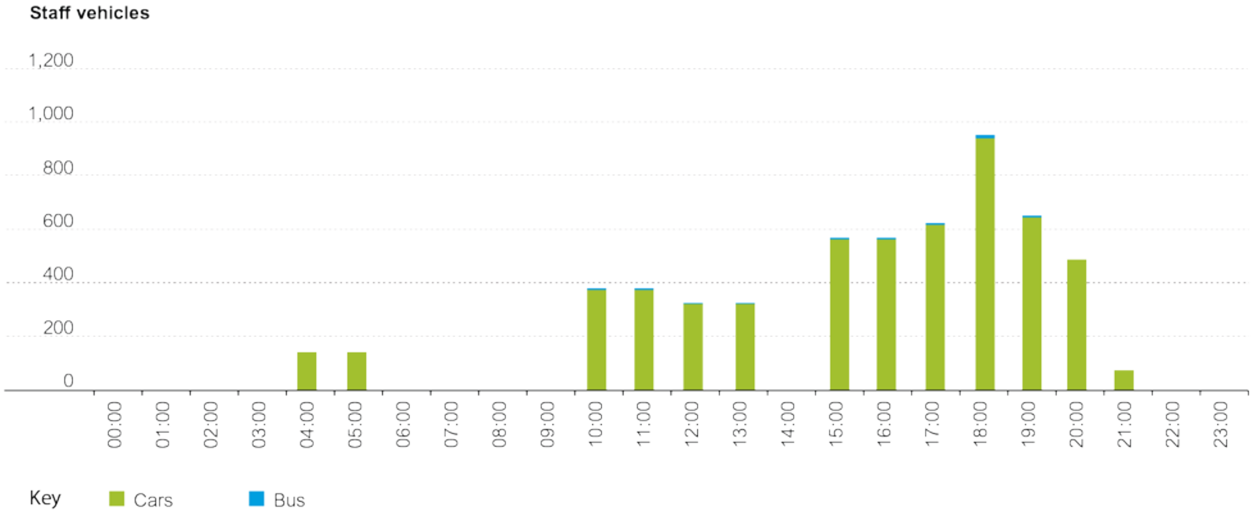


Figure 15–16 Employee vehicle departures by mode – Stage 1 operations

15.5.4 Freight trips

Freight demand has been identified for air freight cargo and for the delivery of aviation fuel to the fuel farm. Demand estimates for airport consumables (e.g. food, retail items) or waste removal cannot be calculated before a detailed terminal plan is developed and have therefore been excluded from the assessment.

The freight demand for air cargo during Stage 1 operations is estimated to be 220,000 tonnes. It has been assumed that the cargo freight arrives at and departs from the airport on heavy rigid trucks, semi-trailers and B-Doubles. Table 15–10 provides the estimated heavy vehicle volumes (and car equivalents) adopted for the assessment.

Table 15–10 Estimated freight movements – Stage 1 operations

Vehicle type	Annual movements	Daily movements	Hourly movements	Passenger car equivalents per hour
Heavy Rigid Truck (12.5 metres long)	16,824	56	4.67	9.35
Semi-Trailer (19 metres long)	2,200	7	0.61	1.83
B-Double (23 -26 metres long)	667	2	0.19	0.93

15.5.4.1 Fuel deliveries

Assuming a fuel supply pipeline is not available to service the proposed airport, it has been estimated that approximately 43 B-Doubles of fuel per day would be required to meet fuel use requirements for Stage 1 operations. This would be equivalent to about two B-Doubles per hour, or 10 passenger car units (pcus) per hour on average entering and leaving the airport site. These volumes are minimal in comparison to the volumes generated by other airport activities.

15.5.5 Total airport traffic generation estimate

Table 15–11 presents the results of the total airport trip generation estimate for passengers, employees and freight provided in the previous sections. The slight discrepancy in accessing and egressing totals is due to park-and-fly trips where access and egress profiles are calculated separately and external taxi trips where the inbound and outbound occupancy rates differ.

Table 15–11 Total modelled traffic to / from the proposed airport – Stage 1 operations

	AM peak	Interpeak	PM peak	Evening	24 hour
Arriving at airport					
Passengers	1,383	687	907	481	15,901
Airport workers	786	285	746	153	5,595
Freight	5	5	5	0	66
Total (arriving)	2,175	977	1,658	638	21,562

Departing from Airport					
Passengers	1,248	758	746	507	15,879
Airport workers	-	235	588	188	5,611
Freight	5	5	5	0	66
Total (departing)	1,254	999	1,339	695	21,556

Notes: Each peak period is presented as the average hourly trip generation of that period.

AM peak (7.00 am to 9.00 am), Interpeak (9.00 am to 3.00 pm), PM peak (3.00 pm to 6.00 pm), Evening (6.00 pm to 7.00 am)

15.5.6 Effect on network performance

As noted in Section 15.5.5, Stage 1 operations are expected to result in 21,562 vehicles accessing the site and 21,556 vehicles leaving the site each day. This would increase traffic on nearby north−south routes in the area including The Northern Road (less than 300 additional vehicles per peak hour by direction), and Luddenham Road and Mamre Road (both less than 200 additional vehicles per peak hour by direction). At the same time, the M12 Motorway is predicted to attract approximately 700 vehicles per hour on the sections closest to the airport. Volumes on Elizabeth Drive, Bringelly Road and Fifteenth Avenue also increase.

Table 15–12, Figure 15–17 and Figure 15–18 show the network conditions for the ‘without airport’ and equivalent Stage 1 operations ‘with airport’ assessment scenarios, for the respective AM and PM peak periods. The table indicates predicted changes in level of service (LoS), while the figures show changes in volume to capacity ratios.

The following specific network effects are expected to result from road traffic associated with Stage 1 operations:

Motorway Network

Traffic demands do not appreciably change on the motorway network, with the exception of:

- an increase from LoS E to LoS F on the M7 southbound, south of the M4; and
- increases from LoS A/B on the M12. The M12 is still well within capacity in the ‘with airport’ scenario.

Arterial Road Network

Traffic volumes increase on Elizabeth Drive and the Northern Road, increasing LoS in the following locations:

- Elizabeth Drive:
  - from E to F, east of the M7. The trip generation from the airport exacerbates the congestion that already exists at this location in the ‘without airport’ scenario. This section of Elizabeth Drive is not being upgraded as part of the M12 scheme and no relief to this section is conferred by the M12; and
  - from D/E to E/F, west of the M7.
- The Northern Road:
  - from C to D, north of Elizabeth Drive; and

- LoS F south of the M4 is unchanged between the ‘without airport’ (existing conditions) and the with airport case.

Collector/Local Roads

- A slight improvement of LoS on Mamre Road from D to C north of Elizabeth Drive. This may be due to the redistribution of background traffic away from the airport due to greater congestion on surrounding roads.
- An overall neutral effect is predicted on Luddenham Drive with some improvement and deterioration in LoS at different locations. Overall, it is still well within capacity in the ‘with airport’ scenario.

Having regard to the proposed road developments in the vicinity of the airport site, including the Western Sydney Infrastructure Plan, it is predicted that Stage 1 operations would not generate the level of traffic required to impact the capacity of the surrounding road network significantly. The Operational Environmental Management Framework (see Section 28.6 (Volume 2b))provides for the preparation and implementation of a Ground Transport Operational Environmental Management Plan to manage impacts on the local road network and internal airport road network.

15.5.7 Public transport, walking and cycling

The public transport, walking and cycling networks proposed by the NSW Government and local councils are expected to have sufficient capacity to cater to the expected airport passenger and employee demand.

Bus routes 789 and 801 currently traverse the airport site and would therefore need to be appropriately altered in consultation with the bus operator and Transport for NSW.

15.5.8 Access

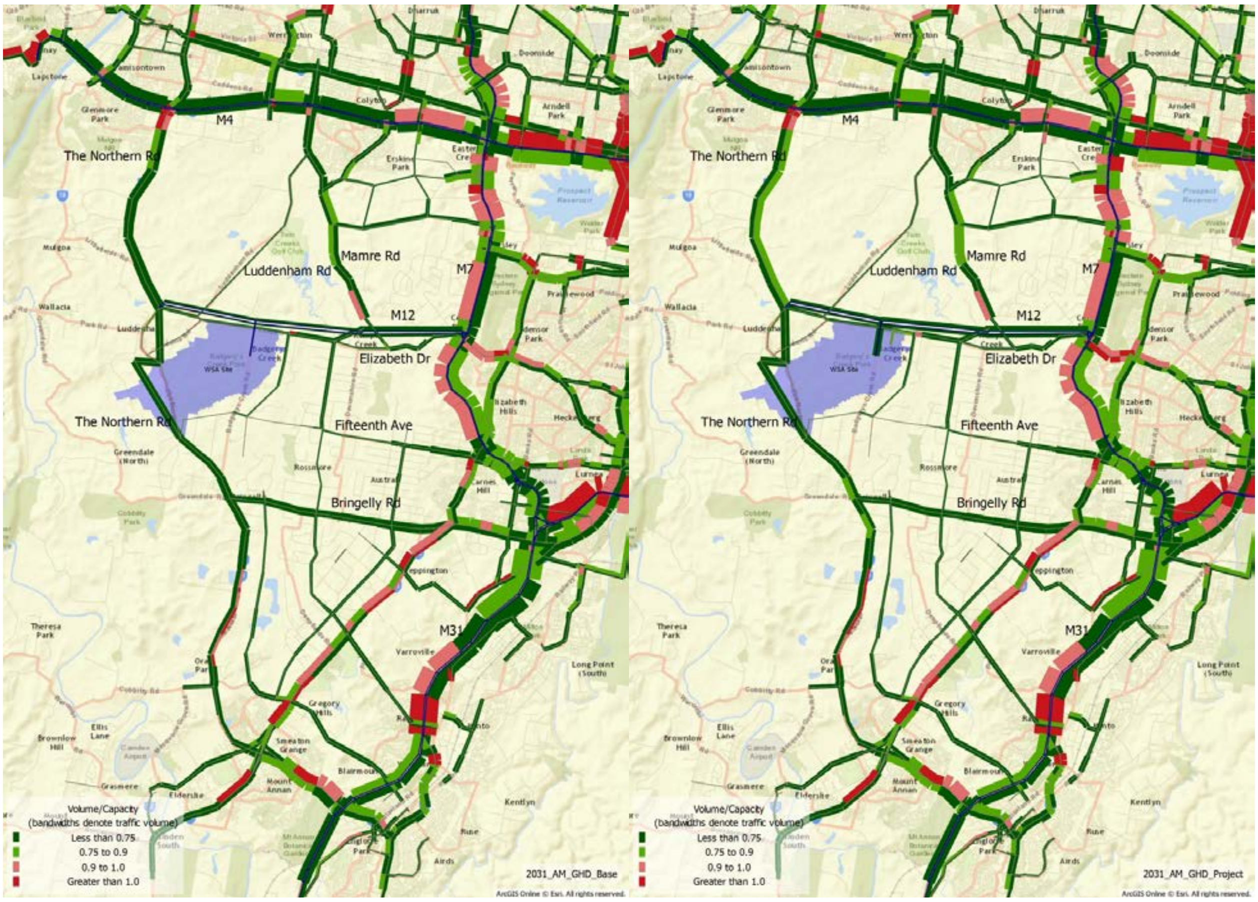
Local traffic originating in Bringelly which currently travels north to Elizabeth Drive via Badgerys Creek Road may need to be re-routed via The Northern Road and proposed M12 Motorway should Badgerys Creek Road be closed at its northern end. Ground transport infrastructure to service the proposed airport is discussed further in Chapter 5 (Volume 1).

Table 15–12 Level of Service for 2031 with and without the proposed airport

ID	Road	Location	Without the airport				With the airport			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd
1	The Northern Road	North of Elizabeth Drive	C	C	C	C	C	D	D	C
2	The Northern Road	South of M4	F	F	F	F	F	F	F	F
3	The Northern Road	South of Bringelly Road	C	C	C	C	C	C	C	C
4	M4	West of Mamre Road	D	C	C	D	D	C	C	D
5	M4	West of M7	E	C	C	E	E	C	C	E
6	M7	South of M4	E	E	F	D	E	F	F	D
7	M7	South of Elizabeth Drive	E	D	D	D	E	D	D	D
8	M5	East of M7	F	D	E	F	F	D	E	F
9	M31	South of Campbelltown Road	D	C	C	D	D	C	C	D
10	Narellan Road	North of Tramway Drive	D	F	D	D	D	F	D	D
11	Bringelly Road	West of Cowpasture Road	C	C	C	C	C	C	C	C
12	Cowpasture Road	At M7	D	D	D	D	D	D	D	D
13	Elizabeth Drive	East of M7	E	E	E	E	F	E	E	F
14	Elizabeth Drive	West of M7	E	B	D	B	F	B	E	B
15	Elizabeth Drive	West of Mamre Road	A	A	A	A	A	A	A	A
16	Elizabeth Drive	East of the Northern Road	C	C	C	C	C	B	C	C
17	Mamre Road	North of Elizabeth Drive	D	B	C	C	C	B	C	C
18	Mamre Road	South of M4	E	C	F	C	E	C	F	C
19	Luddenham Drive	West of Mamre Road	C	A	A	B	B	B	B	B
20	Lawson Road	South of Elizabeth Drive	B	A	A	B	C	A	A	B

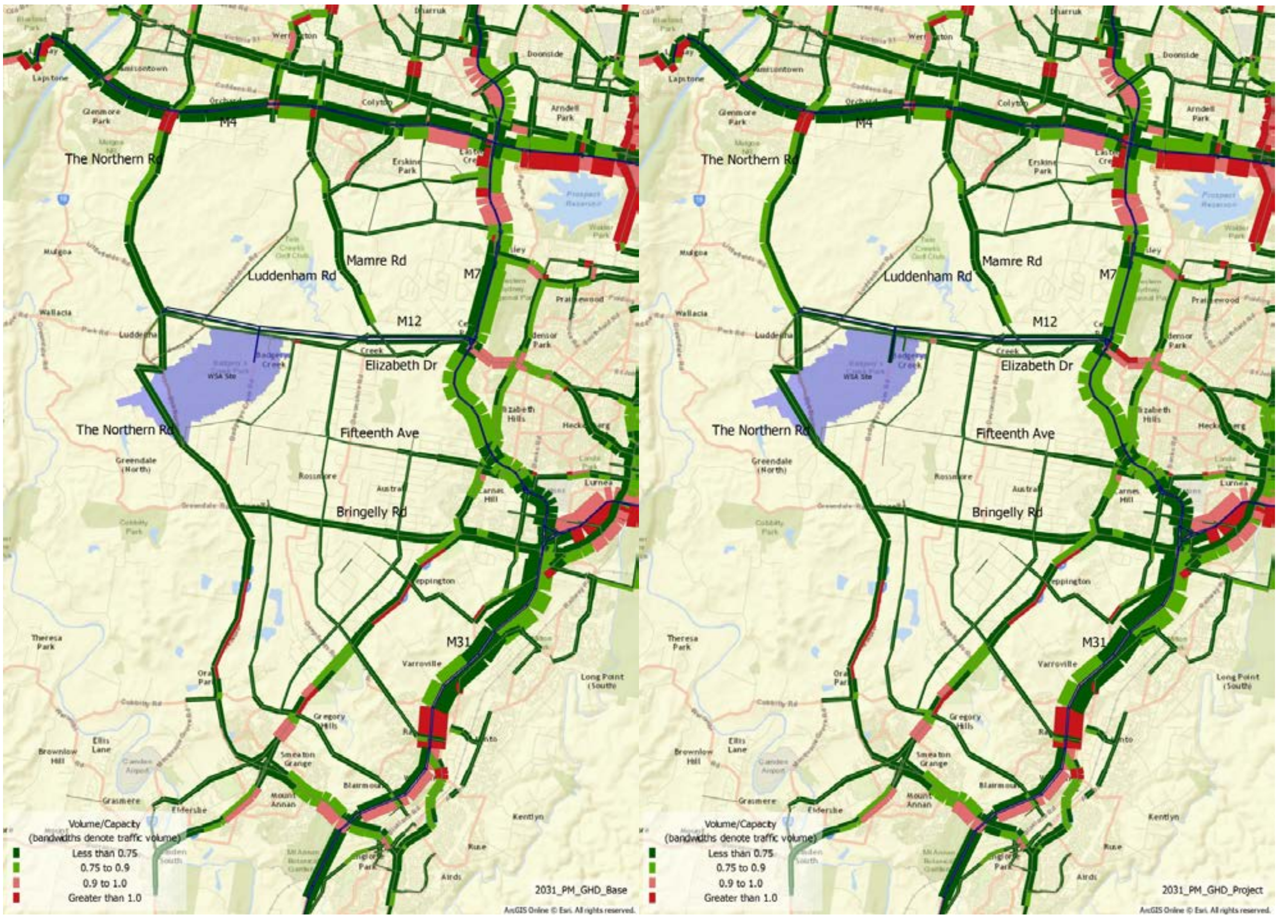
ID	Road	Location	Without the airport				With the airport			
			AM Peak		PM Peak		AM Peak		PM Peak	
			Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd	Nbd/Ebd	Sbd/Wbd
21	Western Road	South of Elizabeth Drive	C	B	B	C	C	B	B	C
22	Fifteenth Avenue	West of Cowpasture Road	B	A	B	B	B	A	B	B
23	M12	West of M7	C	A	B	B	C	**B**	B	**C**
24	M12	West of Mamre Road	A	A	A	A	**B**	A	A	**B**
25	M12	East of the Northern Road	A	A	A	A	**B**	A	A	A

Note: Improvements are indicated in **green bold**. Deteriorations are indicated in **red bold**



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–17 AM peak Volume/Capacity – without airport (left), with airport (right) – Stage 1 operations



Note: Volume/capacity ratio bandwidth definitions are outlined in Table 15–1

Figure 15–18 PM peak volume/capacity − without airport (left), with airport (right) – Stage 1 operations

15.6 Mitigation and management measures

Table 15–13 outlines the mitigation and management measures that are proposed to address the expected traffic and transport effects associated with the proposed Stage 1 development.

A Traffic and Access Construction Environmental Management Plan (CEMP) and Ground Transport Operational Environmental Management Plan (OEMP) will be prepared and submitted for approval prior to Main Construction Works and operation of the Stage 1 development respectively.

The environmental management plans will collate the mitigation and management measures discussed in this section and itemised in Table 15–13. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Table 15–13 Mitigation and management measures

Topic	Mitigation measures	Timing
Community Awareness	As part of the community and stakeholder engagement plan a community awareness programme will be implemented prior to Main Construction Works commencing and would continue throughout the entire construction period. The programme will aim to make road users (including local residents) aware of construction traffic and safety issues, such as diversions, temporary road closures, traffic signalling and speed limits.	Pre-construction Construction
Construction traffic and access	To mitigate and manage potential traffic impacts the Traffic and Access CEMP will include the following elements: • management for the temporary and permanent closures of roads within the airport site; • ongoing consultation with NSW RMS and local councils as appropriate and emergency services; • induction for drivers working on the project to cover safety measures particularly for night works; • review of speed environments along transport corridors; • restriction of construction related traffic within the AM and PM peak periods where required; • management of the transportation of construction materials to optimise vehicle loads in order to minimise vehicle movements; • traffic control measures to manage and regulate traffic movements during construction; • identification of potential disruption to road users; • identification of any road closures and/or road upgrades that may be required; • construction vehicle routes, including the use of arterial roads, haulage routes, access to the airport site and procedures for oversize and heavy vehicles; • parking facilities for construction workers; and • measures to support and encourage sustainable travel for construction workers to and from the airport site, including public transport, shuttle buses, cycling, walking, and car-sharing (as also outlined in the Air Quality Construction Environmental Management Plan).	Construction

Topic	Mitigation measures	Timing
Operational traffic and transport impacts	A Ground Transport OEMP will be prepared as part of the detailed design of Stage 1 and approved before the proposed airport begins operating. The plan will address: • road design speeds; • security issues; • traffic loads from the airport and other onsite developments; • connections with off-site/external roads, including matching capacity, speeds and road geometry; • forecast traffic flows, including public transport requirements; • car parking; • commercial and operational vehicles and storage; • terminal interface; • passenger pick-up and drop-off by private and commercial vehicles; • pedestrian linkages between terminals and all transport drop-off/pick-up areas; • pedestrian, cycle or road networks for movement around the airport site; • use of dedicated busways; • the ability to continue to provide access to and from the airport when key intersections are unavailable; and • the ability to expand, with minimal disruption, to meet future airport and business development requirements.	Pre-operation

15.7 Conclusion

The construction phase of the Stage 1 development is expected to generate an additional 1,254 vehicle movements per day on the surrounding road network during the peak construction period. This equates to around 150-160 peak hour vehicle movements during the morning and afternoon peak periods. The predicted construction traffic would be dispersed throughout the broader road network and would not be significant in the context of the road transport network in the broader Western Sydney region.

Of the major roads used during construction, Elizabeth Drive would likely experience the greatest increase in vehicle volumes due to its proximity to the site and the assumption that most construction vehicles would therefore use it. The forecast AM peak traffic equates to about an 8 per cent increase in traffic on this road. This increase would not be expected to lower the level of service on Elizabeth Drive. Depending on the site activity and origin/ destination, other roads may offer a higher quality of service or more direct route and may therefore also be utilised.

A community awareness programme and Traffic and Access CEMP would be implemented to provide information to road users and manage construction traffic, including oversize vehicles based on the construction methodology proposed by the contractor.

Stage 1 operations are predicted to result in approximately 21,562 vehicles accessing the site and approximately 21,556 vehicles leaving the site each day. With the introduction of the M12 Motorway, this volume of additional traffic is not likely to affect the capacity of the surrounding road network significantly.

A substantial amount of road improvement works is proposed as part of the Western Sydney Infrastructure Plan, in addition to others identified by the NSW Government. These upgraded roads are expected to provide sufficient capacity to cater for the expected passenger, employee and freight travel demand associated with the proposed Stage 1 development. A Ground Transport OEMP would be prepared prior to the commencement of operations to manage impacts on the local and internal airport road networks.

Rail has not been considered as a mode of transport for Stage 1 operations. The Australian and NSW governments are undertaking a Joint Scoping Study into Western Sydney's rail needs, which will help to determine the need, cost, timing and route of a future rail connection to the airport site.

The public transport, walking and cycling systems proposed by the NSW Government and local councils would also have sufficient capacity to cater to the expected airport passenger and employee demand at the proposed airport.

16 Biodiversity

The airport site features remnant patches of grassy woodland and narrow corridors of riparian forest within extensive areas of derived grassland, cropland, and cleared and developed land. The condition of native vegetation is generally poor and there is moderate to severe weed infestation throughout the site. The main land uses are agriculture and low density rural residential development. Notwithstanding the generally poor condition of the airport site, it has high conservation significance as a result of the presence of threatened species and ecological communities and the generally limited extent and quality of similar environments in the Western Sydney region.

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland dominated by exotic species and noxious and environmental weeds. About 318.5 hectares of native vegetation would be removed. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and/or dispersal habitat. Construction of the Stage 1 development would also result in indirect impacts on terrestrial and aquatic flora and fauna, including potential impacts associated with increased fragmentation, altered hydrology, erosion and sedimentation, dust, light, noise and vibration. Indirect impacts may also include fauna displacement, injury and mortality. Operation of the Stage 1 development would involve an increased risk of fauna strike at or near the airport site from contact with aircraft and ground transportation vehicles. Indirect impacts may include those associated with light, noise and the introduction of exotic species.

The Stage 1 development would affect threatened species, populations and ecological communities listed under both the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the *Threatened Species Conservation Act 1995* (TSC Act). Assessments of significance have been prepared for matters of national environmental significance protected under the EPBC Act in accordance with significant impact guidelines prescribed by the EPBC Act. The outcome of these assessments is that the Stage 1 development is likely to have a significant impact on Cumberland Plain Woodland, the Grey-headed Flying-fox and other plants, animals and their habitat (including a number of species, populations and ecological communities listed as threatened under NSW legislation) in an area of Commonwealth land.

Mitigation and management measures would be implemented to reduce the potential impacts on biodiversity. These measures would include: staged vegetation removal during construction, pre-clearing surveys and plans for the salvage of fauna and habitat resources, translocation programmes for threatened flora and fauna species/populations, and designing the airport to minimise its attractiveness to fauna in order to minimise bird, bat and terrestrial fauna strike. In addition, a 117.1 hectare environmental conservation zone would be established along the southern perimeter of the airport site.

Biodiversity offsets are required to compensate for significant residual impacts arising from the proposed airport. An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland, the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox, and on features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation. The offset package is intended to conserve habitat in suitable offset sites in the surrounding region in perpetuity.

Due to the scale and nature of the biodiversity offsets required for the proposed airport, the process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister. A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package.

The Department of Infrastructure and Regional Development will be responsible for delivering this plan that will require approval from the Environment Minister or a Senior Executive Service officer within the Department of Environment and Energy (DoEE) prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to substantial impacts occurring. While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other conservation actions will also be considered to assist in meeting overall offset requirements. This will occur in close consultation with the DoEE and relevant NSW authorities, organisations and stakeholder groups.

16.1 Introduction

This chapter provides a review of the biodiversity values that may be affected by the development of the proposed Western Sydney Airport (proposed airport). It describes terrestrial and aquatic flora and fauna, their habitats at the airport site and the presence and likelihood of occurrence of threatened and migratory species, populations and ecological communities. The potential impacts of the Stage 1 development on terrestrial and aquatic ecology are assessed and mitigation and management measures are identified to reduce potential impacts.

This chapter draws from technical studies including the biodiversity assessment in Appendix K1 (Volume 4), the offset package in Appendix K2 (Volume 4), and the bird and bat strike assessment in Appendix I (Volume 4).

The assessment has been prepared in consultation with the DoEE, previously known as the Department of the Environment, and has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) for the proposed Western Sydney Airport.

16.2 Methodology

The terrestrial and aquatic ecological assessment included a review of databases and relevant literature, field surveys and vegetation and habitat mapping. Impact calculations and an assessment of the significance of impacts were undertaken to determine the effect of the proposed airport on terrestrial and aquatic flora and fauna.

16.2.1 Database and literature review

A desktop assessment was undertaken to identify Commonwealth and State-listed threatened and migratory species, populations and ecological communities that may be affected by the construction and operation of the proposed airport. Relevant biodiversity databases pertaining to the airport site and locality (defined as a 10 kilometre radius from the centre point of the airport site) were reviewed. The database searches included:

- Department of the Environment (DoE) Protected Matters Search Tool – for matters of national environmental significance (MNES) listed under the EPBC Act that have been recorded in the locality (DoE 2015b);
- NSW Office of Environment and Heritage (OEH) BioNet (Atlas of NSW Wildlife) – for records of threatened species, populations and endangered ecological communities listed under the TSC Act that have been recorded within the locality (OEH 2015a); and
- NSW Department of Primary Industries (DPI) Fishing and Aquaculture Threatened and Protected Species Records Viewer – for records of threatened aquatic species listed under the EPBC Act and the NSW *Fisheries Management Act 1994* (FM Act) that have been recorded within the locality (DPI 2015).

Additional databases that were reviewed to inform the terrestrial and aquatic ecological assessment are listed in Appendix K1 (Volume 4).

The results of previous ecological assessments and scientific publications were reviewed to determine the likely presence of terrestrial flora and fauna species and their habitats at the airport site. These included surveys conducted by Biosis Research for the *1997–1999 Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997) and the recent baseline surveys carried out for the referral (SMEC 2014). A list of the literature that was reviewed is provided in Appendix K1 (Volume 4).

The introduction of the EPBC Act following the completion of the 1997–99 EIS (PPK 1997) has provided a revised legislative framework with increased emphasis on biodiversity protection and consideration of offset requirements. The legislative description of threatened species has also broadened substantially at both the Commonwealth and State levels since 1999, reducing the currency of previous investigations.

16.2.2 Likelihood of occurrence

Following the collation of database records, species and community profiles, and the results of previous ecological assessments at the airport site and within the locality, a 'likelihood of occurrence' assessment was prepared with reference to the habitats contained at the airport site. This was further refined following field surveys and the identification and assessment of the habitats present.

16.2.3 Terrestrial flora surveys

Terrestrial flora surveys were undertaken between February and May 2015 and consisted of vegetation mapping and validation (via plot/transect surveys) and targeted threatened flora species searches. A summary of the survey effort is provided in Table 16–1. The locations of plot/transects surveys are shown on Figure 3 in Appendix K1 (Volume 4).

The surveys were designed with reference to the NSW *BioBanking Assessment Methodology (BBAM) and Credit calculator operational manual* (DECC 2009b) and the *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Working Draft) (DEC 2004b), as appropriate. The terrestrial flora field surveys were undertaken across a number of seasons and varying weather conditions. Weather conditions (minimum and maximum temperatures and total rainfall) during the survey period are presented in Appendix K1 (Volume 4).

Table 16–1 Survey effort (terrestrial flora surveys)

Survey method	Survey effort	Approximate field person-hours
Vegetation mapping, plot/transect surveys	43 plot/transects	86
Targeted threatened flora surveys	19 days	380
Wetland assessments	Seven sites	7

16.2.3.1 Vegetation surveys and mapping

A high-level vegetation assessment and map was prepared by SMEC (2014) based on the regional mapping included in *Native Vegetation Maps of the Cumberland Plain, Western Sydney* (NPWS 2006). This vegetation mapping was ground-truthed in the field through driven and walked transects across the entire survey area and by walking the boundary of vegetation units, where possible.

Vegetation types were classified according to vegetation structure, species composition, soil type and landscape position. Terrestrial vegetation types were further split into broad condition classes to yield vegetation zones as follows:

- 'high condition', comprising moderate/good – high or moderate/good – medium condition vegetation which featured overstorey and midstorey vegetation at benchmark levels for the equivalent vegetation type (that is, woodland or forest structure);
- 'poor condition', comprising moderate/good – poor condition vegetation which featured overstorey and midstorey vegetation cover substantially below benchmark levels for the equivalent vegetation type, but greater than 50 per cent of the groundcover present was native species (that is, derived native grassland, shrubland or scrub structure);
- 'exotic grassland', comprising low or cleared condition vegetation which was dominated by perennial plant species and featured overstorey and midstorey vegetation cover substantially below benchmark levels for the expected native vegetation type, and less than 50 per cent of the groundcover present was native species (that is, exotic grassland, shrubland or scrub structure); and
- 'cleared land and cropland', comprising low or cleared condition vegetation which was dominated by annual plant species, bare earth or infrastructure and featured overstorey and midstorey vegetation cover substantially below benchmark levels for the expected native vegetation type, and less than 50 per cent of the groundcover present was native species or greater than 90 per cent of the ground surface was bare earth or infrastructure.

Wetlands were mapped as a native vegetation zone if they contained greater than 10 per cent cover of native plant species and/or habitat features such as standing dead trees, shallow marginal water or mudflats. Waterbodies that were free of native plants or habitat features (such as steep sided clay lined dams, concrete lined dams or flooded quarry pits) were included in the mapped area of 'cleared land and cropland'. Some smaller wetlands were also included in the mapped areas of woodland, forest or grassland if they could not be accurately separated and defined on an aerial photo.

16.2.3.2 Plot/transect surveys

Plot/transect surveys were conducted to confirm vegetation types and assess the condition of the airport site. The surveys were conducted in accordance with BBAM. Data recorded within each plot/transect generally included all vascular plant species present, cover abundance of each species, cover of each structural layer (canopy, midstorey, groundcover), weed abundance, presence of tree hollows, size classification length of fallen logs and a soil classification (colour and texture).

Plots were used to sample potential vegetation zones (that is, plant community types and broad condition classes) based on the initial site stratification. Forty-three plots were sampled within the airport site, as shown on Figure 3 in Appendix K1 (Volume 4).

16.2.3.3 Targeted threatened flora surveys

Targeted threatened flora surveys were undertaken for those species known or likely to occur at the survey area based on previous records (as found in the database and literature review) and the presence of suitable habitat. Areas of suitable habitat (that is, areas of near-intact native vegetation and with natural topsoil) were systematically traversed on foot and inspected for threatened plants. A targeted survey for *Marsdenia viridiflora* subsp. *viridiflora* was undertaken in April 2016 to supplement the initial surveys, following feedback in some submissions on the draft EIS.

16.2.3.4 Wetland assessments

Wetland vegetation was sampled by walking the margins of waterbodies and noting dominant plant species and percentage cover in each vegetation strata present (that is, trees, shrubs, emergent, aquatic and fringing plants). Wetlands were defined based on observed vegetation structure, species composition and whether they were natural or artificial, as inferred from geomorphic position and the presence of features such as dam walls. No natural freshwater wetlands were observed at the airport site. Artificial wetlands were matched to the closest equivalent native vegetation type.

16.2.4 Terrestrial fauna survey

Terrestrial fauna surveys were undertaken between February and June 2015 and consisted of detailed habitat assessments and targeted fauna searches. A summary of the survey effort is provided in Table 16–2. The locations of the fauna surveys are shown on Figure 3 in Appendix K1 (Volume 4).

The fauna surveys were designed with reference to the guidelines administered by the DoEE and OEH. A list of the relevant survey guidelines is provided in Appendix K1 (Volume 4).

Table 16–2 Survey effort (terrestrial fauna surveys)

Survey method	Survey effort	Approximate field person hours
Habitat assessment	18 days	360
Diurnal bird surveys	16 days	320
Early morning bird surveys	10 days	20
Microchiropteran bat surveys (Anabat)	11 nights	162.5
Frog surveys	Four afternoons and nights	80
Spotlighting (birds and mammals)	Nine nights	46
Call playback (owls)	Nine nights	11.25
Infrared cameras	Eight weeks	n/a
Cumberland Plain Land Snail searches	11 days	25
Koala scat searches	11 days	25
Opportunistic observations	18 days	360
Winter bird surveys	Two days	32

16.2.4.1 Fauna habitat assessments

Habitat assessments were conducted to describe the variety of native fauna likely to occur at the airport site. Particular attention was paid to habitat features and resources considered important for threatened species, including identification and assessment of:

- vegetation patch size, connectivity, age, disturbance and floristic and structural diversity, which is important for determining habitat suitability for many threatened birds and mammals;
- quality of substrate (including rocks, logs, peeling bark, leaf litter and native grassland) that provides foraging habitat and shelter for invertebrates, frogs, reptiles and ground-foraging birds;
- presence of feed trees important for threatened birds and mammals;
- hollow-bearing trees and logs which provide refuge, nest and den sites for a range of threatened fauna species;
- stags and other roost sites for raptors and owls; and
- wetlands, watercourses and moist grassland and other foraging or breeding habitat for waterbirds (including migratory birds), frogs, reptiles and mammals.

Evidence of animal presence was noted during the field surveys, including specific searches for mammal scats, tracks, nest/den sites, scratch marks on tree trunks, worn bark around tree hollows and animal remains.

Mapping of hollow-bearing trees was undertaken in areas within the airport site to provide an indication of the distribution and number of hollow-bearing trees, as well as sizes of hollows that would be removed by the construction of the proposed airport. Data collected included tree species, height, diameter at breast height, and number, size and location of hollows.

16.2.4.2 Targeted fauna searches

The targeted fauna searches undertaken at the airport site are summarised below with further detail provided in Appendix K1 (Volume 4). Threatened fauna surveys were undertaken for those species known or likely to occur at the airport site based on previous records (as found in the database and literature review) and the presence of suitable habitat.

Bird surveys comprised:

- diurnal surveys, which were performed in the early morning at the airport site. The surveys comprised area searches targeting larger woodland patches and wetland areas. Species were identified by sight and call. Threatened species targeted during these surveys included the Swift Parrot (*Lathamus discolor*) and Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- wetlands (farm dams) surveys, which were observed during the early morning bird surveys as well as during general fauna surveys throughout the day; and
- slow driven transects, which were conducted to target Swift Parrots and Gang-gang Cockatoos. This method combined with targeted area searches ensured as much of the airport site was covered as possible.

Surveys for microchiropteran bats involved echolocation call recordings using Anabat units. Anabats were placed within the airport site and recordings were undertaken from dusk until the following morning. Calls were then analysed using specialised software (AnalookW, Version 3.8v).

Frog surveys comprised targeted and rapid surveys. Targeted surveys included both diurnal searches (searches for basking frogs and call playback) and nocturnal searches (spotlighting and call playback) in areas of suitable habitat. Rapid surveys included call playback and vocalisations broadcast at each rapid survey site. Species targeted during the frog surveys included the Green and Golden Bell Frog (*Litoria aurea*). The Green and Golden Bell Frog population at Homebush was used as a reference population for the survey to determine the level of frog activity and confirm that conditions were likely to be suitable for the detection of the targeted species.

Nocturnal bird and mammal surveys comprised call playback surveys and spotlighting surveys. The call playback surveys targeted threatened owl species in woodland areas and the spotlighting surveys targeted nocturnal birds and mammals along road reserves and in larger woodland areas. Species targeted during the nocturnal bird surveys included the Barking Owl (*Ninox connivens*), Powerful Owl (*Ninox strenua*) and Masked Owl (*Tyto novaehollandiae*).

Infrared cameras were placed in survey locations in woodland or near dams to target cryptic species. Cameras were baited and set for a minimum of three weeks. Cameras were set to take three pictures over one minute when triggered by movement, with at least five minutes between each set of photographs.

Searches for the Cumberland Plain Land Snail (*Meridolum corneovirens*) were carried out in larger patches of vegetation and along road reserves. Active searches in woodland patches were conducted in leaf litter at the base of trees and under rubbish and logs for between 30 minutes to an hour. Live snails were photographed and empty shells were collected for identification.

Koala scat searches focused on Forest Red Gum (*Eucalyptus tereticornis*), a primary feed tree for the Sydney area, and Grey Box (*Eucalyptus moluccana*), a secondary feed tree for the Sydney area (DECC 2008a). Searches were conducted in woodland patches for between 30 minutes to an hour, depending on the size of the patch.

Opportunistic and incidental observations of fauna species were recorded at all times during the field surveys. Scats, burrows and diggings were noted and mature trees were scanned for roosting birds.

16.2.5 Aquatic flora and fauna surveys

Aquatic flora and fauna surveys were undertaken in March and May 2015 and consisted of habitat assessments, water quality assessments, macroinvertebrate sampling and analysis, and fish surveys. The surveys were undertaken by two people over five days. The aquatic ecology surveys sampled stream and wetland (artificial dam) habitats within the airport site as well as upstream and downstream of the site (15 sites in total). The location of the survey sites are shown on Figure 3 in Appendix K1 (Volume 4).

16.2.5.1 *Aquatic habitat assessment*

An assessment of the in-stream physical habitat was conducted at all sites in accordance with the NSW Australian River Assessment System (AUSRIVAS) (Turak and Waddell 2002). This included detailed assessments of the substrata and water channels, hydraulic habitat features, and their suitability for threatened flora and fauna identified in the database searches and literature review.

16.2.5.2 *Water quality assessment*

Water quality parameters were measured at each survey site including temperature; electrical conductivity; dissolved oxygen; pH; turbidity; alkalinity; metals; nutrients; benzene, toluene, ethylbenzene, and xylenes (BTEX); additional hydrocarbons and other constituents. Water quality was compared to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000) and water pollution thresholds contained within the Airports (Environment Protection) Regulations 1997.

16.2.5.3 *Macroinvertebrate sampling and analysis*

Macroinvertebrates were collected using mesh nets from edge, pool and riffle habitats at the survey sites. Macroinvertebrate samples were live-sorted in the field (for a minimum of 40 minutes and maximum of 60 minutes). Macroinvertebrates were then preserved and transferred to a laboratory for identification. The results were used to assess the biological condition or impairment at each survey site. Impairment was calculated using both AUSRIVAS Observed to Expected Ratio (O/E50) and Stream Invertebrate Grade Number – Average Level (SIGNAL 2) scores (defined in Appendix K1 (Volume 4)). Other biological metrics used as descriptors of the surveys sites were taxa richness, Ephemeroptera-Plecoptera-Trichoptera richness and the community composition at each survey site.

16.2.5.4 *Fish surveys*

Fish were surveyed at each survey site using bait traps and/or fyke nets. Fish were identified and counted. Native species were released and non-native species were euthanised in accordance with ethics permit requirements. The sensitivity of key fish habitats and the functionality of waterways at the airport site were classified according to the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI 2013). Aquatic habitats were also compared with the habitat requirements of threatened aquatic fauna known to occur in the region according to the DPI threatened species profiles (DPI 2015).

16.2.6 Rapid assessments

Additional rapid assessments were completed between March and December 2015 to supplement the initial surveys and support other assessments at the airport site. The rapid assessments were completed at a number of geotechnical investigation sites, European heritage investigation sites, the proposed high intensity approach lighting area and downstream sites. Rapid assessments involved a combination of the following survey techniques as relevant at each location:

- visual inspection of the investigation area and assessment of vegetation type and condition patch size, connectivity, age, disturbance and floristic and structural diversity;

- assessment of the conservation significance of vegetation with reference to the identification and condition criteria for listed threatened ecological communities;
- assessment of the presence and quality of fauna habitat resources such as shelter substrate for Cumberland Plain Land Snails, hollow-bearing trees and logs, stags and roost sites, wetlands and water courses;
- active searches for resident fauna in areas of suitable habitat including checking of shelter substrate for Cumberland Plain Land Snails; and
- targeted searches for threatened plants.

A summary of the survey effort is provided in Table 16–3.

Table 16–3 Rapid assessment effort

Survey method	Survey effort	Approximate field person hours
Rapid assessment – Geotechnical investigations 1	47 sites over 4 days	80
Rapid assessment – Geotechnical investigations 2	56 sites over 6 days	120
Rapid assessment – European cultural heritage	4 sites over 1 day	20
Rapid assessment – High intensity approach lighting	1 site over ½ day	10
Rapid assessment – Downstream locations	6 sites over 1 day	20

16.2.7 Impact calculations

Direct impacts on terrestrial and aquatic flora and fauna (the removal of vegetation and habitat loss) were quantified to determine the potential impacts of the airport and the necessity of biodiversity offsets. The amount of each vegetation zone and fauna habitat type directly affected by the project was recorded in a geographic information system.

16.2.8 Assessment of significance of impacts

Assessments of significance were prepared for one endangered ecological community, six flora species and two fauna species listed under the EPBC Act and for the Greater Blue Mountains World Heritage Area in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a). An assessment of significance was also prepared for impacts on Commonwealth Land in accordance with the *Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (DoE 2013b).

16.2.9 Offsetting impacts

Biodiversity offsets to compensate for significant residual impacts on threatened species and communities listed under the EPBC Act were calculated using the offsets assessment guide under the EPBC Act *Environmental Offsets Policy* (DSEWPaC 2012). Biodiversity offsets to compensate for significant residual impacts on other features of the natural environment on Commonwealth land, plants, animals and their habitat, including threatened species, populations and communities listed under the TSC Act, were calculated with reference to the NSW BioBanking Assessment Methodology and *Credit Calculator Operational Manual 2014* (DECC 2009b) and the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is used to calculate offsets for major projects in NSW. Further detail regarding the methodology for offsetting impacts is provided in Appendix K2 (Volume 4).

16.3 Existing environments

This section describes the physical environment of the airport site and the existing terrestrial and aquatic flora, fauna and fauna habitat at the airport site. Threatened and migratory species, populations and endangered ecological communities known or predicted to occur within the airport site, along with their conservation status are included in the description.

16.3.1 Physical environment

The airport site is part of an elevated ridge system dividing the Nepean River and South Creek catchments on the Cumberland Plain. The site is characterised by rolling landscapes typical of Bringelly Shale with a prominent ridge in the west of the site, reaching an elevation of about 120 metres Australian Height Datum (AHD), and smaller ridge lines in the vicinity with elevations of about 100 metres AHD. The topography of the airport site generally slopes away from the ridges in the west, with elevations between 40 and 90 metres AHD.

The airport site features remnant patches of grassy woodland and narrow corridors of riparian forest within extensive areas of derived grassland, cropland, and cleared and developed land. The main land uses are agriculture and low density rural residential development.

The airport site is contained within the ‘Cumberland Plain’ Mitchell Landscape (DECC 2008b). This landscape is noted to be approximately 30 to 120 metres above sea level, and comprises low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast, with vegetation characterised by grassy woodlands and open forests dominated by Grey Box and Forest Red Gum, and poorly drained valley floors with forests of Cabbage Gum (*Eucalyptus amplifolia*) and Swamp Oak (*Casuarina glauca*) (DECC 2008b).

The airport site is located within the Hawkesbury Nepean catchment area within the Badgerys Creek, Cosgroves Creek and Duncans Creek sub-catchments. Badgerys Creek and Cosgroves Creek are tributaries of South Creek which generally flows northward into the Hawkesbury River. Badgerys Creek flows along the southern and eastern boundary of the airport site and drains into South Creek. Oaky Creek originates in the centre of the site and flows northwards to Cosgroves Creek which drains into South Creek. There are a large number of small first and second order drainage lines across the site, many of which have been dammed and heavily modified resulting in isolated artificial freshwater wetlands. These wetlands support varying degrees of in stream and riparian vegetation.

Duncans Creek starts about three kilometres south-west of the airport site and flows north-westerly before joining the Nepean River about nine kilometres downstream from the airport site. This creek is located just outside the western end of the airport site. Duncans Creek receives flows from a number of unnamed tributaries at the airport site. The Duncans Creek catchment downstream of the site is rural and zoned for primary production (plant or animal cultivation).

Several vegetation communities that occur at the airport site are 'high probability groundwater dependent ecosystems' (SMEC 2014).

The geology of the landscape consists of Triassic shales and lithic sandstones, with a small number of volcanic vent intrusions. Tertiary river gravels and sands partially cover much of the landscape, in addition to Quaternary alluvium along the main watercourses. The soils consist of red and brown texture-contrast soils on crests, grading to yellow harsh texture-contrast soils in valleys (DECC 2008c).

16.3.2 Terrestrial flora

16.3.2.1 Flora species

A total of 280 terrestrial plant species (of which 202 were native and 78 species were exotic) from 72 families were recorded at the airport site. A list of plant species recorded at the airport site is provided in Appendix K1 (Volume 4).

Due to the existence of residential gardens and cropland, the airport site is expected to contain a considerably greater diversity of exotic plant species than are listed in Appendix K1 (Volume 4). These areas were not a focus of the terrestrial and aquatic ecological impact assessment, beyond visual inspection to confirm that they did not contain native vegetation communities. There was no formal sampling of the plant species in these areas.

The majority of the native vegetation at the airport site has been previously cleared, grazed or otherwise modified and is in moderate or poor condition.

Threatened flora species and populations recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.2.5.

16.3.2.2 Weeds of national significance and noxious weeds

Of the 78 exotic species recorded at the airport site, nine are listed as weeds of national significance by the Australian Weeds Strategy (AWS 2015). Eight of the nine weeds of national significance recorded at the airport site are also listed as noxious weeds under the NSW *Noxious Weeds Act 1993* for the Liverpool Local Government Area. An additional seven noxious weeds were recorded at the airport site. These weeds are listed in Table 16–4.

As discussed above, the airport site is likely to contain additional exotic plant species to those revealed by the field surveys. The list below should be considered a guide to the most serious and widespread of the weeds at the airport site.

Weeds of national significance and noxious weeds are present across the majority of the airport site. Particularly severe or extensive infestations include:

- Madeira Vine (*Anredeira cordifolia*), Bridal Creeper (*Asparagus asparagoides*), Lantana (*Lantana camara*), African Olive (*Olea europa subsp. cuspidata*) and privet species in the riparian corridor of Badgerys Creek;
- African Olive and privet species in the riparian corridors of small drainage lines in the site's west;
- Alligator Weed (*Alternanthera philoxeroides*) in dammed sections of Oaky Creek and the adjoining floodplain in the site's north; and
- African Boxthorn (*Lycium feroccissimum*), African Olive, Common Prickly Pear (*Opuntia stricta*) and Blackberry (*Rubus fruticosus* species *aggregate*) on the margins of commercial farms in the centre of the airport site and on rural residential lots in the suburb of Badgerys Creek.

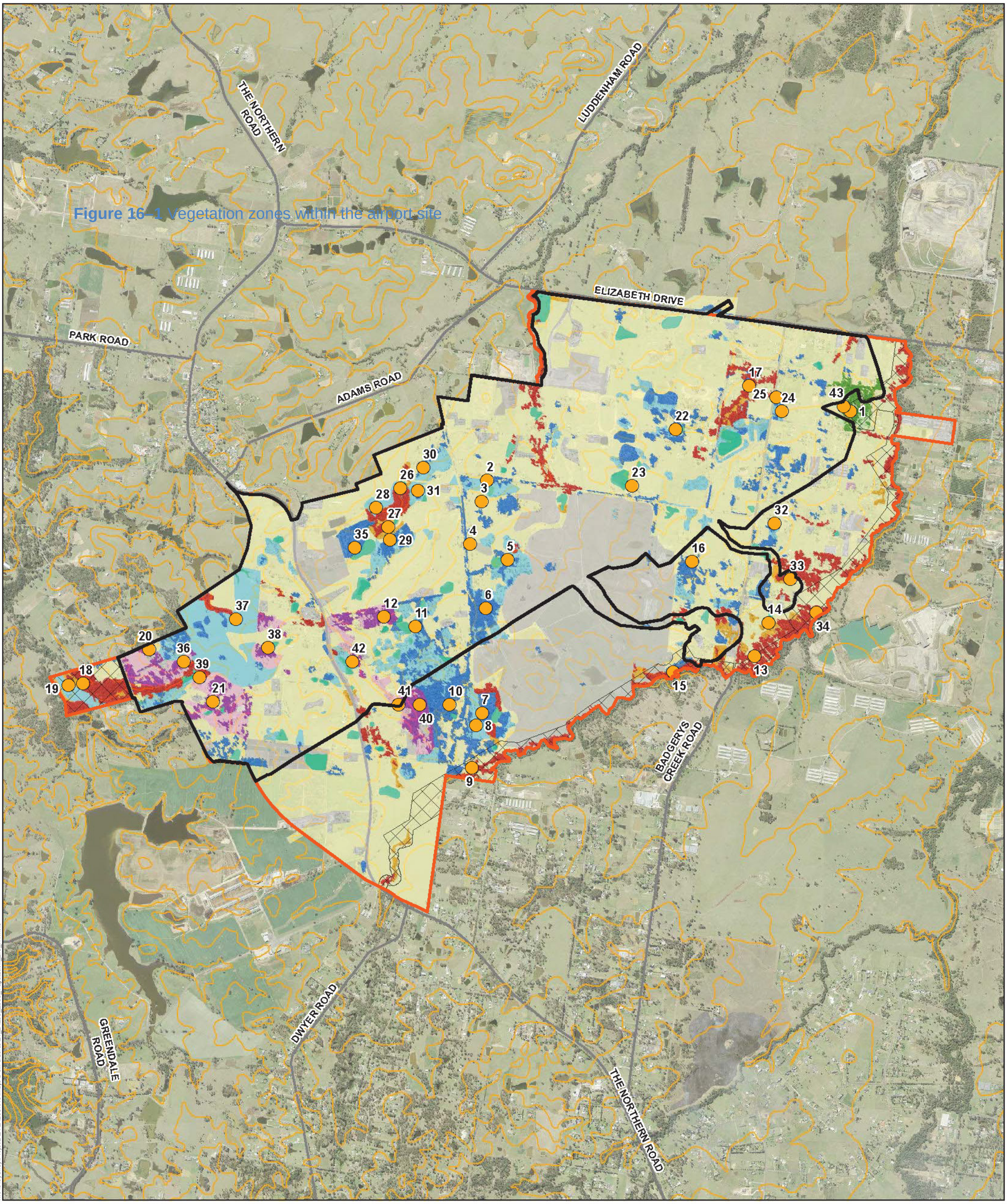
Weeds at the airport site would be managed in accordance with the mitigation measures listed in Section 16.7.2.

Table 16–4 Weeds of national significance and noxious weeds recorded at the airport site

Scientific name	Common name	Weeds of national significance	Noxious weeds
Alternanthera philoxeroides	Alligator Weed	✓	✓
Anredeira cordifolia	Madeira Vine	✓	x
Asparagus asparagoides	Bridal Creeper	✓	✓
Bryophyllum species	Mother of Millions	x	✓
Cestrum parqui	Green Cestrum	x	✓
Cortaderia selloana	Pampas Grass	x	✓
Lantana camara	Lantana	✓	✓
Ligustrum lucidum	Small-leaved Privet	x	✓
Ligustrum sinense	Broad-leaved Privet	x	✓
Lycium feroccissimum	African Boxthorn	✓	✓
Olea europa subsp. cuspidata	African Olive	x	✓
Opuntia stricta	Common Prickly Pear	✓	✓
Ricinus communis	Castor Oil Plant	x	✓
Rubus fruticosus species aggregate	Blackberry	✓	✓
Salvinia molesta	Salvinia	✓	✓
Senecio madagascariensis	Fireweed	✓	✓

16.3.2.3 Vegetation zones

Field surveys confirmed the presence and distribution of five native and two non-native plant community types at the airport site. Stands of these plant community types include a variety of disturbance levels including near-intact vegetation in ‘moderate/good – high’ condition, partially cleared or regrowth vegetation in ‘moderate/good – poor’ condition and extensively modified areas in ‘cleared’ condition. Accordingly, nine native and two non-native vegetation zones (plant community types and broad condition classes) were identified and mapped within the airport site, as shown in Figure 16–1. The attributes of these vegetation zones are summarised in Table 16–5 with further detail provided in Appendix K1 (Volume 4).



LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

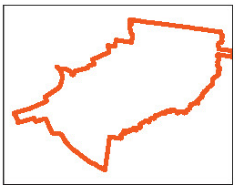


Figure 16-1A - Vegetation zones within the airport site

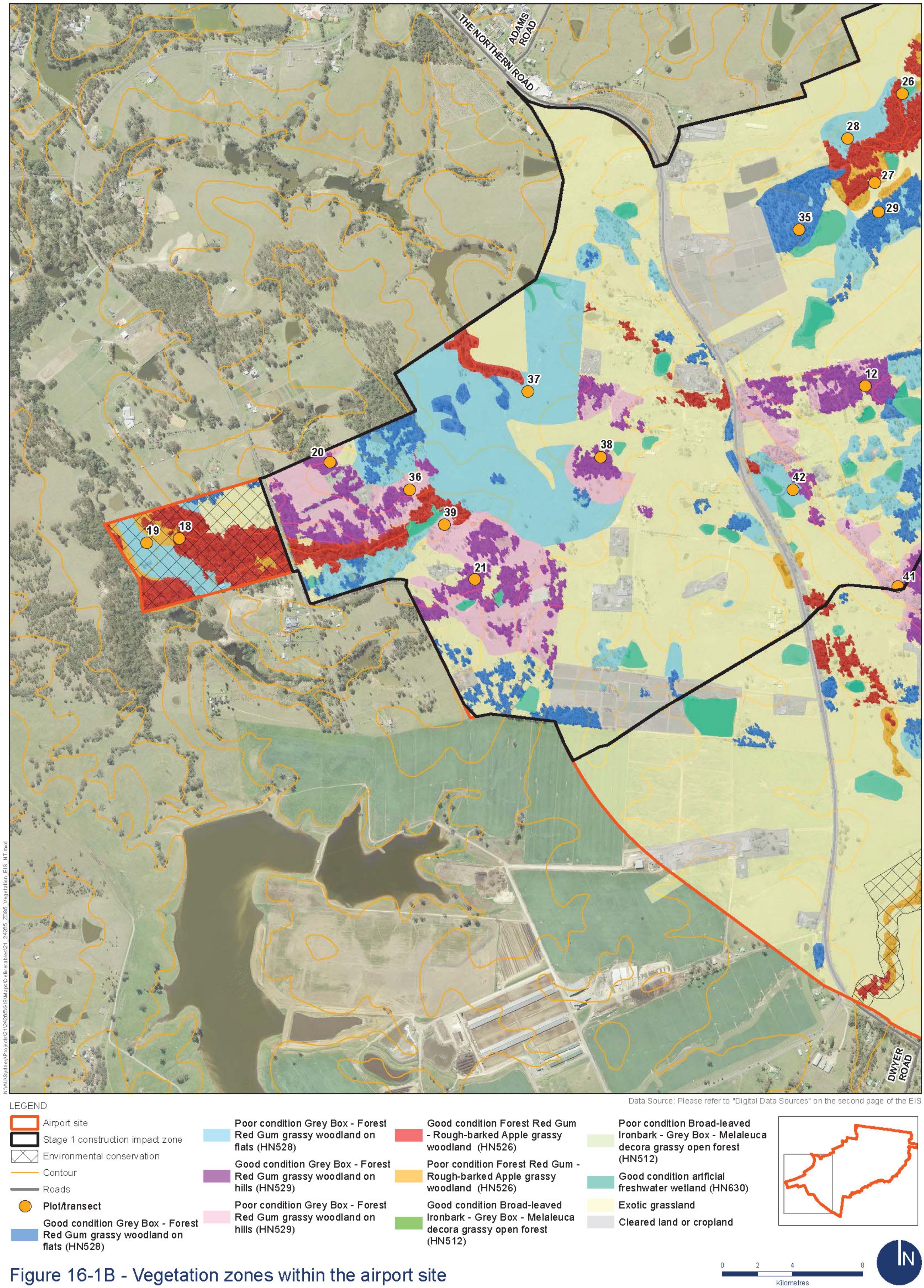
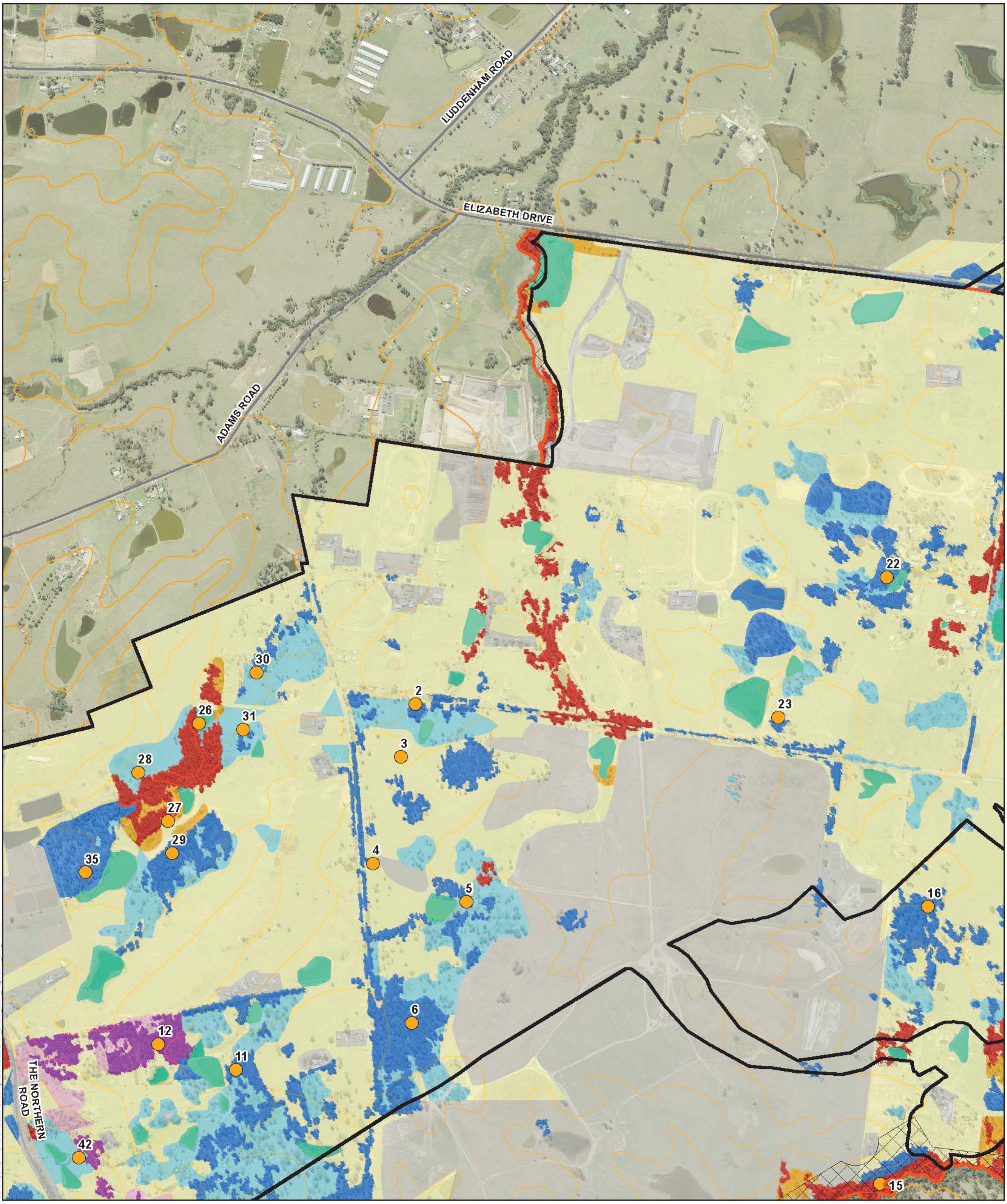


Figure 16-1B - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

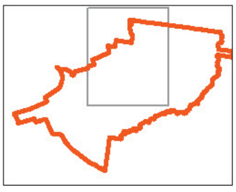


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Figure 16-1C - Vegetation zones within the airport site

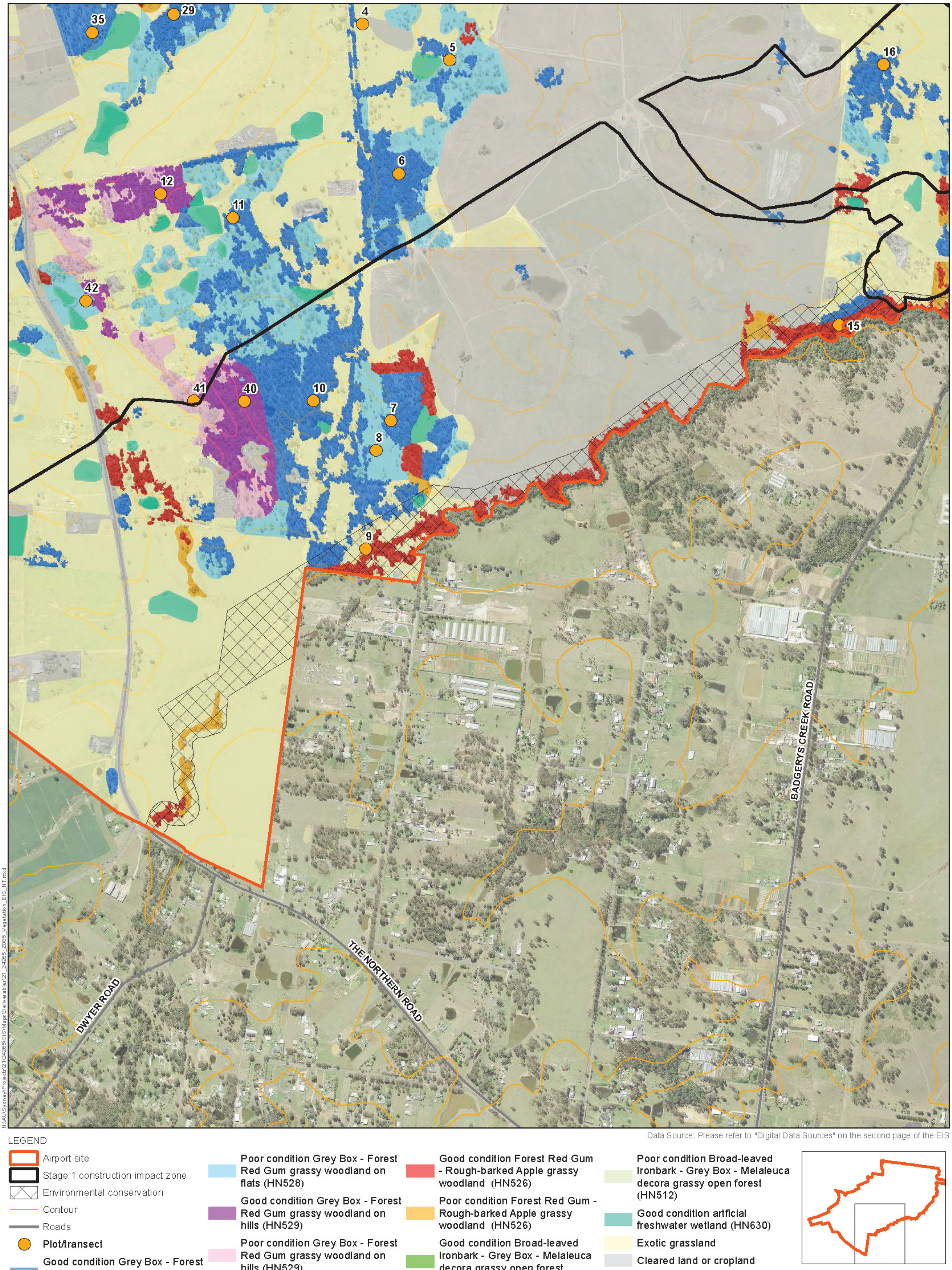
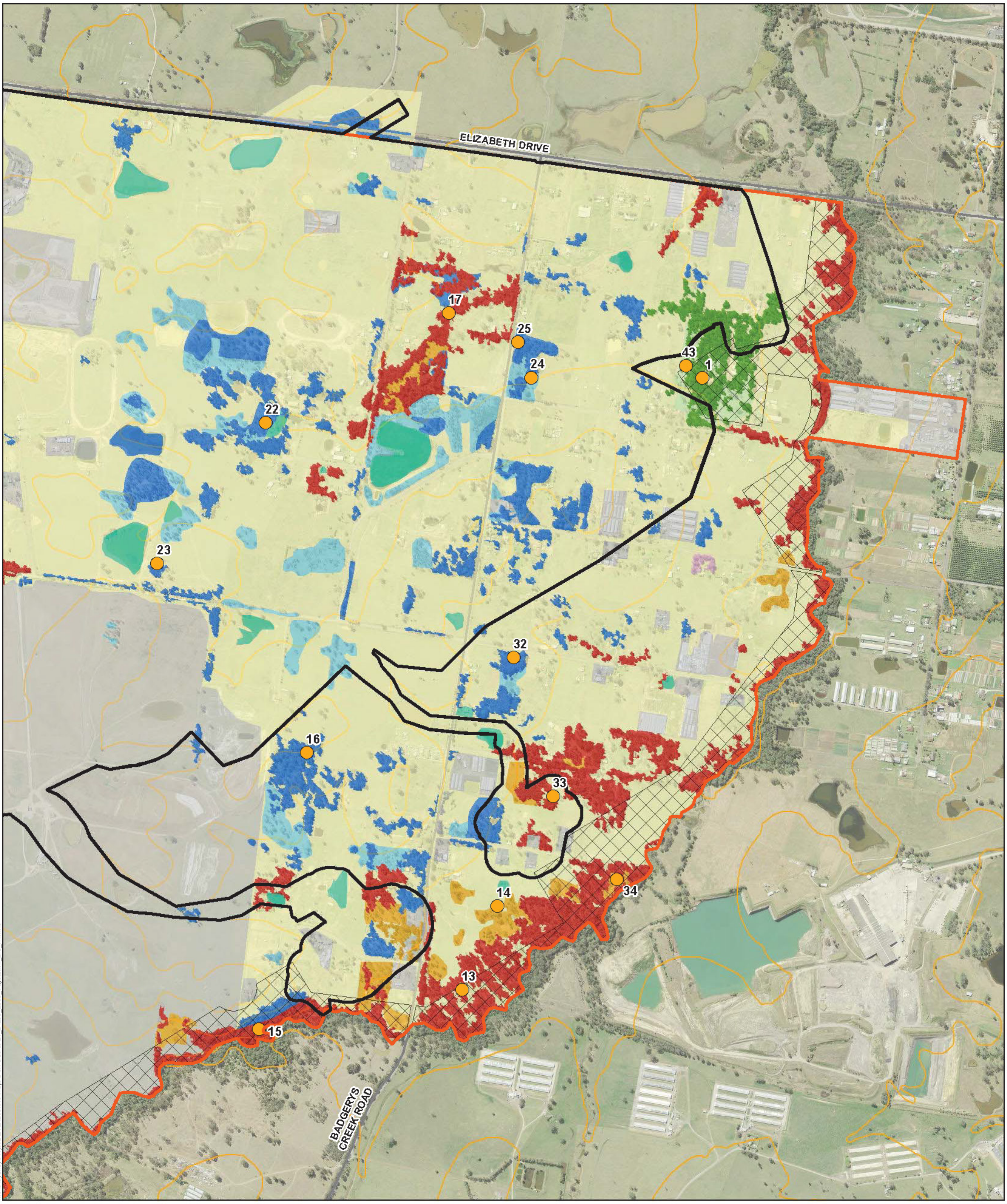


Figure 16-1D - Vegetation zones within the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Plot/transect
- Good condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Poor condition Grey Box - Forest Red Gum grassy woodland on flats (HN528)
- Good condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Poor condition Grey Box - Forest Red Gum grassy woodland on hills (HN529)
- Good condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Poor condition Forest Red Gum - Rough-barked Apple grassy woodland (HN526)
- Good condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Poor condition Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest (HN512)
- Good condition artficial freshwater wetland (HN630)
- Exotic grassland
- Cleared land or cropland

0 2 4 8
Kilometres

Figure 16-1E - Vegetation zones within the airport site

Table 16–5 Vegetation zones within the airport site

Vegetation zone	Condition	Conservation status[1]		Area at the airport site (hectares)
		EPBC Act status	TSC Act status	
Native vegetation zones				
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Cumberland Plain Woodland (CEEC)	119.9
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/good – poor	-	Cumberland Plain Woodland (CEEC)	131.0
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Cumberland Plain Woodland (CEEC)	30.2
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/good – poor	-	Cumberland Plain Woodland (CEEC)	31.0
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/good – medium or high	-	River Flat Eucalypt Forest (EEC)	92.3
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/good – poor	-	River Flat Eucalypt Forest (EEC)	18.4
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/good – medium or high	Cumberland Plain Woodland and Shale-gravel Transition Forest (CEEC)	Shale/gravel Transition Forest (EEC)	8.3
Poor condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/good – poor	-	Shale/gravel Transition Forest (EEC)	2.3
Good condition artificial freshwater wetland on floodplain (HN630)	Moderate/good	-	-	35.4
Non-native vegetation zones				
Exotic grassland	Cleared	-	-	956.8
Cleared land or cropland	Cleared	-	-	348.2
Total				1,773.9

The most extensive vegetation zone at the airport site is exotic grassland. This contains no native overstorey or midstorey vegetation and less than 50 per cent of the ground cover vegetation is native. Grassland areas contain occasional isolated paddock trees that are remnants of adjoining native woodland and forest. There are also extensive areas of buildings, hard stand, bare earth, cropland and waterbodies that feature minimal vegetation cover that have been collectively mapped as 'cleared land and cropland'. Exotic grassland at the airport site is shown in Photograph 16–1.

Photograph 16-1 Heavily grazed exotic grassland (left) and ungrazed exotic grassland (right) at the airport site

Grey Box – Forest Red Gum grassy woodland on flats is associated with mid and lower slopes, on shale derived soils across the airport site, and is the most extensive native plant community type. It comprises an open forest or woodland of Forest Red Gum and Grey Box with a grassy understorey and occasional dense patches of the shrub species Native Blackthorn (*Bursaria spinosa spinosa*). Grey Box – Forest Red Gum grassy woodland on flats at the airport site is shown in Photograph 16–2.

Photograph 16-2 Good condition Grey Box – Forest Red Gum grassy woodland on flats (left) and poor condition (right)

There are small areas of tertiary gravel influenced soils in the east of the airport site that support Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest with a canopy of Forest Red Gum and Grey Box along with Broad-leaved Ironbark (*Eucalyptus fibrosa*), a characteristic midstorey of Honey Myrtle (*Melaleuca decora)* and a shrub and grass understorey.

There is a volcanic intrusion in the central-western portion of the site which is associated with steeper terrain, rock fragments in soil profiles and some rock outcropping. In other parts of the Cumberland Plain this geology is often associated with Moist Shale Woodland and Western Sydney Dry Rainforest (NPWS 2002; Tozer et al. 2010), however at the airport site it contains Grey Box – Forest Red Gum grassy woodland on hills with relatively few species representative of these other communities. Plot/transect data was compared with Tozer et al. (2010) diagnostic species lists to confirm the identity of this vegetation type. The observed vegetation may be because of frequent and/or recent fire and other disturbance at the airport site, which has prevented a succession towards rainforest species.

The above vegetation types transition into Forest Red Gum – Rough-barked Apple grassy woodland along the riparian corridors of Badgerys Creek and other drainage lines through the airport site. This community is a closed woodland or forest of Forest Red Gum, Grey Box and Cabbage Gum (*Eucalyptus amplifolia*) along with Swamp Oak, Broad-leaved Apple (*Angophora subvelutina*) and paperbarks (*Melaleuca* spp.). Understorey vegetation is similar to Shale Plains Woodland along with additional moisture-loving species such as rushes and sedges.

The condition of these plant community types varies across the airport site as a result of previous land use and grazing intensity. Areas that have been historically cleared and/or heavily grazed now contain regrowth vegetation in poorer condition. There is moderate to severe weed infestation throughout, with linear remnants along roads and isolated patches in agricultural land that are the most severely affected. Notwithstanding the generally moderate to poor condition of vegetation at the airport site, it has high conservation significance as a result of the presence of threatened biota and the generally limited extent and quality of similar vegetation in Western Sydney.

There are patches of derived native grassland at the airport site that comprise poor condition forms of the native vegetation communities described above. These areas contain at least 50 per cent native groundcover, mainly comprising native grasses such as Kangaroo Grass (*Themeda australis*). There is a moderate species richness, but relative low cover and an abundance of understorey herbs associated with the woodlands and forests described above. Exotic grasses and herbs are present throughout.

There are a large number of dams and flooded depressions throughout the airport site formed by the construction of barriers across small drainage lines. These waterbodies contain a moderate diversity and abundance of native wetland plants.

There are local occurrences of one threatened ecological community listed under the EPBC Act and three threatened ecological communities listed under the TSC Act at the airport site, as described below.

16.3.2.4 Groundwater dependent ecosystems

The Atlas of Groundwater Dependent Ecosystems (BoM 2015c) maps the potential for creeks and vegetation to be either groundwater dependent or inflow dependent. No waterways at the airport site are mapped as being groundwater dependent ecosystems that are reliant on the surface expression of groundwater. South Creek to the east and the Nepean River to the west are both mapped as this type of groundwater dependent ecosystem but are not anticipated to be directly influenced by groundwater aquifers at the airport site.

Most large patches of native vegetation (including riparian vegetation) at the airport site are mapped as having a high potential for groundwater interaction (that is, they are likely to be groundwater dependent ecosystems that are reliant on subsurface groundwater). Some smaller patches of native vegetation are mapped as having a low or moderate potential for groundwater interaction. Native vegetation along Badgerys Creek is also mapped as being highly likely to be an inflow dependent ecosystem (reliant on groundwater in addition to rainfall). Most other patches of native vegetation at the airport site are also mapped as being likely or highly likely to be inflow dependent (BOM 2015c). According to Kuginis et al. (2012), all native vegetation communities present at the airport site are likely to be groundwater dependent ecosystems.

16.3.2.5 Threatened flora species and populations

Twenty-eight species of threatened flora listed under the EPBC Act and/or TSC Act have been recorded or are predicted to occur within the general locality of the airport site.

Two species that are either threatened or part of an endangered population were recorded at the airport site during field surveys, while an additional seven species may occur. These species are listed in Table 16–6 and their distribution at the airport site is shown on Figure 16–2.

The remaining species predicted to occur in the general locality of the airport site are considered unlikely to occur at the airport site due to a lack of suitable habitat, and therefore would not be affected by the proposed airport. These species are discussed further in Appendix K1 (Volume 4).

Four individuals of *Pultenaea parviflora* were recorded on the southern side of Longleys Road between Ferndale Road and Taylors Road by SMEC (2014) and these records were verified during the field surveys. *Pultenaea parviflora* is listed as a vulnerable species under the EPBC Act and an endangered species under the TSC Act. This is a significant reduction from the 68 individuals previously recorded along both sides of Longleys Road in this location during the field surveys for the 1997–99 EIS (PPK 1997). The former locations of the other 64 individuals currently contain cleared, ploughed cropland or severely weed infested road edges and do not comprise occupied or potential habitat for this species.

In addition, 142 stems of *Marsdenia viridiflora* subsp. *viridiflora* have been recorded at the airport site, with the majority recorded in Grey Box – Forest Red Gum grassy woodland on flats adjacent to Longleys Road and Anton Lane in the centre of the airport site (see Figure 16–2). These comprise part of the endangered *Marsdenia viridiflora* R. Br. subsp. *viridiflora* population in the Bankstown (now Canterbury-Bankstown), Blacktown, Camden, Campbelltown, Fairfield, Holroyd (now Cumberland), Liverpool and Penrith local government areas listed under the TSC Act.

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Table 16–6 Threatened flora recorded or that may occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of occurrence
		EPBC Act	TSC Act	
Pultenaea parviflora		V	E	Present
Marsdenia viridiflora subsp.			EP	Present
Cynanchum elegans	White-flowered Wax Plant	E	E	Possible
Pimelea spicata	Spiked Rice-flower	E	E	Possible
Acacia pubescens	Downy Wattle	E	V	Possible
Grevillea parviflora subsp.	Small-flower Grevillea	V	V	Possible
Grevillea juniperina subsp.	Juniper-leaved Grevillea		V	Possible
Thesium australe	Austral Toadflax	V	V	Possible
Dillwynia tenuifolia			V	Possible

Conservation status: V = Vulnerable, E = Endangered, EP = Endangered Population

16.3.2.6 Threatened ecological communities

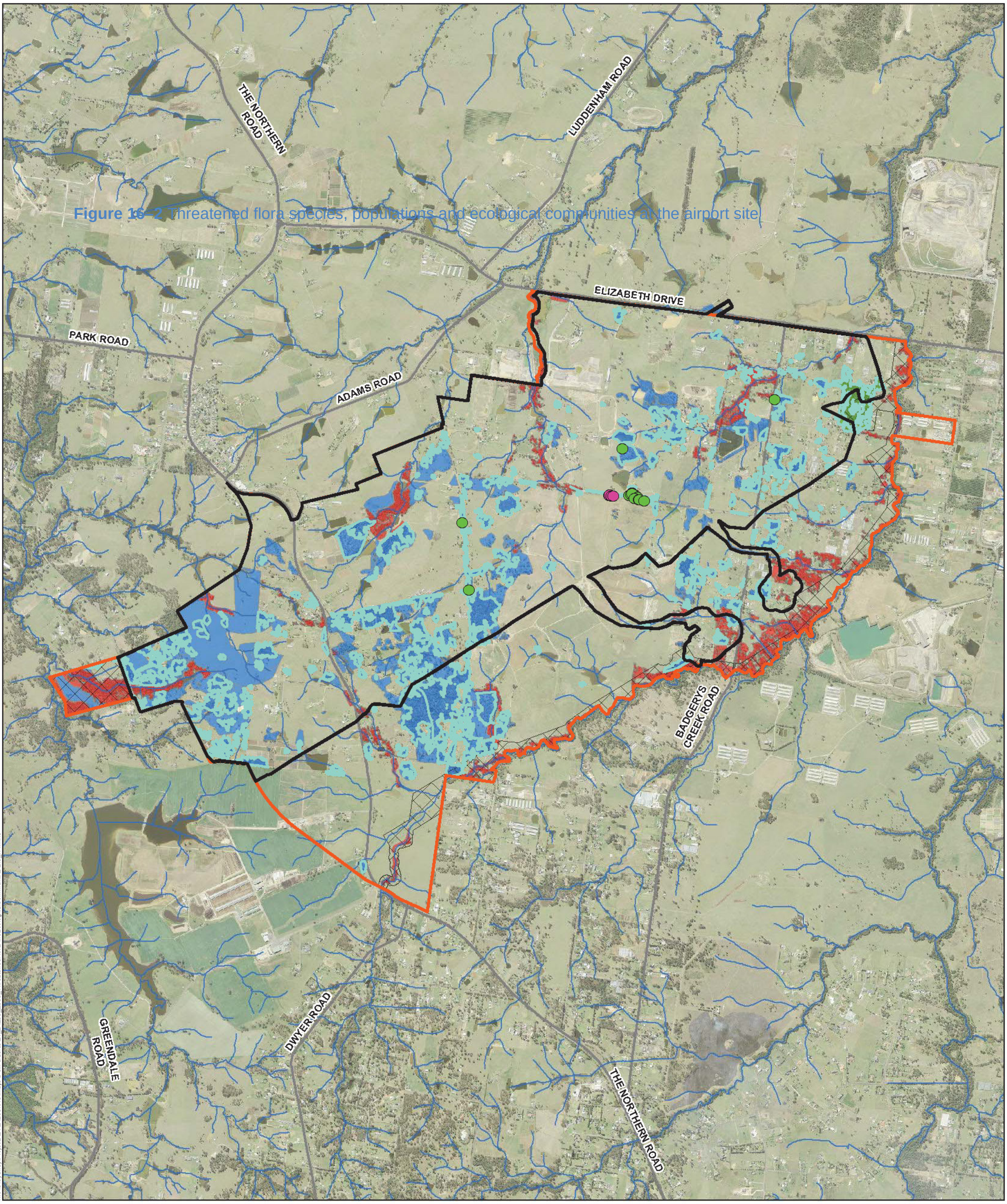
Larger and better condition patches of Grey Box – Forest Red Gum grassy woodland on flats, Grey Box – Forest Red Gum grassy woodland on hills and Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest at the airport site comprise occurrences of ‘Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest’ (Cumberland Plain Woodland) (see Table 16–5). Cumberland Plain Woodland is listed as a critically endangered ecological community under the EPBC Act and the TSC Act.

Derived native grassland and other moderate/good – poor condition vegetation at the airport site does not meet the condition criteria for a local occurrence of Cumberland Plain Woodland as defined under the EPBC Act and associated guidelines, but does meet the definition under the TSC Act.

All of the native woodland and forest vegetation at the airport site, including derived native grasslands, comprise local occurrences of threatened ecological communities listed under the TSC Act, as follows:

- both good and poor condition patches of Grey Box – Forest Red Gum grassy woodland on flats and Grey Box – Forest Red Gum grassy woodland on hills comprise the critically endangered ecological community ‘Cumberland Plain Woodland in the Sydney Basin Bioregion’ (Cumberland Plain Woodland);
- both good and poor condition patches of Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest comprise the endangered ecological community ‘Shale/Gravel Transition Forest in the Sydney Basin Bioregion’ (Shale-Gravel Transition Forest); and
- both good and poor condition patches of Forest Red Gum – Rough-barked Apple grassy woodland comprise the endangered ecological community ‘River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions’ (River Flat Eucalypt Forest) (see Table 16–5).

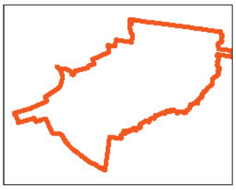
The status of vegetation zones quantified at the airport site as threatened ecological communities under the EPBC Act and TSC Act is included in Table 16–5. These threatened ecological communities are shown on Figure 16–2.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)



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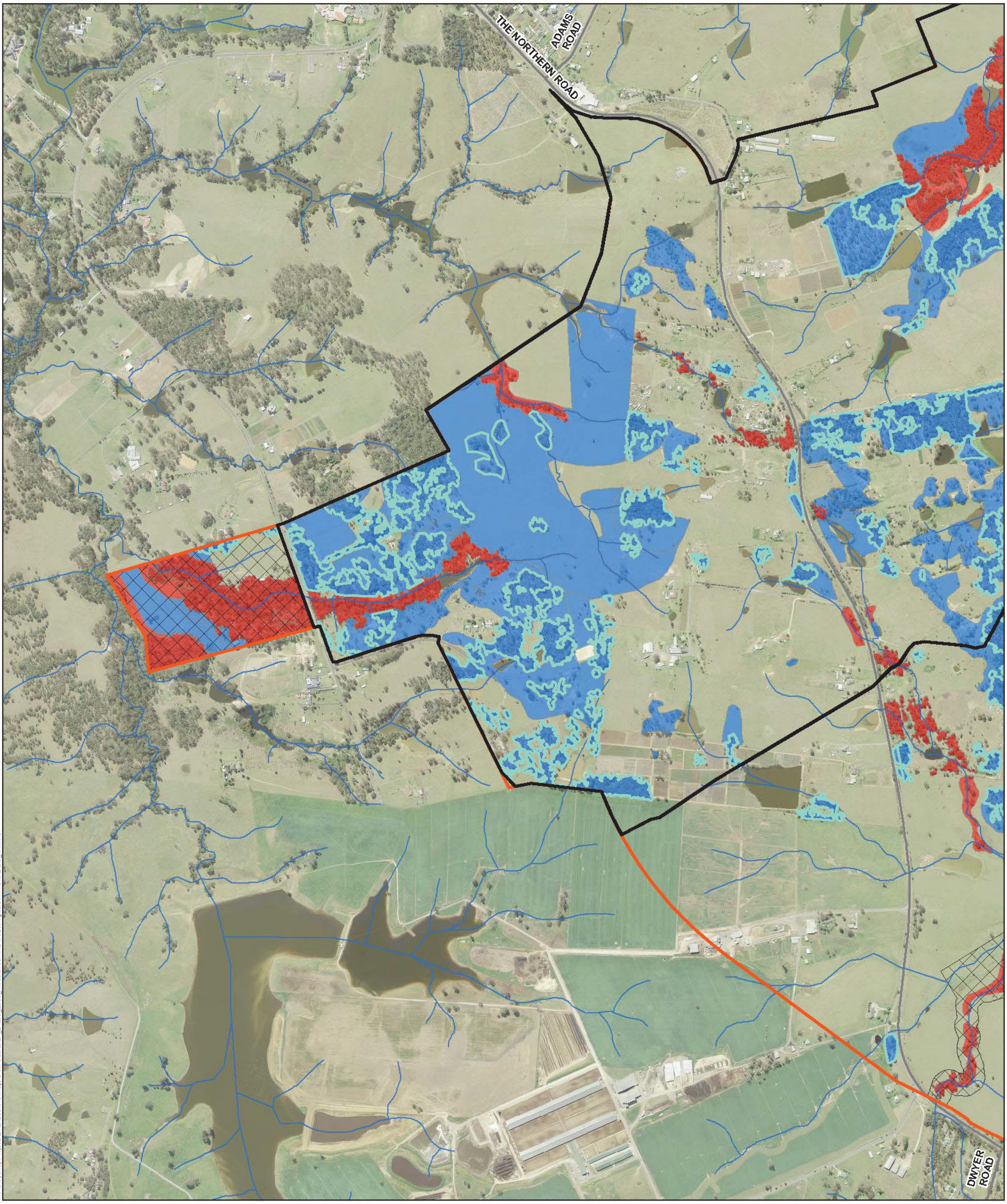
Kilometres

Figure 16-2A - Threatened flora species, populations and ecological communities at the airport site



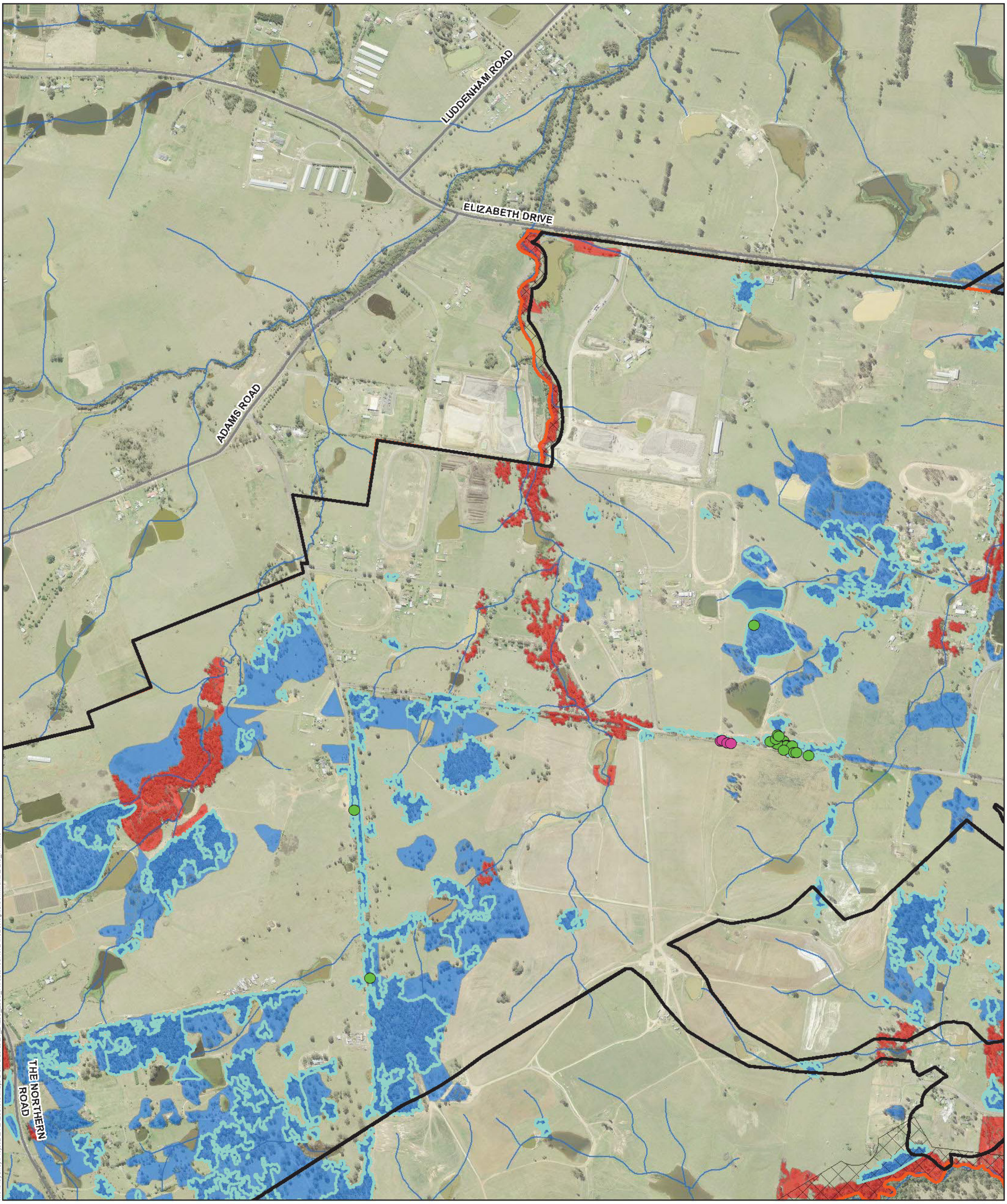
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

0 2 4 8
Kilometres

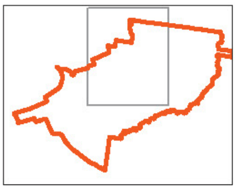
Figure 16-2B - Threatened flora species, populations and ecological communities at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

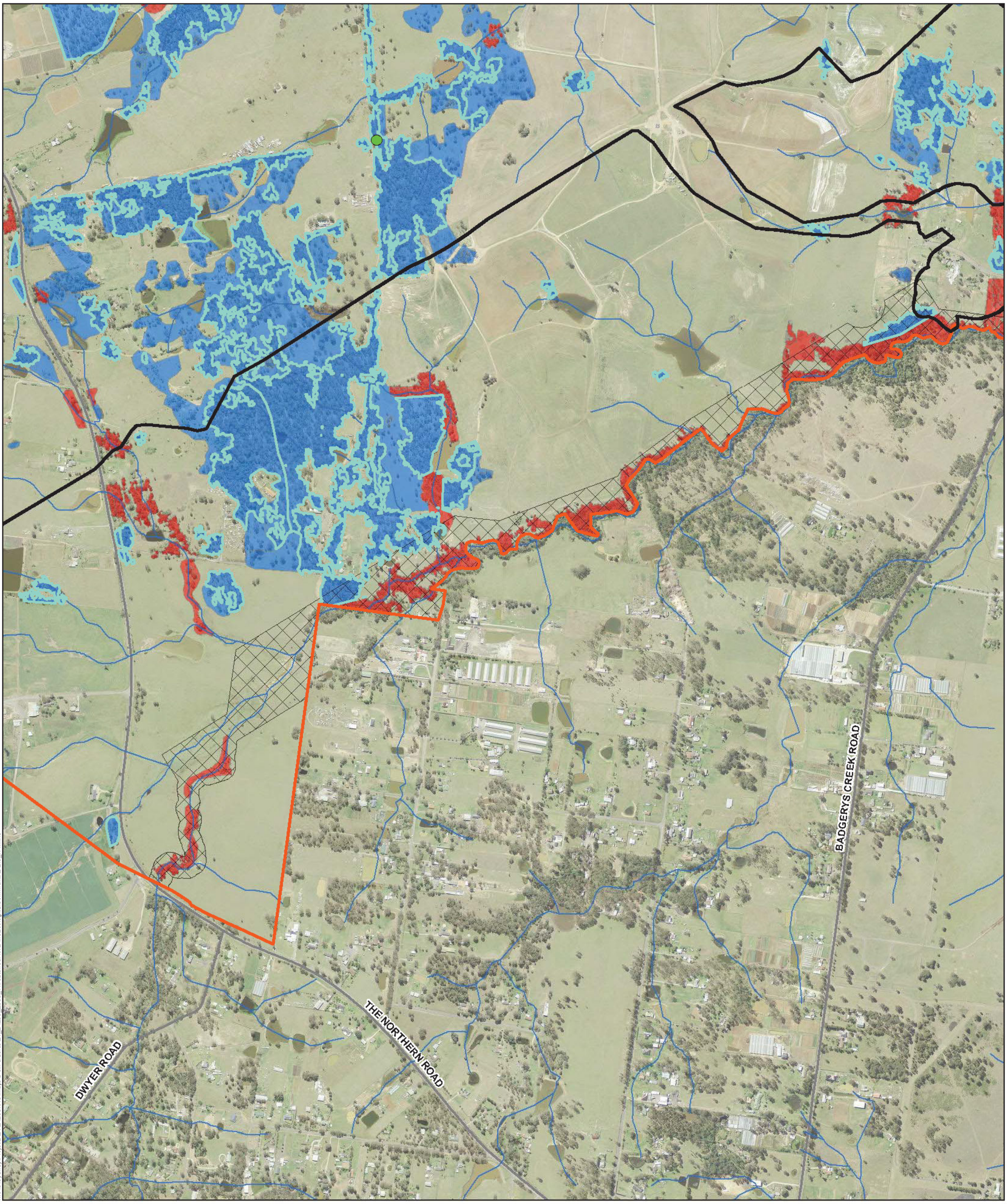
LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)



0 2 4 8
Kilometres

Figure 16-2C - Threatened flora species, populations and ecological communities at the airport site



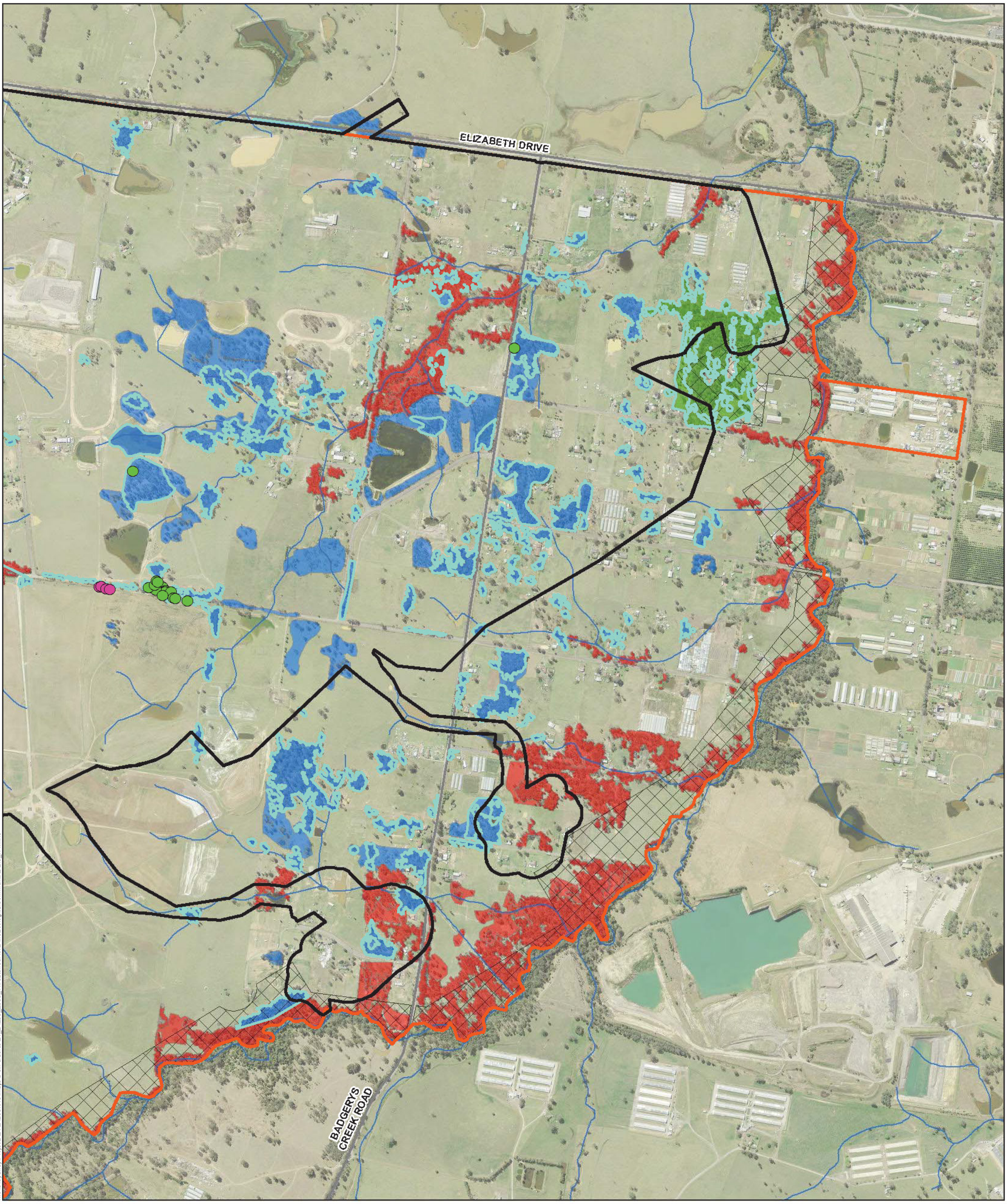
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

0 2 4 8
Kilometres

Figure 16-2D - Threatened flora species, populations and ecological communities at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Watercourses
- Roads
- Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (CEEC under EPBC Act and TSC Act)
- Cumberland Plain Woodland (CEEC under the TSC Act)
- River Flat Eucalypt Forest (EEC under the TSC Act)
- Shale/gravel Transition Forest (EEC under the TSC Act)
- *Pultenaea parviflora* (endangered species under the EPBC Act and TSC Act)
- *Marsdenia viridiflora subsp. viridiflora* (endangered population under the TSC Act)

0 2 4 8
Kilometres

Figure 16-2E - Threatened flora species, populations and ecological communities at the airport site

16.3.3 Terrestrial fauna

16.3.3.1 Fauna species

A total of 173 terrestrial fauna species (four invertebrate species, two fish species, 10 frog species, 10 reptile species, 127 bird species and 20 mammal species) were recorded at the airport site. As many as 10 other microchiropteran bat species may also have been recorded, but poor data quality and/or interspecific call similarities precluded reliable identification of additional species. A further 20 fauna species (10 bird species, seven mammal species, two reptile species and one frog species) were recorded by Biosis Research for the 1997–99 EIS (PPK 1997) and/or by SMEC (2014). The full list of fauna species recorded at the airport site is provided in Appendix K1 (Volume 4).

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4.

A number of introduced fauna species were recorded at the airport site, including seven bird species, six mammal species, one fish species, and two snail species.

16.3.3.2 Fauna habitat

Five broad fauna habitat types were recorded at the airport site: grassland and cropped areas, native woodland, riparian forest, wetlands, and buildings and other structures. These habitat types are described below.

Grassland and cropped areas

The majority of the airport site contains exotic grassland and cleared land or cropped areas. These would have historically supported native woodland vegetation but have been extensively modified by previous clearing and agriculture. Exotic grassland and cleared land contain few habitat resources of relevance to most native species due to low structural and floristic diversity. Exotic grasses and herbs would provide foraging resources for native fauna species that are relatively mobile and opportunistic.

Occasional paddock trees and shrubs (for example, Native Blackthorn or African Olive) also occur in these areas. Regrowth trees and shrubs would provide some foraging resources for native woodland birds.

Most of the species recorded in grassland areas would use these areas as an adjunct to the higher quality, more extensive areas of suitable habitat at and around the airport site. Some small fauna species such as lizards may rely on grassland habitat for their survival.

Native woodland

Native woodland at the airport site provides a moderate quality fauna habitat. Habitat resources include mature canopy trees and associated nectar, fruits and leaves as well as foraging substrate, a range of fruiting and flowering small trees and shrubs, and connectivity with wetland and aquatic habitat. Woodland and forest at the airport site forms some more extensive patches particularly where it is connected by riparian corridors, however the majority is fragmented and subject to edge effects (which are defined as changes in population or community structure that occur at the boundary of two habitats). There are roads, residences, agriculture and industry throughout the airport site creating associated noise and light disturbance as well as physical barriers to fauna movement. Grazing and the presence of exotic pest fauna would further reduce the habitat's value. There is only a moderate quantity of large, hollow-bearing trees at the airport site.

Eucalypts and other native flora species provide foraging and shelter resources for a range of birds and mammals. Foraging resources include seasonal nectar resources, seeds and insects. Winter-flowering acacias and Native Blackthorn would provide year-round foraging resources for a range of native birds, bats and mammals.

Much of the shrub and ground layer vegetation and habitat features of the woodland and forest at the airport site have been removed for grazing. Woodland at the airport site generally contains low quantities of woody debris and leaf litter. Fallen timber and leaf litter provides shelter habitat for reptiles, snakes and small mammals.

Riparian forest

There is a relatively extensive network of drainage lines and waterbodies across the airport site. Most drainage lines are in moderate geomorphic condition and support good instream and riparian vegetation but with moderate to severe weed infestation and some evidence of degradation by cattle such as grazing, bank erosion, increased turbidity and likely also nutrient enrichment from waste.

Riparian forest at the airport site consists of a closed woodland or forest of eucalypts with Swamp Oak present along the margins of the creeks. A range of paperbarks (*Melaleuca* spp.) are also present. Understorey vegetation is similar to the adjacent native woodland along with additional moisture-loving species such as rushes and sedges. Large, hollow-bearing trees tend to occur in higher densities along the riparian corridor than in other woodland patches at the airport site.

Similar to native woodland, eucalypts and other flora species provide foraging and shelter resources for a range of birds and mammals and fallen timber and leaf litter provides shelter habitat for small reptiles and mammals.

Drainage lines provide habitat for native fish and aquatic invertebrates and breeding habitat for a number of stream-breeding frogs.

Wetlands

There are a number of dams and flooded depressions at the airport site with varying growth of native wetland and aquatic plants, including some waterbodies with extensive reed beds. These range in habitat value for native fauna depending on their size, presence of emergent or aquatic vegetation and level of use by cattle and associated disturbance. Many dams contained a variety of aquatic vegetation, including *Typha orientalis*, *Eleocharis cylindrostachys* and *Eleocharis sphacelata*.

Building and other structures

A number of sheds and buildings are present at the airport site. Some of these structures provide roosting habitat for birds and microbats. Sheds and buildings are also likely to provide shelter for rodents and snakes. Roosting microbats were observed under the Badgerys Creek bridge on Badgerys Creek Road.

These five habitats are shown on Figure 16–3. A list of species recorded in each habitat (including threatened, migratory and introduced species) is provided in Appendix K1 (Volume 4).

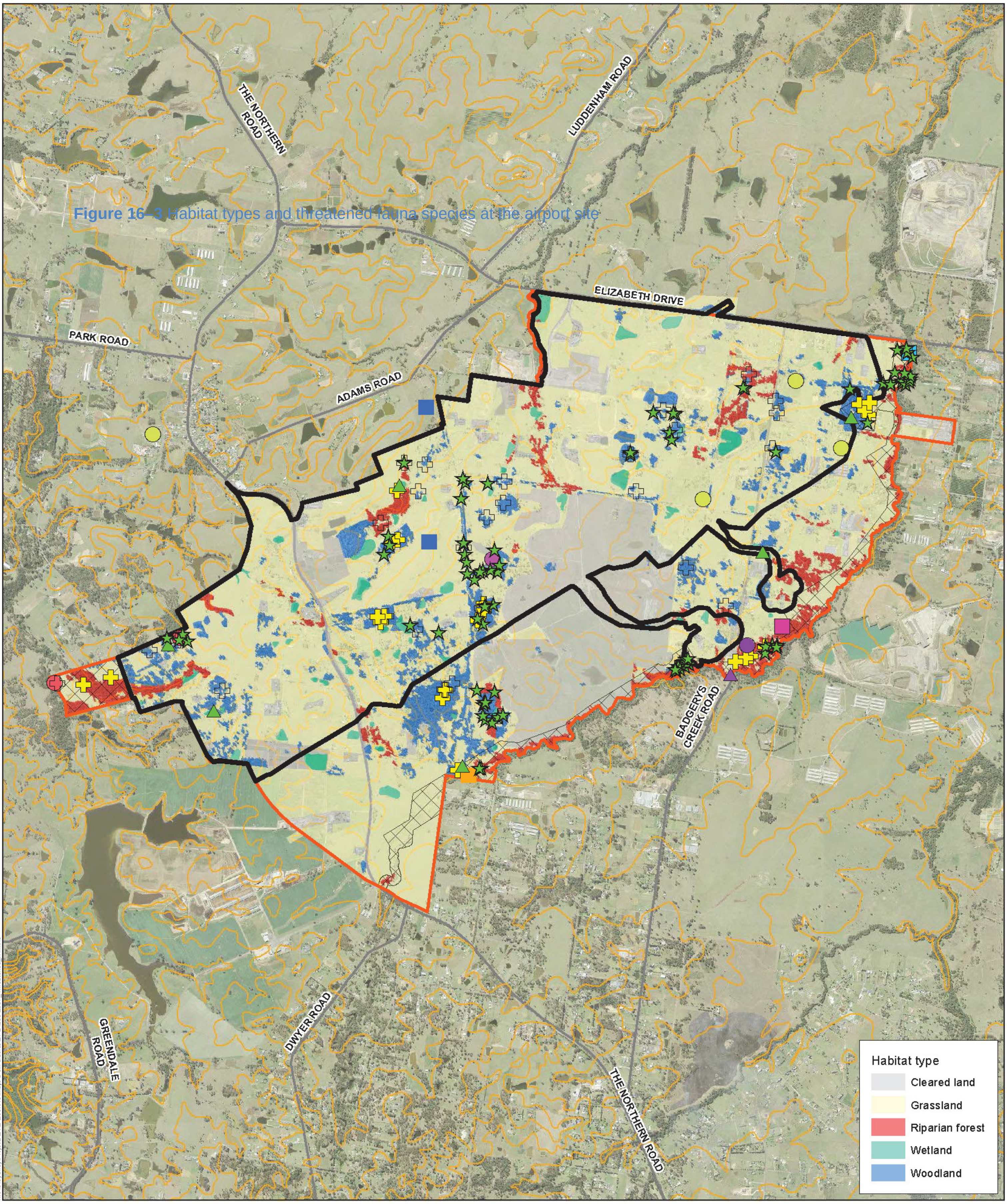
16.3.3.3 Habitat connectivity

Wildlife corridors are vital for the maintenance of ecological processes, including the movement of animals and the continuation of viable populations. Corridors can consist of a sequence of stepping stones across the landscape (discontinuous areas of habitat such as paddock trees, wetlands and roadside vegetation), continuous lineal strips of vegetation and habitat (such as riparian strips, ridge lines), or they may be parts of an extensive patch of vegetation (DEC 2004c).

Connectivity with vegetation outside the airport site is limited. Most vegetation in the locality occurs as small patches, with long linear patches of vegetation tending to occur along creek lines. The Badgerys Creek corridor remains generally vegetated to the north of the airport site, albeit with some gaps in vegetation cover and links to the vegetated corridors of South Creek and Cosgrove Creek. *The Western Sydney Urban Bushland Biodiversity Survey* (NPWS 1997) identified a number of riparian corridors as targets for conservation within the Liverpool Local Government Area, such as South Creek and Kemps Creek, but did not specifically include the Badgerys Creek corridor.

Most patches of native vegetation at the airport site were mapped by Ecological Australia (2012) as being linked and, therefore, having a patch size of greater than 100 hectares. There is only limited connectivity, however, with other patches of vegetation outside the airport site. Large expanses of cleared land occur along the northern edge of Elizabeth Drive and Adams Road. Small patches of vegetation to the south and west provide ‘stepping stones’ to other patches of vegetation outside the airport site.

Connectivity for fauna species is, therefore, mainly along the Badgerys Creek riparian corridor or between closely linked patches within the airport site. Species with only limited mobility, such as the Cumberland Plain Land Snail, have minimal opportunities for dispersal. The Cumberland Plain Land Snail would generally be restricted to isolated patches of vegetation in which the local population occurs, with no opportunity for movement between patches that are separated by grassland or cleared land. Small woodland birds would tend to move along the riparian corridors or along roadside vegetation to access other areas of habitat. More mobile fauna, such as the Grey-headed Flying-fox and larger birds would move easily between patches of vegetation at the airport site and other areas of habitat in the locality.



LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

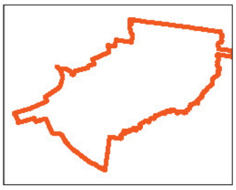
Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

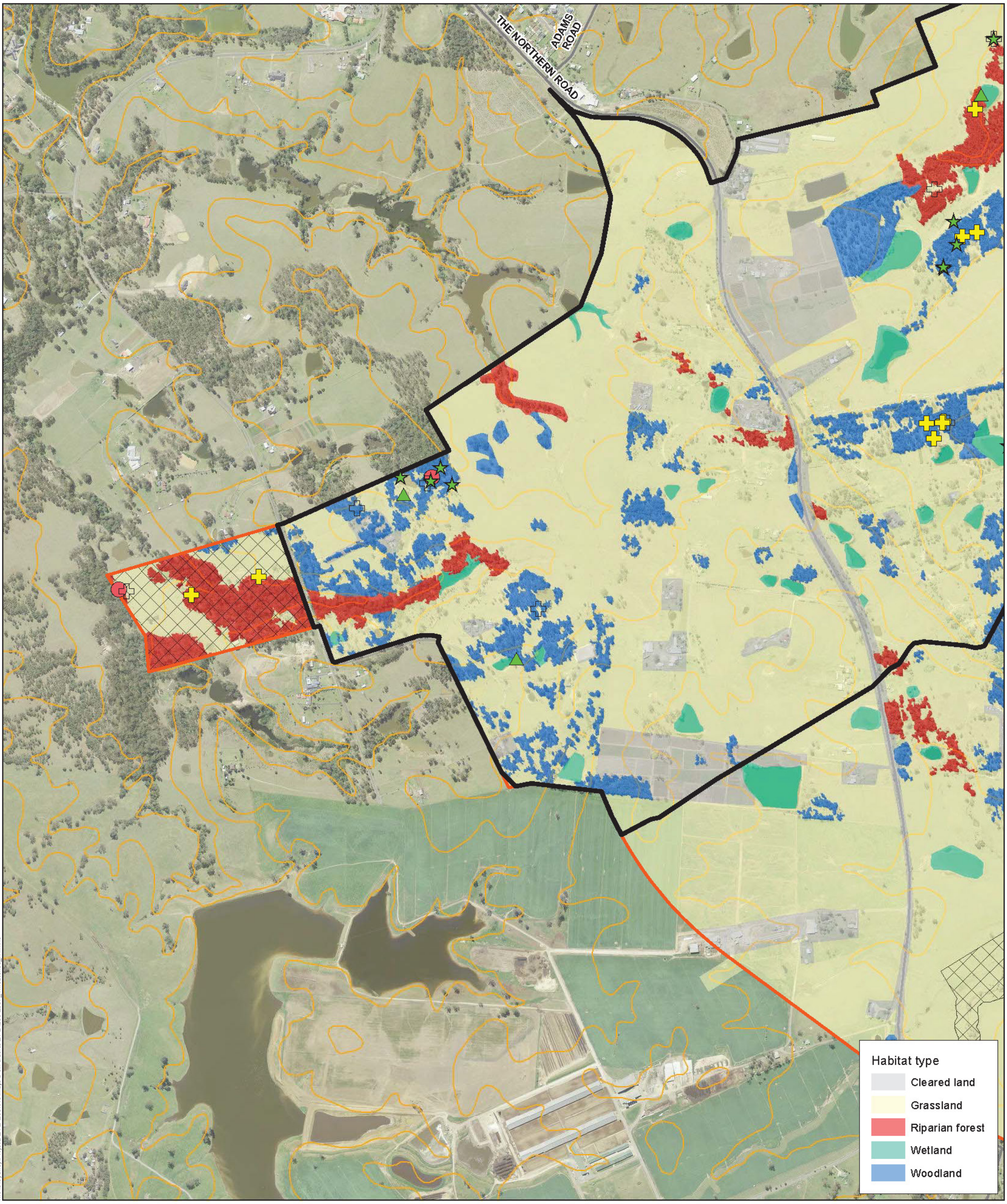
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS



Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act; M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

0 2 4 8
Kilometres

Figure 16-3A - Habitat types and threatened fauna species at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

0 2 4 8
Kilometres

Figure 16-3B - Habitat types and threatened fauna species at the airport site

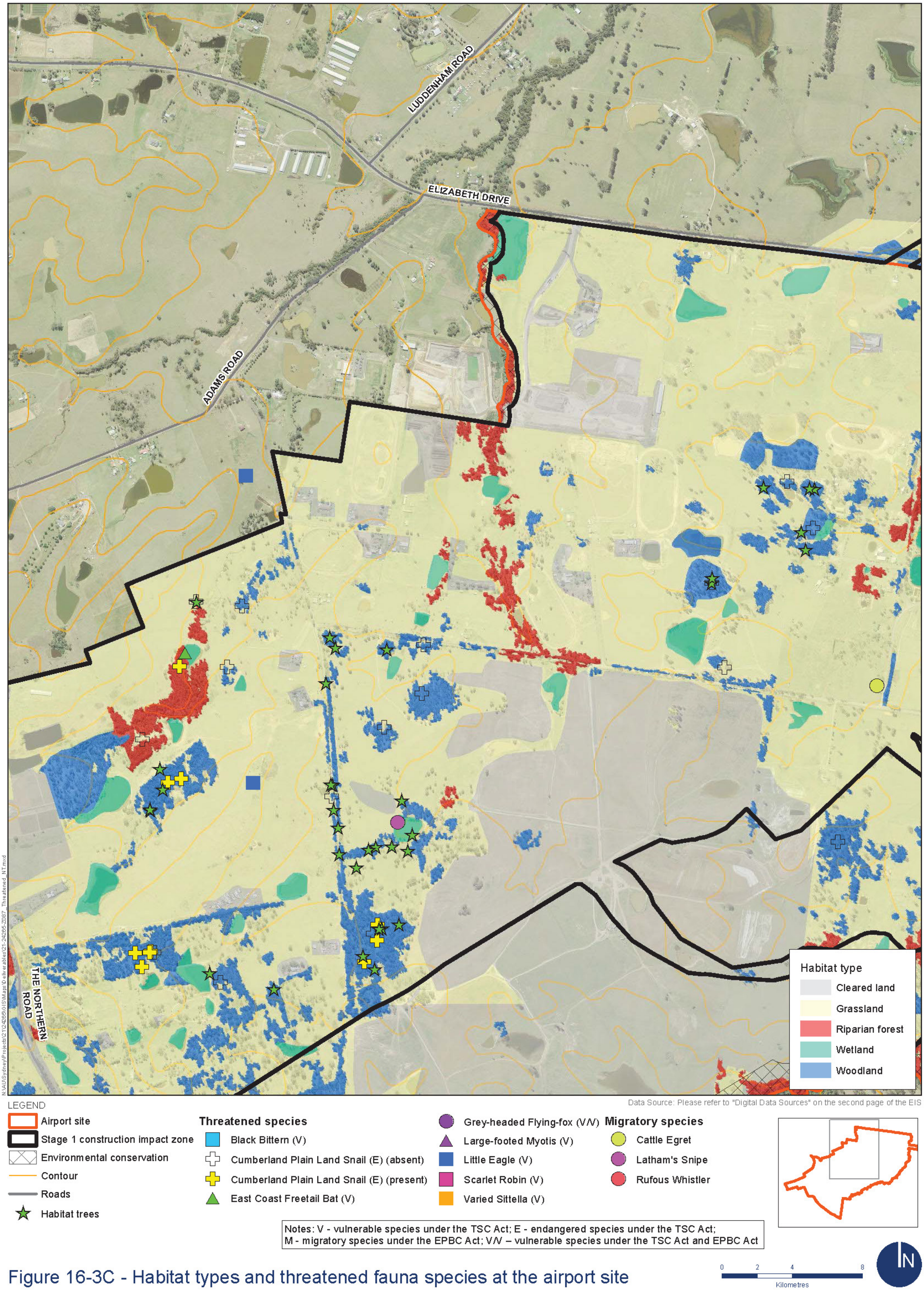
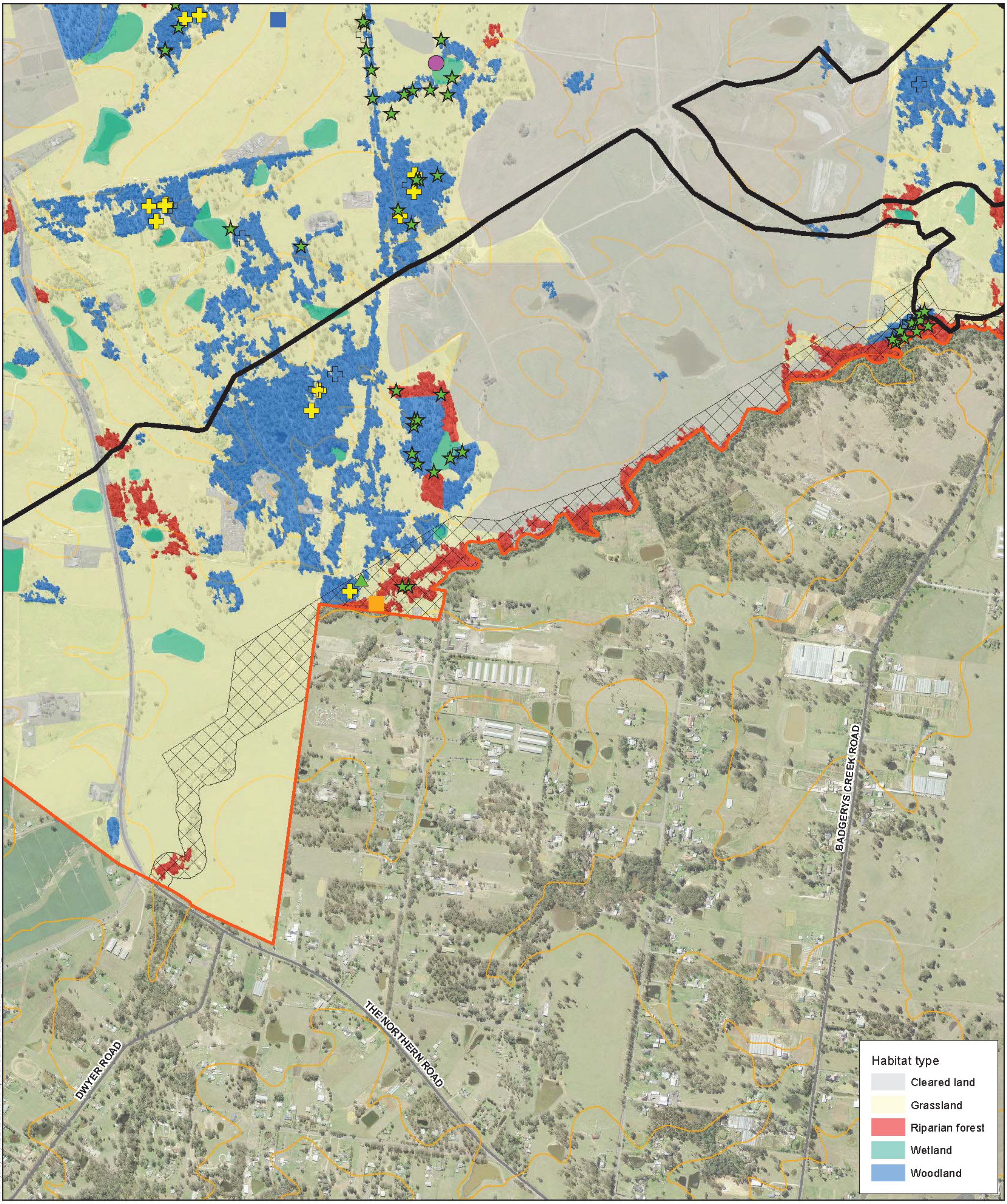


Figure 16-3C - Habitat types and threatened fauna species at the airport site



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

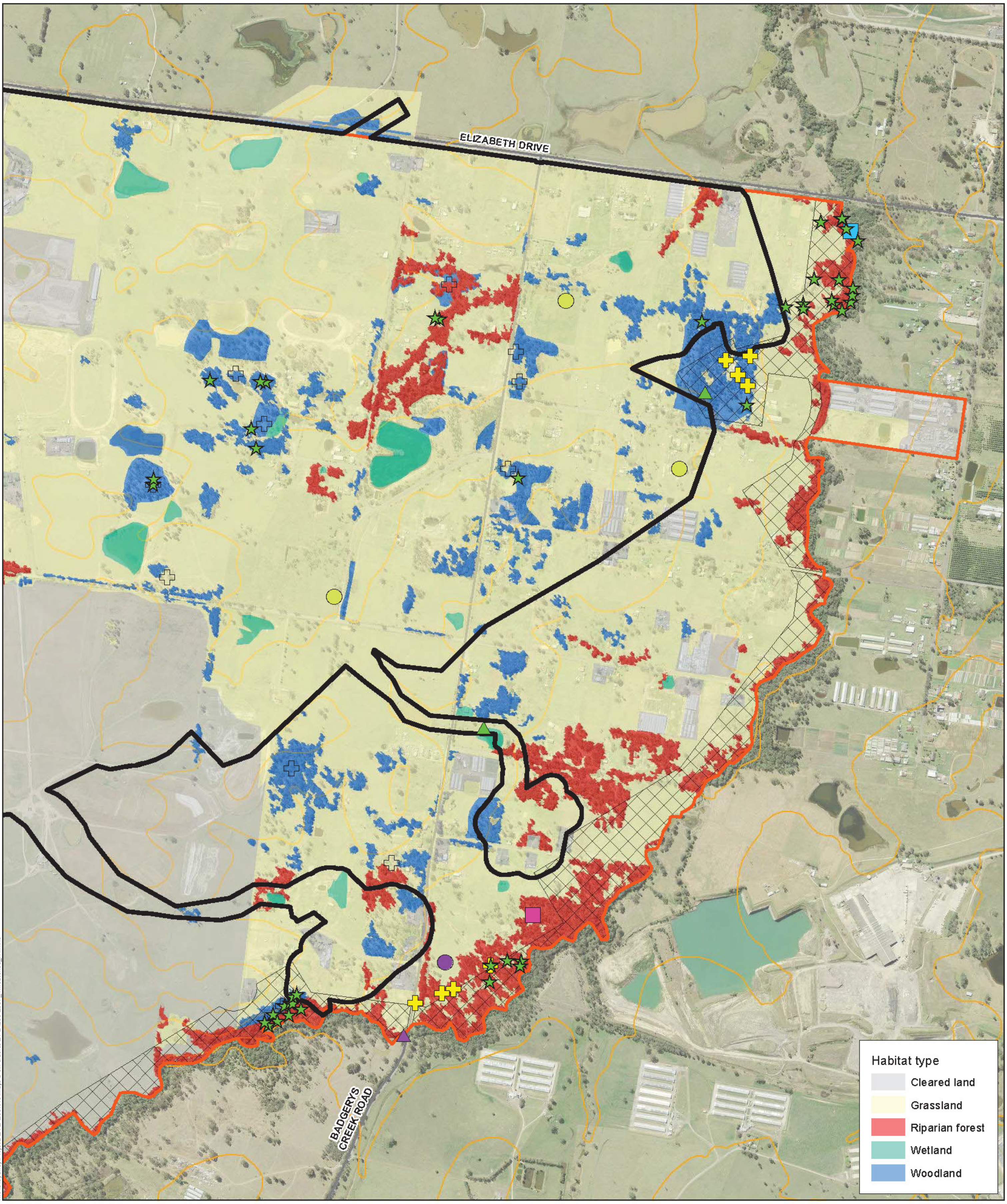
Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

0 2 4 8
Kilometres

Figure 16-3D - Habitat types and threatened fauna species at the airport site



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

- Airport site
- Stage 1 construction impact zone
- Environmental conservation
- Contour
- Roads
- Habitat trees

Threatened species

- Black Bittern (V)
- Cumberland Plain Land Snail (E) (absent)
- Cumberland Plain Land Snail (E) (present)
- East Coast Freetail Bat (V)
- Grey-headed Flying-fox (V/V)
- Large-footed Myotis (V)
- Little Eagle (V)
- Scarlet Robin (V)
- Varied Sittella (V)

Migratory species

- Cattle Egret
- Latham's Snipe
- Rufous Whistler

Notes: V - vulnerable species under the TSC Act; E - endangered species under the TSC Act;
M - migratory species under the EPBC Act; V/V – vulnerable species under the TSC Act and EPBC Act

0 2 4 8
Kilometres

Figure 16-3E - Habitat types and threatened fauna species at the airport site

16.3.3.4 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are listed in Table 16–7. The distribution of these species (where recorded) and their potential habitat at the airport site is shown on Figure 16–3. A complete list of species considered in the likelihood of occurrence assessment is provided in Appendix K1 (Volume 4).

Table 16–7 Threatened fauna recorded or that may occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of Occurrence
		EPBC Act	TSC Act	
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Present
Meridolum corneovirens	Cumberland Plain Land Snail		E	Present
Hieraaetus morphnoides	Little Eagle		V	Present
Glossopsitta pusilla	Little Lorikeet		V	Present
Petroica boodang	Scarlet Robin		V	Present
Daphoenositta chrysoptera	Varied Sittella		V	Present
Ixobrychus flavicollis	Black Bittern		V	Present
Oxyura australis	Blue-billed Duck		V	Present
Mormopterus norfolkensis	East Coast Freetail Bat		V	Present
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Present
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat		V	Present
Myotis macropus	Large-footed Myotis		V	Probably recorded (anabat)
Scoteanax rueppellii	Greater Broad-nosed Bat		V	Possibly recorded (anabat)
Vespadelus troughtoni	Eastern Cave Bat		V	Possibly recorded (anabat)
Saccolaimus flaviventris	Yellow-bellied Sheath-tail Bat		V	Possible
Lathamus discolor	Swift Parrot	CE	E	Likely
Ninox strenua	Powerful Owl		V	Likely
Tyto novaehollandiae	Masked Owl		V	Likely
Petroica phoenicea	Flame Robin		V	Likely
Melanodryas cucullata	Hooded Robin		V	Possible
Stagonopleura guttata	Diamond Firetail		V	Likely
Pyrrholaemus sagittatus	Speckled Warbler		V	Possible
Melithreptus gularis	Black-chinned Honeyeater		V	Possible
Callocephalon fimbriatum	Gang-gang Cockatoo		V	Possible
Calyptorhynchus lathami	Glossy Black-cockatoo		V	Possible
Ninox connivens	Barking Owl		V	Possible
Lophoictinia isura	Square-tailed Kite		V	Possible

Scientific name	Common name	Conservation status		Likelihood of Occurrence
		EPBC Act	TSC Act	
Rostratula australis	Australian Painted Snipe	E	E	Possible
Botaurus poiciloptilus	Australasian Bittern	E	E	Possible
Stictonetta naevosa	Freckled Duck		V	Possible

Conservation status: V = Vulnerable, E = Endangered, CE = Critically Endangered

One threatened fauna species listed under the EPBC Act was recorded at the airport site during the field surveys. This species, the Grey-headed Flying-fox, is listed as vulnerable under the EPBC Act and under the TSC Act. The Grey-headed Flying-fox was also recorded at the airport site during previous surveys for the 1997–99 EIS (PPK 1997). While there are no camps located at the airport site, there are seven known colonies within 20 kilometres of the site.

All native woodland and forest at the airport site provides foraging habitat for the Grey-headed Flying-fox. Dominant canopy species include Forest Red Gum, Grey Box and Broad-leaved Ironbark. Forest Red Gum and Grey Box are recognised as 'significant species' in the blossom diet of the Grey-headed Flying-fox (Eby and Law 2008); however, none of these species are highly productive flowering species. Forest Red Gum scores in the upper quartile of all diet plants for the region for productivity and reliability of flowering. This species flowers in late winter and spring, partly during the 'food bottleneck'. Grey Box has low productivity and reliability, flowering in late summer and early autumn. Broad-leaved Ironbark has high productivity but is an unreliable flowerer (Eby and Law 2008). This species flowers in summer and early autumn, providing foraging habitat during the breeding period.

Habitat at the airport site is thus somewhat productive during food bottlenecks, and may be habitat critical to the survival of the species, as defined in the draft recovery plan for the Grey-headed Flying-fox (DECCW 2009a). The draft recovery plan also notes that it is not possible to predict what localities would be productive in which months and, therefore, which localities would provide essential habitat for the species. All foraging habitat has the potential to be productive during general food shortages and to therefore provide a resource critical to survival (DECCW 2009a).

Three other threatened fauna species listed under the EPBC Act may occur at the airport site, although they were not detected during the field surveys:

- Swift Parrot (*Lathamus discolour*). The Swift Parrot is listed as critically endangered under the EPBC Act and endangered under the TSC Act. This species may occur at the airport site on occasion during its winter migration. Although the airport site does not provide core winter foraging resources for this species, it may provide shelter or supplementary foraging resources for migrating individuals.
- Australasian Bittern (*Botaurus poiciloptilus*). The Australasian Bittern is listed as endangered under the EPBC Act and the TSC Act. Farm dams and creeks at the airport site may provide potential foraging and breeding habitat for this species.
- Australian Painted Snipe (*Rostratula australis*). The Australian Painted Snipe is listed as endangered under the EPBC Act and the TSC Act. Wetlands and nearby flooded grasslands at the airport site may provide potential foraging and breeding habitat for this species.

Eight threatened fauna species listed under the TSC Act were recorded at the airport site during the field surveys:

- Cumberland Plain Land Snail (*Meridolum corneovirens*). The Cumberland Plain Land Snail is listed as endangered under the TSC Act. Habitat for the Cumberland Plain Land Snail occurs in larger patches with remnant trees. Live snails and shells of this species were recorded in a variety of locations where moist, deep leaf litter was present. In general, this species was recorded in locations where it had previously been recorded for the 1997–99 EIS (PPK 1997), as well as some additional locations. In some locations, including some where the species had previously been recorded, appropriate potential habitat with good leaf litter was present but no individuals were found. This may have been as a result of individuals burrowing deep into the soil and not being found, or previous local extinction of a population. Where leaf litter was shallow, woodland patches were small and no remnant trees were present, this species was not detected. It is likely the species has not been able to recolonise due to distances between patches in regrowth woodland areas.
- Little Eagle (*Hieratus morphnoides*). The Little Eagle is listed as vulnerable under the TSC Act. The Little Eagle was observed on a number of occasions flying above open grassland at the airport site. The Little Eagle would prey upon small to medium-sized mammals such as rodents and rabbits that occur in grassland habitats at the airport site. It is likely that the airport site is part of the home range of a number of breeding pairs. The species may use tall trees to nest in, although no raptor nests were observed during the field surveys.
- Little Lorikeet (*Glossopsitta pusilla*). The Little Lorikeet is listed as vulnerable under the TSC Act. A pair of Little Lorikeets was observed flying over the western portion of the airport site. This species is likely to forage throughout the airport site when eucalypts are in flower. While hollow-bearing trees are present in some locations, the species is unlikely to breed at the airport site given the level of fragmentation.
- Scarlet Robin (*Petroica boodang*). The Scarlet Robin is listed as vulnerable under the TSC Act. On individual Scarlet Robin was recorded forgaing in River-flat Eucalypt Forest near Badgerys Creek. The species may also occur in larger patches of Cumberland Plane Woodland. It may breed and forage in larger woodland patches in the airport site, but tends to breed in woodland on foothills and ridges, moving to lower more open habitats in winter'.
- Varied Sittella (*Daphoenositta chrysoptera*). The Varied Sittella is listed as vulnerable under the TSC Act. About three or so individuals were recorded foraging in River-flat Eucalypt Forest near Badgerys Creek, and may also occur in larger patches of Cumberland Plain Woodland. This species is likely to breed and forage in larger woodland patches at the airport site.
- Black Bittern (*Ixobrychus flavicollis*). The Black Bittern is listed as vulnerable under the TSC Act. One individual was observed in the northern section of Badgerys Creek. This species may breed and forage in the riparian corridor and at dams with good cover at the airport site.
- Blue-billed Duck (*Oxyura australis*). The Blue-billed Duck is listed as vulnerable under the TSC Act. Three individuals were observed on the large, deep constructed dam on Taylors Road. This species only rarely occurs east of the Great Dividing Range, occurring as vagrants generally during times of drought. This species is unlikely to rely on habitats present at the airport site.

- East Coast Freetail-bat (*Mormopterus norfolkensis*). The East Coast Freetail-bat is listed as vulnerable under the TSC Act. This species was recorded at many locations at the airport site, and was often the most common bat species recorded. This species may roost and breed in hollow-bearing trees at the airport site and would forage in woodland and open areas at the airport site.

Two additional threatened bat species listed under the TSC Act were recorded at the airport site during the surveys for the 1997–99 EIS (PPK 1997). These species were also possibly recorded at the airport site during the recent field surveys based on echolocation call analysis (though poor data quality and/or interspecific call similarities precluded the definitive identification of these species). These species are:

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*). The Eastern False Pipistrelle is listed as vulnerable under the TSC Act. Possible calls of the species were recorded during the recent field surveys. This species prefers large tracts of vegetation, and would mainly occur along the Badgerys Creek riparian corridor and nearby large patches of vegetation; and
- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). The Eastern Bentwing Bat is listed as vulnerable under the TSC Act. Possible calls of the species were recorded during the recent field surveys. No breeding habitat for this species is present at the airport site, although it may roost under bridges and in buildings. This species forages in cleared and wooded areas, and could forage throughout the airport site.

Three threatened bat species were also possibly recorded at the airport site during the recent field surveys based on echolocation call analysis. These species are:

- Large-footed Myotis (*Myotis macropus*) listed as vulnerable under the TSC Act;
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) listed as vulnerable under the TSC Act; and
- Eastern Cave Bat (*Vespadelus troughtoni*), listed as vulnerable under the TSC Act.

A number of other threatened fauna species listed under the TSC Act are likely to occur at the airport site, based on a combination of recent records in the locality and the presence of suitable habitat (see Table 16–7). The airport site contains extensive areas of habitat in moderate to good condition for each of these species and is likely to support viable local populations or would provide foraging habitat for transient species.

A number of threatened fauna species are considered to have a low likelihood of occurrence at the airport site and are, therefore, unlikely to be significantly affected by the airport. These include:

- Large-eared Pied Bat (*Chalinolobus dwyeri*). The Large-eared Pied Bat is listed as vulnerable under the EPBC Act and the TSC Act. It appears to roost predominantly in caves and overhangs in sandstone cliffs and forages in nearby high-fertility forest or woodland near watercourses. It is unlikely that Large-eared Pied Bat occurs at the airport site more than occasionally. The species has not been recorded at the airport site, nor does the site host suitable habitat such as sandstone cliffs or significant patches of remnant vegetation. The Large-eared Pied Bat has been recorded at bents Basin Estate south-west of the airport site, while large expanses of suitable habitat are present west of the airport site in the Blue Mountains National Park. However, these areas are separated from the airport site by extensive urban and agricultural development;
- Green and Golden Bell Frog (*Litoria aurea*). The Green and Golden Bell Frog is listed as vulnerable under the EPBC Act and endangered under the TSC Act. No Green and Golden Bell Frogs were recorded during the recent, targeted searches, despite the presence of suitable habitat at the airport site. Similarly, none were recorded during the surveys conducted for the 1997–99 EIS (PPK 1997) and there are no other previous records of this species at the airport site (OEH 2015a). Numerous farm dams are present at the airport site and many of these appear to provide good quality potential habitat. Surrounding grassland would also provide good basking sites for frogs (if present). Mosquitofish (*Gambusia holbrooki*) were observed at many of the dams, potentially reducing the habitat quality for this species;

  Large numbers of other species of frogs were recorded during the recent field surveys at the airport site, showing that frogs in general were active at this time and suggesting that if Green and Golden Bell Frogs were present, they would have been recorded. It is likely that the Green and Golden Bell Frog does not occur at the airport site. According to Lemckert (1999) this is a typical situation for this species, as it appears to have become extinct through most of its range, despite the presence of apparently suitable habitat. Many populations in Western Sydney have become extinct over recent decades. According to White and Pyke (2008), the populations at Liverpool, Merrylands, Milperra, and Mount Druitt, also in Western Sydney, are extinct or probably extinct;
- The Giant Burrowing Frog (*Heleioporus australiacus*), listed as vulnerable under the EPBC Act and the TSC Act, was identified in the assessment process notice following determination of the airport as a controlled action as potentially being significantly affected by the proposed airport (DoE 2015c). This species has a strong habitat association with sandstone geology, especially the Hawkesbury Sandstone plateaus surrounding Sydney where it occurs on sandy soils supporting heath, woodland or open forest. It does not occur on the shale and alluvium substrates of the Cumberland Plain and would not occur at the airport site;
- Spotted-tail Quoll (*Dasyurus maculatus*) is listed as endangered under the EPBC Act and vulnerable under the TSC Act. There are no records of Spotted-tail Quoll at the airport site and very few records on the Cumberland Plain. No evidence of the species was found during field surveys at the airport site. The species tends to occupy wet forest habitats that are not present near the airport site. As such, it is considered unlikely to occur; and

- The Koala (*Phascolarctos cinereus*) is listed as vulnerable under the EPBC Act and the TSC Act. There are few records of the species in the locality. It has been recorded to the west in the Blue Mountains National Park, and to the east in the Western Sydney Parklands, however there is minimal connectivity between these areas and the airport site. Koalas were not observed at the airport site, and no scats were recorded during the recent, targeted searches for the species. Potential habitat at the airport site does not constitute 'habitat critical to the survival of the species', as defined in the referral guidelines (DoE 2014c).

16.3.3.5 Migratory species

Seven migratory bird species listed under the EPBC Act have been recorded or are predicted to occur at the airport site or within the locality and may be affected by the proposed airport. These species are described in Appendix K1 (Volume 4) and are listed in Table 16–8. Their distribution at the airport site is shown on Figure 16–3.

Table 16–8 Migratory species known or likely occur at the airport site

Scientific name	Common name	Conservation status		Likelihood of occurrence
		TSC Act	EPBC Act	
Apus pacificus	Fork-tailed Swift	-	M,C,J,K	Likely
Ardea alba	Great Egret	-	M,C,J	Present
Ardea ibis	Cattle Egret	-	M,C,J	Present
Gallinago hardwickii	Latham's Snipe	-	M,C,J,K	Present
Hirundapus caudacutus	White-throated Needletail	-	M,C,J,K	Present
Merops ornatus	Rainbow Bee-eater	-	M,J	Present
Rhipidura rufifrons	Rufous fantail	-	-	Present

Conservation status: M = Migratory; C = China-Australia Migratory Bird Agreement (CAMBA), J = Japan-Australian Migratory Bird Agreement (JAMBA) and K = Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA)

Six migratory of the migratory bird species listed in Table 16–8 were recorded at the airport site during the field surveys for the EIS. Cattle Egrets (*Ardea ibis*) were observed at a number of locations in paddocks and near dams, and on several occasions flocks of about 30 individuals were recorded. Occasional individual Great Egrets (*Ardea alba*) were observed at dams and one Latham's Snipe (*Gallinago hardwickii*) was disturbed from exotic grassland adjacent to a dam.

A flock of White-throated Needletails (*Hirundapus caudacudatus*) was also recorded foraging high above the airport site. The Rainbow Bee-eater (*Merops ornatus*) was heard on a number of occasions in patchy woodland remnants in the vicinity of Badgerys Creek. The Rufous Fantail (*Rhipidura rufifrons*) was observed foraging in grassy woodland at a number of locations across the airport site. Fork-tailed swift, while not recorded in the surveys, was considered likely to occur.

In addition to the seven migratory bird species identified in Table 16–8, a flock of shorebirds was observed during the field surveys. While these were not able to be identified, they were likely to be a type of sandpiper. Potential species include the Marsh Sandpiper (*Tringa stagnatilis*) and the Sharp-tailed Sandpiper (*Calidris acuminata*), which are known to occur on farm dams or the Common Greenshank (*Tringa nebularia*), previously recorded in the locality.

The EPBC Act lists families of birds (such as ducks, waders, eagles and hawks) that are also known to be migratory but are not listed under international agreements. A range of such waterfowl and waders have been recorded at the airport site. Other seasonally migratory or nomadic species would also be likely to occasionally use habitats at the airport site.

The airport site is not considered important habitat for any of these migratory species, according to the relevant significant impact criteria. The airport site would not support an ecologically significant proportion of the population of migratory species, is not of critical importance to these species at particular life-cycle stages, is not at the limit of these species ranges, and is not within an area where these species are declining (DEWHA 2009).

16.3.4 Aquatic flora, fauna and habitat

16.3.4.1 Aquatic flora

Thirteen aquatic plant species were recorded within the waterbodies (wetlands and creeks) sampled at the airport site and in the locality. This included 10 native species and three exotic species (two of which are declared noxious weeds – Salvinia (*Salvinia molesta*) and Water Hyacinth (*Eichhornia crassipes*)). The list of aquatic plant species recorded within waterbodies at the airport site is provided in Appendix K1 (Volume 4). Where exotic or declared noxious weed species were found, they tended to dominate the waterbody.

16.3.4.2 Aquatic fauna

Eight fish species were recorded within the waterbodies sampled at the airport site and in the locality. Native species included Long Finned Eel (*Anguilla reinhardtii*), Australian Smelt (*Retropinna semoni*), Firetail Gudgeon (*Hypseleotris galii*), Western Carp Gudgeon,(*Hypseleotris klunzingerii*) and other unidentified Gudgeon species. Of the native fish species collected, the Firetail Gudgeon (*Hypseleotris galii*) was the most widespread. Exotic species were present at almost all survey sites and accounted for the majority of the species sampled. These included Eastern Gambusia (*Gambusia holbrooki*), Common Carp (*Cyprinus carpio*) and Goldfish (*Carassius auratus*). Eastern Gambusia and Common Carp are both listed as noxious fish under the FM Act. The presence and overwhelming abundance of exotic fish species recorded during the field surveys indicates that aquatic habitat at the airport site and in the locality is highly modified and degraded.

A total of 1,075 individual macroinvertebrates from 15 taxonomic groups were identified within the waterbodies sampled at the airport site and in the locality. The macroinvertebrate communities were dominated by Dipterans (true flies) (31 per cent), Acarina (water mites) (25 per cent) and Odonata (dragonflies) (10 per cent). The taxonomic groups recorded during the field surveys were generally made up of groups that have a high tolerance to moderate to severe pollution.

All survey sites had very low SIGNAL 2 scores (ranging from 1.31 to 3.75). These scores indicate that waterbodies at the airport site and in the locality have been subject to or are consistently exposed to severe pollution.

The survey sites had AUSRIVAS classifications indicating the waterbody is significantly to extremely impaired and highly degraded with very low water quality and habitat quality.

No threatened fish species listed under the EPBC Act and/or the FM Act identified in the database searches as potentially occurring in the locality were collected during the surveys. No suitable habitat for these species was observed during the site visits, which is in agreement with the findings of the SMEC study (2014).

16.3.4.3 Aquatic habitat

As discussed above, the presence and abundance of exotic fish species and the variety of macroinvertebrates recorded during the field surveys indicates that aquatic habitat at the airport site and in the locality is severely modified and degraded.

The results from of the fish habitat assessment indicates that 22 per cent of sites are classified as Class 2 (moderate habitat), 71 per cent of sites are classified as Class 3 (minimal fish habitat), and seven per cent as Class 4 (unlikely habitat) (DPI 2013). The majority of the survey sites were intermittent in nature with some indication of semi-permanent pools existing throughout the reaches surveyed, which may provide refuge during periods of stress for some fish species. The intermittent nature of these systems also suggests that they are unlikely to be suitable habitat for the listed threatened species recorded in the database search.

The results of the water quality assessment also indicate that aquatic habitats at the airport site and in the locality are affected by poor water quality. Electrical conductivity was high at all survey sites (factors that contributed to this could include the influence of local geology, groundwater input during periods of low flow, salinity issues due to agricultural practices, or a combination of these factors). Dissolved oxygen levels were generally low, likely due to a combination of low flow conditions and nutrient enrichment. Alkalinity levels indicated moderate to very hard waters. Survey sites with high alkalinity were also those with elevated electrical conductivity, so some of the high electrical conductivity at those sites relates to elevated calcium and carbonate ion levels.

High levels of zinc, nickel and copper were recorded at the survey sites. While these metals occur naturally, high levels of each can indicate specific catchment-related impacts such as industry, fertilisers and runoff from roads. Total nitrogen and total phosphorous concentrations were high at all survey sites, consistent with the agricultural land use at the airport site and in the locality.

16.3.4.4 Threatened species, populations and ecological communities

No threatened aquatic flora or fauna species, populations or ecological communities listed under the EPBC Act or the FM Act were recorded at the airport site or in adjoining downstream areas and none are likely to occur given known distributions and the absence of suitable habitat.

16.3.5 Additional matters of national environmental significance

There are several matters of national environmental significance (MNES) that are protected under the EPBC Act. Among these are threatened species, populations and ecological communities plus migratory species protected under international agreements (addressed in Section 16.3.2, Section 16.3.3 and Section 16.3.4). Other MNES include world heritage areas.

The Greater Blue Mountains World Heritage Area is located approximately eight kilometres to the west of the airport site and is separated from the airport site by extensive areas of residential and agricultural land, fragmented patches of native vegetation, roads and the Nepean River.

The Greater Blue Mountains World Heritage Area consists of approximately 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest. The area is noted for its diversity of eucalypts, which are associated with its wide range of habitats as well as significant numbers of rare or threatened species, including endemic and evolutionary relict species. A significant proportion of the Australian continent's biodiversity occurs in the area (UNESCO 2015). The Greater Blue Mountains World Heritage Area protects a large number of pristine and relatively undisturbed catchment areas, some of which make a substantial contribution to maintaining high water quality in a series of water storage reservoirs supplying Sydney and adjacent rural areas (DECC 2009c). The Greater Blue Mountains Area is listed as a declared World Heritage property and a National Heritage place under the EPBC Act.

There are no other MNES (for example wetlands of international importance, marine areas, nuclear actions, etc.) at the airport site or in the locality.

16.4 Assessment of impacts during construction

This section presents the anticipated impacts of the Stage 1 development on terrestrial and aquatic flora and fauna at the airport site and in the locality during construction. Construction of the Stage 1 development would result in both direct and indirect impacts on terrestrial and aquatic flora and fauna. Mitigation measures to avoid or reduce these impacts are discussed in Section 16.7.

16.4.1 Direct impacts

Direct impacts on terrestrial and aquatic flora and fauna during construction of the Stage 1 development include the removal of vegetation and the loss of terrestrial, wetland and aquatic fauna habitat.

16.4.1.1 Removal of vegetation

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland, dominated by exotic species and noxious and environmental weeds. Vegetation removal by vegetation zone is summarised in Table 16–9.

Approximately 835.3 hectares of exotic grassland and cleared land or cropland would be removed. These vegetation zones contain little native vegetation cover and have limited habitat value for native plants. Vegetation clearing in these areas would remove a small number of non-threatened native plants, and noxious and environmental weeds.

Approximately 318.5 hectares of native vegetation would be removed, comprising around 169.9 hectares of good condition native vegetation (occurring in small, fragmented patches with moderate weed infestation) and a further 148.6 hectares of poor condition native vegetation (occurring as derived native grassland or scrub with moderate to severe weed infestation).

As discussed in Section 16.3.2, native vegetation at the airport site constitutes a local occurrence of Cumberland Plain Woodland, patches of which are commensurate with the EPBC Act listed form of this threatened ecological community. Native vegetation at the airport site also constitutes a number of threatened ecological communities listed under the TSC Act. Populations of threatened plants listed under the EPBC Act and/or TSC Act also occur at the airport site. The impacts of vegetation removal on threatened species, populations and ecological communities are discussed in Section 16.6.

Vegetation clearance would include the loss of woodland and forest vegetation that contains an overstorey of mature trees (approximately 141.8 hectares). Mature trees have particular value within plant populations because they take longer to replace and are sources of pollen and seed. There are moderate areas of these vegetation types and plant species in the locality, including around 12,569 hectares of similar woodland and forest on shale or alluvial substrates within a 10 kilometre radius of the airport site. Around 56.8 hectares of native vegetation would also be retained in the environmental conservation zone at the airport site, as shown in the revised draft Airport Plan.

These zones contain representative areas of each of the vegetation types at the airport site and would support many of the plant species in the construction impact zone. The environmental conservation zone is located around Badgerys Creek along the southern perimeter of the airport site, around Oaky Creek along the north-western perimeter of the airport site and along the south-western part of the airport site. These would help maintain vegetation connectivity and allow pollination, seed fall and other ecological processes that are necessary to maintain plant populations. Flora populations are also likely to persist within adjoining areas of alternative habitat beyond the airport site.

Plant species with a limited distribution in the locality would be most affected by the removal of vegetation. Notably, the population of *Marsdenia viridiflora* subsp. *viridflora* at the airport site would be removed, which would comprise a significant impact at the local scale (see Section 16.6).

The removal of native vegetation at the airport site is less significant at the regional scale and is unlikely to threaten the persistence of any populations of native plants or vegetation communities. It is unlikely that an ecologically significant proportion of any regional plant population would be located entirely within the airport site. At the regional scale, flora populations would persist in habitat that is conserved in Kemps Creek Nature Reserve, Mulgoa Nature Reserve, existing and proposed BioBank sites at Mulgoa and in the Ropes and South Creek riparian corridors, the Western Sydney Parklands and other offset sites linked to the North and South West Growth Centres. Notably, there is a parcel of land with shale/gravel transition habitat located at Kemps Creek around three kilometres to the east of the airport site that will be set aside as an offset for the South West Growth Centres. This site contains local populations of *Pultenaea parviflora* and other threatened plant species that may be affected by the construction of the Stage 1 development.

Table 16–9 Estimated vegetation removal by vegetation zone (Stage 1 development)

Vegetation zone	Conservation status		Direct impact (hectares)
	EPBC Act	TSC Act	
Native vegetation zones			
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	CEEC	CEEC	79.8
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)		CEEC	112.5
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	CEEC	CEEC	22.9
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)		CEEC	27.6
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	34.2
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)		EEC	7.9
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	CEEC	EEC	4.4
Poor condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)		EEC	0.6
Good condition artificial freshwater wetland on floodplain (HN630)			28.6
Total removal native vegetation			318.5
Non-native vegetation zones			
Exotic grassland			663.2
Cleared land or cropland			172.1
Total removal non-native vegetation			835.3
Total vegetation removal			1,153.8

Conservation status: CEEC = Critically endangered ecological community, EEC = Endangered ecological community.

16.4.1.2 Loss of terrestrial and wetland fauna habitat

The airport site provides habitat for a range of fauna groups including species of macropods, flying-foxes and bats, a wide variety of birds, reptiles (including goannas, snakes and lizards), frogs and small fish. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and/or dispersal habitat. The loss of terrestrial and wetland fauna habitat is summarised in Table 16–10 and is shown on Figure 16–3. The impacts of vegetation removal on threatened and migratory fauna habitat are discussed in Section 16.6.

Fauna species that would be most affected during construction of the Stage 1 development include those that occur in grassland areas, artificial wetlands (in the form of farm dams) and those that can use fragmented patches of woodland vegetation, as the airport site does not provide habitat for species that need extensive patches of vegetation. Exotic grassland and cleared land or cropland provides only limited habitat values for fauna. The loss of these areas would remove foraging, breeding and shelter habitat for small grassland animals such as skinks, and would potentially result in the loss of local populations of these species. The loss of this habitat would also remove foraging habitat for macropods, open-country microchiropteran bats, and bird species such as the Australian Magpie (*Gymnorhina tibicen*), Australian Raven (*Corvus coronoides*), Magpie-lark (*Grallina cyanoleuca*), Straw-necked Ibis (*Threskiornis spinicollis*) and Cattle Egret (*Ardea ibis*), in particular.

Artificial wetlands, minor drainage lines and associated damp soaks would be removed. This would potentially result in the loss of local populations of frog species and the loss of habitat for waterbirds and microchiropteran bat species. Construction would also require the removal of woodland and riparian forest habitat. Clearing this vegetation would permanently remove foraging and breeding resources for native fauna, including birds and arboreal mammal species including bats.

Construction of the Stage 1 development would result in the loss of about 50 hollow-bearing trees, which occur as scattered trees across the airport site. The loss of hollow-bearing trees at the airport site would result in a loss of roosting and nesting habitat for birds and arboreal mammals such as possums and bats.

Shrub layers and leaf litter would also be removed during construction of the Stage 1 development. This would result in the loss of habitat for small woodland birds that rely on these resources for foraging and breeding. In addition, the loss of leaf litter would remove habitat for small reptiles and invertebrates that rely on this feature for shelter, breeding and foraging.

Table 16–10 Estimated loss of terrestrial and wetland fauna habitat (Stage 1 development)

Habitat type	Area in Stage 1 construction impact zone (hectares)	Estimated extent in the locality (hectares)[1]	Percentage of the estimated extent in the locality
Woodland	107.6	10,014	1.08%
Riparian forest	34.2	2,555	1.34%
Sandstone woodland, forest and scrub	-	4,825	-
Total woodland and forest	141.8	17,393	0.82%
Artificial wetlands (farm dams)[2]	28.6	-	-
Grassland[2]	811.2	-	-
Cleared land and cropland	172.1	-	-

Notes:
1. Based on mapping within the airport site and on a composite of Tozer et al. (2010) and NPWS (2002) mapping in the locality.
2. Wetland and grassland vegetation has not been mapped by Tozer et al. (2010) or NPWS (2002).

16.4.1.3 Loss of aquatic fauna habitat

Construction of the Stage 1 development would involve the infilling of stream reaches, including the upper reaches of Oaky Creek and smaller drainage lines that feed into Badgerys, Cosgroves and Duncans creeks within the construction impact zone, and the permanent loss of riparian and aquatic habitats associated with these features. All of the affected reaches are small and largely intermittent. All are highly modified and in poor condition as a result of historical and current land use and disturbance. Water quality is poor and the macroinvertebrate and fish communities are dominated by species indicative of disturbed habitats. Fish habitat is moderate or minimal at most sites and the habitats present are not suitable for threatened fish or invertebrate species (dragonflies) known or predicted to occur in the locality.

Badgerys Creek, which comprises the largest watercourse at the airport site, would be retained within an environmental conservation zone, as outlined in the revised draft Airport Plan.

A large number of artificial wetlands (farm dams) would be removed. In total, approximately 28.6 hectares of artificial wetland habitat would be removed. These provide only limited habitat for native fish species, with most dams dominated by the exotic Eastern Gambusia. Farm dams are not key fish habitat and do not provide habitat for threatened species listed under the EPBC Act or the FM Act.

It is noted that around 2.1 hectares of vegetation in the proposed environmental conservation zone would require clearing for the establishment of detention basins outlets. Vegetation in these areas would be allowed to naturally regenerate and be protected in the environmental conservation zone but have nonetheless been included in the construction impact calculations.

16.4.2 Indirect impacts

Construction of the Stage 1 development may result in indirect impacts such as habitat fragmentation; fauna displacement, injury or mortality; edge effects; altered hydrology; erosion, increased sedimentation and contamination; dust; increased light, noise and vibration; the spread of pests and pathogens; and an increased incidence of fire at the airport site. These impacts are discussed below.

16.4.2.1 Habitat fragmentation

Habitat fragmentation would increase at the airport site and in the locality as a result of the proposed airport. Habitat fragmentation can result in reduced dispersal and reproductive success of biota, a decline in populations resulting from increased predation by introduced species or native species that do not normally occur in the community, and an increased probability that stochastic events (for example, fire) may reduce some population numbers below critical levels required for their survival at the airport site. Past land use, including clearing for agriculture, rural-residential buildings and linear infrastructure such as transmission lines and roads, has resulted in a highly fragmented rural landscape at the airport site. This fragmentation has created barriers for some fauna species, particularly those that have limited dispersal capability and habitat preferences.

More mobile species such as birds and bats can readily traverse the landscape, which is reflected in the variety of fauna species recorded in field surveys. The proposed environmental conservation zone would retain woodland along Badgerys Creek, Oaky Creek and Duncans Creek riparian corridors and would assist in maintaining vegetated fauna movement corridors and habitat stepping stones around the airport site.

16.4.2.2 Fauna displacement, injury or mortality

The removal of vegetation has potential to result in fauna displacement, injury or mortality. This would be particularly the case for less mobile species such as invertebrates (snails), amphibians, small reptiles and terrestrial mammals. More mobile species such as birds, macropods and larger terrestrial mammals would be able to avoid vegetation removal and other construction activities, seeking refuge in nearby alternative habitat outside the airport site. Fauna displacement to nearby habitat may result in increased competition for resources with existing resident fauna. Breeding success may also be disrupted for one or more seasons. There would be mortality of aquatic fauna (including fish, eels, turtles and frogs) associated with the infilling of streams and artificial wetlands (farm dams).

16.4.2.3 Edge effects

'Edge effects' refer to factors including weed invasion, increased noise and light, and erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to plant community type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Construction activities could result in the dispersal of weed propagules into areas of native vegetation through vegetation clearing, erosion and from the movement of workers and vehicles. The effects of erosion and sedimentation and increased light and noise are discussed below.

Given the fragmented nature of habitat in the locality and the extent of exotic plant cover, construction activities would have a minor effect on the extent and seriousness of edge effects in the locality and would be unlikely to introduce any new weed species or increase the prevalence of weed infestations.

16.4.2.4 Altered surface water hydrology

The existing landform and hydrology within the construction impact zone would be altered at the airport site. These alterations have the potential to affect the hydrological regime downstream of the airport site, impacting aquatic and riparian communities.

The water management system included in the Stage 1 development would include a series of detention basins on the periphery of the airport site to retain stormwater runoff prior to discharge into nearby creeks. The detention basins provide controlled release to the receiving waters in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes. The airport site comprises approximately 4 per cent of the total catchment area for South Creek and any minor alteration to the hydrological regime is anticipated to have negligible influence on downstream flows in the catchment. The airport site also comprises about 9 per cent of the catchment area for Duncans Creek (draining to Nepean River) and is predicted to have negligible influence on downstream flows in that catchment.

16.4.2.5 Altered groundwater

There is a potential for a minor reduction in groundwater recharge associated with the increase in paved surfaces with the establishment of the Stage 1 development. Overall, minimal change to local groundwater recharge would be expected, as the existing shale derived clay soils have low permeability and the majority of rainfall is therefore released as stormwater runoff rather than infiltrating to groundwater. It is not expected that a reduction in recharge would affect any sensitive ecological receptors or beneficial uses of the groundwater system.

Groundwater drawdown is also expected during construction as a result of reprofiling the airport site and deeper excavations for the establishment of basements in the terminal complex. The re-profiling would result in a lowering of groundwater elevations in areas that currently have higher topographical elevation, and is expected to result in reduced groundwater flow rates and hence reduced discharge to surrounding surface features. The re-profiling would not result in dewatering of the groundwater system below the level of the surrounding creeks and there would be no potential for drying up of the creeks from this activity.

Groundwater drawdown and reduced groundwater infiltration are expected to be limited due to the generally low hydraulic conductivity of the soils and geology at the airport site. Although several vegetation communities in or around the airport site are likely to have some level of groundwater dependence, potential impacts would be limited by this low hydraulic conductivity.

Particularly sensitive vegetation in the riparian area of Duncans Creek, Oaky Creek and Badgerys Creek intersect alluvial deposits that have limited hydraulic connectivity with the shale aquifers and are not likely to be directly impacted by construction activities.

No creek waterways at the airport site are mapped as being reliant on the surface expression of groundwater, supported by historic water quality data that indicate groundwater expression as a very small proportion of surface water flow. Downstream impacts in terms of surface water and groundwater interaction would be mitigated through the operation of the water management system included in the Stage 1 development.

16.4.2.6 Erosion, sedimentation and contamination

As described in Section 16.3.4.3, existing water quality in the project area is poor with elevated nutrients, suspended sediments and salinity. Erosion, sedimentation and potential contamination may occur from activities such as vegetation removal, excavations and earthworks, and the accidental release of fuel, oil or other chemicals. This could result in further reduced habitat quality and the potential mortality of aquatic flora and fauna downstream of the airport site. The water management system included in the Stage 1 development would include a system of vegetated swales and bio-retention basins that would improve water quality prior to discharge under normal flow conditions.

16.4.2.7 Dust

Dust from vegetation removal, excavation and earthworks could reduce plant and animal health. Dust may affect photosynthesis, respiration and transpiration in plants, and allow the penetration of gaseous pollutants. This could then lead to decreased productivity and in the long term could alter community structure. Dust could also impact the health of fauna, such as through respiratory disease, and the reduction in health of animals could be exacerbated by changes to plant health and community structure.

16.4.2.8 Light, noise and vibration

An increase in light at the airport site from vehicles and machinery could affect nocturnal fauna, potentially disrupting movement and behaviour. Construction activities would also result in an increase in noise levels at the airport site, which may affect fauna species. Some fauna species would likely tolerate an increase in noise, while others may not, causing them to leave the affected area or making the area less desirable for foraging, nesting and breeding.

Vibration from construction activities, such as heavy vehicle movements, may deter native fauna from using the area near vibration sources. This may potentially interrupt dispersal within the locality if an individual is unwilling to travel through an area where vibration is detectable, or may cause some species to abandon an area in search of areas where vibration is not detectable.

16.4.2.9 Spread of pests and pathogens

There is the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent native vegetation through vegetation disturbance and increased visitation. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can cause mortality in some populations once introduced into an area.

16.4.2.10 Fire

There may be an increase in the incidence of fire at the airport site from the accidental ignition of combustible fuels. An increase of fire could result in the injury or mortality of flora and fauna at the airport site or locality.

16.5 Assessments of impact during operation

This section presents the anticipated impacts of the Stage 1 development on terrestrial and aquatic flora and fauna at the airport site and in the locality during operation. Similar to construction, operation of the Stage 1 development would result in both direct and indirect impacts on terrestrial and aquatic flora and fauna, as discussed below. Mitigation measures to avoid, reduce or minimise these impacts are discussed in Section 16.7.

16.5.1 Direct impacts

Direct impacts on terrestrial and aquatic flora and fauna during operation of the Stage 1 development include bird and bat strike and terrestrial fauna strike from aircraft and ground transportation vehicles.

16.5.1.1 Bird and bat strike

Operation of the Stage 1 development would create a risk of mortality for birds and bats at or near the airport site. It is noted that most bird and bat strikes occur during take-off and landing below 3,500 feet. As such, bird and bad strikes tend to involve birds occupying habitats close to airports rather than migratory species moving across the landscape at higher altitudes.

Birds are often attracted to airports because of the presence of grass, lights, water, feeding trees, or roosts, while bats (particularly flying-foxes) tend to come in contact with aircraft while transiting between roosting sites (camps) and foraging areas (Parsons et al. 2009). Features in and around the airport site with the potential to attract birds and bats include farm dams, nearby landfills and flying-fox camps. Seven flying-fox camps have been identified in the region of the airport (see Appendix I (Volume 4)).

A high diversity of bird species were recorded at the airport site, including many that occur in large flocks or that would fly at heights where aircraft strike is a risk. A small number of large raptors were observed at the airport site, including Wedge-tailed Eagles (*Aquila audax*), White-bellied Sea-eagles (*Haliaeetus leucogaster*), Little Eagles (*Hieraaetus morphnoides*), Black Kites (*Milvus migrans*) and Whistling Kites (*Haliastur sphenurus*). It is most likely that one or two pairs of each species occur at or near the airport site. Large flocks of ibis and herons occur at or in the vicinity of the airport site, due to the large number of farm dams and fertilised crop fields, as do a wide variety of ducks and other waterbirds. Few migratory wader species are likely to occur at or in the vicinity of the airport site, although at least two species were recorded. A wide range of other bird species is also likely to be at risk of aircraft strike, including magpies, swallows, ducks and ravens.

Although potentially moderate and high risk species were recorded during the field surveys, their numbers were not unusually large and there were limited transits through the air. The bird and bat strike risk assessment summarised in Chapter 14, and included as Appendix I (Volume 4), found that there would be a moderate risk of strike during operation. While birds are likely to be struck on occasion, management measures would minimise the risk of this occurring and, as such, the viability of populations in the local area is not likely to be threatened. This finding is supported by data from existing airports provided in the bird and bat strike risk assessment, which shows that strikes are too infrequent to affect the viability of bird and bat populations.

16.5.1.2 Ground vehicle strike

Movement of aircraft and ground support vehicles on the tarmac has the potential to result in the injury or mortality of fauna that reside or forage in cleared areas alongside the tarmac. These fauna species may attempt to cross the tarmac and be struck by aircraft and ground support vehicles. The final design of the proposed airport would consider deterrence measures such as fencing of the airport site, which would likely prevent large mammals such as kangaroos and wallabies entering the airport site, thus minimising the potential for impact.

There would be an increase in general traffic in the area surrounding the airport site that could result in an increased risk of fauna injury or mortality on surrounding roads. Vehicle strike on surrounding roads is already likely to be high, given the presence of vegetated and agricultural areas. As Western Sydney continues to grow and more areas of agricultural and forested land are removed, fauna mortality from vehicle strike would reduce.

16.5.2 Indirect impacts

Operation of the Stage 1 development may result in indirect impacts such as increased light, noise and vibration; an increased incidence of fire; contamination of aquatic habitats; decreased water quality and changes to the hydrology of waterbodies; and the introduction of exotic species. These impacts are discussed below.

16.5.2.1 Light, noise and vibration

Increased light associated with tarmac and terminal lighting and from aircraft and ground transportation vehicles could affect fauna species at the airport site and in the locality. Many fauna individuals and species that are currently resident at the airport site would already be accustomed to existing residential and road lighting. The increased light may, however, result in the displacement of less tolerant species, but could also attract some birds and bats that forage on insects attracted to light. These species may then be susceptible to aircraft strike in the absence of mitigation.

Aircraft and vehicle movements at the airport site would result in increased noise and vibration. Fauna most at risk would be those residing in close proximity to the airport site. Most fauna species are likely to become accustomed to increased noise and vibration, as many species that occur in the surrounding area are already accustomed to noise from roads and agricultural areas. Increased noise and vibration, however, may result in impacts to foraging and breeding behaviours and/or the displacement of less tolerant species.

16.5.2.2 Fire

There may be an increase in the incidence of fire at the airport site from the accidental ignition of combustible fuels or from aircraft incidents. An increase of fire could result in the injury or mortality of flora and fauna at the airport site or in the locality.

16.5.2.3 Contamination

Spills of fuel, oil or other chemicals such as pesticides and/or herbicides could reduce habitat quality and potentially harm or kill aquatic flora and fauna downstream of the airport site.

16.5.2.4 Hydrology and water quality

As described in Section 16.3.4.3, existing water quality in the project area is poor with elevated nutrients, suspended sediments and salinity. The operation of the Stage 1 development has the potential to affect water quality and hydrology at the airport site and downstream. The Stage 1 development includes a water management system that would capture and treat surface water runoff prior to release to the surrounding environment.

The water management system would be designed to avoid substantial alteration to the timing, duration, volume and velocity of flows leaving the airport site and at downstream locations. The operation of the water management system is unlikely to have a substantial impact on downstream hydrology or dependant ecological values. The water management system would also be designed to capture and treat runoff in order to reduce entrained pollutants prior to release to the surrounding environment.

Given the existing poor water quality downstream of the site and the design of the water management system, it is expected that the proposed airport would have no adverse impact on downstream water quality and aquatic health. As such, the airport is unlikely to have an adverse impact on downstream key fish habitat and other aquatic or riparian habitat, or on threatened species that may occur downstream of the airport site.

The performance of the water management system with regard to surface water hydrology and water quality is discussed in Chapter 18 and assessed in detail in Appendix L1 and Appendix L2 (Volume 4).

16.5.2.5 Groundwater dependent ecosystems

The impermeable surface of the Stage 1 development at the airport site would have the potential to reduce groundwater infiltration, leading to impacts on groundwater resources, groundwater dependant ecosystems and groundwater dependant waterways.

Groundwater drawdown and reduced groundwater infiltration are expected to be limited due to the generally low hydraulic conductivity of the soils and geology at the airport site. Although several vegetation communities in or around the airport site are likely to have some level of groundwater dependence, potential impacts would be limited.

Sensitive vegetation in the riparian area of Duncans Creek, Oaky Creek and Badgerys Creek intersect alluvial areas which have minimal potential to be impacted by the Stage 1 development.

No creek waterways at the airport site are mapped as being reliant on the surface expression of groundwater, supported by historic water quality data that indicate groundwater expression as a very small proportion of surface water flow. Downstream impacts in terms of surface water and groundwater interaction would be mitigated through the operation of the water management system included in the Stage 1 development.

The operation of the proposed airport would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. Remediation would be implemented as soon as practicable in the unlikely event of a significant leak or spill of contaminants.

16.5.2.6 Introduction of exotic species

As with any international airport, there is the potential for the introduction of exotic species as a result of the transport of goods on aircraft. Any escaped exotic species could potentially establish in nearby vegetated areas, or be unintentionally transported to other areas of native vegetation and impact the local native flora and fauna. These risks are managed through the biosecurity regulatory framework.

16.5.2.7 Fuel jettisoning

As discussed in Chapter 7 (Volume 1), fuel jettisoning is extremely rare worldwide and is a procedure used in certain emergency situations to reduce an aircraft's weight to allow it to land safely. Aircraft do not jettison fuel as a standard procedure when landing. Indeed, most aircraft are unable to jettison fuel. 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.

There are specific procedures in place, published by Airservices Australia, to regulate fuel jettisoning in Australia. For example, pilots must obtain authority from air traffic control before commencing a fuel jettison and must receive instruction on where the fuel jettison is to be performed. Fuel jettisons are required to occur in clear air at an altitude of above 6,000 feet (approximately 1.8 kilometres) and in an area nominated by air traffic control. Reasonable precautions must also be taken to ensure the safety of persons or property in the air and on the ground. Most of the fuel evaporates rapidly within the first few hundred metres as it falls.

The effects of fuel jettisoning on local air quality would be limited due to the rarity of such events, the inability of many aircraft to perform fuel jettisons, the rapid vaporisation and wide dispersion of jettisoned fuel and the strict regulations on fuel jettisoning altitudes and locations.

16.6 Assessments of significance

This section lists key threatening processes of relevance to the Stage 1 development and discusses impacts on MNES and on State-listed threatened species, populations and ecological communities from the construction and operation of the Stage 1 development. Impacts of the long term development are also discussed.

16.6.1 Key threatening processes

Key threatening processes threaten, or have the potential to threaten, the survival or evolutionary development of a species, population or ecological community. They are listed under the EPBC Act, TSC Act and/or FM Act. The key threatening processes of relevance to the Stage 1 development are listed in Table 16–11. Key threatening processes have been considered in the assessment of impacts and tests of significance for the listed species, populations and ecological communities potentially present at the airport site. Mitigation measures to limit the potential impacts are discussed in Section 16.7.

Table 16–11 Key threatening processes

Key threatening process	Status
EPBC Act key threatening processes	
Clearing of native vegetation	EPBC Act/TSC Act
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	EPBC Act/TSC Act
Novel biota and their impact on biodiversity	EPBC Act

Key threatening process	Status
Infection of native plants by *Phytophthora cinnamomi*	EPBC Act/TSC Act
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act/TSC Act
Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant Noisy Miners (*Manorina melanocephala*)	EPBC Act/TSC Act
Predation by the European red fox	EPBC Act/TSC Act
Predation by feral cats	EPBC Act/TSC Act
Competition and land degradation by rabbits	EPBC Act/TSC Act
Human-caused climate change	EPBC Act/TSC Act
TSC Act and FM Act key threatening processes	
Clearing of hollow-bearing trees	TSC Act
Removal of dead wood and dead trees	TSC Act
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act
Invasion of plant communities by perennial exotic grasses	TSC Act
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners	TSC Act
Invasion of native plant communities by African Olive Olea *europaea subsp. cuspidata* (Wall. ex G. Don) Cif.	TSC Act
Invasion of the Yellow Crazy Ant *Anoplolepis gracilipes* (Fr. Smith) into NSW	TSC Act
Predation by the Plague Minnow (*Gambusia holbrooki*)	TSC Act
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act/FM Act
The degradation of native riparian vegetation along NSW water courses	FM Act
The removal of large woody debris from NSW rivers and streams	FM Act

16.6.2 Impacts on matters of national environmental significance

Assessments of significance for MNES have been prepared in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) and the *Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies* (DoE 2013b). The assessments of significance are included in Appendix K1 (Volume 4).

This assessment was based on the Stage 1 development but also considered cumulative impacts that would occur with the long term development.

A significant impact was determined for Cumberland Plain Woodland and the Grey-headed Flying-fox. Construction and operation of the proposed airport would also have a significant impact on other plants, animals and their habitat on Commonwealth land. The key findings of the assessments are summarised below.

16.6.2.1 Threatened flora species

One threatened flora species listed under the EPBC Act was recorded at the airport site during the field surveys – *Pultenaea parviflora*. An additional five species listed under the EPBC Act are considered likely to occur at the airport site: Downy Wattle (*Acacia pubescens*), White-flowered Wax Plant (*Cynanchum elegans*), Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*), Spiked Rice-flower (*Pimelea spicata*) and Austral Toadflax (*Thesium australe*) (see Table 16–6). Assessments of significance were prepared for these threatened flora species, the results of which are summarised below with further detail provided in Appendix K1 (Volume 4).

Pultenaea parviflora

Construction of the Stage 1 development would require the removal of four *Pultenaea parviflora* individuals which would be the entire known local population at the airport site. Construction of the airport would also require the removal of approximately 107.1 hectares of better quality potential habitat for the Stage 1 development and up to approximately 45.3 hectares of additional better quality potential habitat for the long term development. The *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) include specific criteria for assessing impacts on a vulnerable species, which primarily relate to impacts on an important population.

The population of *Pultenaea parviflora* at the airport site is not an important population because:

- it is not identified in a recovery plan;
- it would not be important for breeding or dispersal as it includes only four plants and it is in a comparatively isolated and poor quality patch of habitat surrounded by extensive areas of cleared cropland or grazing country;
- it is not important for maintaining genetic diversity because it comprises only four plants that are in close proximity and as such would be unlikely to contain much genetic diversity. Further, this genetic material has already been retained via the Royal Botanic Gardens Trust sampling and propagation programme (RBGS 1992); and
- this population is near the limit of the species range as it is at the western extent of recognised outlier populations near Kemps Creek (OEH 2015b). The majority of the known population at Kemps Creek is associated with a parcel of land within tertiary gravel and shale/gravel transition habitat located around three kilometres to the east of the site (OEH 2015a). This land parcel is to be set aside as an offset for the South West Growth Centres. The population at the airport site would probably make a very minor contribution to the viability of this population.

Therefore, construction of the proposed airport would not result in any direct impacts on an important population of the species and would not substantially interfere with the recovery of *Pultenaea parviflora*. The proposed airport would not result in a significant impact on *Pultenaea parviflora*.

Other threatened flora species

Construction and operation of the airport would not affect any known populations of the endangered White-flowered Wax Plant or Spiked Rice-flower, nor would it affect the vulnerable species Downy Wattle, Small-flower Grevillea or Austral Toadflax. Despite targeted surveys for these species, there is no evidence that the airport site or any adjoining areas of vegetation contain populations of these threatened plants (PPK 1997; SMEC 2014; OEH 2015a). Any populations of these threatened plant species at the airport site are likely to have relatively low viability since they are not abundant or extensive enough to have been detected by surveys. The airport site is also extensively degraded and modified and there is limited potential for either recruitment or population expansion given the extent of habitat fragmentation.

Any local populations of these species (if present) would probably make a minor contribution to the maintenance or recovery of these species. Given these considerations, the proposed airport is unlikely to interfere with the recovery of any of these threatened plant species. The airport would not result in a significant impact on Downy Wattle, White-flowered Wax Plant, Small-flower Grevillea, Spiked Rice-flower or Austral Toadflax.

16.6.2.2 Threatened ecological communities

Cumberland Plain Woodland has been recorded at the airport site (see Section 16.3.2.6). As shown in Section 16.4.1.1, construction of the Stage 1 development would involve the removal of around 1,153.8 hectares of native vegetation including woodland of varying condition.

Assessment of this woodland found that 104.9 hectares of this vegetation would classify as the Cumberland Plain Woodland threatened ecological community under the EPBC Act.

An additional 46.4 hectares of vegetation cleared for construction of the long term development would also classify as this threatened ecological community.

In accordance with the relevant guidelines and listing advice, these totals exclude certain areas of vegetation based on a range of criteria. The criteria include requirements that the vegetation is in good condition and of sufficient patch size. The criteria are explained further in Appendix K1 (Volume 4).

The removal of the vegetation is considered to constitute a significant impact on the local and regional occurrence of the threatened ecological community. A biodiversity offset package has been prepared to compensate for this significant impact through the protection of other areas of Cumberland Plain Woodland in perpetuity. The offset package is discussed in Section 16.7.

16.6.2.3 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4. As discussed, the Grey-headed flying fox was recorded at the airport site while the Swift Parrot was considered likely to occur. As such, an assessment of significance has been undertaken for potential impacts to these species.

The Australasian Bittern and Australian Painted Snipe may occur at the airport site on a transient basis with only low quality potential habitat present at the airport site for these species. The construction and operation of the airport is highly unlikely to have a significant impact on these species and, as such, assessments of significance were not prepared for these species.

Grey-headed Flying-fox

The airport site may provide foraging habitat during food bottlenecks for the Grey-headed Flying-fox. Much of the foraging habitat in the locality would be of a similar nature and may comprise habitat critical to the survival of the species, as defined in the draft recovery plan for the Grey-headed Flying-fox (DECCW 2009). Construction of the Stage 1 development would require the removal of approximately 141.8 hectares of foraging habitat and 64.4 hectares of foraging habitat for the long term development. This amounts to a large area of foraging habitat in a fragmented rural landscape.

These areas of habitat contribute to the availability of foraging resources for local camps when resources are scarce and at critical life stages. In addition, development of the locality would likely follow as a result of the construction of the airport, resulting in additional clearing of foraging habitat for the species. Furthermore, individuals may be at risk of mortality from aircraft strike during operation, though this is unlikely to substantially impact the population as a whole. For these reasons, the airport may interfere with the recovery of the species and is likely to have a significant impact on the Grey-headed Flying-fox.

A biodiversity offset package has been prepared for the airport to compensate for these significant impacts (see Section 16.8). This would include the protection and management of Grey-headed Flying-fox habitat at offset sites in perpetuity. It is also noted that about 46.8 hectares of potential habitat for Grey-headed Flying-fox would be retained within the environmental conservation zone along Badgerys Creek.

Swift Parrot

Dominant canopy species at the airport site include Grey Box and Forest Red Gum, which may provide foraging resources for migrating Swift Parrots. However, much of the airport site is vegetated with relatively young regrowth, which is not the preferred foraging habitat of the species. A range of aggressive competitors such as the Noisy Miner (*Manorina melanocephala*) and the Bell Miner (*Manorina melanophrys*) are common at the airport site, potentially further reducing habitat suitability for the Swift Parrot. The construction of the airport would require the removal of approximately 141.8 hectares of highly fragmented, relatively low quality potential foraging habitat for the Stage 1 development and an additional 64.4 hectares of foraging habitat for the long term development. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. A total of about 17,393 hectares of potential foraging habitat (woody native vegetation) is mapped in the locality, although not all of this vegetation is likely to be suitable for the species. There is a low risk of aircraft strike for this species given the low numbers that may forage in the area, and lack of good quality foraging habitat in surrounding areas. The proposed airport is unlikely to result in a significant impact on the Swift Parrot.

16.6.2.4 Migratory species

Seven migratory species have been recorded or are predicted to occur at the airport site (see Table 16–8). The Stage 1 development would require the removal of approximately 28.6 hectares of artificial wetlands (farm dams) (habitat for the Great Egret, Cattle Egret, Latham's Snipe and White-bellied Sea-eagle), 141.8 hectares of woodland and forest vegetation (habitat for the Rufous Fantail and Rainbow Bee-eater), and 663.2 hectares of exotic grassland (habitat for the Cattle Egret). No habitat for the White-throated Needletail would be removed as this species forages in the air, well above the ground.

The long term development would require the removal of a further 6.3 hectares of artificial wetlands, 87.3 hectares of woodland and forest and 243.1 hectares of exotic grassland. While birds are likely to be struck by aircraft on occasion during operation, management measures would minimise the risk of this occurring and, as such, the viability of populations in the local area are not likely to be threatened.

The airport site is not considered important habitat for any of these species, according to the significant impact criteria for migratory species (DEWHA 2009). Construction and operation of the proposed airport is, therefore, unlikely to result in significant impacts on these migratory fauna species. No assessments of significance have been prepared for these species.

16.6.2.5 Greater Blue Mountains World Heritage Area

An assessment of significance has been prepared in accordance with the *Significant Impact Guidelines 1.1 – Matters of National Environmental Significance* (DoE 2013a) for impacts on the Greater Blue Mountains World Heritage Area. The results of this assessment are summarised below with further detail provided in Appendix K1 (Volume 4). The assessment focused on biodiversity values, in particular.

It is unlikely that construction and subsequent operation of the proposed airport would have a significant impact on biodiversity values of the Greater Blue Mountains World Heritage Area for the following reasons:

- there would be no direct impact on the Greater Blue Mountains World Heritage Area;
- the construction and operation of the proposed airport is unlikely to result in the loss of biological diversity or biological processes within the Greater Blue Mountains World Heritage Area;
- potential impacts on the Greater Blue Mountains World Heritage Area as a result of changes to air quality are likely to be negligible given the distance to the Greater Blue Mountains World Heritage Area and prevailing wind conditions;
- the airport design and land use plan includes measures to manage surface water that have been purposefully designed to capture water on-site and to avoid substantial alteration of surface water drainage patterns outside of the airport site; and
- while greenhouse gas emissions would increase as a result of the construction and operation of the proposed airport, this is unlikely to directly result in the loss of biological diversity or biological processes within the Greater Blue Mountains World Heritage Area.

Impacts on the Greater Blue Mountains World Heritage Area are discussed further in Chapter 26 (Greater Blue Mountains World Heritage Area).

16.6.2.6 Commonwealth land

An assessment of significance was prepared for impacts on other plants, animals and their habitat in an area of Commonwealth land. The outcome of this assessment is that the proposed airport would likely have a significant impact on:

- flora – through large-scale native vegetation clearance, especially of vegetation containing an endangered population of *Marsdenia viridiflora* subsp. *viridiflora* that would threaten the viability of the regional population of the species; and
- fauna – by displacing animals, reducing or fragmenting available habitat and causing a long term decrease or extinction of local populations of small, less mobile animals such as frogs, reptiles and the Cumberland Plain Land Snail.

16.6.3 Impacts on State-listed threatened species, populations and ecological communities

An assessment of impacts was undertaken for threatened species, populations and ecological communities listed under the TSC Act. This assessment was based on the Stage 1 development but also considered cumulative impacts that would occur with the long term development.

A significant impact was determined for one threatened flora population (*Marsdenia viridiflora* subsp. *viridiflora*) and for three threatened ecological communities (Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest).

In addition, a significant impact was determined for one threatened invertebrate (the Cumberland Plain Land Snail) and four threatened bat species (the Eastern False Pipistrelle, East Coast Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat). The key findings of the assessment are summarised below.

16.6.3.1 Threatened flora species and populations

The majority of the flora species listed as a threatened under the TSC Act that may occur at the airport site are also listed as threatened species under the EPBC Act. Impacts on these species have been assessed in Section 16.6.2. There is potential habitat at the airport site for two additional threatened plant species (*Dillwynia tenuifolia* and *Grevillea juniperina* subsp. *juniperina*) and one threatened population (*Marsdenia viridiflora* subsp. *viridiflora*) listed under the TSC Act.

There is no evidence of a viable local population of *Grevillea juniperina* subsp. *juniperina* or *Dillwynia tenuifolia* at the airport site or in nearby vegetation despite weeks of targeted surveys in multiple seasons (PPK 1997; SMEC 2014; OEH 2015a). There is a possibility that these species may be present at the airport site in low numbers in areas that were not directly observed or in the soil seed bank. There is also a chance that these species could colonise this habitat at some point in the future. As such, there is a risk of affecting a possible local population of these threatened plants through the removal, modification or fragmentation of potential habitat at the airport site.

Construction of the Stage 1 development would remove up to 289.8 hectares of potential habitat for *Grevillea juniperina* subsp *juniperina*. There is no evidence that this habitat is of particular value or significance to the species and there are around 10,014 hectares of similar shale woodland habitat and relatively abundant populations in the locality (NPWS 2006, Tozer 2010, OEH 2015a).

Construction of the Stage 1 development would remove up to 5.0 hectares of potential habitat for *Dillwynia tenuifolia* which is likely to have minor value compared to the relatively extensive areas of shale/gravel transition and alluvial habitat supporting thousands of individuals at Kemps Creek, around three kilometres to the east of the airport site (OEH 2015b). The long term development would remove additional areas of lower quality potential habitat but the removal of any known individuals of these threatened plants is not likely. The proposed airport is, therefore, not likely to result in a significant impact on a local population of these threatened plant species (if present at the airport site).

Construction of the Stage 1 development would completely remove the known local population of *Marsdenia viridiflora* subsp. *viridiflora* and its occupied and potential habitat. No stems of *Marsdenia viridiflora* subsp. *viridiflora* were recorded in the environmental conservation zone or in the area potentially impacted by the long term development. The closest known records of the species are around five kilometres away near Bringelly and Mulgoa (OEH 2015a). Construction of the Stage 1 development would result in a significant impact on the local population of *Marsdenia viridiflora* subsp. *viridiflora*. Impacts to the population may be partially mitigated by the proposed translocation programme and the retention of some potential habitat in the environmental conservation zone (see Section 16.7). It is acknowledged translocation may not provide assurance of survival and in recognition of this, the impact assessment and offset calculations conservatively assume the loss of all individuals in the construction impact zone.

Offsets for threatened flora listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.8).

16.6.3.2 Threatened ecological communities

All of the native woodland and forest vegetation at the airport site, including derived native grasslands, comprise local occurrences of threatened ecological communities listed under the TSC Act (Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest).

Construction of the Stage 1 development would comprise a significant reduction in the extent and increase in the degree of fragmentation of Cumberland Plain Woodland, River Flat Eucalypt Forest and Shale-Gravel Transition Forest. The Stage 1 development would result in the removal of approximately 242.8 hectares of Cumberland Plain Woodland, 42.1 hectares of River Flat Eucalypt Forest and 5.0 hectares of Shale-Gravel Transition Forest. The Stage 1 development would, therefore, likely result in a significant impact on these threatened ecological communities. The long term development would further reduce the extent and increase the degree of fragmentation of Cumberland Plain Woodland and River Flat Eucalypt Forest. The long term development would not result in any direct impacts on Shale-Gravel Transition Forest.

Offsets for threatened ecological communities listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.8).

16.6.3.3 Threatened fauna species

Threatened fauna species recorded site or otherwise considered to potentially occur at the airport site are discussed in Section 16.3.3.4.

As shown, eleven species listed under the TSC Act were considered present. It was considered that another 19 species listed under the TSC Act may occur at the airport site.

Four of these species – Grey-headed flying fox, the Swift Parrot, Australian Painted Snipe and Australasian Bittern – are also listed under the EPBC Act and are discussed in Section 16.6.2.

The loss of approximately 141.8 hectares of woodland and forest habitat for construction of the Stage 1 development would have a significant impact on the Cumberland Plain Land Snail. The removal of good quality occupied patches of vegetation would remove local populations and subpopulations and would reduce the genetic diversity in the locality of the airport site.

Construction of the Stage 1 development would not result in a significant impact on any of the threatened bird species recorded or considered likely to occur at the airport site. The loss of approximately 141.8 hectares of woodland and forest vegetation would reduce the total area of habitat for threatened woodland bird species in the locality (for example, the Scarlet Robin and Varied Sittella). However, many of these species require large patches of intact vegetation for their survival and may only occur at the airport site on a transient basis (if at all). These woodland bird species are also highly unlikely to breed at the airport site.

The construction of the Stage 1 development would remove approximately 981.6 hectares of potential foraging and breeding habitat for the Little Eagle. This species may continue to forage above the southern portion of the airport site prior to this area being developed as part of the long term development. Given the large home range of this species and the large area of potential habitat present in the locality, the loss of this habitat is unlikely to have a significant impact on the species. Individuals would be at risk of mortality from aircraft strike during operation, however, this is unlikely to significantly affect the population of this species in the locality.

The Blue-Billed Duck would be a rare visitor to the airport site, and would not breed there. The construction of the proposed airport would remove approximately 28.6 hectares of artificial wetlands (farm dams) that provide only occasional foraging habitat for a few individuals. No breeding habitat would be removed.

There is a very low risk of mortality from aircraft strike given the low numbers of individuals that may occur in the area. Due to this, the construction and operation of the proposed airport is unlikely to have a significant impact on this species.

Threatened owls may forage at the airport site on occasion. These include the Powerful Owl, Masked Owl and Barking Owl. Given the large areas of cleared land in the area, the airport site is not likely to contain core habitat for these species. Large, hollow-bearing trees are present that would be suitable for breeding, however, given the lack of good quality foraging habitat, breeding is unlikely to occur at the airport site. Construction of the proposed airport is unlikely to have a significant impact on these species.

The Gang-gang Cockatoo was not recorded during targeted surveys, but may forage at the airport site. Most local records of this species are associated with well vegetated areas such as the Blue Mountains. This species often moves to lower altitudes during autumn and winter, occurring in drier, more open eucalypt forests and woodlands and is often recorded in urban areas. During spring and summer it moves to tall mountain forests and woodlands for breeding. As such, it is unlikely to breed at the airport site. The proposed airport would remove around 141.8 hectares of woodland and forest which is potential foraging habitat for the species. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the lack of evidence of this species at the airport site, the patchy nature of the vegetation to be removed, and that breeding at the airport site is unlikely, construction of the proposed airport is unlikely to have a significant impact on this species.

The Little Lorikeet was recorded flying over woodland at the airport site. The airport site is likely to provide foraging habitat for occasional transient individuals. The Little Lorikeet is unlikely to breed at the airport site given the patchy nature of the vegetation, low density of hollow-bearing trees, and because most breeding occurs west of the Great Dividing Range. Construction of the proposed airport would remove about 141.8 hectares of woodland and forest, which is potential foraging habitat for the species. Approximately 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the lack of evidence of this species at the airport site, the patchy nature of the vegetation to be removed, and that breeding at the site is unlikely, construction of the proposed airport is unlikely to have a significant impact on this species.

The Black Bittern was recorded within the riparian corridor of Badgerys Creek, near Elizabeth Drive. Preferred habitat for this species at the airport site is primarily located along this riparian corridor, which would mostly be retained within the environmental conservation zone. Habitat for this species could also occur at artificial wetlands (farm dams) at the airport site where there is suitable cover and the riparian corridors of Duncans Creek and Oaky Creek. Approximately 62.7 hectares of artificial wetland and riparian vegetation would be removed for the Stage 1 development. Not all of this area would be suitable for the species, as it requires dense vegetation for cover. About 46.8 hectares of potential habitat would be retained within the environmental conservation zone along Badgerys Creek. Given the protection of the riparian corridor along Badgerys Creek and the large numbers of artificial wetlands present in the locality, construction of the proposed airport is unlikely to have a significant impact on this species.

The construction of the proposed airport is likely to result in a significant impact on four obligate hollow-breeding bat species (the Eastern False Pipistrelle, East Coast Freetail-bat, Greater Broad-nosed Bat and Yellow-bellied Sheathtail-bat) through direct impacts on individual bats and from the removal of a substantial area of foraging and roosting habitat (approximately 141.8 hectares of woodland and forest vegetation and hollow-bearing trees). The proposed airport may also have a significant impact on the Large-footed Myotis if it uses tree hollows in the airport site for breeding. This species mainly breeds in caves and man-made structures. The construction of the proposed airport is unlikely to impact the Eastern Bentwing Bat and Eastern Cave Bat because it would only remove foraging resources and less valuable roost sites such as buildings and culverts. While individuals may be at risk of mortality from aircraft strike during operation, this is unlikely to substantially impact any populations of threatened bats.

Offsets for threatened fauna listed under the TSC Act have been calculated using the BioBanking methodology for a major project as part of the assessment of offsets for impacts on the environment (see Section 16.7).

16.7 Mitigation and management measures

Measures to mitigate impacts on terrestrial and aquatic flora and fauna (including threatened and migratory species, threatened populations and threatened ecological communities) from the construction and operation of the proposed airport are presented below, according to the hierarchy of avoidance, minimisation and mitigation of impacts.

A Biodiversity Construction Environmental Management Plan (CEMP) and Biodiversity, Land and Safety Operational Environmental Management Plan (OEMP) will be prepared and submitted for approval prior to Main Construction Works and operation of the Stage 1 development respectively. The plans would collate the mitigation and management measures discussed in this section and itemised in Table 16–12. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Offsetting of impacts is discussed in Section 16.8. Mitigation measures and biodiversity offsets would be further developed with reference to relevant conservation advice and recovery plans for threatened biota potentially affected by the proposed airport.

16.7.1 Avoidance of minimisation of impacts

A number of avoidance and minimisation measures would be included in the design of the proposed airport in order to minimise the potential impacts on flora and fauna at the airport site and in the locality, where practicable. These measures would include:

- designing the airport to minimise its attractiveness to fauna, minimising bird and bat strike risk and other terrestrial fauna strike risk, including measures such as:
  - designing and building the airfield, drains and water basins to reduce the availability of water;
  - installing fencing to restrict terrestrial animal access to the airfield; and
  - designing airside access roads to facilitate wildlife management;
- designing the surface water management system to minimise the potential for adverse impacts on downstream environments, including measures such as:
  - separating ‘clean’ and ‘dirty’ water and retaining and treating any surface water generated on hard stand areas before discharge from the airport site;
  - avoiding substantial alteration of surface water drainage patterns and the volume of downstream flows;
  - designing and locating new waterway crossings or upgrades of existing crossings (if required) to minimise impacts on riparian and aquatic habitats. Crossings would be designed to minimise potential impacts on watercourse functionality, in particular impacts on aquatic and riparian habitats and fish passage; and

- designing airport lighting to avoid unnecessary light spill into adjoining areas of retained vegetation (such as in the environmental conservation area) as far as practicable given operational and security requirements.

Approximately 117.1 hectares of land in the environmental conservation zone would be protected. The environmental conservation zone includes around 56.8 hectares of native vegetation and representative areas of each of the vegetation types at the airport site. The 60.3 hectares of land within the environmental conservation zone that does not currently contain native vegetation would be revegetated. It is noted that around 2.1 hectares of vegetation in the proposed environmental conservation zone would require clearing for the establishment of detention basins outlets. Vegetation in these areas would be allowed to naturally regenerate and be protected in the environmental conservation zone. The environmental conservation zone is well placed, primarily around the southern perimeter of the airport site, to maintain vegetation connectivity and to provide opportunity for fauna movement and other ecological processes that are necessary to maintain biodiversity values.

The parts of the airport site outside the construction impact zone of the Stage 1 development but potentially impacted by the long term development would not be cleared until required for construction of the second runway or other infrastructure, except to the extent necessary or relevant for Stage 1 (for example, drainage and services lines, fire protection and other ancillary purposes), or subsequent development of the airport site. This approach means that impacts on biodiversity values would be avoided for as long as is practicable. Where practical, biodiversity values would be maintained in the long term development area through:

- retention of native vegetation and flora and fauna populations in areas not subject to development. This would help maintain the viability of populations outside the airport site by providing source populations for ecological processes such as pollination, reproduction and recruitment as well as helping to maintain genetic variability;
- retention of habitat resources, including potential refuge habitat and resources such as tree-hollows in areas not subject to development for fauna displaced by clearing for the Stage 1 development; and
- maintenance of habitat connectivity, including locally important vegetated corridors linking larger patches of Cumberland Plain Woodland at the airport site with riparian corridors extending away from the airport site.

A staged vegetation clearing process would be implemented during construction of the Stage 1 development. This would provide the opportunity for fauna that are resident in the construction impact zone to seek refuge in alternative habitat in the environmental conservation zone, long term development area or outside the airport site. Vegetation clearing would commence in the north-east of the airport site and proceed south and west. Subject to safety and security requirements, this clearing would be undertaken before the construction of the southern perimeter fence to allow fauna to relocate towards the environmental conservation zone and off-site. This approach would be taken to maximise the opportunity for resident fauna to vacate the clearing footprint via vegetated remnants and move toward alternative habitat.

16.7.2 Mitigation and management of impacts

Mitigation and management measures proposed to minimise the impacts on terrestrial flora and fauna are listed in Table 16–12.

The mitigation and management measures listed in Chapter 12, Chapter 17 and Chapter 18 would be implemented, as far as practicable, to minimise the impacts associated with dust, erosion and sedimentation on terrestrial and aquatic flora and fauna at the airport site.

Table 16–12 Mitigation and management measures

Issue	Mitigation/management measure	Timing
Worker induction	All workers are to be provided with an environmental induction prior to starting onsite construction activities. This would include information on: • the ecological values of the airport site; and • protection measures and site procedures to be implemented to protect biodiversity during construction.	Pre-construction
Waterway crossings	New waterway crossings or upgrades of existing crossings, if required on the airport site, will be designed and constructed to minimise potential impacts on watercourse functionality, in particular impacts on riparian and aquatic habitats and fish passage.	Pre-construction Construction
Pre-clearance surveys for threatened species	Pre-clearance surveys for threatened species will be undertaken by a qualified ecologist. Specific management plans will be prepared to manage impacts on each threatened flora and fauna species. These plans would include: • additional targeted searches of the airport site for the Green and Golden Bell Frog (in suitable conditions) to confirm that they are not present at the site. Should this species be located during targeted surveys, a management plan would be prepared to provide detail on Green and Golden Bell Frog relocation and habitat management. Frog collection and relocation would need to be conducted by appropriately experienced ecologists; • targeted searches of the airport site for the Cumberland Plain Land Snail (in suitable conditions) and salvage and relocation of any snails and/or suitable shelter sites that are detected. A management plan would be prepared to provide more detail on Cumberland Plain Land Snail relocation and habitat management. Snails and/or suitable shelter sites would be relocated to appropriate habitat near the airport site. Snail collection and relocation would need to be conducted by appropriately experienced ecologists; • searches for roosting bats at any bridges or culverts that need removal; • pre-clearing surveys for larger birds' nests, particularly the White-bellied Sea-Eagle and Little Eagle; and • targeted searches for threatened flora species in areas of appropriate habitat with particular attention to the vicinity of known populations of *Marsdenia virdiflora* subsp. *viridiflora* and *Pultenaea parviflora*. Any unexpected finds would be communicated to the Department of Infrastructure and Regional Development and addressed in the translocation plan and/or offset delivery plan as appropriate.	Pre-construction

Issue	Mitigation/management measure	Timing
Habitat clearing and fauna removal plan	A habitat clearing and fauna removal plan will be developed as part of the Biodiversity CEMP for the management of impacts on fauna species during clearing activities. The plan will include the following measures: • preparing a nest box strategy, including provisions for the: ▪ installation of nest-boxes within the Environmental Conservation Zone prior to clearing areas of native vegetation. This would provide a safe location for hollow-dwelling fauna to be transferred to during clearing operations; ▪ reuse of hollows and fallen debris within conversation areas; and ▪ salvage of native fauna from existing nest boxes in the construction impact zone prior to their removal and translocation. • providing for pre-clearing surveys to be undertaken by a suitably qualified ecologist to mark and map hollow-bearing trees, logs and existing nest boxes that would require fauna management during removal; • establishing protocols for the staged clearing of vegetation and safe tree felling and log removal to reduce the risk of fauna mortality; • measures outlined in the threatened species translocation plan; • establishing protocols for the capture and relocation of less mobile fauna (such as nestling birds and nocturnal fauna) by a trained fauna handler; and • establishing protocols for the appropriate management of injured or deceased individuals.	Pre-construction
Weed management plan	A weed management plan will be developed as part of the Biodiversity CEMP and will include the following measures: • implementing soil erosion and sediment control measures; • mapping of weed infestations; • removing and controlling noxious weed species; • appropriate disposal of weeds and weed-infested soils; • stabilising disturbed areas following clearing to prevent weed spread; • monitoring and adaptive management of weeds; and • reporting on the extent, composition and severity of weed infestations and adaptive management measures.	Pre-construction

Issue	Mitigation/management measure	Timing
Dam decommissioning and repurposing protocol	A protocol for the decommissioning of dams, or repurposing of dams for storage and use of water during construction, will be developed as part of the Biodiversity CEMP, in consultation with relevant agencies. The measures to be implemented through the protocol include: • any requirements of a Green and Golden Bell Frog management plan; • eradication of the Alligator Weed infestation on the dammed section of Oaky Creek near Elizabeth Drive prior to any works in the vicinity; • progressively emptying dams over a number of days to allow fauna to relocate; • avoiding the nesting season of waterbirds, where possible. A pre-removal survey would be conducted to identify bird breeding locations; • salvaging and relocating aquatic vertebrate fauna, including frogs, turtles and eels, to areas of suitable habitat retained at the airport site or nearby habitats, with regard to numbers and identification of suitable release sites; • preventing the release of Eastern Gambusia (*Gambusia holbrooki*) and other noxious fish into local waterways as a result of the draining of farm dams. Eastern Gambusia will be eradicated from dams using humane methods; and • establishing protocols for the humane euthanasia of aquatic fauna, including fish.	Pre-construction
Bushfire management	As part of ongoing site management activities, the Department of Infrastructure and Regional Development has prepared and implemented a bushfire management plan for the Commonwealth owned land at Badgerys Creek. This plan addresses current bushfire risk and identifies response actions. The existing bushfire management plan will be reviewed and updated in consultation with NSW Rural Fire Service to minimise the risk of bushfire and associated impacts on adjoining areas of native vegetation during construction and operation of the proposed airport, including the proposed environmental conservation area. This would include: • identifying activities likely to generate sparks and putting in place appropriate restrictions based on the forecast fire danger; • preparing pre-planned fire response action plans. The action plans would be issued as part of the site induction for all site personnel; • developing limitations on relevant construction procedures which would be applied during the fire season based on specific fire danger ratings. An example of such restrictions would include the halting of all construction works during extreme or catastrophic fire danger days; • managing the airport site to maintain a low overall fuel hazard. Measures to achieve this would include a combination of herbicide application, slashing, low intensity burning and hand removal; and • ensuring that fuel-reduction measures are appropriate to biodiversity values in each area, e.g. low intensity burns rather than slashing would be used in native woodland and forest.	Pre-construction
Natural environments adjacent to and downstream from the airport site	Measures to minimise the potential hydrological and contamination impacts on natural environments adjacent to and downstream of the airport site which will be implemented through the Soil and Water CEMP as discussed in Chapter 28 (Volume 2b). Measures to minimise the generation of dust and associated impacts on natural environments adjacent and downstream of the airport will be implemented through the Air Quality CEMP as discussed in Chapter 28 (Volume 2b).	Pre-construction Construction

Issue	Mitigation/management measure	Timing
Threatened flora translocation plan	A threatened flora salvage and translocation plan will be developed as part of the Biodiversity CEMP, in consultation with relevant agencies and the Australian Botanic Garden at Mount Annan and with consideration of the *Guidelines for the Translocation of Threatened Plants* (Vallee et al 2004). The plan will specify measures for the salvage and translocation of threatened flora species. In particular, it will include: • the salvage and propagation or transplanting of the known local populations of Pultenaea parviflora and Marsdenia viridiflora subsp. viridiflora and any other threatened flora detected at the airport site; and • consideration of the suitability of sites within the Environmental Conservation Zone in order to maintain populations of these species as close to their original location as is possible.	Pre-construction Construction
Threatened species management plans	Threatened species management plans will be prepared and implemented as part of the Biodiversity CEMP to reduce the potential for impacts on threatened species known to occur on the airport site, both inside and outside of the construction impact zone. These plans will include: • maps identifying locations of threatened species; • the scope and requirements for targeted surveys and pre-clearing surveys; including an unexpected finds protocol; • vegetation and habitat clearing protocols; and • reporting and adaptive management measures.	Pre-construction Construction
Vegetation clearance and habitat loss	The following measures will be taken to reduce the potential for adverse impacts on ecologically sensitive areas due to vegetation clearance and habitat loss: • deferring vegetation removal until necessary; • locating site offices and stockpiles in already cleared and disturbed areas where possible, to avoid further unnecessary removal or disturbance of native vegetation and hollow-bearing trees; • providing maps to construction staff engaged in Main Construction Works clearly showing vegetation clearing boundaries and exclusion/no-go zones; • engaging a suitably qualified ecologist or environmental officer prior to any clearing works that form part of Main Construction Works to clearly demarcate vegetation protection areas; and • establishing an unexpected finds protocol to detail measures to be undertaken if threatened flora and fauna not previously recorded at the airport site are detected during Main Construction Works.	Preparatory Activities Construction
Disease management protocol	A disease management protocol will be developed as part of the Biodiversity CEMP to minimise the potential for the spread of diseases. The protocol will include procedures for the management of plant diseases (such as Phytophthora, Myrtle Rust and Chytrid fungus), as well as any other likely diseases.	Construction

Issue	Mitigation/management measure	Timing
Management of vegetation areas outside the construction impact zone	A vegetation management plan will be developed as part of the Biodiversity CEMP to guide the activities for managing areas of vegetation outside the Stage 1 construction impact zone. The plan will identify how environment protection objectives for the Environmental Conservation Zone shown in the Land Use Plan in the Airport Plan will be met. The plan will detail specific measures to: • avoid unnecessary disturbance in nearby areas of retained vegetation outside of the construction impact zone such as avoiding unnecessary light spill; • replace exotic grasslands with suitable native vegetation in the Environmental Conservation Zones; • rehabilitate existing remnant and native vegetation within the Environmental Conservation Zones; and • protect environmental values within the Environmental Conservation Zone.	Pre-construction Construction
Landscaping	Landscaping on the airport site will utilise predominantly native vegetation endemic to the region, sourced from the local area where possible. This will include: • planting of native grasses in open areas around airport infrastructure; and • the use of native vegetation in decorative gardens and plant screenings used to minimise visual impacts.	Construction
Biodiversity and Vegetation (Environmental Conservation Zone)	A vegetation management plan will be prepared and implemented as part of the Biodiversity Land and Safety OEMP to guide the activities for managing areas of endemic native vegetation with the Environmental Conservation Zone outlined in the Land Use Plan in the Airport Plan. The vegetation management plan will include the following measures: • retaining endemic vegetation and/or supplementary replanting with local native species; • slashing of grassland to manage fuel loads and bushfire risk; • identifying threatened flora populations and measures to avoid impacts from activities such as weed control or bushfire hazard reduction; • identifying measures for the management of weeds; • planting schedules; and • monitoring and reporting the success of revegetation, weed control and adaptive management.	Pre-operation Operation

Issue	Mitigation/management measure	Timing
Biodiversity and Vegetation (Other areas outside the Stage 1 construction impact zone)	A vegetation management plan will be prepared and implemented as part of the Biodiversity, Land and Safety OEMP to protect those areas of significant vegetation outside the Stage 1 construction impact zone and the Environmental Conservation Zone, where the vegetation: • comprises a threatened ecological community under the EPBC Act; or • provides important or critical habitat for a listed threatened species under the EPBC Act. The vegetation management plan will: • map and identify those areas of significant vegetation within the airport site to which the plan applies; • identify measures to ensure that no clearance of significant vegetation occurs without prior approval under the Airports Act; • identify measures to protect significant vegetation from impacts associated with land management activities and development activities; and • detail any other measures necessary to retain significant vegetation and protect it from accidental or inadvertent disturbance.	Pre-operation/ Operation
Wildlife hazard management plan	To manage the risk of fauna hazard and bird and bat strike a wildlife hazard management plan will be developed and implemented. The plan will include the following measures: • the conduct of additional surveys to study and monitor for changes in species and movement patterns. The surveys will be conducted in accordance with relevant Commonwealth and State guidelines and standards including any recovery plans for threatened species; • the review of detailed design documentation to identify potential bird and bat attractants; • liaison with local government in relation to plans for proposed developments within 13 kilometres of the airport site that are likely to increase the bird and bat strike risk; • active management of bird and bat presence at the airport site six months prior to the commencement of airport operations; and • the outcomes of bird and bat strike monitoring will be reviewed by a wildlife strike expert and the results taken into account in any audit of the airport's impacts on wildlife in and around the airport site.	Pre-operation Operation
Fauna hazard	To minimise bird and bat strike risk and terrestrial fauna strike risk, the design of the proposed airport will seek to minimise the attractiveness of the airport site to fauna. To achieve this, the following measures will be incorporated into the detailed design process: • drains, water basins and other airfield components that minimise the availability and attractiveness of water and other potential roosting, nesting or foraging habitat; • an appropriate fence to restrict terrestrial animal access to the airfield; and • airside access roads to facilitate active wildlife management.	Pre-operation
Fire	Review, update and implement the Bushfire Management Plan developed for the airport site in response to the transition to the airport operation phase, including in response to changes to locations of building envelopes, fuel loads, ignition sources etc.	Operation

16.8 Offsetting impacts

Biodiversity offsets are required to compensate for the significant residual impacts arising from the proposed airport in accordance with the EPBC Act Offsets Policy and the EIS guidelines. Biodiversity offsets to compensate for significant residual impacts on threatened species and communities listed under the EPBC Act were calculated using the offsets assessment guide under the EPBC Act *Environmental Offsets Policy* (DSEWPaC 2012).

Biodiversity offsets to compensate for significant residual impacts on other features of the natural environment on Commonwealth land, plants, animals and their habitat, including threatened species, populations and communities listed under the TSC Act, were calculated with reference to the NSW BioBanking Assessment Methodology*, Credit Calculator Operational Manual 2014* (DECC 2009b) and the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is used to calculate offsets for major projects in NSW. Further detail regarding the methodology for offsetting impacts is provided in Appendix K2 (Volume 4).

The Department of Infrastructure and Regional Development will be responsible for delivering offsets for the Stage 1 development.

The biodiversity offset package discussed here comprises the first stages in the process of delivery of biodiversity offsets for the proposed airport. The process involving offset identification, securing and delivery is shown schematically in Figure 16–4.

An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland; the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox; and on features of the natural environment including plant populations, fauna populations and several species and communities listed under NSW legislation and TSC Act (collectively referred to as plants, animals and their habitat).

The offset package is intended to conserve habitat as offsets for affected biota at suitable offset sites in the surrounding region in perpetuity. The details of the offset package are described below. Further information on the offset package is provided in Appendix K2 (Volume 4).

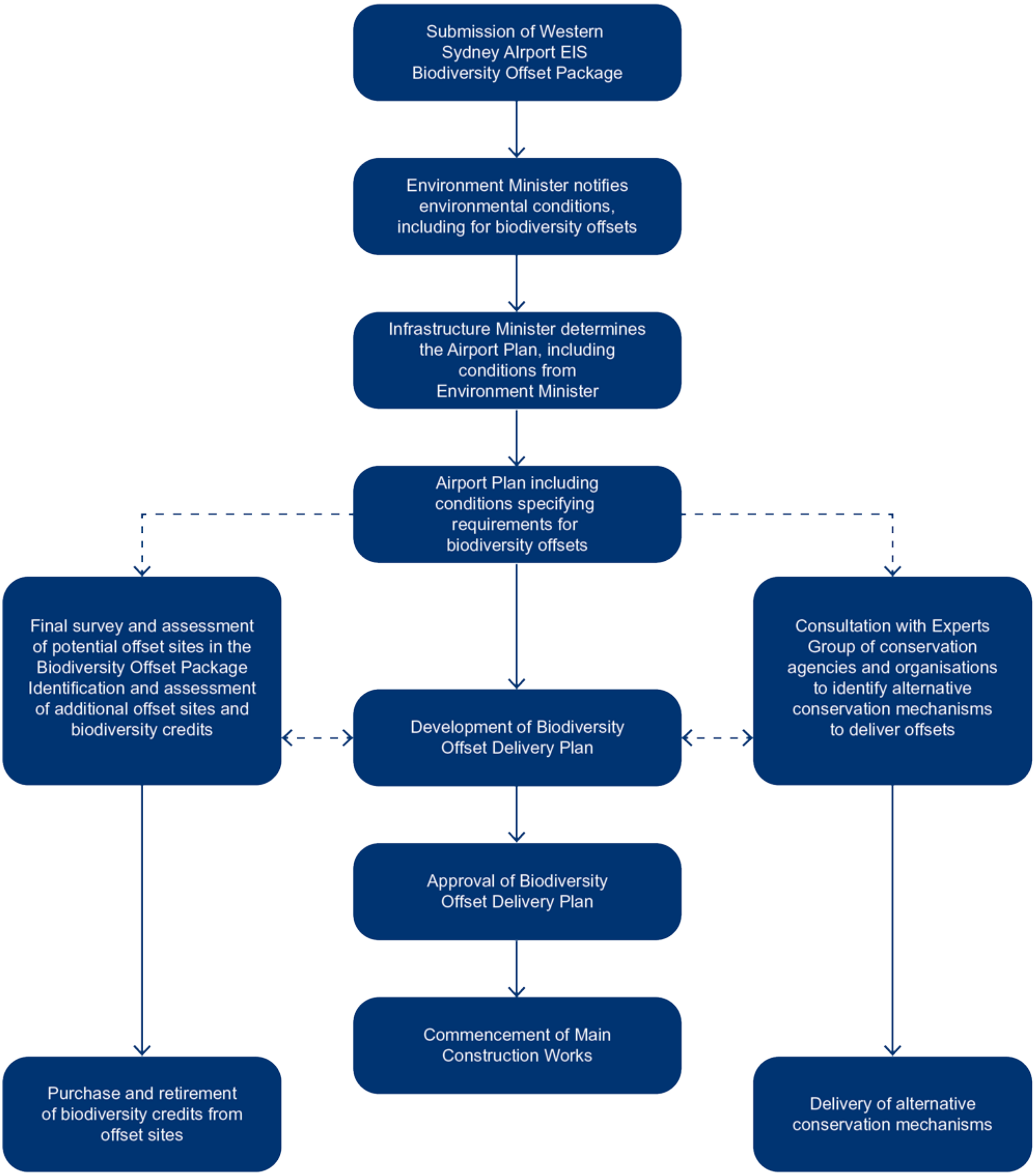


Figure 16–4 Overview of offset delivery process

16.8.1 Overview of the offset proposal

The EIS guidelines state that the proposed airport will require biodiversity offsets calculated with reference to the EPBC Act Offsets Policy. The key considerations included in the policy are that:

- offsets are described as measures that compensate for significant residual adverse impacts on the environment and the policy applies to all matters that are protected under the EPBC Act;
- the ‘offsets assessment guide’ spreadsheet is a tool that has been developed to help assess the suitability of offset proposals. The offsets assessment guide uses a balance sheet approach to measure impacts and offsets;
- at least 90 per cent of a project’s impacts should be directly offset (subject to exceptions outlined in the EPBC Act Offsets Policy) and any offsets should be implemented prior to or at the time of the impact occurring; and
- up to 10 per cent (or more if an appropriate exception applies) of a project’s impacts may be indirectly offset through compensatory measures such as contributions to a research fund or an educational programme.

A deviation from the 90 per cent direct offset requirement may be considered where it can be demonstrated that a greater benefit to the protected matter is likely to be achieved through increasing the proportion of other compensatory measures.

Following consultation with the DoEE, it was determined that the estimate of offsets for significant residual impacts on other features of the natural environment plants, animals and their habitat, including threatened biota listed under the TSC Act, would be calculated with reference to the NSW *Framework for Biodiversity Assessment* (OEH 2014b). The framework is based on the NSW Biodiversity Banking and Offsets Scheme (BioBanking) credit calculator and assessment methodology and is used to calculate offsets for major projects in NSW.

The EPBC Act Offsets Policy requires biodiversity offset sites to be securely titled under a legally binding conservation covenant and actively managed under a fully funded plan. There are a variety of mechanisms for achieving this, including BioBanking, Voluntary Conservation Agreements or dedication of land to the National Parks estate.

Due to a variety of factors, most notably the scale and nature of the biodiversity offsets required for the proposed airport, it will not be possible to identify and secure all of the proposed biodiversity offsets as part of this final EIS. The Department of Infrastructure and Regional Development has also identified strategic offsetting opportunities which involve working with the NSW Government and local stakeholders to source and manage suitable biodiversity offsets, but some of these opportunities cannot be realised immediately. The process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister for the proposed airport and will comprise the following main stages:

- The biodiversity offset package (the package provided in this EIS), which outlines the approach to the delivery of biodiversity offsets for the proposed airport, including an estimate of the quantum of offsets required, options to deliver these offsets, an estimate of the costs involved and the additional steps required to finalise their delivery.

- The biodiversity offset delivery plan which will set out the specific actions to be taken to meet the offset conditions for the Stage 1 development as set out in the Airport Plan. Development of the plan will be guided by the framework established in this biodiversity offset package. The delivery plan will include further information such as:
  - the final quantum of impacts arising from the Stage 1 development, including refinements to impact calculations based on detailed design, pre-clearing surveys of the Stage 1 construction impact zone and any necessary modifications to vegetation and habitat mapping;
  - identification of additional offset areas to address the shortfall in the offset areas for EPBC Act Cumberland Plain Woodland and biodiversity credits for impacts on plants, animals and their habitat;
  - location details and fine scale mapping of individual offset sites;
  - current tenure arrangements, land uses, risk of loss of offsets and legal mechanisms proposed to avert the risk of loss at individual offset sites;
  - confirmed presence of threatened biota and assessment of the extent and quality of habitat at individual offset sites and details of studies and surveys used to inform offset calculations;
  - the final number and type of biodiversity credits to be purchased, or other action to be taken in relation to alternative offset mechanisms;
  - a detailed description of the specific management actions that will be undertaken to improve the quality of the offset sites; and
  - the overall cost of the proposed offset package.
- The biodiversity offset delivery plan will be submitted and require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to the substantial impacts occurring.

At this stage of the planning and assessment for the proposed airport, the intent is to deliver biodiversity offsets through conservation of suitable offset sites. The offset sites would be secured by registration of a BioBanking agreement on title to the sites. A BioBanking agreement is recognised as a practical and secure way of delivering biodiversity offsets and is endorsed by the DoEE as well as OEH and the NSW Department of Planning and Environment (DPE) for this purpose. This approach would require purchase of the number and type of biodiversity credits that match the proposal’s impacts as calculated in accordance with the EPBC Act Offsets Policy.

While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other alternative mechanisms to offset impacts will also be considered, especially where they would be more readily implemented or achieve better conservation outcomes in the region. These other compensatory measures could include actions such as:

- contributing to the Cumberland Conservation Corridor programme to enhance efforts to acquire and protect priority conservation lands within the Cumberland Conservation Corridor;
- contributing to Cumberland Plain restoration projects such as funding of revegetation programmes in the Western Sydney Parklands or expanding the 20 Million Trees programme;
- contributing to landholders such as local councils to fund bush regeneration or revegetation programmes;
- funding a seed collection and propagation programme to support bush regeneration or revegetation programmes;
- translocation of threatened flora from within the Stage 1 construction impact zone and monitoring of translocated populations in a way that will contribute to the long term conservation of the species; and
- payments into the NSW Biodiversity Conservation Fund, noting that it has not yet been established but could be before offsets need to be implemented.

Continued consultation with agencies and bodies such as the DoEE Biodiversity Conservation Division, NSW OEH, NSW Department of Planning and the Environment, Penrith City Council, Greater Sydney Local Land Services, the Western Sydney Parklands Trust, and members of the Cumberland Conservation Corridor Reference Group may identify options that are more suitable.

As a coordinated approach to consulting on the development of alternative conservation mechanisms, the Department of Infrastructure and Regional Development will establish an Experts Group including DoEE, other relevant NSW authorities, organisations and stakeholder groups as determined by the Department. Key considerations, with reference to the EPBC Act Offsets Policy, will include that any offsets must directly benefit the protected matter to be affected, must be based on sound ecological survey and assessment, and must be additional to any existing or proposed government funding for conservation programmes.

16.8.2 Summary of impacts requiring offsets

According to the EPBC Act Offsets Policy, biodiversity offsets are required for significant residual impacts on matters protected by the EPBC Act after any proposed avoidance and mitigation measures have been taken into account. The proposed airport is likely to have an impact on:

- Cumberland Plain Woodland, which is listed as a critically endangered ecological community under the EPBC Act and occurs at the airport site. Offsets are required for the removal of approximately 104.9 hectares of vegetation within the local occurrence of the community;
- the Grey-headed Flying-fox which is listed as a vulnerable species under the EPBC Act and which has been observed at the airport site. Offsets are required for the removal of approximately 141.8 hectares of foraging habitat; and
- plants, animals and their habitat including several species and communities listed under NSW legislation.

Impacts on EPBC Act-listed biota have been entered in the EPBC Act offset assessment guide. The offset assessment guide can only be used to calculate offsets for threatened biota listed under the EPBC Act and so an alternative approach is required for impacts on other protected matters. The EPBC Act Offsets Policy requires that the approach to calculating offsets must be in proportion to the level of statutory protection that applies to the protected matter, be of a size and scale proportionate to the residual impacts on the protected matter and be scientifically robust and reasonable (DSEWPC 2012). The NSW *Framework for Biodiversity Assessment* (OEH 2014b) has been used to calculate required offsets for significant residual impacts to plants, animals and their habitat as it meets each of these criteria and is supported by DoEE for this purpose. The calculated offsets are summarised in Table 16–13 and Table 16–14.

Table 16–13 Ecosystem credits required to offset impacts of the proposed airport

Plant community type name	Condition	Conservation status		Management zone area	Ecosystem credit requirement	Offset options – Plant community types
		EPBC Act Status	TSC Act Status			
Good condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/ Good	CEEC	CEEC	79.8	4,220	HN528, HH526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on flats (HN528)	Moderate/ Good_Poor		CEEC	112.5	3,686	HN528, HH526
Good condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good	CEEC	CEEC	22.9	1,062	HN529, HN528, HN526[1]
Poor condition Grey Box – Forest Red Gum grassy woodland on hills (HN529)	Moderate/ Good_Poor		CEEC	27.6	884	HN529, HN528, HN526
Good condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good		EEC	34.2	1,878	HN526, HN528
Poor condition Forest Red Gum – Rough-barked Apple grassy woodland (HN526)	Moderate/ Good_Poor		EEC	7.9	262	HN526, HN528
Good condition Broad-leaved Ironbark – Grey Box – *Melaleuca decora* grassy open forest (HN512)	Moderate/ Good	CEEC	EEC	4.4	337	HN512, HN513, HN604, HN556[1]
Poor condition Broad-leaved Ironbark – Grey Box – Melaleuca decora grassy open forest (HN512)	Moderate/ Good_Poor		EEC	0.6	21	HN512, HN513, HN604, HN556
Good condition artificial freshwater wetland on floodplain (HN630)	Moderate/ Good			28.6	873	HN630, HN520

Notes: 1) Ecosystem credits that are used to offset impacts on EPBC Act Cumberland Plain Woodland would need to be plant community types HN528, HN529 or HN512 and associated with better quality vegetation in order to comply with the EPBC Act offset policy (DSEWPaC 2012).

Table 16–14 Species credits required to offset impacts of the proposed airport

Common name	Scientific name	Threatened species multiplier	Species credits required
Black Bittern	*Ixobrychus flavicollis*	1.3	815
Cumberland Plain Land Snail	*Meridolum corneovirens*	1.3	1,843
Marsdenia viridiflora subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	*Marsdenia viridiflora* subsp. *viridiflora* – endangered population	4.0	5,800
Pultenaea parviflora	*Pultenaea parviflora*	1.5	60
Southern Myotis	*Myotis macropus*	2.2	752

16.8.3 Potential offset sites

The biodiversity offset package sets out the overarching framework and strategy for how biodiversity offsets will be identified and secured for the proposed airport. Offsets for the proposed airport would mainly comprise the conservation of habitat for the affected protected matters in suitable offset sites. This section of the report outlines potential offset sites that the Department of Infrastructure and Regional Development intends to secure and has been used to estimate the quantum and cost of biodiversity offsets for the Stage 1 development of the proposed airport. Most of the offset sites would be secured by registration of a BioBanking agreement on title that will ensure that they are securely conserved and managed in perpetuity.

A desktop assessment was performed to identify and describe potential offset sites for the proposed airport. Candidate sites would be secured under a BioBanking agreement that would ensure that the offset sites would be securely titled for conservation as a biobank in perpetuity. The sources that were considered in the desktop assessment include BioBanking online registers administered by OEH, BioBanking assessment reports for existing and potential biobank sites and consultation with private landowners and agencies.

The desktop assessment revealed suitable offset sites that contain Cumberland Plain Woodland and/or Grey-headed Flying-fox habitat. Potential offset sites that contain habitat for the affected threatened biota and that could be included in the offset package are detailed in Table 16–15. Portions of four of these potential offset sites (Williamswood, Montpelier Stages 1 and 2 and Durham biobanks), are located in Cumberland Plain Priority Conservation Lands identified in the recovery plan for Cumberland Plain Woodland (DECC 2010).

Table 16–15 Potential offset sites

Potential offset site	Location	Total area (hectares)	Status and ownership
Williamswood biobank	Mount Hunter	104.5	Established biobank, private owner.
Durham biobank	Oxley Park (Ropes Creek riparian corridor)	46.85	Potential biobank, DPE.
Mamre biobank	Mamre Park (South Creek riparian corridor)	98.1	Potential biobank, DPE.

Potential offset site	Location	Total area (hectares)	Status and ownership
Luddenham biobank	Mamre Park (South Creek riparian corridor)	42	Potential biobank, DPE.
Roper biobank	Minchinbury (Ropes Creek riparian corridor)	14.05	Potential biobank, DPE.
Caddens biobank	Claremont Meadows (South Creek riparian corridor)	36.08	Potential biobank, DPE.
Dunheved biobank	Werrington County (South Creek riparian corridor)	90.17	Potential biobank, DPE.
Forrester biobank	Tregear (Ropes Creek riparian corridor)	30.43	Potential biobank, DPE.
Stage 1 Montpelier biobank	The Oaks	76.24	Potential biobank, private owner.
Stage 2 Montpelier biobank	The Oaks	79.5	Potential biobank, private owner
Menangle Road biobank	The Oaks	57.07	Potential biobank, private owner
Bruelle biobank	Mulgoa	27.5	Potential biobank, private owner
The Oaks	Mowbray Park	40	Established biobank, private owner
Western Sydney Parklands ID 120	Cecil Park	19.4	Established biobank, Western Sydney Parklands Trust
Western Sydney Parklands ID 70	Cecil Park and Chandos West	40.5	Established biobank, Western Sydney Parklands Trust
Hampden Vale biobank	Razorback	101	Potential biobank, private owner

At the offset sites, there are local occurrences of each of the threatened ecological communities that would be removed for construction of the proposed airport and known or potential habitat for many of the threatened species that would be affected at the offset sites.

The potential offset sites described above contain some areas of native vegetation and habitat that is not an appropriate ‘like for like’ match for impacts on the EPBC Act listed affected threatened biota or is associated with biodiversity credits that have already been sold. A subset of the habitat available at the potential offset sites has been selected that would directly offset impacts on the affected threatened biota. DoEE would require these specific areas to be clearly documented and mapped in the biodiversity offset delivery plan.

The criteria for selecting the proposed offset areas are:

- areas that are linked to biodiversity credits that area available for sale at established biobanks or that would be available for sale at proposed biobanks;
- presence of EPBC Act Cumberland Plain Woodland; and
- presence of habitat for the Grey-headed Flying-fox.

The ‘proposed offset areas’ (that is, the specific areas of habitat at potential offset sites that would look to be included in the offset delivery plan to offset impacts on the affected threatened biota) are summarised in Table 16–16. This table presents the potential offset areas that are available at the time of publication (i.e. September 2016). Biodiversity credits linked to these areas may be sold to other parties prior to the finalisation of the biodiversity offset delivery plan. Additional or alternative offset areas as other compensatory measures will also be identified and considered to assist in meeting overall offset requirements for the offset delivery plan.

The area of Grey-headed Flying-fox habitat available in the proposed offset areas (at least 451 hectares) is greater than the estimated area required to meet this species’ offset requirement (410 hectares). This area would also offset impacts to plants, animals and their habitat.

Table 16–16 Proposed offset areas

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
Williamswood biobank	104.5	31.9	28.0	50.4	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland.
The Oaks	40.0	10.0	3.0	10.4	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland.
Durham biobank	42.7	2.9	0.0	24.1	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and close to a known roost camp.
Mamre Biobank	98.1	0.0	0.0	52.5	Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and linked to biodiversity credits that area available for sale.
Luddenham biobank	40.0	4.1	0.7	34.6	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest. Additional poorer quality Cumberland Plain Woodland.
Roper biobank	13.3	3.0	1.7	6.7	EPBC Act Cumberland Plain Woodland and poorer quality Cumberland Plain Woodland linked to credits that are available for sale.
Caddens biobank	33.3	4.8	1.2	17.3	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
Dunheved biobank	65.0	3.8	8.7	23.0	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Forrester biobank	30.4	11.6	0.0	26.7	Grey-headed Flying-fox habitat associated with River Flat Eucalypt Forest and linked to biodiversity credits that area available for sale.
Stage 1 Montpelier biobank	76.2	34.1	11.4	40.9	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Stage 2 Montpelier biobank	79.5	20.9	9.2	48.5	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Menangle Road biobank	57.1	27.0	21.1	36.0	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Additional poorer quality Cumberland Plain Woodland. Biodiversity credits for other impacts on the environment.
Bruelle biobank	26.8	14.4	0.0	27.5	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Western Sydney Parklands ID 120	19.4	18.2	0.0	18.2	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Western Sydney Parklands ID 70	40.5	5.2	0.0	5.2	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox

Potential offset site	Total area (hectares)	Extent of available EPBC Act Cumberland Plain Woodland (hectares)[1]	Extent of available poorer quality Cumberland Plain Woodland (hectares)[2]	Grey-headed Flying fox habitat (hectares) [3]	Notes
					habitat. Biodiversity credits for other impacts on the environment.
Hampden Vale biobank	101.0	16.0	50.1	28.7	EPBC Act Cumberland Plain Woodland linked to credits that are available for sale, which also comprises Grey-headed Flying-fox habitat. Biodiversity credits for other impacts on the environment.
Total	867.8	207.9	135.0	450.6	

16.8.4 Preliminary offset calculations

16.8.4.1 Overview

The EPBC Act Offsets Policy requires a formal assessment of impacts and offset contributions for EPBC Act-listed species and communities using the 'offsets assessment guide'.

The Offsets Assessment Guide utilises a balance sheet approach to measure impacts and offsets. According to the EPBC Act Offsets Policy, controlled actions requiring offsets must achieve a minimum 90 per cent 'direct offset' (subject to exceptions outlined in the EPBC Act Offsets Policy). The EPBC Act offset policy requires 'like for like' biodiversity offsets and the site must be able to reach the same site quality score as the development site.

Offset Assessment Guide calculations have been performed based on the significant residual impacts documented in this chapter and the likely conservation and management of the potential offset sites. The 'area of offset' has been treated as a variable in these preliminary offset assessment guide calculations to estimate the total area of habitat at offset sites that would be required to directly offset 100 per cent of the proposed airport's impacts. The calculator inputs associated with the other attributes of the offset areas is an aggregate based on the assessment of the potential offset sites. This approach has been used to demonstrate that suitable offset areas are available having regard to the EPBC Act Offset Policy and that these potential offset areas would substantially meet the offset requirements for the proposed airport as direct offsets. A detailed description of the calculations is provided in the Biodiversity Offset Package (see Appendix K2 (Volume 4)).

The NSW *Framework for Biodiversity Assessment* (OEH 2014b) has also been used to estimate offset requirements for impacts on plants, animals and their habitat, as ecosystem credits and species credits respectively.

Potential offset sites would be subject to targeted surveys to confirm their like for like qualities and their value in terms of ecosystem credits and species credits.

16.8.4.2 Preliminary calculations

Preliminary offset guide calculations were made based on the summary of impacts requiring offsets in Section 16.8.2 and the potential offset sites in Section 16.8.3. In summary:

- impacts to 104.9 hectares of Cumberland Plain Woodland require around 355 hectares in offset area. Potential offset sites contain around 207.9 hectares in comparable condition and another 135 hectares in poor condition that could be actively managed to achieve equivalence.
- impacts to 141.8 hectares of Grey-headed flying fox habitat require around 410 hectares in offset area. Potential offset sites contain around 451 hectares in comparable condition.

The preliminary offset guide calculations indicate that the additional Cumberland Plain Woodland offset area must be identified to meet the requirements of the EPBC Act Offsets Policy.

Ecosystem credits for impacts to the environment are quantified in Table 16–17, while species credits for impacts to species protected under NSW legislation are quantified in Table 16–18.

Table 16–17 Ecosystem credits for impacts on the natural environment

Potential offset site	Total area (hectares)	Available HN528 credits	Available HN529 credits	Available HN526 credits	Available HN512 credits	Available HN630 credits	Available HN524 credits
Williamswood biobank	104.5	0	694	280	0	0	38
Durham biobank	42.7	31	0	246	0	0	0
Mamre biobank	98.1	0	0	680	0	7	0
Luddenham biobank	40.0	34	0	246	0	0	0
Roper biobank	13.3	48	0	20	25	0	0
Caddens biobank	33.3	47	0	181	0	5	0
Dunheved biobank	65.0	93	0	362	0	0	0
Forrester biobank	30.4	81	0	127	0	0	0
Stage 1 Montpelier biobank	76.2	119	442	0	0	0	153
Stage 2 Montpelier biobank	79.5	0	363	0	0	0	118
Menangle Road biobank	57.1	0	454	36	0	0	29
Bruelle biobank	26.8	0	141	0	0	0	0
The Oaks	40.0	0	261	11	0	0	69
Western Sydney Parklands ID 120	19.4	120	0	61	0	0	0
Western Sydney Parklands ID 70	40.5	49	0	10	0	0	0
Hampden Vale biobank	101	185	417	52	0	0	36
Total	867.8	807	2,772	2,312	25	12	443
Ecosystem credit requirement		7,906	1,946	2,140	358	873	0
Credit balance		-7,099	826	172	-333	-861	443
Total including trading of matching credits		979					
Credit balance including trading of matching credits		-6,927	826	0	-333	-861	443

Notes: 1) includes 531 HN526 credits which may be traded with HN528.

Table 16–18 Species credits potentially available at offset sites

Common name	Scientific name	Species credits required	Individuals / area required in offset site	Individuals / area available in offset site(s)
Black Bittern	*Ixobrychus flavicollis*	815	115 ha	Up to around 314 hectares of potential habitat in Forest Red Gum – Rough-barked Apple grassy woodland (HN526) and Coastal freshwater wetland (HN630) at proposed offset sites.
Cumberland Plain Land Snail	*Meridolum corneovirens*	1,843	260 ha	Up to around 414 hectares of potential habitat in Grey Box – Forest Red Gum grassy woodland on shale (HN529) and Grey Box – Forest Red Gum grassy woodland on plains (HN528). The species has been recorded at the Forrester and Caddens biobank sites.
Marsdenia viridiflora subsp. *viridiflora* in endangered population	*Marsdenia viridiflora* subsp. *viridiflora* – endangered population	5,800	817 stems	Up to around 476 hectares of potential habitat in Grey Box – Forest Red Gum grassy woodland on shale (HN529), Grey Box – Forest Red Gum grassy woodland on plains (HN528) and Grey Box – Forest Red Gum shrubby woodland (HN524). Around 75 stems of the species have been recorded as a result of partial survey of around 80 hectares of habitat at the Hampden Vale biobank site. The species has also been recorded at Ninth Ave. Penrith.
Pultenaea parviflora	*Pultenaea parviflora*	60	8 individuals	100 individuals recorded at the Dunheved biobank site.
Southern Myotis	*Myotis macropus*	750	106 ha	Up to around 313 hectares of potential habitat in Forest Red Gum – Rough-barked Apple grassy woodland (HN526) at proposed off set sites. The species has been recorded at the Mamre biobank site.

16.8.5 Delivery of offsets

Biodiversity offsets will be delivered through procurement of biodiversity credits to match the proposed airport's impacts on affected EPBC Act-listed biota as calculated by the offsets assessment guide. Additional biodiversity credits would be purchased to offset impacts on plants, animals and their habitat. This would secure the conservation covenant over the area of land that is linked to the biodiversity credits and provide funds for management in perpetuity.

The process of identifying and securing suitable offset areas will continue through the development of a biodiversity offset delivery plan, with work to commence on this plan after the Infrastructure Minister's determination of the Airport Plan for the proposed airport. Further information for completing this delivery plan, as the next stage of the offset delivery process, would include the steps identified in Section 16.8.1. These steps comprise the identification of further offset areas for Cumberland Plain Woodland in addition to the areas which have been identified at the time of this EIS. Potential offset sites would be subject to targeted surveys to confirm their like for like qualities and their value in terms of biodiversity credits or other offsetting potential.

Delivery of offsets may also include other compensatory measures such as the examples discussed in Section 16.8.1 or other options identified through consultation with an Experts Group to be established by the Department of Infrastructure and Regional Development.

A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package. The Department of Infrastructure and Regional Development will be responsible for delivering this plan.

The plan will be submitted and require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development of the proposed airport, ensuring that biodiversity offsets have been identified (and secured where possible) prior to the substantial impacts occurring.

16.9 Conclusion

Construction of the Stage 1 development would result in the removal of approximately 1,153.8 hectares of vegetation. The majority of this vegetation consists of exotic grassland and cleared land or cropland dominated by exotic species and noxious and environmental weeds. Approximately 318.5 hectares of native vegetation would be removed. The removal of vegetation at the airport site would result in the loss of fauna foraging, breeding, roosting, sheltering and dispersal habitat. Construction of the Stage 1 development would also result in potential for indirect impacts on terrestrial and aquatic flora and fauna including impacts associated with increased fragmentation, altered hydrology, erosion and sedimentation, dust, light, noise and vibration. Indirect impacts may also include fauna displacement, injury and/or mortality.

Operation of the proposed airport would involve an increased risk of fauna strike from contact with aircraft and ground transportation vehicles. Indirect impacts may include those associated with light, noise and vibration, the increased incidence of fire and the introduction of exotic species.

The Stage 1 development would affect threatened species, populations and ecological communities listed under both the EPBC Act and the TSC Act. Assessments of significance have been prepared in accordance with the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013a) for impacts on threatened biota and other MNES, and the Significant Impact Guidelines 1.2 – Actions on, or Impacting upon, Commonwealth Land and Actions by Commonwealth Agencies (DoE 2013b) for impacts on the natural environment. The outcome of these assessments is that the Stage 1 development is likely to have a significant impact on Cumberland Plain Woodland, the Grey-headed Flying-fox and other plants, animals and their habitat (including a number of species populations and ecological communities listed as threatened under the TSC Act) in an area of Commonwealth land.

Mitigation and management measures would be implemented to reduce the potential impacts on biodiversity. These measures would include staged vegetation removal during construction, pre-clearing surveys and measures for the salvage of resident fauna and habitat resources, translocation programmes for threatened flora and fauna species and populations, and designing the airport to minimise its attractiveness to fauna and thus minimising bird and bat strike and terrestrial fauna strike. In addition, an environmental conservation zone would be established along the southern perimeter of the airport site where approximately 117.1 hectares of land would be protected.

Biodiversity offsets are required to compensate for significant residual impacts arising from the proposed airport. An offset package has been prepared to compensate for the removal of approximately 104.9 hectares of Cumberland Plain Woodland, the removal of about 141.8 hectares of foraging habitat for the Grey-headed Flying-fox and impacts on plants, animals and their habitat including species and communities listed under NSW legislation. The offset package provides the strategic framework for the conservation of habitat for the affected threatened biota in suitable offset sites in the surrounding region in perpetuity.

Due to the scale and nature of the biodiversity offsets required for the proposed airport, the process of identifying and securing suitable offset areas will continue after the Airport Plan is determined by the Infrastructure Minister. A biodiversity offset delivery plan will be developed to set out the specific actions to be taken to meet offset requirements for the Stage 1 development and will be guided by the framework established in the offset package. The Department of Infrastructure and Regional Development will be responsible for delivering this plan that will require approval from the Environment Minister or an SES officer in DoEE prior to the commencement of Main Construction Works for the Stage 1 development, ensuring that biodiversity offsets have been identified (and secured where possible) prior to substantial impacts occurring.

While conservation of offset sites through the NSW BioBanking Scheme is expected to form the primary component of the biodiversity offsets, a variety of other conservation actions will also be considered that would assist in meeting overall offset requirements. These other conservation mechanisms which could be used to deliver offsets, such as the Cumberland Conservation Corridor programme and proposed NSW Biodiversity Conservation Fund, among others, may achieve greater strategic benefits for biodiversity conservation in the region. The Department of Infrastructure and Regional Development will consult closely with the DoEE and other relevant NSW authorities, organisations and stakeholder groups on these and other potential offsetting opportunities.

When implemented, the biodiversity offset delivery plan would improve or maintain the viability of the protected matters that would be affected by the proposed airport.

17 Topography, geology and soils

The airport site comprises approximately 1,780 hectares of undulating terrain. Soils at the airport site are primarily firm residual clays with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek. A major bulk earthworks programme would be carried out for the construction of the Stage 1 development. To achieve a level surface suitable for the construction of airport facilities the earthworks programme would essentially involve the redistribution of about 22 million cubic metres of soil across a construction impact zone covering about 60 per cent of the airport site. Measures including erosion control structures, sediment basins and stockpile management are proposed to mitigate and manage potential soil erosion and degradation associated with earthworks. Fuel and other chemicals would be responsibly stored and handled in accordance with relevant standards, minimising the potential for contamination to occur. Due to the prior land uses at the airport site, including agriculture, light commercial and building demolition, there is potential for contaminated land to be present. Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment. Construction and operation would also involve the controlled storage, treatment and handling of fuel, sewage and other chemicals with potential to contaminate land if improperly managed. The potential impacts of the operation of the proposed airport are typical of a large scale infrastructure project and would be managed with the implementation of stormwater, erosion and dust controls and adherence to relevant industry standards for the storage and handling of chemicals. Waste water would be treated and irrigated on site in accordance with an irrigation scheme that maintains the receiving soil in a stable and productive state.

17.1 Introduction

This chapter provides an assessment of the existing topography, geology and soils that would be affected by the development of the proposed airport. The assessment draws on a number of field assessments including geotechnical investigations and a preliminary contamination assessment.

The methodology is described further in Section 17.2 while the existing environment is described in Section 17.3. Potential impacts of construction and operation are described in Section 17.4 and Section 17.5 while measures to mitigate and manage impacts are described in Section 17.6.

17.2 Methodology

The following tasks were undertaken to describe the existing environmental values of the airport site and to assess the impact of the airport with regard to topography, geology and soils:

- desktop reviews of prior reporting, mapping and databases;
- geotechnical investigation of the airport site to characterise soils and geology;
- contamination assessment of the airport site to identify potentially contaminated land;
- identification of potential impacts on topography, geology and soils; and
- development of mitigation and management measures.

17.2.1 Geotechnical investigation

The purpose of the geotechnical investigation was to determine the constructability of soils at the airport site. The geotechnical investigation involved sampling at 137 boreholes, 11 test pits and 10 kilometres of seismic survey across the airport site. This sampling distribution and density was selected to provide confidence in planning bulk earthworks, particularly hard rock excavation.

The samples collected during geotechnical investigation underwent laboratory testing for their geotechnical properties. Field testing was also undertaken to identify potential for acid sulfate soils.

Further geotechnical investigations would be undertaken prior to construction to supplement the investigations to date.

17.2.2 Contamination investigation

The purpose of the contamination investigation was to identify potential sources of land contamination at the airport site. The contamination investigation included a Phase 1 (preliminary) contamination investigation followed by a Phase 2 (detailed) site contamination investigation.

The Phase 1 contamination investigation involved an initial desktop analysis to identify properties at the airport site which may be of potential concern due to known prior land uses. The desktop analysis was followed by visual inspection of properties and analysis of samples gathered during the geotechnical investigation.

Properties that were of potential concern were subject to an on-site visual inspection, while remaining properties were inspected from the roadside to confirm their low risk status. Samples gathered during the geotechnical investigations underwent laboratory testing for potential contamination indicators.

The Phase 2 site contamination investigation involved sampling including:

- Sampling for asbestos in soil at 50 sites;
- Sampling for asbestos fragments at 162 sites;
- Sampling for chemical contamination at 147 sites;
- Sampling for groundwater contamination at 16 boreholes; and
- Sampling for surface water and sediment contamination at 30 dam sites.

The identified potential sources of land contamination were then assessed for their potential impacts on human health and the environment. This assessment was conducted through the development of a site conceptual model that charted potential pathways between potential sources of land contamination and human or environmental receptors.

Further contamination investigations are expected to be undertaken before construction. In addition, the proposed airport will be subject to ongoing obligations in the Airports (Environment Protection) Regulations 1997 (AEPR) to prevent, monitor and manage soil pollution at the airport site.

17.3 Existing environment

17.3.1 Topography

The topography of the airport site is depicted in Figure 17–1. The airport site is part of an elevated ridge system dividing the Nepean River and South Creek catchments. The site is characterised by rolling landscapes typical of Bringelly Shale (see Section 17.3.2). The site features a prominent ridge in the west, reaching an elevation of about 120 metres Australian Height Datum (AHD), and smaller ridge lines in the vicinity with elevations of about 100 metres AHD. The broad topography of the airport site generally slopes away from the ridges in the west, with elevations generally between 40 metres and 90 metres AHD, with the lower elevations toward Badgerys Creek.

17.3.2 Geology

As outlined in Figure 17–1 the dominant geological formations beneath the airport site are Bringelly Shale, the Luddenham Dyke and alluvium.

Bringelly Shale is a Triassic geological unit mainly comprising claystone and siltstone, with some areas of sandstone. This unit underlies most of the airport site (Coffey Partners International 1990). Bringelly Shale is the top unit of the Wianamatta Group and is about 150 metres thick beneath the airport site, along with some overlying weathered material.

Luddenham Dyke is a Jurassic groundmass of olivine basalt, analcite, augite, feldspar and magnetite in the west of the airport site (Bannerman and Hazelton 1990). The dyke outcrops towards the peak of the ridge in the west of the airport site (see Section 17.3.1).

Alluvium at the airport site comprises of Quaternary sedimentary deposits along Cosgroves Creek and Badgerys Creek. These sedimentary deposits can be up to five metres thick and are made up of fine sands, silts and clays with some areas of gravelly clay (Coffey Partners International 1990).

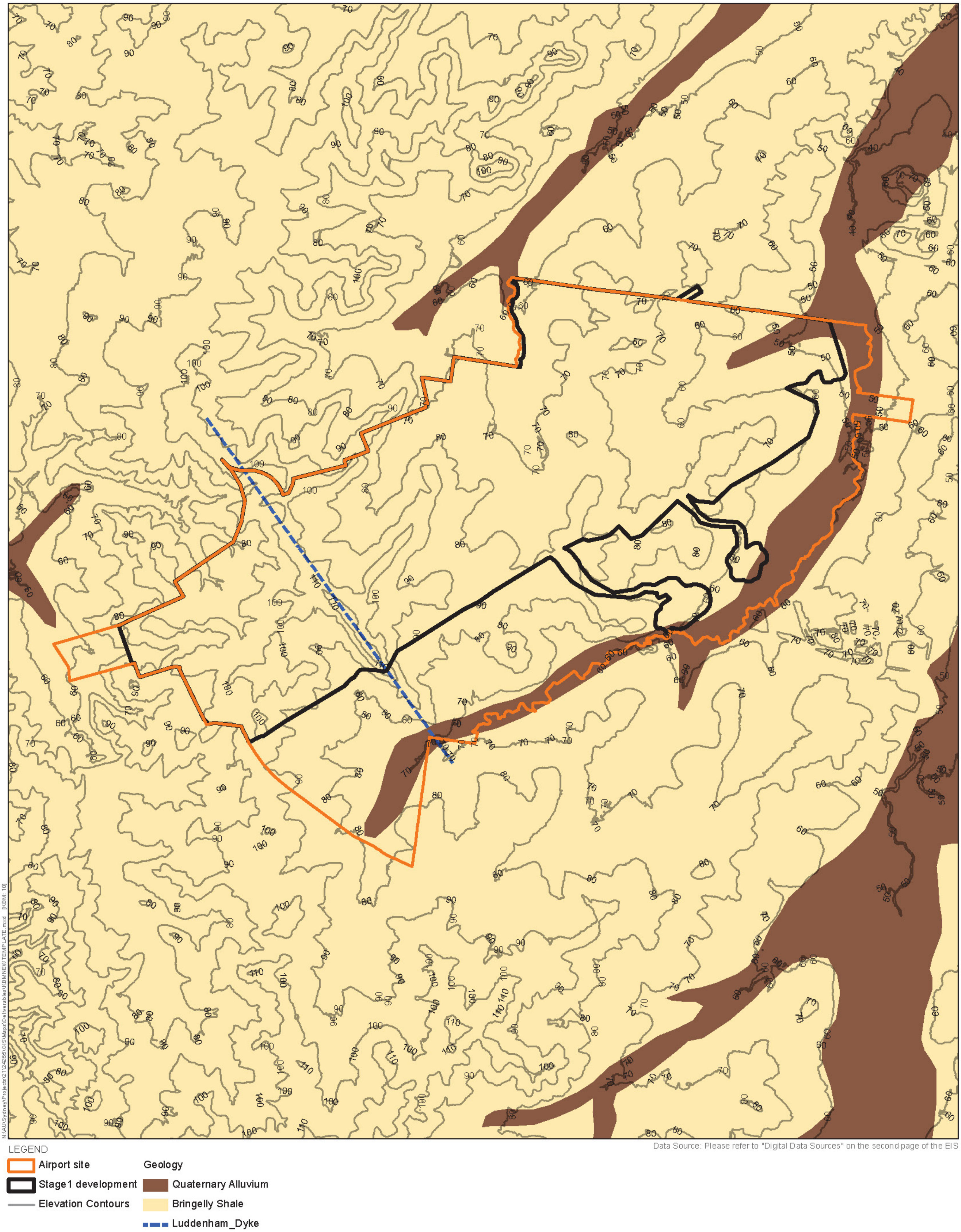


Figure 17-1 - Topography and geology at the airport site

17.3.3 Soils

17.3.3.1 Soil types

Geotechnical investigations at the airport site generally indicated surficial silt and/or clay topsoils overlying firm residual clays from the weathering of Bringelly Shale, with areas of alluvial gravels, sands, silts and clays associated with Badgerys Creek.

The soils at the airport site are categorised as the Blacktown, Luddenham and South Creek soil landscapes – based on consistent soil type, material, depth and erosion characteristics. The characteristics of these soil types are summarised in Table 17–1.

Soils at the airport site have also been mapped in line with the Australian Soil Classification (see Figure 17–2). The mapped soils are classified as Kurosols, which occur over the majority of the airport site, and Hydrosols in the vicinity of Badgerys Creek. Kurosols are characterised by a strong texture contrast between their A horizons (topsoils) and their strongly acid B horizons (subsoils). Hydrosols are characterised by prolonged periods of saturation.

Parts of the airport site have been used for agricultural activities including cattle grazing and horticulture. The site is not mapped as biophysical strategic agricultural land (high quality soil capable of sustaining high levels of productivity) in the associated mapping for the NSW *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*.

17.3.3.2 Saline soils

Soil salinity mapping of Western Sydney (DIPNR 2002) indicates moderate salinity potential. Additionally, there are some localised areas of high salinity potential associated with Badgerys Creek and drainage lines to the south and west of the airport site. Selected soil samples gathered during the geotechnical investigations were tested for salinity. The selected samples returned relatively low salinity levels, between 120 and 384 mg/L. Given the recognised potential for salinity to occur, further soil salinity sampling would be undertaken before construction to supplement the investigations to date.

17.3.3.3 Acid sulfate soils

Acid sulfate soils are naturally occurring sediments containing iron sulfides, which produce sulfuric acid when exposed to air. Acid sulfate soils are widespread in Australia's estuarine floodplains and coastal lowlands. Acid sulfate soils are not expected at the airport site given that it is not a coastal location and has an elevation ranging between 40 and 120 metres AHD. Previous acid sulfate soil risk mapping indicated no known occurrences at the airport site (OEH 1993). Field testing during the geotechnical investigation indicated that isolated acid sulfate soil may be present, but not to an extent requiring measures for acid sulfate soil management.

Table 17–1 Soil landscape characteristics

Unit	Soil matter	Soil depth	Soil fertility	Erosion potential
Luddenham	Brown loams, clay loams or clays with clay subsoils.	Shallow on crests (<100 cm) and moderately deep (< 150 cm) on slopes and depressions.	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is moderate to very high with slopes of 5–20 per cent and certain clays considered highly erodible. Minor gully erosion and moderate sheet erosion are evident in disturbed areas.
Blacktown	Brownish black loams and brown clay loams with clay subsoils.	Shallow to moderately deep (>100cm).	The soil landscape has generally low to moderate fertility. It is generally capable of being grazed and cultivated.	The potential for erosion in the soil landscape is typically slight to moderate, with slopes usually greater than five per cent. Some clay subsoils are sodic and dispersive making them highly erodible. Existing minor gully erosion and sheet erosion may be found in disturbed areas.
South Creek	Brown sandy loam, sandy clay loams or clay loams with clay subsoils.	Shallow to moderately deep (>100 cm) in low terraces and channels, with deeper stratified clays (> 190 cm) on terraces.	The soil landscape has generally low fertility but is capable of supporting grazing and cultivation.	The potential for erosion in the soil landscape is potentially very high to extreme. The erodibility of the soil material is high. Stream bank and gully erosion are common results of concentrated water flows.

Source: (NSW Environment and Heritage 2015a; 2015b; 2015c)

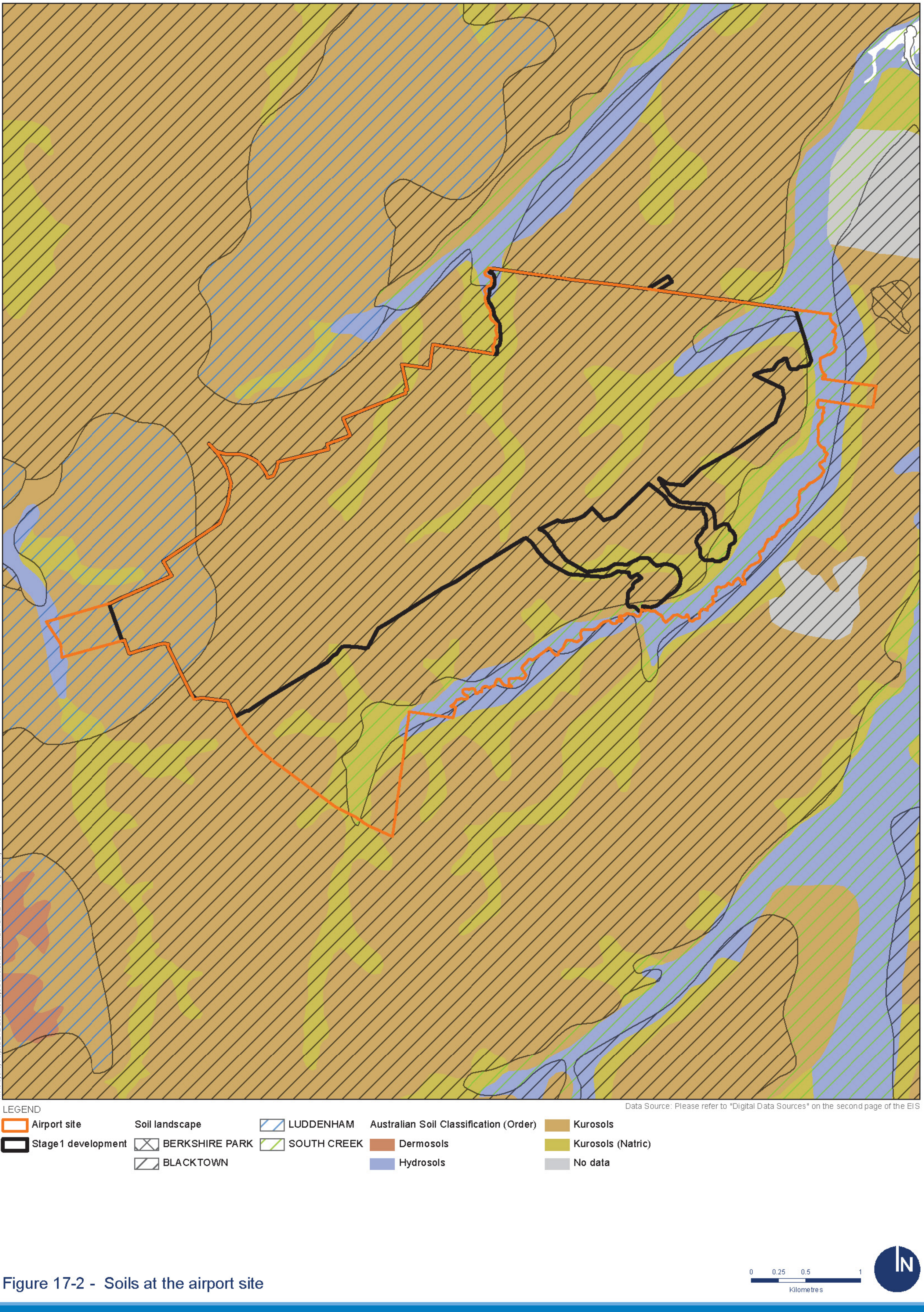


Figure 17-2 - Soils at the airport site

17.3.4 Contaminated land

A range of contaminants associated with prior land uses may be present at the airport site. Previous and current land uses at the airport site that may potentially result in contamination include agriculture, light commercial and building demolition works.

The contaminants associated with these land uses are of concern due to their potential to affect human health or the environment if not effectively managed. Potentially contaminated land is identified here while Section 17.6 discusses its effective management.

The NSW Environment Protection Authority (EPA) administers a number of records relevant to contaminated land, including the record of regulatory notices issued under the NSW *Contaminated Land Management Act 1997* and the public register of environment protection licences and notices under the NSW *Protection of the Environment Operations Act 1997*.

The record of regulatory notices under the *Contaminated Land Management Act 1997* contains one notice at the airport site. The notice regards illegal dumping of chemical wastes and was issued in 1985. The property was subsequently remediated in 1996–97, including removal of 1,904 tonnes of contaminated soil. A following audit found the land suitable for residential use.

The public register under the *Protection of the Environment Operations Act 1997* contains one licence at the airport site. The license is for dairy animal accommodation, indicating potential for farm chemicals or other contaminants. The licence was issued in 2002 and is held by Leppington Pastoral Company. No other environment protection licences are registered at the airport site.

A review of the contamination register administered by the Department of Infrastructure and Regional Development, historic aerial photos (from 1947, 1965, 1975, 1986, 1991 and 2005), and subsequent inspection of the airport site identified further evidence of potential contamination.

Evidence included chemical storage tanks and drums, rubbish dumping, stockpiled demolition waste, fibre cement sheeting, hydrocarbon stains and stockpiled fill material of unknown origin. Contaminants associated with this evidence include fuels, lubricants, solvents, acids, asbestos, heavy metals, ash, herbicides, pesticides and pathogens.

About half the properties were considered to present at least moderate risk of contamination. In particular, historic demolition sites, stockpiled demolition waste and fill material of unknown origin indicated potential for asbestos to be present.

Samples were collected during the detailed site contamination investigation and tested for the presence of contaminants. A number of samples collected at the airport site returned contaminant levels posing a risk to human health or the environment, including:

- lead at one property;
- asbestos in soil at 13 properties;
- asbestos fragments at 65 properties;
- total hydrocarbons at eight properties;
- poly aromatic hydrocarbons at 28 properties; and
- elevated levels of copper, nickel and zinc at 10 properties.

Elevated levels of copper, nickel and zinc were identified across the airport site. In general, these levels are considered attributable to natural background conditions – except for localised elevated levels of metals detected at 10 sites. Surface water and groundwater sampling also returned elevated concentrations of metals attributable to natural background conditions.

In addition to the general obligations to prevent, monitor and manage soil pollution under the AEPR, a construction environmental management plan would require the remediation of soil prior to the start of construction. Elevated levels of heavy metals would also be addressed in this plan. Measures to mitigate potential impacts on human health and the environment are detailed in Section 17.6.

17.4 Assessment of impacts during construction

17.4.1 Topography and geology

The bulk earthworks programme proposed to be carried out for construction of the Stage 1 development would change the topography of the airport site from rolling landscapes to a built environment with some landscaping. The earthworks would affect the upper geological units of the Bringelly Shale, Luddenham Dyke and alluvium down to approximately 30 metres depth.

Following bulk earthworks, the elevation of the airport site within the construction impact zone would be generally level with elevations between approximately 50 and 100 metres AHD, with no major embankments. The secondary impacts of this change would mainly relate to hydrology (see Chapter 18) and visual amenity (see Chapter 22).

17.4.2 Soil erosion and degradation

The bulk earthworks programme carried out for construction of the Stage 1 development would involve the excavation of approximately 22 million cubic metres of material including about two million cubic metres of topsoil within the construction impact zone (see Figure 17–2).

Topsoil would be stockpiled while the remaining excavated material would be distributed within the construction impact zone. As cut and fill requirements are expected to be equal, most soil material would remain at the airport site and would not generally be moved further than two kilometres.

Clearing and bulk earthworks would increase the surface area, and in some instances, the slope of exposed soil at the airport site. These changes to the landscape would increase the risk of erosion. The majority of bulk earthworks would occur in the Blacktown soil landscape which has slight to moderate erosion potential for non-concentrated flows. The Luddenham and South Creek soil landscapes, and some subsoils in the Blacktown soil landscape, have higher erosion potential and would potentially require specific mitigation and management measures. Erosion may occur in the form of runoff during rainfall or windblown dust.

If improperly managed, topsoil stockpiles would not only present an erosion hazard but would also potentially lose their chemical and physical fertility over time.

Potential soil erosion and degradation impacts would be avoided, mitigated or managed by implementing standard stormwater, erosion and dust control measures detailed in Section 17.6. As a result, the impacts are not expected to be significant.

17.4.3 Land contamination

Construction of the Stage 1 development has the potential to interact with existing sources of potential contamination (see Section 17.3.4). Construction would also involve the storage, treatment and/or handling of fuel, sewage and other potential contaminants.

Any contamination discovered during construction would be managed and mitigated to make the land suitable for its intended use and to prevent impacts on human health and the environment.

Demolition works before construction would include measures to mitigate contamination risks of asbestos and lead based paints, including site clearance during site preparation works.

Although unlikely, the accidental release or mobilisation of contaminants has the potential to affect human health and the environment through contact with pathogens (such as sewage), inhalation (such as asbestos or chemical vapours), or mobilisation to surface waters and bioaccumulation.

These events would be managed in the first instance through implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak of spill or contaminants, remediation would be implemented as soon as practicable.

Potential contamination impacts are not expected to be significant and would be avoided, mitigated and managed by implementing the measures further detailed in Section 17.6.

17.5 Assessment of impacts during operation

17.5.1 Soil erosion and degradation

Operation of the Stage 1 development would not involve any significant direct disturbance or exposure of soils. The design of the proposed airport would incorporate landscaped areas and stormwater drainage including grassed swales and detention basins to control the quantity and quality of stormwater runoff. The operation of the proposed airport is therefore not expected to have a material impact in terms of soil erosion and degradation.

Saline soils have the potential to damage subsurface infrastructure and disrupt revegetation. Some soil samples gathered during geotechnical investigations have indicated some areas of relatively low level soil salinity. Given the recognised potential for salinity, further soil salinity sampling is expected to be undertaken prior to construction to supplement investigations to date.

17.5.2 Land contamination

Operation of the Stage 1 development would involve the storage, handling and treatment of potential contaminants including fuel, sewage and other chemicals, particularly near fuel farms, fuel reticulation and maintenance areas.

Contamination would be avoided in the first instance through meeting obligations under the AEPR to prevent, monitor and manage soil pollution, and the implementation of applicable Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

17.5.3 Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. Wastewater would be reticulated to a water treatment facility. The water treatment facility is expected to have membrane biological reactor technology, which produces high quality reclaimed water suitable for various beneficial reuses including recycling and irrigation.

Recycling opportunities include the reuse of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes, and landscaping. On average, these activities are expected to use around 1.8 ML of reclaimed water per day. Irrigation of excess reclaimed water, which is expected to average around 0.72 ML per day, could occur in areas previously disturbed by bulk earthworks, such as grassed areas between aprons and taxiways. Irrigation areas would be designed and operated in accordance with the guidelines discussed in Section 17.6.

The key risks to soils associated with the irrigation of reclaimed water include adverse physical or chemical changes, which may lead to an ongoing reduction in fertility and potential to grow turf or pasture. The principal cause of these risks is excess irrigation, causing waterlogging, leaching of nutrients, rising water tables and increases in soil salinity or other soil properties. These risks are therefore expected to be adequately managed through the planning, design and operation of the irrigation area – including active control of water application rates (see Section 17.6).

17.6 Mitigation and management measures

Measures to manage soil erosion and degradation, land contamination and treated water irrigation during construction and operation are discussed below and itemised in Table 17–2.

A Soil and Water Construction Environmental Management Plan (CEMP) and Operation Environmental Management Plan (OEMP) will be prepared and submitted for approval prior to Main Construction Works and operation of the Stage 1 development respectively. The plans would collate the mitigation and management measures discussed in this section and itemised in Table 17–2. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of soil impacts. Erosion controls would be employed to reduce the area of exposed soil, the volume of water that reaches the exposed soil, and the quality of water that runs off. Controls would include:

- site stormwater drainage and sediment basins;
- sediment fencing around all disturbed sites;
- stabilisation (such as vegetation) on soil stockpiles; and
- progressive revegetation of landscape areas.

A remedial action plan would be prepared prior to construction of the Stage 1 development. The plan would guide the remediation of contamination identified at the airport site to ensure the land is suitable for its intended use prior to construction. The plan would outline measures for the management of contaminated material including on-site containment and off-site disposal. Measures to remove asbestos containing material would be in accordance with the relevant guidelines including *Managing asbestos in or on soil* (WorkCover 2014) and *How to Safely Remove Asbestos Code of Practice* (Safe Work Australia 2011).

An unexpected finds protocol would be prepared to account for any areas of contamination not already identified by site contamination investigations. The protocol would define the response of personnel in the event of an unexpected find and would link with the remedial action plan. Together, the plan and protocol would facilitate the quarantining, isolation and remediation of contamination identified through the construction programme.

The irrigation areas would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (EPHC 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004). It is considered that this approach would avoid environmental harm and maintain the receiving soil in a stable and productive state, given the following points.

- The irrigation area would be delineated based on the expected rate of irrigation and the drainage characteristics of the receiving soil.
- The quality of treated water would be determined to prevent accumulation of contaminants, with reference to the relevant guidelines.
- The irrigation area would be designed to include capacity to store treated water for the duration of typical wet weather events.
- The rate of irrigation would be optimised to avoid waterlogging or ponding of reclaimed water.
- Soil and groundwater conditions would be monitored to identify and correct trends in soil salinity or other potential effects of irrigation.

Table 17–2 Mitigation and management measures

Issue	Measure	Timing
Erosion and sedimentation	Impacts associated with erosion and sediment will be mitigated through: • installing a site drainage system prior to commencement of bulk earthworks; • minimising the surface area disturbed at any one time by, where practical, staging construction works and stabilising soils with vegetation or appropriate cover materials; • establishing erosion and sediment controls in accordance with the 'NSW OEH Blue Book – *Managing urban stormwater: soils and construction'*; • providing intermediate sediment retention basins within the construction impact zone to provide additional treatment prior to completion of the airport's site drainage system. Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes; • mulching cleared vegetation for use in erosion control at construction sites; • covering and stabilising soil stockpiles with vegetation or mulch; • stockpiling topsoil at a maximum height of two metres, where practicable; and • distributing and seeding topsoil over landscaped areas at the completion of bulk earthworks.	Construction
Leaks or spills of fuel or other chemicals	To minimise the risk of leaks or spills the following mitigation measures will be put in place: • maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled will be bunded to contain any accidental spills or leaks; • fuel and other chemicals will be stored and handled in accordance with relevant Australian standards such as: ▪ AS 1940-2004 The storage and handling of flammable and combustible liquids; ▪ AS/NZS 4452:1997 The storage and handling of toxic substances; ▪ AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and ▪ AS/NZS 1547:2012 On-site domestic wastewater management; and • a protocol will be developed and implemented to respond to and remedy leaks or spills.	Construction Operation
Land Contamination	A remedial action plan and unexpected finds protocol would be established to facilitate the quarantining, isolation and remediation of contamination identified throughout the construction programme.	Construction
	Any asbestos identified on site would be managed in accordance with applicable regulatory requirements.	Pre-construction Construction
Wastewater reuse	The treated water irrigation scheme will be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (EPHC 2006) and Environmental guidelines: Use of effluent by irrigation (DEC 2004).	Operation

17.7 Conclusion

Potential impacts of the construction of the Stage 1 development are typical of large scale construction projects and would be managed with the implementation of standard stormwater, erosion and dust controls and adherence to industry standards for handling of chemicals.

The major bulk earthworks required for site preparation would substantially alter the natural landscape of the airport site. Measures to mitigate and manage soil erosion and degradation, land contamination and wastewater reuse will be collated in environmental management plans to be approved prior to Main Construction Works and operation of the Stage 1 development.

18 Surface water and groundwater

The airport site contains about 64 kilometres of mapped watercourses and drainage lines (notably Badgerys Creek, Cosgroves Creek, Oaky Creek and Duncans Creek) and overlies the Bringelly Shale aquifer as well as unconfined areas of alluvial groundwater. Water quality sampling indicates that existing water quality is relatively degraded, with high levels of phosphorous and nitrogen in surface water that is attributable to land uses at the airport site and within the broader catchment.

Site preparation and construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to essentially a built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow.

An estimated 1.36 megalitres (ML) of water would be required per day for site preparation works for the proposed airport including potable water for drinking and ablutions plus raw water for soil conditioning and dust suppression. For the purposes of this EIS it has been assumed that the necessary 8,600 litres (0.0086 ML) of potable water required per day would be sourced from existing assets operated by Sydney Water with the remaining water requirement supplied through stormwater runoff captured in the water management system or existing farm dams. It may be necessary to utilise other surface water sources or groundwater. Any such use would be subject to a separate assessment.

The design of the Stage 1 development includes a water management system to control the flow of surface water and improve the quality of water prior to its release back into the environment. This system comprises a series of channels and basins to collect and treat flows prior to release to receiving waters. The assessment indicates that this system would be generally effective at mitigating flooding and water quality impacts.

Because water quality at the airport site is already degraded and does not meet existing water quality criteria, it is unlikely the proposed airport will be able to achieve water quality criteria outlined in the Airports (Environment Protection) Regulations 1997 (AEPR). To take into account these existing conditions, local standards for water quality will be developed under Part 5 of the AEPR, with due consideration to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

The ongoing development of local standards will be based on the results of continued baseline water quality monitoring, derived from a minimum of 24 months of data collected prior to the commencement of Main Construction Works. Water quality during the Stage 1 development was found to meet interim site-specific water quality criteria at all modelled locations. The interim water quality criteria were developed on the basis of 9 months of water quality monitoring.

The excavation and increase in impervious surfaces due to the development of the airport site would alter groundwater levels and recharge conditions. Impacts on groundwater receptors, including impacts on dependent vegetation or watercourses, are unlikely to be significant given the existing low hydraulic conductivity of the Bringelly Shale aquifer. Registered bores near the airport site are understood to target the Hawkesbury Sandstone aquifer, which is significantly deeper than the Bringelly Shale aquifer and not considered connected. As such, impacts on groundwater users are not expected.

The identified impacts would likely be further reduced during detailed design of the water management system. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.

18.1 Introduction

This chapter provides an analysis of the surface water and groundwater systems potentially affected by the development of the proposed airport. It draws on technical assessments of surface water hydrology and geomorphology (see Appendix L1 (Volume 4)), surface water quality (see Appendix L2 (Volume 4)) and groundwater (see Appendix L3 (Volume 4)). The assessment describes the existing surface and groundwater resources at the airport site, considers potential impacts during construction and operation of the proposed airport and proposes measures to mitigate and manage these impacts.

18.2 Methodology

A range of qualitative and quantitative assessment approaches were adopted to consider the impact of the proposed airport on surface and groundwater resources at the airport site.

Field surveys were undertaken to provide an overview of the existing surface water features at the site, determine the physical stability of watercourses, identify hydraulic structures (such as bridges and culverts) and describe existing water quality. Predictive models were used to consider the impact of the change in landform characteristics at the airport site on runoff volumes and the subsequent impacts upon stream flow, flooding, groundwater recharge and water quality. Identification of the potential impacts on the environmental values and beneficial uses of surface and groundwater resources were identified, and mitigation and management measures were proposed to minimise the extent of potential impacts. The assessment included an analysis of the potential for climate change to exacerbate the environmental impacts arising from the proposed airport, including the susceptibility of the airport site to flooding.

18.2.1 Baseline data

Existing surface water and groundwater resources were described with reference to:

- desktop information including:
  - aerial imagery (AusImage 2014);
  - topography data (NSW LPI 2014);
  - watercourse data (NSW LPI 2012); and
  - climatology data (BoM 2015a).
- prior reporting including:
  - 1997-99 EIS (PPK 1997);
  - South Creek Flood Study (Worley Parsons 2015); and
  - surface water quality data in the Environmental Field Survey of Commonwealth Land at Badgerys Creek (SMEC 2014).
- site assessments for the EIS including:
  - contamination investigations (GHD 2015; GHD 2016);
  - geotechnical investigations (Coffey & Partners 1991); and
  - water quality monitoring (GHD 2015-2016).

18.2.2 Predictive modelling and analysis

Hydrologic and hydraulic models were developed to simulate runoff and streamflow associated with storms of varying severity. These storms are categorised in terms of the average recurrence interval (ARI), or average length of time between successive storms, and include the one year ARI, two year ARI, five year ARI, 20 year ARI and 100 year ARI events. The largest expected flood over any duration was also modelled based on estimates of maximum rainfall. The results of the hydrologic and hydraulic models were analysed to identify changes in the volume and velocity of surface water. Water quality models were developed to assess the quality of surface water leaving the airport site. Models used as part of the assessment included:

- hydrology models (RAFTS);
- hydraulics models (DRAINS and MIKE 21); and
- water quality models (MUSIC).

All models included representations of the water management system incorporated into the indicative design of the proposed airport. The water management system includes a series of grassed swales to convey run-off from the developed areas within the airport site to a series of bio-retention and detention basins as shown in Figure 18–1.

Each basin includes provision for water quality treatment by a bio-retention system and a flood detention basin to control the volume of discharges from the site. Stormwater will typically flow to the bio-retention treatment system located in the forebay of each basin for treatment prior to release to receiving waters. The minimum bio-retention area required to provide water quality treatment at each basin is shown in Table 18–1. It is noted that the civil design for each of the bio-retention basins has additional buffer areas set aside, to enable a greater treatment area to be provided as required based upon ongoing water quality monitoring.

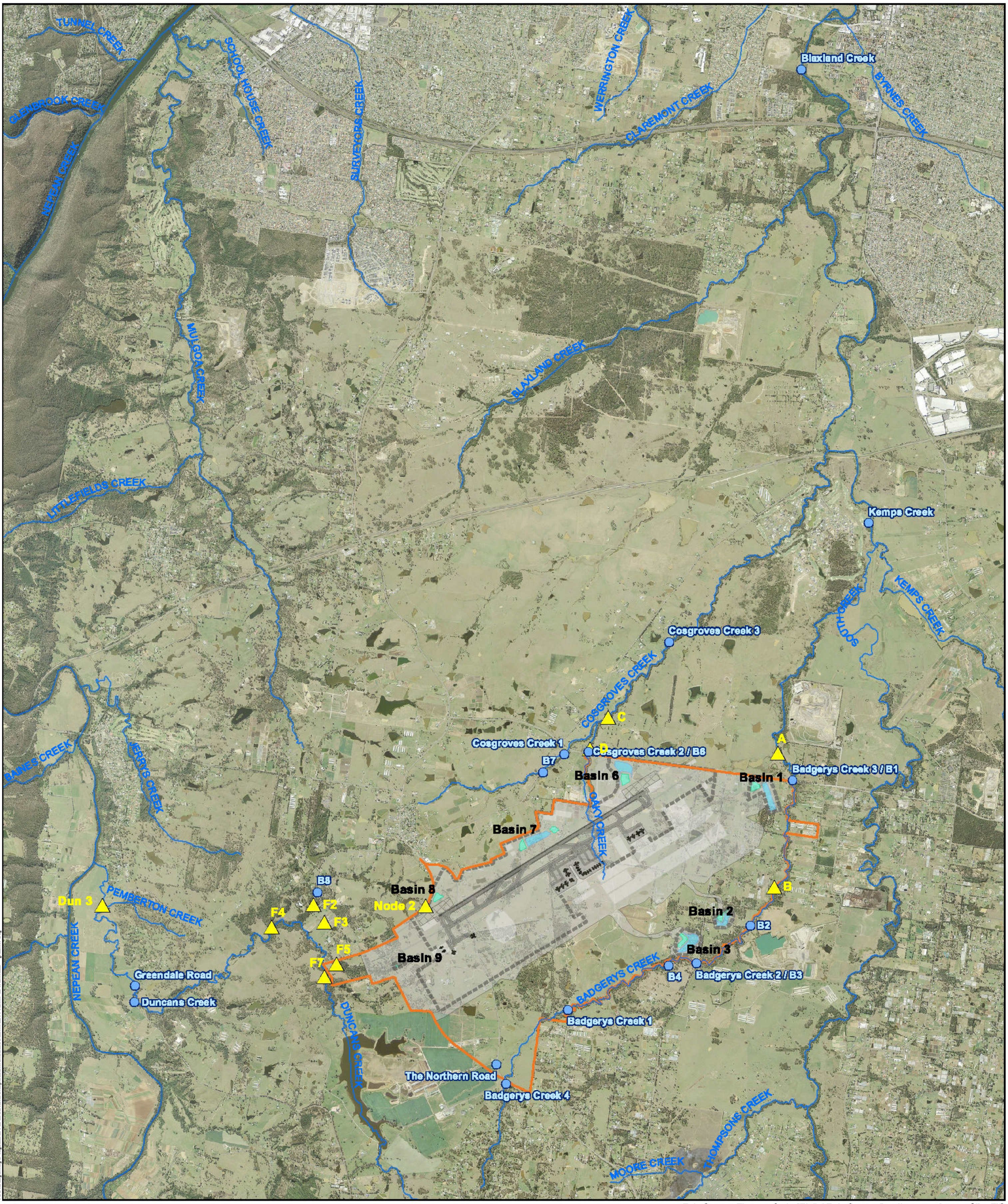
Higher flows during heavy rainfall will be diverted into the flood detention basins to provide storage and controlled release to the receiving waters. The detention basins have been designed to allow stormwater to be released in a way that mimics the natural flows as closely as possible over a range of storm durations and magnitudes.

The water management system has been designed to contain flows up to the 100 year ARI event without uncontrolled discharges occurring. The capacities of the basins to store surface water flows are presented in Table 18–1, excluding Basin 4 and 5 which would be integrated into the water management system for the long term development (see Chapter 36 (Volume 3)). The results of models were analysed to identify impacts on waterways, people and property.

Table 18–1 Stage 1 development basin sizing

Basin	Minimum Bio-retention Area (ha)	Flood detention volume (kl)	Discharge
Basin 1	0.6	125,000	Badgerys Creek
Basin 2	0.22	39,000	Badgerys Creek
Basin 3	0.6	100,000	Badgerys Creek
Basin 6	1.0	101,000	Oaky Creek
Basin 7	0.5	117,000	Oaky Creek (via tributary)
Basin 8	0.2	59,000	Duncans Creek (via tributary)
Basin 9	0.15	NA	Duncans Creek

Note: Basin 4 and Basin 5 would be integrated into the long term development (see Chapter 36 (Volume 3)) and so have not been included in the assessment of the Stage 1 development. Basin 9 is included in the Stage 1 development but is a relatively small bio-retention basin with no detention basin component.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND
- Airport site
- Water quality sampling sites
- Watercourses
- Hydrology assessment reporting locations
- Detention Basin
- Bioretention Basin
- Stage 1 development area

Figure 18-1 - Surface water management system and sample sites

0 0.5 1 2
Kilometres

It is recognised that receiving water quality is influenced by the surrounding land-use and antecedent rainfall and run-off conditions occurring throughout the year. Water quality monitoring provides a snapshot of the quality of receiving water at the time of the sampling event and therefore does not capture the full range of run-off conditions experienced at the airport site.

Predictive modelling was therefore undertaken to estimate pollutant loads in the catchment under existing baseline conditions and calibrated with the available water quality monitoring results. The MUSIC model was chosen as it has the ability to estimate the quantity and quality of surface water generated at a site under a range of rainfall and catchment configurations. It can therefore provide a direct comparison between the baseline catchment conditions and the proposed development scenarios.

The water quality assessment was calibrated with water quality monitoring data collected in and around the airport site for the EIS and prior assessments. Historical water quality monitoring data available for the airport site and downstream areas includes data from the 1997-1999 EIS and the SMEC Environmental Field Survey of Commonwealth Land at Badgerys Creek. Water quality monitoring for the EIS has been ongoing since the completion of the draft EIS and will continue through construction and operation of the proposed airport.

The MUSIC model was initially set up to represent the existing airport catchment comprising a total of 39 individual subcatchments which were delineated using one m contours generated for the site. Two additional external catchments were modelled to represent the area downstream of Elizabeth Drive down to the confluence of South Creek with Blaxland Creek in order to assess the impacts on downstream water quality at a more regional scale.

Each individual subcatchment was broken down into five land use types to represent the existing land uses at the airport site and pollution parameters assigned based upon modelling guidelines and statistical analysis from extensive research undertaken at locations throughout Australia. The existing baseline model was then simulated for the full range of rainfall data and calibrated using the recent monitoring data. An iterative approach was taken to achieve modelled results similar to the monitoring data. Full details of the MUSIC modelling approach are provided in Appendix L2 (Volume 4).

18.3 Regulatory and policy setting

The Stage 1 development would be developed in accordance with the Airport Plan under the provisions of the *Airports Act 1996* (Airports Act) and associated regulations including the Airports (Environment Protection) Regulations 1997 (AEPR).

The Commonwealth and NSW legislative and policy settings and guidelines concerned with water resources – even where not directly applicable to the proposed airport – have been considered as part of the assessment process.

18.3.1 Legislation

18.3.1.1 Airport Act 1996

Environmental management at the airport site would be undertaken in accordance with Part 6 of the Airports Act and the AEPR, following the grant of an airport lease to an Airport Lessee Company (ALC). The Airports Act specifies offences relating to environmental harm, environmental management standards, and monitoring and incident response requirements, including in relation to water pollution. Standards in relation to water pollution include water quality criteria such as oxygen content, pH, salinity and turbidity.

Part 4 of the AEPR requires an ALC to take all reasonable and practicable measures to avoid polluting water. Part 6 of the AEPR requires an ALC to monitor pollution levels, including laboratory analysis accredited by the National Associated of Testing Authorities. In the period prior to granting an airport lease, any construction activities on the airport site would be conducted in accordance with the Airport Plan and have regard to the requirements of the AEPR.

Schedule 2 of AEPR sets out acceptable limits for water pollution (see Table 18–2 for an excerpt of key parameters). It is noted that these regulations are about five times more stringent than the current *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ 2000) (ANZECC guidelines) for total phosphorus and total nitrogen. It is understood that the limits within the AEPR are currently under review. A recent discussion paper recommended that these limits be updated to align with the current ANZECC guidelines (Department of Infrastructure and Transport 2013).

Table 18–2 Key water quality parameters under the AEPR

Parameter	Accepted limit
Total Phosphorous	< 0.01 mg/L
Total nitrogen (TN)	< 0.1 mg/L
Dissolved oxygen (DO)	80% of average level for a normal 24 hr period or < 6 mg/L
Total suspended solids (TSS)	Change not more than 10% from seasonal mean
Turbidity	Reduction of 10% clarity in the euphotic zone from the seasonal mean
pH	6.5 – 9.0
Salinity	> 1000 mg/L or an increase of > 5%

Note: The full list of water quality parameters and acceptable limits can be found in Schedule 2 of the AEPR

To allow for climatic, topographic and other site-specific considerations, Part 5 of the AEPR allows for the development of local standards for water quality. Local standards may be proposed by an ALC and approved by the Infrastructure Minister following a period of consultation with relevant authorities, stakeholders and the broader public. In particular, Regulation 5.02 (1) of the AEPR states that a substitute standard (local standard) may be proposed where it is considered that a limit of contamination specified in the AEPR is inappropriate.

However, the AEPR does not provide any technical guidance on how a local standard should be derived. The approach for the development of site specific trigger levels in accordance with the ANZECC (2000) Guidelines has therefore been adopted to develop interim site-specific water quality criteria as part of this assessment as described in Section 18.4.5.2. The interim criteria presented in this EIS are based upon nine months of monitoring data currently available.

It is expected that the interim site-specific water quality criteria would be reviewed following the completion of 24 months of water sampling. At that stage formal approval of the criteria would be sought in accordance with Part 5 of the AEPR.

18.3.1.2 Water Management Act 2000

The *Water Management Act 2000* (NSW) (Water Management Act) is administered by the NSW Department of Primary Industries and is intended to ensure that water resources are conserved and properly managed for sustainable use benefitting both present and future generations. The Water Management Act is also intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses, and to provide for protection of catchment conditions. The Water Management Act will have limited direct applicability to the proposed airport as a result of the Airports Act and the AEPR. However, the intent and objectives have been considered as part of this assessment.

Water sharing plans have been developed under the Water Management Act for all water sources within NSW. The water sharing plans are developed with the aims of:

- clarifying the rights of the environment, landholders, town water suppliers and other licensed users;
- defining the long term average annual extraction limit for water sources;
- setting rules to manage impacts of extraction; and
- facilitating the trading of water between users.

Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources

The Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources commenced in 2011 and covers 87 management zones that are grouped into six water sources. The airport site is situated in the Hawkesbury and Lower Nepean Rivers source or catchment.

The Hawkesbury and Lower Nepean Rivers catchment is separated into numerous management areas, which include the Upper and Lower South Creek Management Zones and the Mid Nepean River Catchment Management Zone. Badgerys Creek, Oaky Creek and Cosgroves Creek are interpreted to be within the Upper South Creek Management Zone, and Duncans Creek is interpreted to be within the Wallacia Weir Management Zone (one of the Mid Nepean River Catchment Management Zones). The water sharing plan background document (NOW 2011) suggests that the South Creek region has high economic significance and depends on extraction for irrigation, town and industrial water supply.

Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources

The Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources covers 13 groundwater sources on the east coast of NSW. The airport is located within the Sydney Basin Central Porous Rock groundwater source area. The porous rock aquifer is referenced in the plan as sedimentary sandstone and siltstone formations with intervening coal seams.

The background document for the water sharing plan (NOW 2011) lists the Sydney Basin Central porous rock aquifer as having low to moderate contact with surface water with generally long travel times (years to decades). The allocated volumes of 2,592 ML/year versus a long term average annual extraction limit of 45,915 ML/year suggests that there is a significant amount of groundwater in the aquifer that has not been released for use.

18.3.1.3 Protection of the Environment Operations Act 1997

The objectives of the *Protection of the Environment and Operations Act 1997* (NSW) include the protection, restoration and enhancement of the quality of the environment, in recognition of the need to maintain ecological sustainable development including specific references to the protection of water quality. This assessment has taken into account the intent and objectives of that legislation.

18.3.2 Policies and guidelines

18.3.2.1 National Water Quality Management Strategy

The National Water Quality Management Strategy aims to protect Australian water resources by improving water quality while supporting the businesses, industry, environment and communities that depend on water for their continued development. The strategy consists of three major elements: policy, process and guidelines.

The main policy objective of the strategy is to achieve sustainable use of water resources by protecting and enhancing their quality, while maintaining economic and social development. The process strives to form a nationally consistent approach to water quality management through the development of high-status national guidelines. The guidelines provide the point of reference when issues are being determined on a case-by-case basis. These include guidance on regulatory and market-based approaches to managing water quality as well as regional water quality criteria.

The policy and principles document states that the generally accepted mechanism for establishing in-stream or aquifer water quality requirements is a two-step process which involves establishing a set of environmental values and establishing scientifically based water quality criteria corresponding to each value.

Criteria have been developed to characterise water quality relative to these environmental criteria and are outlined in the ANZECC guidelines and the Australian Drinking Water Guidelines (NHMRC 2011) and are discussed further below. The criteria specified in these documents have been used as the basis for the current environmental values in this assessment for the treatment requirements for discharge to receiving water environments.

18.3.2.2 NSW Water Quality Objectives

The NSW Water Quality Objectives (1999) are environmental values and long term goals endorsed by the NSW Government and the community for NSW's surface waters. They set out community values and uses for waterways and a range of water quality indicators to assist in establishing whether their current conditions support those values and uses.

The NSW Water Quality Objectives are generally consistent with the National Water Quality Management Strategy. The NSW Water Quality Objectives provide the environmental values for NSW waters, while the ANZECC guidelines provide the technical guidance in assessing the water quality needed to protect those values. Endorsed environmental values for the Hawkesbury-Nepean catchment include:

- aquatic ecosystem protection;
- recreational water use;
- raw drinking water; and
- irrigation and general use.

18.3.2.3 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The national guidelines on water quality benchmarks within the ANZECC guidelines are applicable to the Stage 1 development and provide default trigger values of various analytes for comparison with sampled values.

The core concept of the guidelines relates to managing water quality for environmental values. For each environmental value, the guidelines identify particular water quality characteristics or 'indicators' that are used to assess whether the condition of the water supports that value.

The environmental values, expressed as water quality objectives, provide goals to assist in the selection of the most appropriate management options within a catchment. The guiding principles include the identification and protection of the environment values of a waterway. Where targets are not achieved for environmental values, activities in the catchment should be geared toward improving these values.

The guidelines also advocate an 'issues-based' approach to assessing ambient water quality, rather than the application of rigid numerical criteria without an appreciation of the context. This means that the guidelines focus on:

- the environmental values we are seeking to achieve or maintain;
- the outcomes being sought; and
- the ecological and environmental processes that drive any water quality problem.

It should also be noted that the environmental values and respective numerical indicator values apply to ambient background water quality and are not intended to be applied directly to stormwater discharges.

The ANZECC guidelines, containing the default trigger values for physical and chemical stressors applicable to the airport site and adopted in this assessment, are shown in Table 18–3. It is noted that these default trigger values are guideline values or water quality objectives only, and are not compliance standards or discharge criteria.

Table 18–3 ANZECC Guidelines Default Trigger Values for Slightly Disturbed Ecosystems in NSW Lowland Rivers

Parameter	Default Trigger Value for Lowland Rivers
Chlorophyll a Chl a (mg/L)	0.005
Total phosphorus TP (mg/L)	0.05
Filterable reactive phosphate FRP (mg/L)	0.02
Total nitrogen TN (mg/L)	0.5
Oxides of nitrogen NO_x (mg/L)	0.04
Ammonium NH4+ (mg/L)	0.02
Dissolved oxygen DO	85-110 %
pH	6.5 – 8
Salinity (µS/cm)	125-2200
Turbidity (NTU)	6 – 50

Source: ANZECC Guidelines (2000)

Default trigger values are generally adopted in the absence of available data, however the intent of the ANZECC guidelines is that the relative health and assimilative capacity of the actual receiving waters be taken into account. The ANZECC Guidelines state that site specific water quality values are therefore preferred and should be established and adopted where possible. This ensures that the trigger levels applied are not excessively and unnecessarily onerous. This is particularly the case for waterways that are already degraded, such as the airport site and South Creek catchments.

According to ANZECC Guidelines, site specific trigger levels should be based on a minimum of two years of contiguous monthly data at the site, with the trigger levels computed as the 80th percentile values. Interim site-specific water quality criteria for the Stage 1 development have been developed based upon nine months of available monitoring data.

18.3.2.4 Australian Drinking Water Guidelines

The Australian Drinking Water Guidelines (NHMRC 2011) provide a framework for the management of drinking water supplies to achieve a safe and appropriate point of supply. The guidelines provide a base standard for aesthetic and health water quality levels. These values apply in this assessment to the suitability of the groundwater for potable use.

18.3.2.5 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011 includes provisions requiring development within Sydney drinking water catchments to demonstrate a neutral or beneficial effect on water quality. As the airport site is not within a Sydney drinking water catchment, the policy does not directly apply to the Stage 1 development. Neutral or beneficial effect has nonetheless been considered in the process of describing the potential impacts of the Stage 1 development with reference to existing water quality.

18.3.2.6 New South Wales Flood Plain Development Manual

The New South Wales Floodplain Development Manual (Department of Infrastructure, Planning and Natural Resources 2005) concerns the management of flood-prone land within NSW. It provides guidelines in relation to flood management, including any development that has the potential to influence flooding, particularly in relation to increasing the flood risk to people and infrastructure.

18.3.2.7 Greater Sydney Local Land Service Transition Catchment Action Plan

Catchment action plans are 10-year plans to guide the management of water, land and vegetation by state government and local communities. The main waterways at the airport site (Badgerys Creek, Oaky Creek, Cosgroves Creek and Duncans Creek) fall within the Hawkesbury-Nepean catchment, which is managed under the Greater Sydney Local Land Service Transition Catchment Action Plan (NSW Catchment Management Authority 2014).

The action plan is relevant to any influence the proposed airport may have on the downstream catchments in relation to surface water and aquatic ecology. Relevant strategies within the action plan include development of a more water sensitive catchment, promoting resilience through climate change adaptation and a number of strategies relating to protecting aquatic ecosystems.

18.3.2.8 Lower Hawkesbury-Nepean River Nutrient Management Strategy

The Lower Hawkesbury-Nepean River Nutrient Management Strategy (OEH 2010a) has been developed with the aim of reducing nutrient loads from existing sources and limiting the growth in nutrient loads from changing land uses. The strategy includes development of a catchment-wide framework to coordinate and guide action on managing nutrients in the lower Hawkesbury-Nepean. The sources of nutrients identified as a priority are: urban stormwater, agricultural practices, onsite sewage management systems, sewage treatment systems and overflows, and degraded land and riparian vegetation.

18.3.2.9 Managing Urban Stormwater: Soils and Construction

Managing Urban Stormwater: Soils and Construction (Landcom 2004), also known as ‘the Blue Book’, provides guidance on stormwater management with a focus on control of erosion and sedimentation during construction. The guidance contained in the Blue Book has been considered in the commitments to mitigation and management measures during construction.

18.3.2.10 Water Sensitive Urban Design: Technical Guidelines for Western Sydney

Water Sensitive Urban Design: Technical Guidelines for Western Sydney (Upper Parramatta River Catchment Trust 2004) provides guidance on stormwater management with a focus on urban land uses. The technical guidelines include recommendations for onsite treatment measures to mitigate and limit the potential adverse effects on downstream receiving waterways. The guidelines also specify percentage reduction targets of 45 per cent for total phosphorus and total nitrogen and 85 per cent for suspended solids. The technical guidelines have been considered in the assessment of potential impacts and commitment to mitigation and management measures.

18.3.2.11 Aquifer Interference Policy

The purpose of the Aquifer Interference Policy is to explain the role and requirements of the responsible NSW Minister in administering the water licensing and assessment processes for aquifer interference activities under the Water Management Act. The aquifer interference assessment framework is a supporting tool to assess proposed activities against the Aquifer Interference Policy.

The proposed Stage 1 development includes the excavation of an underground cavity to provide for basement levels for the major terminal buildings. These works may constitute aquifer interference activities and as such the Aquifer Interference Policy has been considered as part of the assessment of these works.

18.3.2.12 NSW State Groundwater Policy Framework Document

The objective of the NSW State Groundwater Policy Framework Document (Department of Land and Water Conservation 1997) is to manage the State's groundwater resources so that they can sustain environmental, social and economic uses for the people of NSW. The NSW groundwater policy contains provisions regarding the protection of groundwater dependent ecosystems in addition to groundwater quantity and quality.

18.4 Existing environment

18.4.1 Climate and rainfall

The airport site hosts an automatic weather station operated by the Bureau of Meteorology. The weather station has recorded rainfall data at the airport site since 1998. Average annual rainfall at the airport site is 676.4 mm. Monthly rainfall and evaporation data are shown in Table 18–4.

Table 18–4 Average monthly rainfall at the airport site

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly rainfall (mm)[a]	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)[a]	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)[a]	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)[a]	138.0	106.8	67.8	82.4	54.0	63.8	28.4	70.0	50.8	63.0	63.0	65.0
Evaporation (mm)[b]	172.7	128.4	115.9	75.6	50.2	38.4	38.4	55.5	75	120	145.5	154.1

[a] Data from Bureau of Meteorology automatic weather station.
[b] Data from Bureau of Meteorology Parramatta weather station, as the nearest representative location with available evaporation data.

18.4.2 Catchments

The airport site lies in the east of the Hawkesbury-Nepean catchment, which covers an area of 21,400 square kilometres. The Hawkesbury-Nepean catchment is characterised by meandering watercourses and is highly disturbed by clearing and urbanisation. All of the airport site subcatchments drain to the Hawkesbury Nepean system downstream of Lake Burragorang.

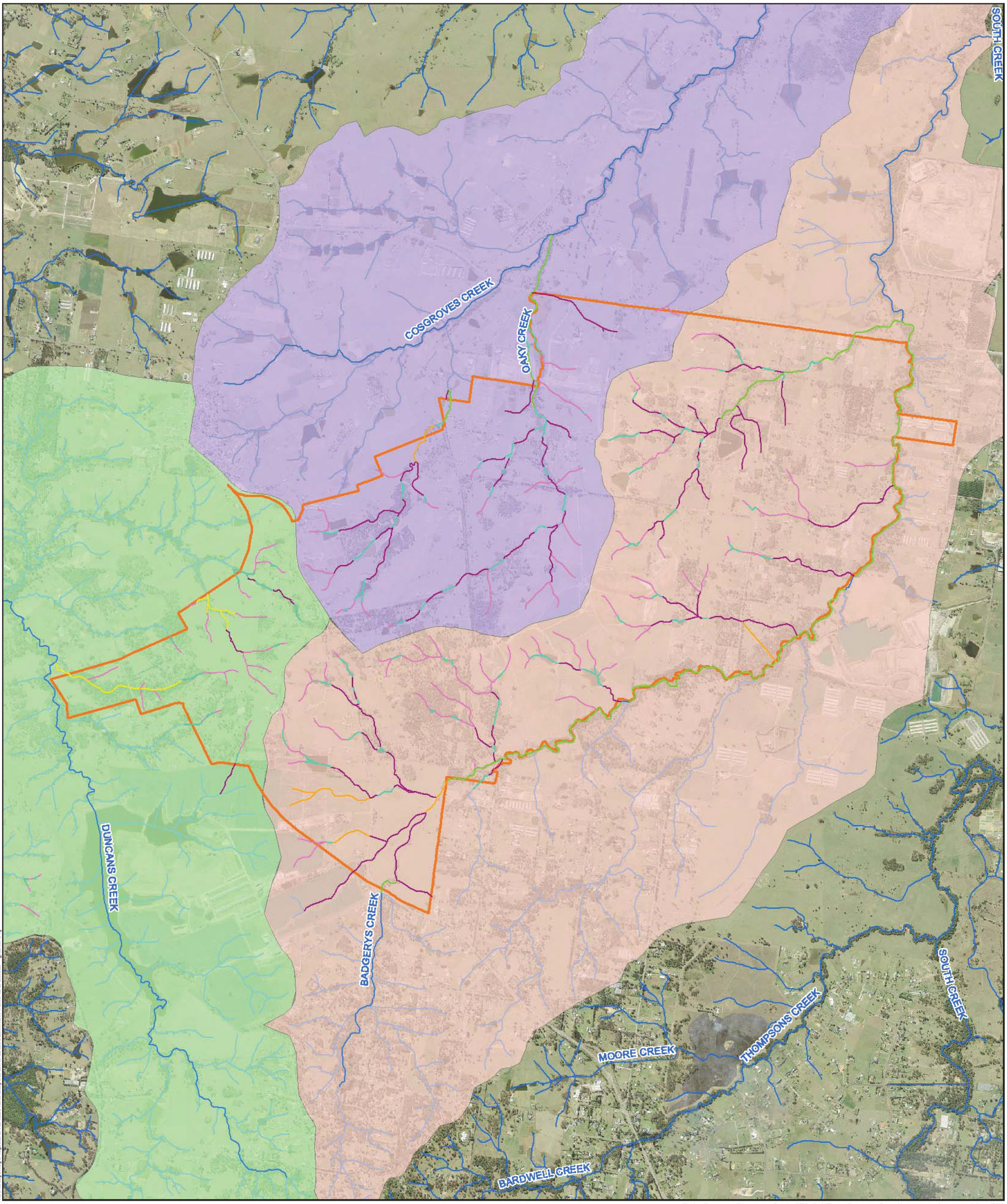
Subcatchments at the airport site are shown in Figure 18–2. The majority of the airport site drains to South Creek, which then flows to the Hawkesbury River. South Creek has a subcatchment area of 414 square kilometres with headwaters located near Narellan to the south of the airport site. The south-western corner of the airport site drains to Duncans Creek, which then flows to the Nepean River. Land uses within the airport site are predominantly agricultural (85 per cent), with smaller areas of rural residential (10 per cent), forest (four per cent) and horticulture (one per cent).

Water drawn from the catchment is used for irrigation for lucerne, fodder, pasture, turf, vegetables, orchards, cereals, flowers and stock watering purposes. Recreational facilities such as golf courses and sporting fields also draw water for irrigation, and the downstream estuarine reaches of the Hawkesbury River support fishing, prawning and oyster industries and recreational boating. It is noted that the airport site is not located within Sydney’s drinking water catchment area.

18.4.3 Watercourses

The airport site contains around 64 kilometres of watercourses and drainage lines as shown in Figure 18–2. The major watercourses include Badgerys Creek, Oaky Creek and Cosgroves Creek in the South Creek catchment and Duncans Creek which is a tributary of the Nepean River. Clearing, agriculture and the construction of in-stream dams have affected the physical stability of many watercourses at the airport site. Bank erosion and head cut are evident at Badgerys Creek and Cosgroves Creek, despite these watercourses also having well vegetated riparian zones.

Badgerys Creek has its headwaters in the vicinity of Findley Road, Bringelly, approximately two kilometres south of the airport site. It flows in a north to north-east direction and forms the south-eastern boundary of the airport site as far as Elizabeth Drive. Badgerys Creek continues downstream for a further four kilometres until its confluence with South Creek. Land use within the Badgerys Creek catchment consists of agricultural, landfill, as well as residential uses. Ecologically sensitive riparian vegetation is also located along sections of Badgerys Creek.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

Airport site

Watercourses

Catchment
- Badgerys creek
- Duncans creek
- Oaky and Cosgroves creeks

Watercourse type
- Drainage lines
- Steep confined watercourses
- Valley fill
- Channelised fill
- Fine grained systems
- Dam

0 0.25 0.5 1
Kilometres

Figure 18-2 - Sub-catchments and watercourses at the airport site

18.4.4 Flooding

Existing surface water flows at the airport site during one year ARI and 100 year ARI storms were simulated in hydrologic and hydraulic models. In the one year ARI event, flooding is mostly confined to main watercourse channels and dams, while considerable overbank flooding is expected in a 100 year ARI event, as shown in Figure 18–3 and Figure 18–4.

The floodplain is more extensive on the western bank of Badgerys Creek than on the eastern bank due to the wider and flatter floodplain at the airport site. A number of the flood-affected rural residential lots outside the airport site are located in Bringelly in the area bounded by the airport site, The Northern Road and Badgerys Creek Road. Based on the available imagery, while a number of lots experience some inundation in a 100 year ARI event, most existing dwellings in this area remain outside the flood extent.

A number of dwellings are also located within or close to the flood extent on Badgerys Creek upstream of the airport site. Two dwellings close to the flood extent were also identified downstream of the airport site on Cosgroves Creek.

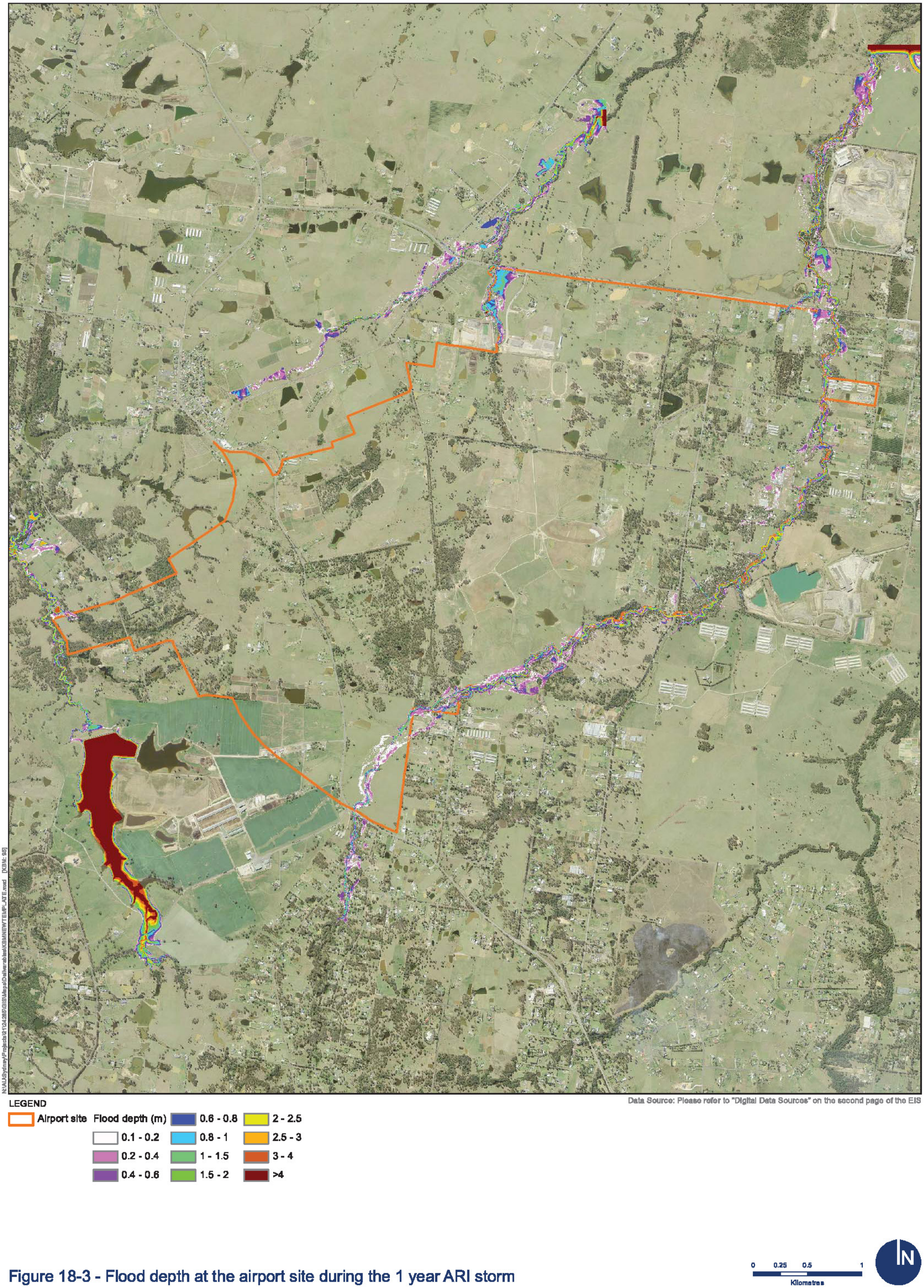
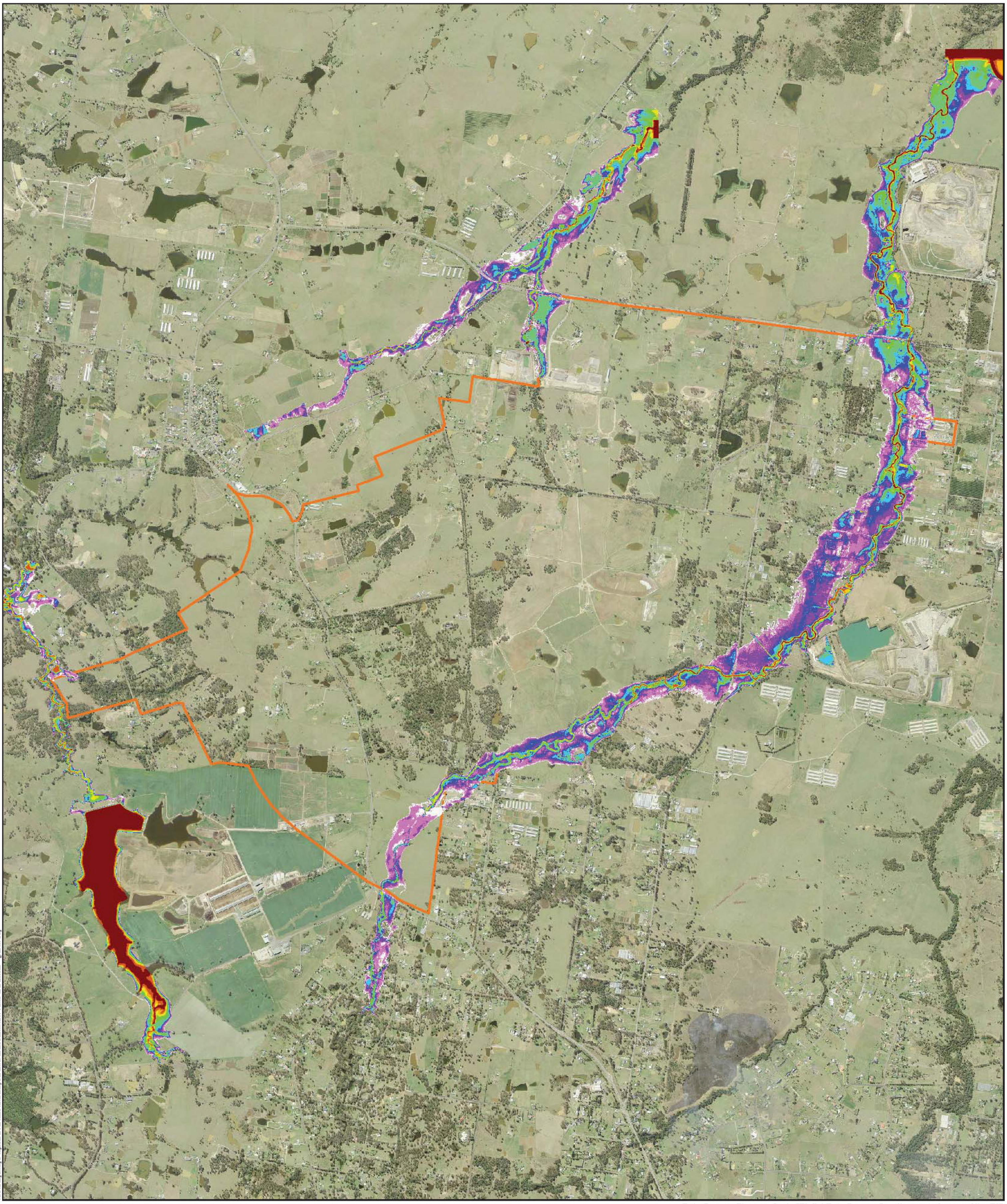


Figure 18-3 - Flood depth at the airport site during the 1 year ARI storm



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Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

LEGEND

Airport site	Flood depth (m)	0.6 - 0.8	2 - 2.5
	0.1 - 0.2	0.8 - 1	2.5 - 3
	0.2 - 0.4	1 - 1.5	3 - 4
	0.4 - 0.6	1.5 - 2	>4

0 0.25 0.5 1
Kilometres

Figure 18-4 - Flood depth at the airport site during the 100 year ARI storm

18.4.5 Surface water quality

18.4.5.1 Overview of existing water quality

The results of surface water quality sampling undertaken for the EIS are presented in Table 18–5. The results indicate that the water quality is generally poor and that the nutrient loads are generally well above both the AEPR accepted limits and the default values in the ANZECC guidelines. Turbidity and total suspended solids were found to be within acceptable levels, while dissolved oxygen levels were found to be relatively low. The data also indicate that conductivity levels were high, and above those for typical lowland rivers. Some exceedances of chromium, copper and zinc were also detected. These results are generally consistent with prior sampling (PPK 1997; SMEC 2014), which can be attributed to the minimal change to existing land use between the periods of sampling.

Water quality modelling of existing surface water quality was undertaken at upstream, downstream and major outflow locations in and around the airport site and calibrated using the existing surface water sampling results. The surface water quality modelling predicted that surface water runoff from the airport site contributes 230,440 kilograms of suspended solids, 376 kilograms of phosphorous and 3,404 kilograms of nitrogen to downstream waterways on average each year. The model results are consistent with surface water quality sampling at the airport site and prior data (PPK 1997; SMEC 2014).

Overall, the results indicate that both the airport site and downstream catchments are fairly degraded, particularly in terms of nutrients. The existing water quality does not typically satisfy the AEPR limits or default ANZECC guideline criteria for the protection of aquatic ecosystems, primary and secondary contact recreation, as well as irrigation water use for food and non-food crops.

18.4.5.2 Local standards

As outlined in Section 18.3.1.1, to allow for climatic, topographic and other site-specific considerations, Part 5 of AEPR provides a process for the development of local standards for water quality. However, the AEPR does not provide any technical guidance on how such local standards should be derived. Under the ANZECC Guidelines, site specific trigger levels may be established by computing the 80th percentile values from a minimum of two years of contiguous monthly data. The ANZECC Guideline approach has been used for the development of interim site-specific water quality criteria for the purposes of this EIS. It is expected that the interim criteria will be updated following the completion of 24 months of water sampling and that formal approval would be sought for the local standards in accordance with Part 5 of the AEPR.

The results indicate that the water quality is generally poor and that the nutrient loads are generally well above both the AEPR accepted limits and the default values in the ANZECC guidelines.

The existing water quality in the subcatchment areas draining from the airport site is generally poor as a result of previous agricultural development and urbanisation, so the use of site specific data to develop interim criteria is more appropriate than the use of either the default trigger levels in the ANZECC Guidelines or the current AEPR limits. Monthly water quality monitoring commenced in November 2015 and nine months of monitoring data have been collected and analysed at the time of this report, as shown in Table 18–5. This comprises more than 80 samples collected at various locations around the airport site for each water quality parameter.

Table 18–5 Background surface water quality

Location	Dissolved oxygen (%)	Conductivity (µS/cm)	Turbidity (Nephelometric Turbidity Units)	Total suspended solids (mg/L)	Nitrogen (mg/L)	Phosphorous (mg/L)
AEPR Limits	80% of average or < 6 mg/L	6.5-9	Reduction of 10% clarity from seasonal mean	< 10% change from seasonal mean	0.1	0.01
ANZECC Guidelines	85-110	125-2,200	6-50	<40	0.5	0.05
Sampling results for March 2015						
Badgerys Creek 2	36	3,100	7.71	5	18.5	0.31
Badgerys Creek 3	8.6	3,050	13	5	2.3	1
Badgerys Creek 4	21.3	2,710	12	23	6.2	0.42
Cosgroves Creek 1	73.6	5,020	4.25	5	0.8	0.03
Cosgroves Creek 2	55.4	4,320	38.1	19	1.2	0.05
Duncans Creek	52.5	847	89.2	14	0.9	0.06
Sampling results for November 2015 to July 2016, averaged monthly data						
B1	44.4	1486	39.9	14.2	3.7	0.4
B2	45.7	1646	19.1	15.6	3.2	0.4
B3	57.1	6933	55.1	20.7	5.6	0.8
B4	45.8	1825	70.2	26.3	9.3	1.6
B6	54.5	2370	28.2	8.4	2.4	0.1
B7	41.2	770	31.9	8.8	1.1	0.1
B8	58.8	1502	20.3	11.7	1.1	0.1
Greendale Road	48.1	1534	33.6	10.5	1.1	0.1
The Northern Road	17.8	2736	251.2	80.1	36.3	5.9

The interim site-specific water quality criteria derived from the nine months of data, for total phosphorus, total nitrogen and suspended solids, are summarised in Table 18–7 and compared with AEPR limits and ANZECC default trigger levels.

It is recognised that, despite the number of existing samples, the period of sampling still falls short of the 24 months stipulated in ANZECC Guidelines. Nevertheless, these interim results are considered to be useful in providing an early indication of the likely range of results expected when the full 24 months of data becomes available.

In Table 18–6, it is noted that the interim site trigger levels for total phosphorus and total nitrogen concentrations are significantly elevated above both the ANZECC Guidelines default trigger levels and AEPR limits. For suspended solids, however, the interim site trigger level is less than that in ANZECC Guidelines and the NSW Blue Book for Soils and Construction.

Table 18–6 Interim site-specific water quality criteria

	Total suspended Solids (mg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)
Interim water quality criteria[1]	23.2	0.92	6.2
ANZECC Guidelines Default Trigger Levels	40	0.05	0.5
`AEPR Limits	Change not more than 10% from seasonal mean	0.01	0.1

1) Based on monthly water quality monitoring data obtained at various locations around the airport site, consisting of more than 80 samples for each parameter.

18.4.6 Groundwater

Groundwater at the airport site is generally poor quality with limited beneficial use or environmental value. The aquifers at the airport site include:

- an unconfined aquifer in the shallow alluvium of the main watercourses at the airport site;
- an intermittent aquifer in weathered clays overlying the Bringelly Shale;
- a confined aquifer within the Bringelly Shale; and
- a confined aquifer within the Hawkesbury Sandstone.

Groundwater within the alluvium has been measured at depths between 0.7 and 4.7 metres. Within the Bringelly Shale, groundwater has been measured at depths between 3.0 and 11.7 metres, and at depths between 2.4 and 4 metres in the overlying weathered material (PPK 1997; Coffey & Partners 1991). Groundwater within the Hawkesbury Sandstone is significantly deeper because the aquifer is 100 metres below ground level. The variation in depths to groundwater indicates low potential for connectivity between groundwater aquifers.

The Bringelly Shale aquifers at the airport site are considered to have limited hydraulic conductivity. Vertical hydraulic conductivities are expected to be two to three orders of magnitude lower than horizontal hydraulic conductivities, indicating a strong downward head gradient, further limiting potential for connectivity with the underlying Hawkesbury Sandstone aquifer.

The weathered soils of the Bringelly Shale that occur over most of the airport site are anticipated to result in relatively low groundwater recharge with an average of 0.5 per cent of annual rainfall entering the groundwater system. Soil infiltration testing estimates maximum recharge rates of approximately 0.012 millimetres per day for the clayey shale soils, and 0.0057 millimetres per day for the alluvium, indicating very limited groundwater recharge conditions.

An idealised hydrogeological conceptual model for the airport site is shown on Figure 18–5, highlighting the interactions between groundwater and potential systems reliant on groundwater.

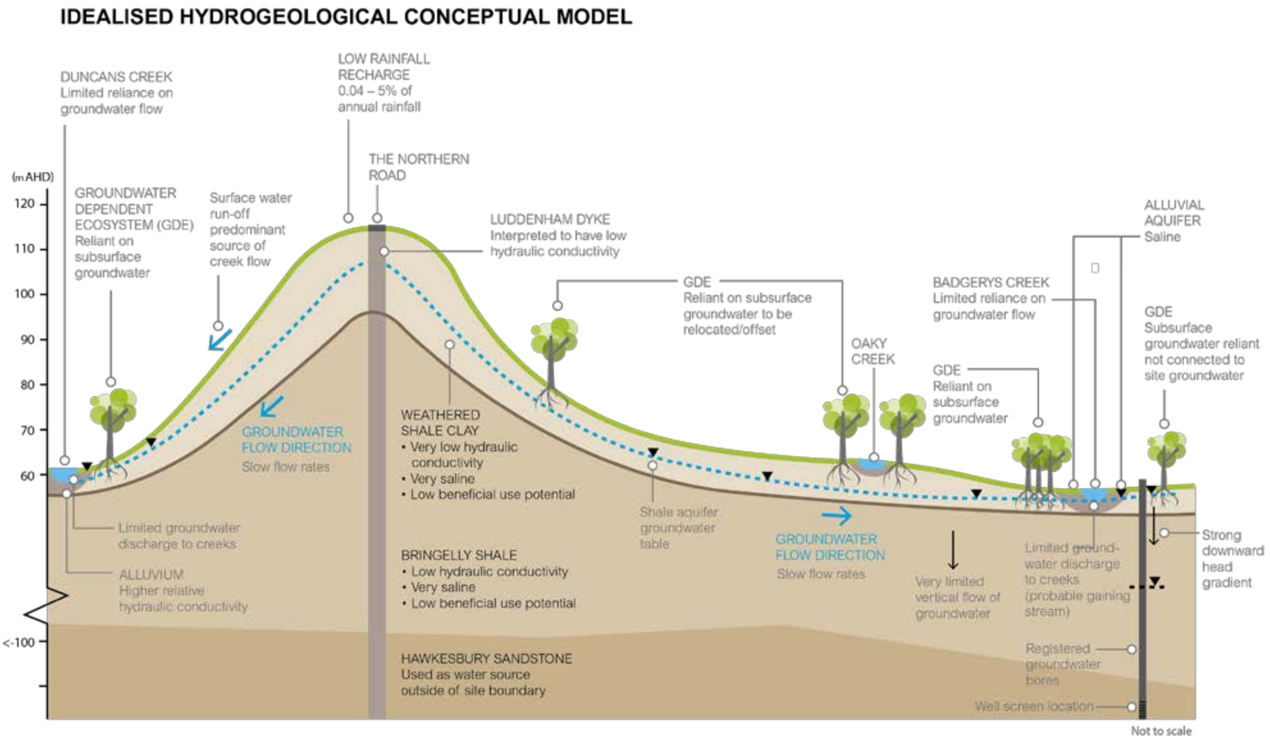


Figure 18–5 Conceptual hydrogeological model

Groundwater quality data indicates elevated concentrations of lead, zinc, copper, nitrogen and phosphorous above the values in the ANZECC freshwater guidelines. Nitrate and sulphate exceeded guideline values at some locations. Groundwater was found to be saline with an average electrical conductivity equalling 21,474 µS/cm and exceeding the 2,200 µS/cm guideline (PPK 1997), indicating a low beneficial reuse potential.

The airport site has been cleared extensively with the exception of stands of remnant and regrowth vegetation located predominantly along Badgerys Creek and the south-western portion of the airport site. This remaining vegetation generally comprises Cumberland Plain Woodland and River-flat Forest. These stands of vegetation broadly correlate with the areas identified as potentially groundwater dependent ecosystems; however, no watercourses in or adjoining the airport site are recorded as being groundwater dependent (BoM 2015a).

The shallower alluvial aquifer at the airport site is understood to discharge at Badgerys Creek, Cosgroves Creek and Duncans Creek. However, surface discharges from the Bringelly Shale aquifer and overlying weathered material are likely to be limited by low connectivity and hydraulic conductivity. Groundwater salinity is an order of magnitude higher on average than surface water salinity at the airport site, which is further evidence of the limited groundwater discharge.

A number of surface water farm dams are present across the site. These features are expected to have been developed initially to capture surface water runoff and are therefore primarily reliant on surface water inputs rather than groundwater. The low permeability clays in which these dams have been developed would limit the connection with surrounding groundwater.

A total of 42 groundwater bores are registered in the vicinity of the airport site. The groundwater bores are recorded as being constructed to significant depths and are understood to generally target the Hawkesbury Sandstone aquifer, which is known to be of higher beneficial use value. It is likely that the Hawkesbury Sandstone is preferentially targeted because of the relatively poor quality of Bringelly Shale groundwater.

18.5 Assessment of impacts during construction

Construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which in turn would alter the quality, duration, volume and velocity of surface water flows from the site.

The Stage 1 development would include a water management system to control the flow of surface water and improve the quality of water before it flows downstream (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts to waterways, people and property.

18.5.1 Watercourses

The bulk earthworks programme proposed to be carried out for construction of the Stage 1 development would involve the removal of minor watercourses within the construction impact zone. The total length of watercourses that would be removed is 36.5 kilometres. The majority of these watercourses are minor drainage lines and valley fills with less defined channels.

Construction would also change the topography and permeability of subcatchment areas at the airport site. These changes would affect flows in receiving watercourses upstream and downstream of the airport site. The changes would occur progressively during construction and would be greatest at completion.

18.5.2 Flooding

The Stage 1 development would include substantial and large-scale earthworks which would modify drainage direction and overland flow paths, changing the nature of flooding on the airport site. As construction progresses and the impervious area expands, the volume of runoff from the airport site would also increase.

Without progressive introduction of formal drainage designed to cater to the new site conditions, there is potential for disruption to construction activities due to flooding and waterlogged soils, as well as the potential for downstream flooding. Detention basins have been incorporated into the indicative site design which would mitigate the increase in runoff, reducing offsite impacts of surface water flows. The detention basins would be established at the commencement of the construction programme. This would enable the management of stormwater releases throughout the remainder of the construction programme.

There is a high likelihood of large rainfall events during the construction of the Stage 1 development and throughout operation of the proposed airport. The operation of the water management system during such events is discussed in Section 18.6.2.

18.5.3 Surface water quality

Clearing and bulk earthworks would increase the surface area, and in some places the slope, of exposed soil surfaces at the airport site. These conditions would present a risk of erosion and associated surface water quality impacts. With regard to the main watercourses at the airport site, bulk earthworks would not occur within 90 metres of Badgerys Creek, 300 metres of Cosgroves Creek or 880 metres of Duncans Creek.

The design capacity and placement of detention basins would ensure that all drainage water from disturbed areas would be captured prior to discharge. The water management system would include the main detention basins (see Figure 18–1) supplemented by a series of interim sediment basins and control measures within the immediate work area. The water management system would have the effect of improving the quality of the surface water prior to release to receiving waters by allowing sediment to settle within the basins. The water management system, in combination with other standard construction erosion control measures, would readily mitigate the potential impacts of sedimentation. These and related measures are detailed in Section 18.7.

Construction of the proposed Stage 1 development would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling.

Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. In the unlikely event of a significant leak or spill of contaminants, remediation would be implemented as soon as practicable.

18.5.4 Groundwater

The proposed airport has the potential to affect groundwater conditions through three principal mechanisms involving groundwater recharge, groundwater drawdown and groundwater quality.

18.5.4.1 Groundwater recharge

Groundwater recharge, the process by which surface water infiltrates downward toward the water table, would be affected by compaction and the establishment of impermeable surfaces across the airport site during construction. Re-profiling of the land surface may lead to a temporary increase in rainfall recharge during bulk earthworks, as the fill is expected to have a higher overall permeability than the existing site conditions. However, as construction progresses, the proportion of paved surfaces would increase, which would reduce recharge to below existing conditions.

Overall, minimal change to local groundwater recharge would be expected as the existing shale derived clay soils have low permeability resulting in the majority of rainfall at the site being released as stormwater runoff rather than infiltrating to groundwater. It is not expected that a reduction in recharge would affect any sensitive ecological receptors or beneficial uses of the groundwater system.

18.5.4.2 Groundwater drawdown

Groundwater drawdown is anticipated as a result of airport site re-profiling and dewatering of excavation beneath the water table. Extensive re-profiling of the airport site would be undertaken to create a flatter surface for the development of the proposed runway and associated facilities. The re-profiling would result in a lowering of groundwater elevations in areas that currently have higher topographical elevation. It is also expected to result in reduced groundwater flow rates and hence reduced discharge to surrounding surface features. The peripheries of the re-profiled area would have exposed cuttings that would seep and reduce groundwater elevations in the elevated areas around the cuttings. The re-profiling would not result in dewatering of the groundwater system below the level of the surrounding creeks and there would be no potential for creeks to dry up due to this activity.

Establishment of basements in the terminal complex would likely intercept the underlying shale aquifers and require dewatering and management throughout construction. Due to low inherent hydraulic conductivities of the geology in these areas, it can be expected that seepage volumes would be relatively small.

As drawdown impacts are expected to be minor, a groundwater monitoring programme at potential sensitive receptors (riparian vegetation and creeks) is considered to be sufficient to identify the emergence of any impacts.

18.5.4.3 Groundwater quality

Potential groundwater quality risks include isolated spills and incidents occurring during construction, and diffuse impacts associated with general construction activities such as the use of machinery. Contaminants of primary concern are usually hydrocarbons; however, other chemicals such as herbicides, pesticides and fertiliser may also be used during construction. Impacts may result from the infiltration of pollutants through the ground surface or through dirty water retention facilities (such as temporary sediment basins) to the underlying groundwater systems.

Groundwater seepage into excavations for building basements would need to be managed by pumping seepage to stormwater management facilities or other suitable treatment systems. Chemicals of concern in groundwater seepage include total dissolved solids, metals, total nitrogen, phosphorus and sulphate. Minor small seepage from cuttings would also require appropriate management prior to discharge offsite.

Groundwater present in the shallow geology has been identified to have high salinity values. The excavation and use of this material for infilling could permit the release of additional salts into groundwater. This would only occur where increased recharge occurs to fill areas, and where a shallow groundwater table develops in the fill material.

As the underlying aquifer system is of low beneficial use, adverse impacts may potentially occur when affected groundwater migrates beneath areas of groundwater-reliant vegetation (located in creek riparian areas) or discharges into creeks. Groundwater flow velocities are expected to be slow, and as such the emergence of any impacts would also be slow. A groundwater monitoring approach is considered suitable to manage the identification of groundwater quality impacts.

18.5.5 Water use

Water would be utilised during construction for soil conditioning and dust suppression.

An estimated 1.36 ML of water would be required per day for site preparation works. For the purposes of this assessment it has been assumed that to meet this requirement 8,600 litres (0.0086 ML) of potable water would be required per day and would be supplied from existing assets operated by Sydney Water. The remaining water would be supplied through stormwater runoff captured in sediment dams or existing farm dams.

To meet water demand during construction it may be necessary to access water from other sources such as groundwater or surface water sources within the catchment. However, water extraction from such alternative sources would be subject to a separate assessment.

18.6 Assessment of impacts during operation

The Stage 1 development will result in modifications to topography and land use within the airport site. The catchment areas within the airport site and the permeability of the ground surface would be altered, which in turn alters the duration, volume and quality of stormwater run-off from the site.

The design of the Stage 1 development includes a water management system for the management of discharge from the site (see Section 18.2.2). The assessment accounts for the effectiveness of this system in mitigating potential impacts on waterways, people and property.

18.6.1 Watercourses

The alterations to the topography and permeability of the airport site made during construction would persist through operation of the Stage 1 development. During operation of the Stage 1 development flows in receiving watercourses upstream and downstream of the airport site would be affected, relative to existing conditions. Changes to flows in receiving watercourses have the potential to affect their physical conditions.

Hydrologic and hydraulic modelling, which incorporates the Stage 1 development landform and water management system, indicates that duration, volume and velocity of surface water flows in watercourses are similar or reduced when compared to existing flow conditions in all but a few cases. The Stage 1 development would therefore not significantly affect watercourse morphology.

Increased shear stress may occur in localised areas during the larger 100 year ARI flood events. These increases would potentially affect physical stability through bed or bank erosion in localised areas, but would not be significant in the context of these large flood events.

Increases in flood depth at Cosgroves Creek and Oaky Creek (see Section 18.6.2) have the potential to affect the physical stability of watercourses through bed or bank erosion. Localised increases are also expected to occur at basin outflows.

Other changes to surface water flows upstream and downstream of the airport site are not expected to affect the physical stability of watercourses.

Potential impacts would be mitigated through further refinement of the water management system, including the provision of erosion controls at basin outlets.

18.6.2 Flooding

The Stage 1 development would result in a modification to existing onsite flow paths and subcatchment boundaries, with resultant potential impacts on surface water flows and the receiving watercourses.

The Stage 1 development would result in a portion of the airport site that currently drains towards the Oaky Creek and Cosgroves Creek catchments to the north being diverted south towards Badgerys Creek, while a portion of the airport site that currently drains to Badgerys Creek would be diverted to Duncans and Oaky Creeks. The proposed airport would change surface run-off conditions in the catchments it intersects, which may also create minor incidental losses associated with evaporative changes.

A summary of changes to subcatchment areas within the airport site is provided in Table 18–7. A reduction in catchment area would generally result in reduced flows downstream; conversely, an increase in catchment area would increase flows downstream. An increase in impervious surfaces would also increase runoff and downstream flows.

Table 18–7 Changes in catchment area and impervious area at the airport site

Location	Catchment area (ha)		Impervious area (%)	
	Existing	Stage 1	Existing	Stage 1
Badgerys Creek at Elizabeth Drive	2,361	↓2,351	12	↑16
Oaky Creek at Elizabeth Drive	361	↓286	10	↑43
Cosgroves Creek at Elizabeth Drive	550	↑635	14	↑20
Badgerys Creek at South Creek	2,799	↓2,792	12	↑14
Cosgroves Creek at South Creek	2,165	↑2,183	14	↑20
Duncans Creek at Nepean River	2,379	↓2,357	14	↑15

↓/↑ denotes decrease/increase

Hydraulic and hydrologic modelling indicates that the volume, duration and velocity of surface water flows in water courses would be usually similar or reduced compared to existing conditions. Changes in volume, duration or intensity of flows would be variable depending on the storm event.

Table 18–8 shows the peak flow rates for the critical duration storm event for the Stage 1 development compared to the equivalent storm event for the existing catchment at the locations mapped in Figure 18–1. As shown, peak flows are usually similar or reduced with some localised increases at Duncans Creek near the airport site. These peak flows were determined for critical storm durations and as such are considered to encompass other, less severe impacts for other storm events.

The introduction of detention basins would also lead to decreases in flow depth at watercourses downstream of the airport site. Decreases were predicted in the order of 300 mm at Oaky Creek and 100 mm at Cosgroves Creek for the 1 year ARI event. Flow depths at Badgerys Creek would likewise decrease by up to 150 mm.

Localised increases were predicted of 250 mm at Oaky Creek upstream of Cosgroves Creek, minor increases of 25 mm at Cosgrove Creek upstream of the airport site and 90 mm at Badgerys Creek near The Northern Road. Flow depths during the larger 5 year and 100 year ARI events would similarly decrease downstream of the site, as with the 1 year ARI event. Increases in flow depth at Oaky Creek and Cosgroves Creek are not expected to affect dwellings. Increases in flow depth at Badgerys Creek are due to the realignment of The Northern Road and would be further assessed and mitigated through the assessment and design of that project. Changed flow depths at Duncans Creek would be within 50 mm in most cases and are not expected to affect dwellings. Mapping of all modelled floods is provided in the hydrology and geomorphology assessment in Appendix L1 (Volume 4).

Table 18–8 Modelled peak flows at the airport site for the Stage 1 development

Location	1 year ARI peak flows (m3/s)		100 year ARI peak flows (m3/s)	
	Existing	Stage 1	Existing	Stage 1
Location A	27.1	25.9	136.6	125.7
Location B	25.7	23.3	120.7	114.4
Location C	21.7	15.8	114.5	77.2
Location D	7.4	3.1	34.3	12.8
Location F2	5.8	4.0	22.5	19.1
Location F3	2.6	2.4	10.4	9.5
Location F4	2.8	2.8	14.3	14.3
Location F5	2.1	2.6	7.9	11.4
Location F7	3.8	3.9	17.4	18.1
Node 2	2.8	0.9	12.2	4.3
Dun3	8.8	8.8	35.9	35.9

Note: Peak flows have been determined for the critical duration storm event for the Stage 1 development. Peak flows of the equivalent storm event have then been modelled for the existing catchment.

18.6.3 Surface water quality

Surface water runoff generated during the operation of the Stage 1 development may be impacted by a range of pollutants such as suspended and dissolved solids, nutrients, gross pollutants, heavy metals, and total petroleum hydrocarbons (TPH).

Suspended solids and nutrients are generated, in differing quantities, under all types of rural and urban catchments, and may be the result of soil erosion, decaying vegetation and matter, and the use of fertilisers. Gross pollutants include anything larger than sediment, and may be organic or non-organic. They include rubbish, plastic, bottles, tyres, or larger items such as shopping trolleys. Heavy metals such as zinc, lead, chromium and copper are generally associated with aircraft and vehicle movement, as well as repair workshops and maintenance areas. The corrosion of galvanised materials, pipes, metal work, wear and tear of tyres, brakes, and the combustion of lubricating oils all have the potential to generate heavy metals. Total petroleum hydrocarbons in fuels stored, transferred or burnt may also find their way into the water management system and impact on the downstream waterways.

It is noted that heavy metal elements may also originate from natural soils in the area or from existing land uses. Recent water quality data obtained at the airport site watercourses indicate elevated levels for zinc, copper and chromium in addition to suspended solids and nutrients. Heavy metals contained in stormwater runoff are generally strongly bound to suspended solids and can be effectively filtered in grass swales and sediment basins.

Modelling the impact of surface water runoff pollutants on the receiving water environment has been undertaken for suspended solids, nutrients (phosphorous and nitrogen) and gross pollutants. The modelling has considered the effectiveness of the proposed water management system to meet the objectives for the receiving waters with respect to:

- average annual pollutant loads (kg/year);
- pollutant retention targets for urban development; and
- average pollutant load concentrations.

18.6.3.1 Average annual pollutant loads

In assessing the average annual loads, the post development levels are compared to those under existing conditions. This approach is similar to the NORBE (Neutral OR Beneficial Effect) approach to water quality management, which aims to manage the post development pollutant loads discharging from a site, such that the water quality is equal to or better than the pre-development or existing loads. The approach is typically extremely difficult to achieve when modifying land use from a rural to an urbanised or developed catchment.

The average annual pollutant loads resulting from the Stage 1 development are presented in Table 18–9 for suspended solids, total phosphorus, total nitrogen and gross pollutants. The percentage change in these pollutant loads compared to existing conditions (pre-development) is also shown in brackets for comparison. Local impacts relate to those immediately downstream of the airport site, while the regional impacts relate to those up to 16 km downstream of the airport site. The percentage change in loads for gross pollutants has not been calculated due to the fact that, in practice, gross pollutants are readily controlled through the use of gross pollutant traps and other standard stormwater devices.

Table 18–9 Modelled pollutant loads

Location	Flow (ML/year)	Average Annual Loads (kg/yr)			
		Suspend solids	Phosphorous	Nitrogen	Gross pollutants
Local Impacts					
Basin 1 Outlet (to Badgerys Creek)	555 (+10%)	18400 (-68%)	103 (+5%)	702 (-23%)	257
Basin 2 Outlet (to Badgerys Creek)	456 (+709%)	34400 (+418%)	142 (+1530%)	825 (+890%)	2430
Basin 3 Outlet (to Badgerys Creek)	410 (+175%)	20400 (+1%)	106 (+367%)	626 (+188%)	1360
Basin 4 Outlet (to Badgerys Creek)	130 (+67%)	15600 (+251%)	60.9 (+83%)	336 (+15%)	2310
Basin 5 Outlet (to Badgerys Creek)	529 (+103%)	67500 (+89%)	254 (+321%)	1340 (+153%)	9750
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	899 (+142%)	44300 (-15%)	188 (+147%)	1200 (+75%)	2160
Basin 7 Outlet (to Cosgroves Creek)	573 (+235%)	20100 (-34%)	109 (+174%)	745 (+88%)	696
Basin 8 Outlet (to Duncans Creek)	169 (+41%)	6400 (-61%)	34.4 (+47%)	220 (+4%)	0
Basin 9 Outlet (to Duncans Creek)	172 (+219%)	8400 (+17%)	44.2 (+412%)	272 +258%)	539
B1 – Badgerys Creek 4	1080 (+15%)	110000 (+9%)	355 (+94%)	2330 (+35%)	12600
Badgerys Creek 2 / B2	1700 (+11%)	199000 (+11%)	523 (+59%)	3680 (+20%)	15800
Badgerys Creek 3 / B3	3620 (+32%)	337000 (+5%)	976 (+72%)	6830 (+30%)	20700
Regional Impacts					
Cosgroves Creek 1	1930 (+93%)	146000 (-8%)	404 (+84%)	3030 (+39%)	3250
Cosgroves Creek 3	2610 (+54%)	240000 (-6%)	549 (+49%)	4480 (+23%)	5130
Duncans Creek	2480 (+8%)	332000 (+5%)	507 (+6%)	4540 (+7%)	3190

Location	Flow (ML/year)	Average Annual Loads (kg/yr)			
		Suspend solids	Phosphorous	Nitrogen	Gross pollutants
Kemps Creek	23400 (+4%)	2770000 (-5%)	4900 (+8%)	47200 (+3%)	90400
Blaxland Creek	33800 (+6%)	3710000 (-4%)	6670 (+9%)	63800 (+4%)	132000

The Stage 1 development would result in increased loads of phosphorous and nitrogen, largely as a function of the increase in runoff volumes associated with the modified catchment areas and changes to land use. Relative increases in phosphorous and nitrogen loads attributed to the proposed airport would be most pronounced at basin outlets, where surface water flows leave the airport site, but would progressively decrease downstream of the airport site as receiving waterways receive flows from the wider catchment. The proposed water management system would be generally effective at reducing loads of suspended solids in surface water, compared to existing conditions.

18.6.3.2 Pollution retention targets

The WSUD Guidelines specify pollutant retention targets as a practical way of treating urban stormwater quality. These targets recognise that urban development will typically lead to an increase in pollutant loads in comparison to rural land uses. The focus is therefore on managing the pollutant loads to acceptable levels, rather than maintaining the existing load levels. The application of these guidelines is generally less stringent than the NORBE approach where the existing catchments are of a rural nature.

The bio-retention basins proposed as part of the water management system in the revised draft Airport Plan have been designed to achieve the WSUD Guidelines. It is also noted that the civil design for each of the bio-retention basins has additional buffer areas set aside to enable a greater treatment area to be provided as required. This approach provides flexibility to increase the level of treatment following the adoption of local standards and site specific water quality trigger levels developed following the completion of long term baseline monitoring in accordance with AEPR and the ANZECC guidelines.

The potential impacts of the proposed Stage 1 development, measured against the requirements of the WSUD Guidelines, are presented in Table 18–10. The targets are that 80 per cent of suspended solids, 45 per cent of total phosphorus, and 45 per cent of total nitrogen should be retained on the airport site. It is noted that in the use of the WSUD Guidelines for Western Sydney, the basin outlet flows are derived only from the proposed development areas and Basin 4 and Basin 5 will not be constructed during the Stage 1 development.

The nine basin outlets effectively represent the locations where the pollutant loads generated from the proposed airport would discharge into the downstream environment. The results show that, in terms of suspended solids, total phosphorus and total nitrogen, Basins 1, 3, 6, 7 and 8 satisfy the reduction target. Basins 2 and 9 do not completely satisfy the retention target and increasing the treatment area is recommended during the detailed design of these basins.

Table 18–10 Retention of pollutant loads

Location	Retention of pollutant loads (%)		
	Total suspended solids	Total phosphorous	Total nitrogen
Western Sydney Guidelines	80%	45%	45%
Basin 1 Outlet (to Badgerys Creek)	85.0	60.6	48.4
Basin 2 Outlet (to Badgerys Creek)	62.9	40.4	34.7
Basin 3 Outlet (to Badgerys Creek)	83.0	59.6	53.7
Basin 4 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 5 Outlet (to Badgerys Creek)	0.0	0.0	0.0
Basin 6 Outlet (to Oaky/ Cosgroves Creek)	82.6	61.3	45.1
Basin 7 Outlet (to Cosgroves Creek)	83.4	61.0	45.3
Basin 8 Outlet (to Duncans Creek)	83.4	60.1	45.4
Basin 9 Outlet (to Duncans Creek)	76.1	50.8	37.4

18.6.3.3 Pollutant concentrations

Pollutant concentrations are readily monitored and have a direct correlation with the relative health of waterways and ecosystems. Both AEPR and ANZECC Guidelines refer to concentrations in the setting of trigger levels and pollutant limits.

Existing surface water quality was modelled at upstream, downstream and major outflow locations in and around the airport site. This was done to allow a direct comparison with the predicted surface water quality during the Stage 1 development.

The model results are summarised in Table 18-10 for comparison with ANZECC Guidelines default trigger levels for slightly disturbed ecosystems in lowland rivers, AEPR limits, and interim site-specific water quality criteria established for the airport site catchment. The results show that pollutant concentrations would typically decrease at most downstream locations. Despite the water management system for the Stage 1 development leading to general improvements in pollutant concentrations locally and regionally, the improvements would not be sufficient to meet the AEPR limits or default values in the ANZECC guidelines. However, using the interim site-specific water quality criteria established for the airport catchment, the post-development water quality is found to satisfy the site specific water quality objectives for suspended solids, total phosphorus, and total nitrogen at all the locations.

The above outcomes are attributed to the degraded nature of the existing catchments which have not met ANZECC Guidelines default trigger levels for several years. Nevertheless, it is noted that the proposed airport does not preclude the opportunity to make further improvements in downstream water quality in South Creek in the future, to work towards satisfying the NSW Water Quality Objectives.

Table 18–11 Modelled surface water quality at the airport site

	Existing (mg/L)			Stage 1 development (mg/L)		
Location	Suspended solids	Phosphorous	Nitrogen	Suspended solids	Phosphorous	Nitrogen
AEPR Limits	< 10% change from Seasonal Mean	0.01	0.1	< 10% change from Seasonal Mean	0.01	0.1
ANZECC Guidelines	40	0.05	0.5	40	0.05	0.5
Interim water quality criteria	23.2	0.92	6.2	23.2	0.92	6.2
Basin 1	22.1	0.14	1.54	↓7.09	↓0.12	↓0.75
Basin 2	22.1	0.09	1.25	↓15.7	↑0.11	↓0.97
Basin 3	21.9	0.09	1.26	↓13.2	↑0.11	↓0.91
Basin 4	20.7	0.38	2.91	↑23.5	↓0.10	↓1.19
Basin 5	23.0	0.17	1.74	↑23.9	↓0.10	↓1.18
Basin 6	22.5	0.15	1.60	↓12.3	↓0.11	↓0.87
Basin 7	22.2	0.15	1.59	↓7.56	↓0.12	↓0.75
Basin 8	23.2	0.13	1.52	↓2.45	↓0.12	↓0.62
Basin 9	20.4	0.10	1.26	↓13.3	↑0.11	↓0.94
Badgerys Creek 1	21.5	0.14	1.48	↑23	↓0.11	↓1.20
Badgerys Creek 2	21.8	0.15	1.55	↑22.9	↓0.11	↓1.22
Badgerys Creek 3	21.9	0.15	1.55	↓15.1	↓0.12	↓1.00
Cosgroves Creek 1	22.7	0.15	1.61	↓11.0	↓0.12	↓0.88
Cosgroves Creek 3	22.5	0.15	1.58	↓11.4	↓0.12	↓0.91
Duncans Creek	22.1	0.14	1.54	↓14.9	↓0.12	↓1.03
Kemps Creek	21.0	0.13	1.45	↓15.2	↓0.12	↓1.04
Blaxland Creek	20.9	0.13	1.39	↓14.4	↓0.11	↓1.01

↓/↑ denotes decrease/increase

18.6.4 Reclaimed water irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. The wastewater would be reticulated, treated and recycled (as grey water) or irrigated onsite. Treatment and irrigation methods would be determined in detailed design, but it is expected that wastewater would be treated with membrane biological reactor technology to produce high quality reclaimed water suitable for beneficial reuse or irrigation.

The key risks to surface water and groundwater associated with the irrigation of reclaimed water are runoff to surface water or infiltration to groundwater. These risks would be limited in the first instance as reclaimed water would be of relatively high quality and appropriate management practices would be adopted, such as balancing storages and proper irrigation scheduling to avoid excessive irrigation.

18.6.5 Groundwater

The potential groundwater impacts during operation of the Stage 1 development would likely encompass those previously discussed in Section 18.5.4, namely groundwater recharge, groundwater drawdown and groundwater quality. Impacts on groundwater recharge are not expected to be significant given the very limited groundwater recharge conditions at the airport site (see Section 18.4.6). Groundwater drawdown effects due to inflows would be limited following the initial effects of bulk earthworks and excavation. Significant groundwater inflows to underground infrastructure are not expected and would be controlled, if necessary, through the use of lining or other engineering controls.

The operation of the proposed airport would involve the use of a range of fuels and chemicals. These substances may be released to the environment in the event of a mishap during refuelling, maintenance or general storage and handling. Releases would be avoided with the implementation of Australian Standards for the storage and handling of hazardous materials. Remediation would be implemented as soon as practicable in the unlikely event of a significant leak or spill of contaminants.

18.7 Mitigation and management measures

Measures to manage potential impacts on surface water and groundwater during construction and operation are listed in Table 18–12.

A Soil and Water Construction Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) will be prepared prior to Main Construction Works and operation of the Stage 1 development respectively. The plans will collate the mitigation and management measures discussed in this section and itemised in Table 18–12. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Some of the main proposed measures include:

- refinement of the water management system to improve flood and water quality performance as far as practicable;
- regular inspection and maintenance of the water management system to ensure all components are functioning as designed;

- implementation of standards for storage and handling of fuels or chemicals with the potential to contaminate surface water or groundwater; and
- baseline and ongoing monitoring of surface water and groundwater, fulfilling the requirements of the AEPR.

The establishment of erosion controls in line with *Managing urban stormwater: soils and construction* (Landcom 2004) would be central to the management and mitigation of erosion and associated surface water quality impacts. These measures are discussed in Chapter 17.

The reclaimed water reuse scheme would be designed and operated in accordance with the risk framework and management principles contained in the *National Guidelines on Water Recycling* (Environment Protection and Heritage Council 2006) and the *Environmental guidelines: Use of effluent by irrigation* (DEC 2004d). This approach would avoid harm to surface water and groundwater. These measures are also discussed in Chapter 17.

Table 18–12 Mitigation and management measures

Issue	Measure	Timing
Surface water management system	As part of the detailed design process for the Stage 1 development, a surface water management system will be developed. Development of a surface water management system for the airport site may involve a progressive process of design and implementation covering both the construction and operational phases. This may include the implementation of temporary system elements specifically for the construction phase. The system will include: • a detailed design of basins and channels to capture the majority of runoff, including during construction; • refined drainage system design performance standards to optimise capacity and release timing, mimicking natural flows as far as practicable; • separate bio-retention basins to provide additional treatment for low flows and separation of these features from the drainage system to protect contained water during flood events; • pollutant traps to prevent debris and other coarse material entering the drainage system; • stabilisation structures at outlets to include rock check dams at regular intervals along channels and energy dissipaters at basin outlets; • capacity for containment of accidental leaks or spills in the drainage system at maintenance areas, fuel farms or other areas where fuels or chemicals are stored or handled in accordance with Australian standards; and • measures to address impacts on downstream and upstream uses, including sensitive environmental values.	Pre-construction Construction
Development of local standards	Local standards for water quality will be developed under the AEPR, with due consideration to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) and the results of baseline water quality monitoring which will take place for a minimum of 24 months prior to the commencement of Main Construction Works.	Pre-construction

Issue	Measure	Timing
Erosion and sedimentation	Impacts associated with erosion and sediment will be mitigated through: • installing a site drainage system prior to commencement of bulk earthworks; • minimising the surface area disturbed at any one time by, where practical, staging construction works and stabilising soils with vegetation or appropriate cover materials; • establishing erosion and sediment controls in accordance with the 'NSW OEH Blue Book – *Managing urban stormwater: soils and construction'*; • providing intermediate sediment retention basins within the construction impact zone to provide additional treatment prior to completion of the airport's site drainage system. Specific erosion control measures would be developed for the management of highly erodible soils such as those anticipated in the Luddenham and South Creek soil landscapes; • mulching cleared vegetation for use in erosion control at construction sites; • covering and stabilising soil stockpiles with vegetation or mulch; • stockpiling topsoil at a maximum height of two metres, where practicable; and • distributing and seeding topsoil over landscaped areas at the completion of bulk earthworks.	Construction

Leaks or spills of fuel or other chemicals	To minimise the risk of leaks or spills the following mitigation measures will be put in place:
	• maintenance areas, fuel farms and other areas where fuels or chemicals are stored or handled would be bunded to contain any accidental spills or leaks;
	• fuel and other chemicals will be stored and handled in accordance with relevant Australian standards such as:
	  ▪ AS 1940-2004 The storage and handling of flammable and combustible liquids;
	  ▪ AS/NZS 4452:1997 The storage and handling of toxic substances;
	  ▪ AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods; and
	  ▪ AS/NZS 1547:2012 On-site domestic wastewater management; and
	• a protocol will be developed and implemented to respond to and remedy leaks or spills.
		Construction
		Operation

Surface and groundwater quality monitoring	The most suitable surface and groundwater locations will be determined in consultation with the NSW Environment Protection Authority and relevant local councils. Regular site inspections will be carried out to monitor the effectiveness of the water management system and water management controls, recording inspection results, and making an inspection log available to the Department of Infrastructure and Regional Development. The frequency of site inspections will be increased during and immediately after wet weather when there is a higher potential for the offsite transport of pollutants from the airport site. Groundwater elevation monitoring will be conducted to detect potential impacts to base flow in the vicinity of potentially sensitive creeks and groundwater dependent vegetation. Monitoring will be undertaken quarterly through construction up to a minimum period of three years after the completion of the Stage 1 development and until any identified impacts stabilise. Monitoring will also be undertaken quarterly up to a minimum period of three years after commencement of operations or until any identified impacts stabilise. Groundwater quality monitoring of alluvial and Bringelly shale aquifers will be conducted at major infrastructure, locations, down gradient from these locations and in the vicinity of groundwater dependent vegetation or water courses. Monitoring will initially be undertaken quarterly and adjusted as appropriate. Monthly surface water quality monitoring will be conducted to monitor performance of the water management system. This monitoring will occur once the water management system is in place and take place at basin outflows and during selected upstream and downstream locations.	Construction Operation

Issue	Measure	Timing
Groundwater inflows	To mitigate the impacts associated with groundwater inflows the following measures will be implemented: • groundwater inflows will be reused or released with appropriate treatment; • where groundwater is released to surface waters, treatment will be undertaken to bring water pollution below the accepted limits set out in the AEPR or any local standards; and • corrective measures will be developed and implemented to supplement groundwater supplies in the unlikely event of impacts to dependent vegetation or watercourses.	Construction Operation
Wastewater reuse	The treated water irrigation scheme will be designed and operated in accordance with the risk framework and management principles contained in the National Guidelines on Water Recycling (EPHC 2006) and Environmental guidelines: Use of effluent by irrigation (DEC 2004).	Operation
Review and refinement of water management system	In the event monitoring shows that water quality or hydrology criteria established for the airport site are not met, relevant aspects of the water management system will be reviewed and refined, as necessary, to ensure future compliance.	Operation

18.8 Conclusion

Construction of the Stage 1 development would transform approximately 60 per cent of the airport site from a rolling grassy and vegetated landscape to an essentially built environment with some landscaping. These changes would alter the catchment areas within the airport site and the permeability of the ground surface, which would in turn alter the duration, volume and velocity of surface water flow. The proposed bulk earthworks and excavations at the airport site are likely to receive some groundwater inflows.

Hydrologic and hydraulic modelling of the airport site during construction and operation indicates that there is a degree of variation in how the water management system responds to different storm events. The water management system as currently planned would be generally effective at mitigating watercourse and flooding impacts; however, refinement of the water management system would occur during detailed design of the proposed airport.

The refinement of the water management system would address some of the more substantial increases to flows at Oaky Creek, as well as the enhanced use of bio-retention basins and swales and other intermediate structures to further improve water quality outcomes.

Because water quality at the airport site is already degraded and does not meet existing water quality criteria, it is unlikely that the proposed airport will be able to achieve water quality criteria outlined in the AEPR. To take into account these existing conditions, local standards for water quality will be developed under Part 5 of the AEPR, with due consideration to the ANZECC Guidelines. The development of local standards will be based on the results of baseline water quality monitoring, derived from a minimum of 24 months of data collected prior to the commencement of Main Construction Works.

Water quality during the Stage 1 development was found to meet site-specific interim water quality criteria at all modelled locations. The interim water quality criteria were developed on the basis of 9 months of water quality monitoring.

Overall it is considered that the residual impacts to surface water and groundwater would be reasonable considering the scale and nature of the proposed airport development. Baseline and ongoing monitoring of surface water and groundwater would be undertaken to characterise any residual impacts and prompt corrective action where necessary.

19 Aboriginal heritage

Since the early 1800s, land use at the airport site has consisted of varying phases of stock grazing, cropping, orcharding, dairying, market gardening, poultry farming and some light industrial functions. Consequently, most of the original native vegetation has been cleared and the airport site is now dominated by agricultural grasslands or cultivated fields with small pockets of open eucalypt woodland or shrubland. These activities are expected to have had a substantial impact on the Aboriginal archaeological resource, especially in the top soil and the plough zone at the airport site.

The airport site has been the subject of a number of previous archaeological assessments as part of the search for an appropriate site for a second Sydney airport. These previous assessments date back to 1978, with the most recent being undertaken in 2014. Fifty-one Aboriginal heritage sites have been recorded during these surveys, consisting of surface artefact occurrences and a modified tree. Twenty-three additional sites were recorded at the airport site during the course of the current assessment, which focused on test excavation and characterising the sub-surface archaeological resource. The new recordings comprised nine sites with surface artefacts (including a grinding groove site) and 14 sites where subsurface artefacts were confirmed through test pit excavations.

The test excavation programme included a representative sample of landform types and zones within the airport site. It was determined that a relatively high average artefact incidence occurred across valley floors, basal slopes, first-order spurlines and within 100 metres of second, third and fourth order streams. These findings are generally consistent with numerous other investigations in the vicinity of the airport site that have confirmed that Aboriginal heritage sites occur widely across the landscape, but particularly on elevated level ground and slopes within relative proximity of a water source. These investigations also indicate that larger sites with higher artefact densities are more likely to be found near permanent water.

Aboriginal stakeholder consultation undertaken for the current assessment identified the airport site as a place of cultural significance and continuing cultural connection. The reasons for this include the site's material evidence of occupation, its cultural landscape values, and culturally significant plants, animals and resources. All of these contribute to a sense of place and cultural identity, and are considered to be a valuable educational resource. In addition, the remaining Aboriginal sites across the Sydney hinterlands may be considered to have an intrinsic value because of their endurance amid concerns about disappearing heritage. The cumulative impacts on Aboriginal heritage sites caused by continuing urban and industrial development of the Cumberland Plain, of which the proposed airport would be a part, effectively impose a greater significance on those sites that remain.

All of the Aboriginal heritage sites recorded at the airport site are considered to have significance. Many sites contain archaeological material which has both cultural and scientific value, and all sites, irrespective of their scientific or other values, are considered to be culturally significant by the Aboriginal community. The predicted archaeological resource of the airport site, as revealed by the test excavation programme, is also assessed to be significant.

Construction of the proposed Stage 1 development would affect at least 39 sites recorded at the airport site, all of which comprise artefact occurrences. Construction activities would also impact approximately 514 hectares of archaeologically sensitive landforms. Impacts during operation of the proposed airport would be limited to indirect impacts on adjacent and nearby sites. The heritage values of these sites are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the proposed Stage 1 development would be low.

Mitigation and management measures would be implemented to minimise the impacts on Aboriginal cultural heritage. These measures include the conservation of heritage sites, recording and salvaging of heritage sites, the commemoration of cultural heritage values at the airport site, curation and repatriation of heritage items and protocols for the discovery of artefacts and human remains.

19.1 Introduction

This chapter provides a review of the Aboriginal cultural heritage values that may be potentially affected by the development of the proposed airport. In doing so, it draws on a comprehensive Aboriginal cultural heritage impact assessment, which is included as Appendix M1 (Volume 4). This chapter describes the Aboriginal cultural heritage values of the airport site and assesses the potential impacts of the proposed Stage 1 development on these cultural heritage values. Mitigation and management measures are identified to reduce potential impacts. The assessment has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) for Western Sydney Airport.

19.2 Methodology

The methodology for the Aboriginal cultural heritage impact assessment included consultation, a database and literature review, field surveys and assessments of significance.

The adopted methodology builds upon data obtained from previous site studies which focused predominantly on the investigation of surface sites. All field data generated by the archaeological survey undertaken as part of the 1997–99 *Second Sydney Airport Proposal Environmental Impact Statement* (1997–99 EIS) (PPK 1997), were reviewed, together with the results of the 2014 environmental survey, which reinspected a selection of the 1997 recordings (AMC 2014). The environmental survey reported low levels of ground surface visibility and revealed that only a small proportion of the 1997 recordings was still identifiable from surface artefacts. This finding indicated that the current assessment should focus on the investigation of the potential subsurface archaeological resource, rather than repeat surface archaeological survey in low visibility conditions. Emphasis was also placed on recording cultural values and the views of the Aboriginal stakeholder community.

The investigation of the potential subsurface resource employed a landscape-based approach and involved the development of a predictive model and a programme of archaeological test excavation within a sample of locations. This complemented the site-based approach of previous studies. Optimal test excavation locations were selected through a field survey programme conducted with Aboriginal stakeholders.

The predictive modelling now allows the extrapolation of surface and subsurface artefact incidence data to untested landforms of the same type, and the nature of the predicted archaeological resource to be mapped in terms of broad area landforms and topographic variables. This integration of surface and subsurface information characterises current best practice, and represents a shift in paradigm – from one which is site-based and focused on surface evidence, to one focused on the subsurface resource that may be revealed by both surface sites and test excavation.

19.2.1 Consultation

Consultation was undertaken with reference to *Ask First, A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission 2002) and was guided by the requirements set out in the document *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (OEH 2010b). This included:

- **Stage 1 – Notification of the project proposal and identification and registration of stakeholders.** A public notice advising of the Aboriginal cultural heritage assessment and inviting registrations from interested parties was placed in several local newspapers in February 2015. The newspapers were the *Blacktown Advocate, Liverpool Leader, Fairfield City Champion, Camden Advertiser, Penrith Press and Macarthur Chronicle*. Letters were also sent to organisations seeking the identification of Aboriginal stakeholders for the purpose of inviting their participation in the consultation programme. There are 50 registered Aboriginal stakeholders for the airport proposal. A list of registered stakeholders is provided in Appendix M1 (Volume 4).
- **Stages 2 and 3 – Presentation of information about the project and proposed assessment methodology, and gathering of information about cultural significance.** A combined background paper and draft methodology for the Aboriginal cultural heritage assessment was sent to all registered Aboriginal stakeholders in March 2015 with an invitation to provide comment on both the methodology and any known cultural heritage values relevant to the airport site. Two meetings were also held with the registered stakeholders in April 2015 to discuss the airport proposal, outline previous assessment work at the airport site and explain the proposed methodology for the Aboriginal cultural heritage assessment. All Aboriginal stakeholders who were registered at the time opted to participate in the fieldwork programme.
- **Stage 4 – Review of Aboriginal cultural heritage assessment.** Meetings to present the findings of the Aboriginal cultural heritage assessment were held with Aboriginal stakeholders in October and November 2015. All registered Aboriginal stakeholders were notified on 23 October 2015 once the draft EIS was published and invited to provide written submissions. Stakeholders were advised where to access hard copies and electronic copies of the draft EIS. Submissions were received over the statutory public display period ending on 18 December 2015. All submissions were reviewed and addressed through the EIS finalisation process.

Two separate meetings were held with Liverpool City Council and the NSW OEH in May 2015. A general outline of the airport proposal and the Aboriginal cultural heritage assessment approach was provided followed by a discussion of potential issues and priorities.

Further detail of the consultation undertaken is provided in Appendix M1 (Volume 4). The results of the consultation activities are summarised in Section 19.3.5.

19.2.2 Database and literature review

A desktop assessment was undertaken to determine the nature and status of known Aboriginal heritage sites within and around the airport site, to facilitate site prediction on the basis of regional and local site patterns, and to place the area within an archaeological and heritage management context.

The desktop assessment included searches of heritage registers and schedules and a review of local histories and archaeological reports. Searches were undertaken of the following heritage registers and schedules:

- World Heritage List (United Nations Educational, Scientific and Cultural Organization (UNESCO));
- Commonwealth Heritage List (Australian Heritage Council);
- National Heritage List (Australian Heritage Council);
- Register of the National Estate (Australian Heritage Council); and
- Aboriginal Heritage Information Management System (AHIMS) (NSW OEH).

The results of previous archaeological assessments undertaken at the airport site and in the vicinity were reviewed. These included:

- Major Airport Needs of Sydney (MANS) Study (Haglund 1978);
- Second Sydney Airport Site Selection Programme Draft Environmental Impact Statement (Kinhill Stearns 1985);
- Draft Environmental Impact Statement Second Sydney Airport Proposal (PPK 1997);
- Draft Environmental Impact Statement Second Sydney Airport Proposal, Auditor's Report (SMEC 1998);
- Supplement to Draft Environmental Impact Statement Second Sydney Airport Proposal (PPK 1999);
- Supplement to Draft Environmental Impact Statement Second Sydney Airport Proposal, Auditor's Report (SMEC 1999);
- Proposed Second Sydney Airport at Badgerys Creek Environmental Assessment Report (Environment Australia 1999); and
- Environmental Field Survey of Commonwealth Land at Badgerys Creek (SMEC 2014).

A comprehensive list of the literature that was reviewed is provided in Appendix M1 (Volume 4).

19.2.3 Field surveys

19.2.3.1 Overview

A three week fieldwork programme was conducted from 4 to 22 May 2015. This programme reflected the objectives of the assessment, which included the identification of Aboriginal cultural values and the testing of the subsurface archaeological resource. A decision not to systematically revisit or test previously identified sites was made based on the findings of the 2014 environmental field survey conducted by Australian Museum Consulting (AMC 2014). The AMC study encountered low ground surface visibility and found that a low proportion of previously recorded surface artefacts remained visible.

The first week of fieldwork was devoted to site walkovers with Aboriginal parties, which provided an opportunity for stakeholders to identify and discuss cultural and intangible values associated with the airport site. This included a broad scale review of the site characteristics and diversity of landforms, and the identification and prioritisation of potential test pit locations. An archaeological test pit programme was undertaken over the subsequent two weeks of the fieldwork programme.

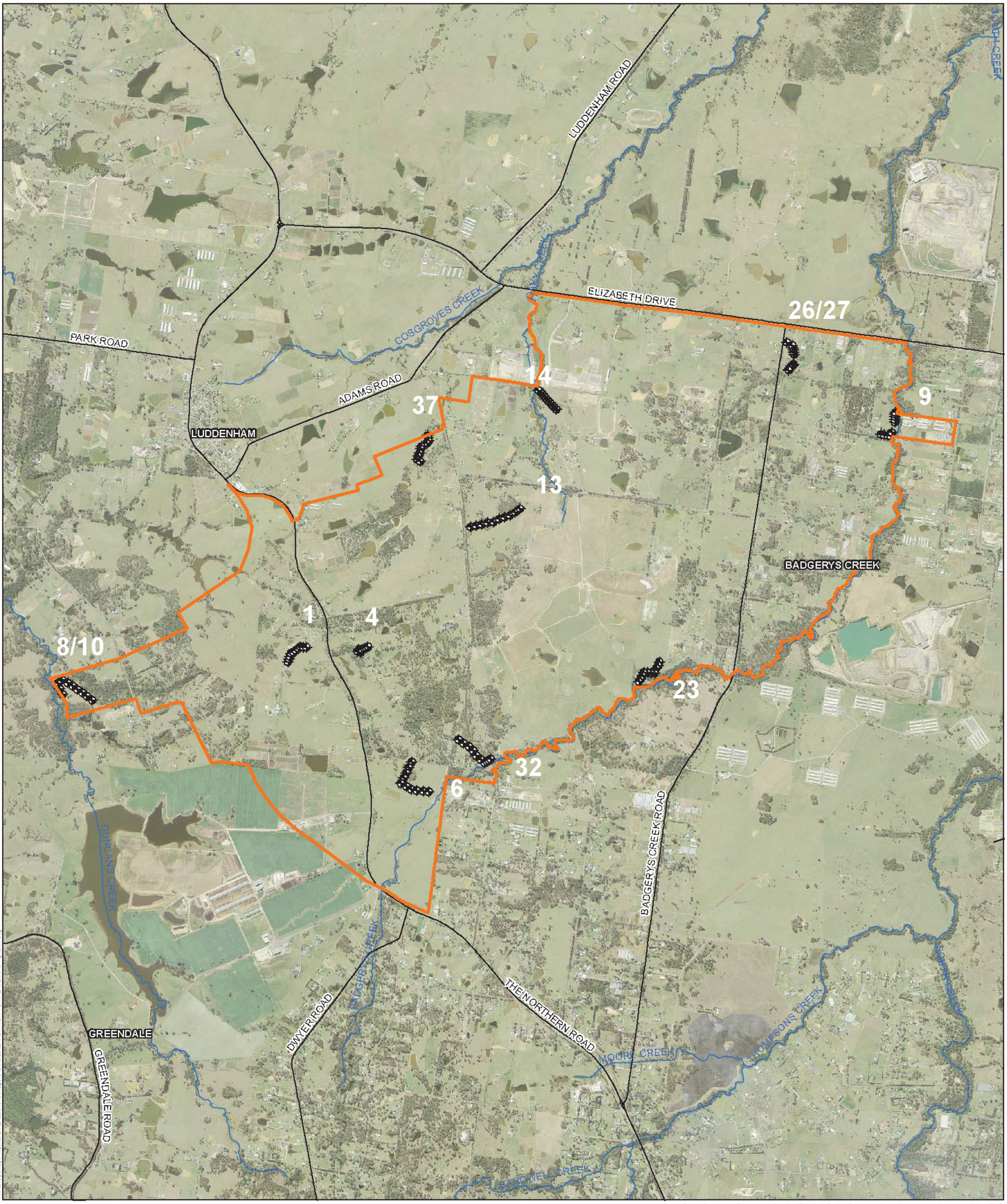
19.2.3.2 Test excavations

The aim of the test excavation programme was to characterise the nature and occurrence of the subsurface archaeological resource, by conducting archaeological test excavations within a representative selection of landform types present within the airport site.

Thirty-eight possible archaeological test locations were identified through a desktop assessment. Potential locations were identified based on landform representativeness, access constraints and degree of disturbance. Previously recorded sites were not prioritised in the selection process. Following on-site review and a field inspection of each location with Aboriginal stakeholders, the test locations were prioritised and a shortlist developed. Archaeological test excavations (test pits) were conducted at 13 of the 38 locations. Four of these locations were paired, resulting in a total of 11 test locations. The test locations are shown in Figure 19–1.

Ten test pits (each 1 x 0.5 square metres in area and totalling approximately five square metres) were conducted at each test location, with the exception of Test Location 26/27, where 13 pits were conducted (see to Figure 19–1).

All test pits were excavated by hand, using spades, hand trowels and, where necessary, picks. The end depth of each pit varied depending on when stiff clay, rock or other constraints were encountered. All sieving was conducted by hand using pressurised water sourced from a water truck. All artefactual material was recovered and subject to itemised description in the laboratory. All pits were backfilled with sieved spoil and/or imported clean fill.



LEGEND

Airport site   Test pits

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

0 0.25 0.5 1
Kilometres

Figure 19-1 - Test excavation locations

19.2.4 Assessments of heritage values

Assessments of significance were prepared for all Aboriginal heritage sites recorded at the airport site. The assessments of significance were prepared with reference to the Burra Charter and the heritage provisions of the EPBC Act.

The EPBC Act defines three tiers of significance through the establishment of the World Heritage List, the National Heritage List and the Commonwealth Heritage List. World Heritage properties are places of outstanding universal value that are inscribed on the World Heritage List administered by UNESCO. National Heritage places are places of outstanding value to the nation and are listed on the National Heritage List. Commonwealth Heritage places are places with significant heritage values that are owned or controlled by the Commonwealth or a Commonwealth agency and are listed on the Commonwealth Heritage List.

The EPBC Act prescribes obligations for Commonwealth agencies that own or control properties that have, or might have, National Heritage or Commonwealth Heritage values. Obligations include taking all reasonable steps to assist in the identification, assessment and monitoring of values, and preparation of management plans for any identified values in line with the National Heritage management principles and Commonwealth Heritage management principles. Commonwealth agencies must similarly take all reasonable steps to ensure their actions are not inconsistent with the Australian World Heritage management principles or any plans in force for a World Heritage property.

The EPBC Act also provides for the protection of the environment generally, where actions are undertaken by the Commonwealth or on Commonwealth land. The environment includes heritage values. The heritage values of a place include the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.

No heritage values consistent with World Heritage or National Heritage listing were identified within the airport site. Assessments of Commonwealth Heritage values within the airport site were undertaken for this EIS, and are described in Section 19.3.6. According to guidelines issued by the Australian Heritage Council, the relevant significance threshold for the satisfaction of Commonwealth Heritage criteria is local heritage significance.

The Commonwealth Heritage List is an instrument for managing places on Commonwealth owned or leased land with Commonwealth Heritage values. This assessment has not been undertaken for the purpose of any actual or proposed decision about whether to nominate a place for listing on the Commonwealth Heritage List and it is not presently intended that any items identified in this assessment as having Commonwealth Heritage values would be nominated for inclusion on the Commonwealth Heritage List.

19.2.4.1 The Burra Charter

The Burra Charter defines cultural significance as 'aesthetic, historical, scientific or social value for past, present and future generations' (Australia ICOMOS 1987). The Burra Charter outlines five broad categories applicable to the assessment of the significance of Aboriginal sites. These are:

- significance to contemporary Aboriginal people;
- scientific or archaeological significance;

- aesthetic value;
- representativeness; and
- value as an educational and/or recreational resource.

All Aboriginal heritage sites located within the airport site have been assessed with reference to the Burra Charter.

19.2.4.2 Heritage assessment criteria

The criteria for National Heritage values and Commonwealth Heritage values consist of nine similar assessment criteria but attach different thresholds. The National Heritage criteria specify a threshold of ‘outstanding heritage value to the nation’. None of the cultural values identified at the airport site are considered to fulfil this threshold, and further detail regarding National Heritage values is not presented here.

The threshold for identification of Commonwealth Heritage values is ‘significant’ heritage value (Department of the Environment, Heritage website, accessed June 2015). In accordance with the EPBC Act, a place has a Commonwealth Heritage value if it meets one of the following criteria:

a. the place has significant heritage value because of the place’s importance in the course, or pattern, of Australia’s natural or cultural history;

b. the place has significant heritage value because of the place’s possession of uncommon, rare or endangered aspects of Australia’s natural or cultural history;

c. the place has significant heritage value because of the place’s potential to yield information that will contribute to an understanding of Australia’s natural or cultural history;

d. the place has a significant heritage value because of the place’s importance in demonstrating the principal characteristics of:

    i. a class of Australia’s natural or cultural places, or

    ii. a class of Australia’s natural or cultural environments;

e. the place has significant heritage value because of the place’s importance in exhibiting particular aesthetic characteristics valued by a community or cultural group;

f. the place has significant heritage value because of the place’s importance in demonstrating a high degree of creative or technical achievement at a particular period;

g. the place has significant heritage value because of the place’s strong or special association with a particular community or cultural group for social, cultural or spiritual reasons;

h. the place has significant heritage value because of the place’s special association with the life or works of a person, or group of persons, of importance in Australia’s natural or cultural history; and

i. the place has significant heritage value because of the place’s importance as part of Indigenous tradition.

In guidelines prepared by the Australian Heritage Council it is stated that ‘the threshold for inclusion on the Commonwealth Heritage List is local heritage significance’.

As indicated above, this assessment against Commonwealth Heritage criteria has not been undertaken for the purpose of any actual or proposed decision about whether to nominate a place for listing on the Commonwealth Heritage List.

19.3 Existing environment

This section describes the landscape and cultural context of the airport site. The results of previous archaeological assessments at the airport site are summarised and the results of the field surveys for the current assessment are presented. The outcomes of the stakeholder consultation are outlined and a summary of the assessments of significance is also provided.

19.3.1 Landscape context

19.3.1.1 The regional landscape

The airport site is located on the central western margin of the Cumberland Plain. This section of the Cumberland Plain is where the creek lines drain north and west to the Hawkesbury River (McDonald and Rich 1993). The Cumberland Plain is in a centrally positioned portion of the inner Sydney Basin, which consists of rolling and low gradient topographies that have developed on the shale-dominated bedrocks of the Wianamatta Group of the middle Triassic age.

The Wianamatta Group makes up the uppermost portion of the Triassic depositional sequence and was laid down as epimarine, intertidal, back-swamp and alluvial sediments during a period of marine regression (the exposure of former seabed), and progradation (the seaward and progressive deposition of shoreline deposits) (Smith 1979; Jones and Clarke 1991). The topography of the airport site reflects the underlying geology, which is dominated by the Bringelly Shale, the upper most unit of the Wianamatta Group.

The Cumberland Plain comprises three broad physiographic units:

- the River Plain, comprising the alluvial flats associated with the Nepean-Hawkesbury River, and the Eastern, South and Ropes Creeks (approximately 11 per cent of the plain);
- the Dissected Plateau, where stream incision into the underlying sandstone has occurred, particularly around the margins of the Plain (approximately 33 per cent of the plain); and
- the Shale Slopes, formed on the Ashfield and Bringelly Shales (approximately 56 per cent of the plain) (Department of Environment and Planning 1984).

The airport site falls within the Shale Slopes unit. The airport site, which covers approximately 1,780 hectares, comprises around 1.2 per cent of this unit. Some characteristics of the Shale Slopes unit include:

- gently undulating, rounded hills and valleys with a low degree of vertical differentiation – this has a consequence that in the more elevated country, the network of ridges and spurlines (also known as interfluves) do not pose a major obstacle to, and have less strategic value in, cross-country movement and control;
- mature landforms;
- deep texture contrast soils which are clayey and stiff;
- surface hydrology characterised by a dendritic pattern of drainage lines;

- native vegetation structures dominated by grassy woodland and open forests; and
- broad area flooding and associated aggradation of sediments across valley floor contexts.

19.3.1.2 The airport site

The landscape of the airport site is typical of the Shale Slopes component of the Cumberland Plain. It has low relief, undulating and low gradient topography, and a medium drainage line density. Ground elevation varies from 43 to 118 metres above Australian Height Datum (AHD). The Bringelly Shale outcrops throughout the area. Surface exposures of Minchinbury Sandstone also occur in isolated locations. A post-Triassic basaltic dyke outcrops along a north-west/south-east alignment in the western half of the airport site. The resistant nature of this rock has formed higher slope gradients and a small area of moderately graded undulating terrain. The steeper slopes contain screes of volcanic gravels.

Small areas of naturally occurring surface silcrete gravels occur across some portions of the airport site. These may constitute a surface lag (ancient remnant gravels from a now fully eroded deposit), or relate to as yet poorly mapped subsurface remnants of ancient weathering.

The mapped soil landscapes within the airport site are Blacktown, Luddenham and South Creek (Bannerman and Hazelton 1990).

Most of the airport site falls within the upper catchment of South Creek, a north draining tributary of the Hawkesbury River with a course length of approximately 64 kilometres and a catchment area of around 620 square kilometres (Rae 2007). The far western portion of the airport site forms part of the immediate catchment of the Nepean River, via the north and west draining minor tributary of Duncans Creek. This watershed is significant in terms of the hydrology of the Cumberland Plain but, for most of its length, provides an unimposing topographic feature as a broad and low gradient ridgeline.

The airport site is dominated by upper catchment terrain, with most of its drainage lines originating from headwaters situated within the airport site and reaching third and fourth order streams. The exceptions are Badgerys Creek along the southern and eastern boundary and Duncans Creek just outside the western site boundary. For the purposes of modelling the potential archaeological resource, these two streams have a fifth order status when they leave the site. It should be noted that stream orders identified in this heritage analysis differ marginally from those in other assessments presented in this EIS. This is a consequence of different disciplinary objectives and do not indicate errors in fact. The headwaters of Badgerys Creek are situated about three kilometres upstream of the airport site, and its confluence with South Creek occurs approximately four kilometres downstream. The southern and eastern fall of the Badgerys Creek catchment occupies the southern margin of the airport site. Two tributaries of Cosgroves Creek, including Oaky Creek, drain to the north.

The vegetation across most of the Cumberland Plain prior to European land use comprised open eucalypt woodland in which the trees were widely spaced and the ground cover was dominated by grasses (Perry 1963). Most of the original native vegetation has been cleared and the airport site is now dominated by agricultural grasslands or cultivated fields, with scattered eucalypt and exotic trees and pockets of open eucalypt woodland or shrubland. The remaining native vegetation includes pockets of native grassland and mostly regenerating woodland or forest. Older eucalypts, dating from the early twentieth century, may remain as isolated occurrences.

Since the early 1800s, non-Aboriginal land use of the airport site has been primarily agricultural and has consisted of varied phases of stock grazing, cropping, orchards, dairying and market gardening. A pattern of increasingly smaller subdivision commenced in the mid-nineteenth century and culminated in the delineation of numerous rural residential lots associated with post war immigration. A broader spectrum of activities characterised the middle and later twentieth century including market gardening, hobby farming, animal husbandry such as poultry farming, horse and dog breeding and training, and some light industrial functions.

All of these activities can be expected to have had a substantial impact on the Aboriginal archaeological resource, especially where resident in the top soil and the plough zone. Vegetation clearance and repeated ploughing and cropping will have removed nearly all trees with the potential for Aboriginal scarring. Artefact occurrences will have been affected by soil loss and lateral and vertical soil movement across the land surface, to the depth of the relevant plough zone.

19.3.1.3 Landform classification of the airport site

The following landform categories have been applied in the mapping and analysis of topographic variables across the airport site. This classification has simplified landscape variations into a concise set of types relevant to the archaeological modelling. The classification system includes large scale independent landform categories and a series of sub-categories which only occur in conjunction with a large scale landform category (for example, fluvial corridor within a valley floor).

Table 19–1 summarises the proportion of various landforms within the airport site. The landform categories within the airport site are also defined in Appendix M1 (Volume 4), and shown on Figure 3.3 in that appendix.

Table 19–1 Landform categories within the airport site

Landform category or feature	Area within airport site (hectares)	Net linear distance (kilometres)
Riparian corridor (100 metres either side of drainage line)	711	41.3
Ridge and spur crests	392.3	66.4
Broad scale landforms		
Valley floor	184.0	-
Basal slopes	214.2	-
Mid and upper slopes	1,324.4	-
Total area of 3rd, 4th and 5th order crests	122.5	18.8
Total broad scale landforms within airport site	1,845.1	-

Note: Some of these categories overlap and the area total includes Australian Government owned lands which are non-contiguous with the airport site.

19.3.2 Cultural context

19.3.2.1 Historical context

References to the Aborigines of the Sydney region are found in the journals, diaries and general writings of the early colonists, explorers and settlers.

The location and nature of boundaries between Aboriginal groups in the Sydney region that existed in 1788 are difficult to reconstruct because of the lack of reliable data from that time. A number of authors have variously interpreted the available evidence and drafted maps of the pre-contact and contact territories of Aboriginal people in the Sydney region (Mathews 1901a and 1901b, Capell 1970, Tindale 1974, Eades 1976, Kohen 1986 and 1988, Ross 1988). The identification of tribal boundaries by the early anthropologists, later ethnographers and subsequent linguists have often involved contrasting conclusions, both regarding geographic extent, and whether a distinction relates to a clan, dialect or language (Mathews 1901a and 1901b, Capell 1970, Tindale 1974, Eades 1976, Kohen 1986, Ross 1988).

Since the 1970s, archaeologists and anthropologists working in the Sydney region have adopted the nomenclature for linguistic groups compiled by Capell (1970) and amended by Eades (1976) and Attenbrow (2010). These schemes all place the airport site within the area of the Darug linguistic group. Debate continues whether the use of Darug was exclusively inland or extended in dialect form to the coast on the Sydney Peninsula (Ross 1988, Kohen 1993, Attenbrow 2010).

The Darug peoples bore the first impact of Sydney’s European settlement, because their lands were situated on the Sydney peninsula and the adjoining hinterlands of the Cumberland Plain. The peninsula and its embayments became the residential and commercial focus of the settlement, while the fertile lowlands and woodland of the hinterland were developed for agricultural production and the granting of freehold lands. The Cumberland Plain was an integral component of Darug territory and cultural identity, from which they were incrementally excluded and dispossessed by European land-use and occupation.

In the five decades following the establishment of the Sydney Cove colony, the impact of European incursion saw a steep decline in the Darug population, along with loss of economic autonomy, and a break-down in traditional social organisation and practice. Despite this, the Darug and their descendants maintained their local presence and adapted as necessary to survive as a minority in a drastically changed cultural and social landscape.

Aboriginal people were granted small portions of land in some parts of the Sydney region; however, no references have been found to grants at or within the vicinity of the airport site (Kohen 1993). In fact, by 1821 all of the airport site had been the subject of European land grants, with a majority of the area falling within a 6,710-acre grant made to John Blaxland in 1813 (Robinson 1953). This pattern of land alienation was repeated across most of the Darug lands. The establishment of European ownership imposed a cumulative sequence of constraints on traditional Aboriginal land use. The effect, over the course of a relatively short period of time, was to severely limit access to traditional food and habitation sites and to disrupt the normal seasonal round of movement which formed part of social and territorial life. As a consequence, the Sydney Aborigines displaced by European settlement became increasingly dependent on European food sources, estates to live on, and employment.

Darug people are known to have lived on nearby estates, such as at ‘Mamre Farm’, Orchard Hills, and at Mulgoa (Martin 1988, Keating 1996). Closer to the airport site, oral history recounts how Aboriginal people were living on the Badgery Estate ‘Exeter Farm’ in the mid-nineteenth century (AHIMS site card 45-5-215 27 Jan 1978). Darug descendants continued to have an association with Badgerys Creek into the twentieth century, with families resident in the local district (pers. comm. Ms Sharyn Halls 24 April 2015) and as part of rabbiting expeditions into the 1960s (letter from Colin Gale (DTAC) to Kerry Navin 17 Feb 1997). Further detail regarding early post-European Aboriginal history is provided in Appendix M1 (Volume 4).

19.3.2.2 Archaeological context

The Sydney region has been the subject of detailed archaeological survey and assessment since the passing of legislation protecting Aboriginal sites in 1974. The focus of this assessment has shifted in the last two decades to Western Sydney and in particular to the new urban and industrial developments across the Cumberland Plain. Such research has resulted in thousands of site recordings and a wide range of site types and features. The most prevalent recordings comprise surface occurrences of stone artefacts (ranging from single items to hundreds of artefacts), shell middens, rock shelters containing occupation evidence (including deposits and rock art), grinding groove sites and open context engraving sites. Rare site types include culturally modified trees, quarry and procurement sites, burials, stone arrangements, and traditional story or other ceremonial places.

Hundreds of Aboriginal sites, predominantly open artefact scatters (also referred to as open camp sites), have been recorded within the Cumberland Plain. The camp sites vary greatly in size from small sparse scatters to large concentrations of artefacts. Rare site types that have been recorded include scarred trees, raw material extraction/procurement sites, stratified deposits and grinding groove sites. Unlike the majority of grinding groove sites across the Sydney Basin, which occur on Hawkesbury sandstone, the few recordings on the Cumberland Plain occur on Minchinbury sandstone, making them a rare site type.

The picture of Aboriginal utilisation and occupation of the Cumberland Plain is constantly being revised and refined as archaeological methods improve and more archaeological data become available.

Recent investigations have confirmed that sites occur widely across the landscape, particularly on hilltops and slopes and near creeks. Larger sites with higher artefact densities are more likely to be near permanent water (Haglund 1980, Kohen 1986, Smith 1989a and 1989b, Kohen 1996, McDonald and Rich 1993, Rich and McDonald 1995, Comber 2014). Recent excavations on the Cumberland Plain have also demonstrated that surface sites are generally an inaccurate representation of subsurface deposits (McDonald and Rich 1993, Rich and McDonald 1995, Comber 2014). Subsurface deposits have been found to be present even when there has been no surface indication of a site.

19.3.3 Previously recorded sites at the airport site

The airport site has been the subject of a number of previous archaeological assessments as part of investigations into the potential location for a second Sydney airport. A comprehensive review of these previous assessments is provided in Appendix M1 (Volume 4).

Fifty-one confirmed Aboriginal heritage sites have been recorded within the airport site as a result of previous heritage assessments. These consist of surface artefact occurrences and a modified tree. None of the sites are registered on National or Commonwealth Heritage Lists, but all are registered on the AHIMS. It should be noted that, at the time of the assessment, the AHIMS listed 52 Aboriginal recordings within the airport site.

The general location of the sites is shown in Figure 19–2.

An additional three sites previously recorded were re-inspected to confirm the findings of the previous assessments. The results of these inspections are as follows:

- Possible Aboriginal Scarred Tree, AHIMS 45-5-2634. This site was found to be located outside of the airport site and would not be affected by the construction or operation of the proposed airport. It was, therefore, not considered further in the assessment;
- Possible Aboriginal Scarred Tree, AHIMS 45-5-2630. This site was noted in previous assessments at the airport site to have significant damage. The site was re-inspected and it was found that the condition of the scar was poor, as was that of the tree, which had a hollow trunk and a missing crown. Despite the poor condition of the heartwood and the un-occulated scar, the regrowth around the margin of the scar appeared to be intact. This means that the tree retains a tree-ring record of regrowth following the scarring event; and
- Surface Artefact Occurrence. This site was originally recorded as a single surface artefact by Australian Museum Consulting (AMC) in 2014 and ascribed to the previously recorded site B5 (AHIMS 45-5-2637). Following a refinement of the 1997 grid reference for B5, based on original recording data, it has been determined that the AMC find is located more than 100 metres from the original B5 recording. As a consequence, this is considered to be a new recording of a separate site and has been designated as B136.

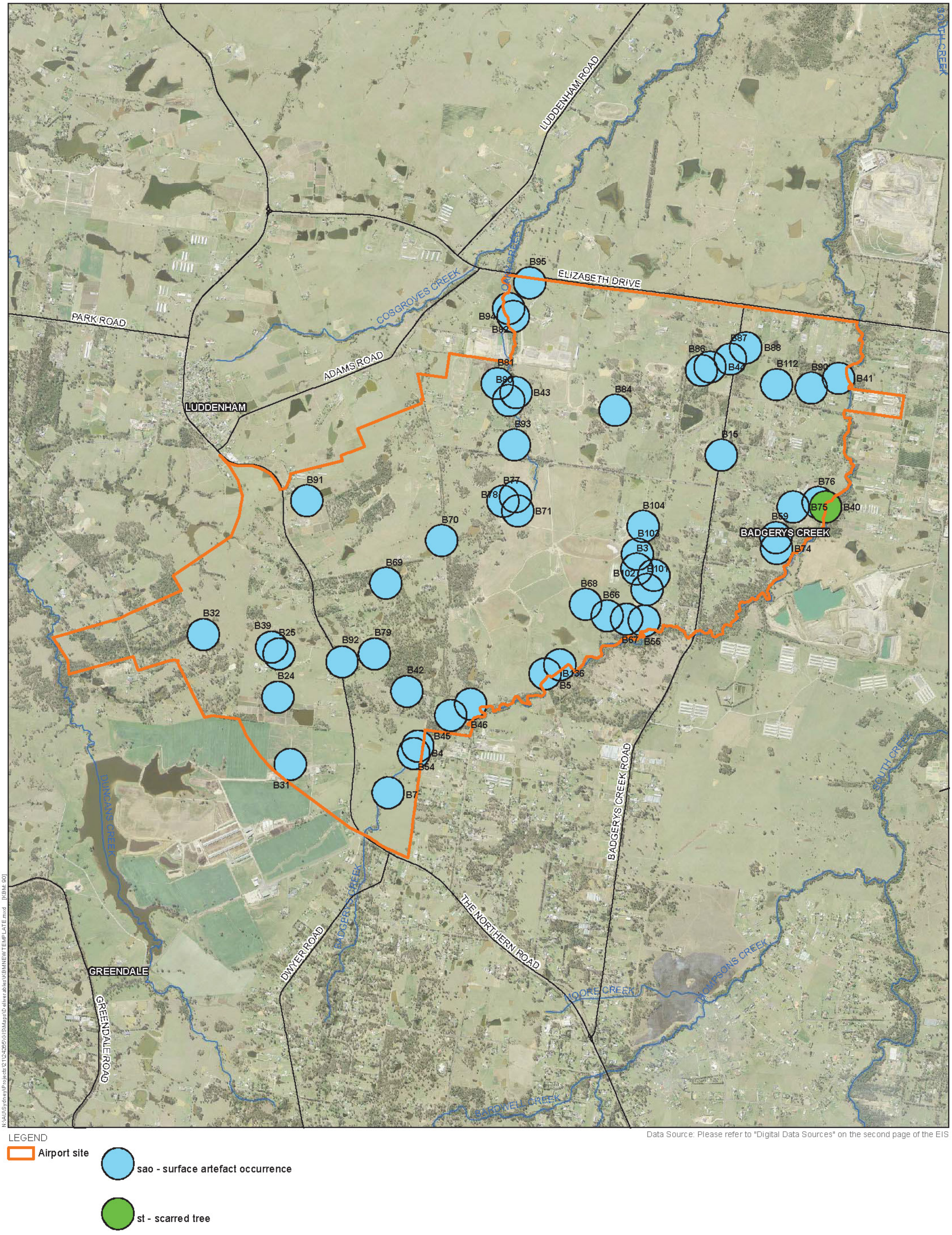


Figure 19-2 - Previously recorded Aboriginal sites at the airport site

19.3.4 Results of EIS field surveys

Twenty-three new recordings of Aboriginal heritage sites were made during the course of the field investigations for the current assessment. These comprised:

- nine recordings with surface artefacts only, including one grinding groove site (B113 to B120 and B122); and
- 14 recordings where subsurface artefacts were confirmed through test excavation (B121, B123 to B135).

Within the latter category, one site also included surface artefacts (B121 at Test Location 9).

A summary of the new site recordings is provided in Table 19–2. The locations of all site recordings to date at the airport site are shown in Figure 19–3.

Table 19–2 Summary of new Aboriginal heritage sites recorded at the airport site during field investigations

Site number/type		Number of surface stone artefacts recorded	Test location and test pit numbers	Type of ground surface exposure
B113 -	Surface artefact occurrence	20	-	Eroded track and dam wall
B114 –	Surface artefact occurrence	10	-	Eroded track, creek edge
B115 –	Surface artefact occurrence	20	-	Erosion and disturbance
B116 –	Surface artefact occurrence	2	-	Track
B117 -	Surface artefact occurrence	2	-	Erosion scald
B118 –	Surface artefact occurrence	2	-	Edge of ploughed field
B119 -	Surface artefact occurrence	2	-	Gate exposure
B120 –	Grinding grooves	at least 4 grooves	-	Sandstone outcrop
B121 –	Surface and subsurface artefact occurrence	3	TL9, test pits 2-10	Track/gate exposure
B122 -	Surface artefact occurrence	1	-	Dam wall
B123 -	Subsurface artefact occurrence	-	TL6, test pits1-4	-
B124 -	Subsurface artefact occurrence	-	TL6, test pits 9, 10	-
B125 -	Subsurface artefact occurrence	-	TL8/10, test pits 3, 4	-
B126 -	Subsurface artefact occurrence	-	TL8/10, test pits 7, 9	-
B127 -	Subsurface artefact occurrence	-	TL13, test pit 3	-
B128 -	Subsurface artefact occurrence	-	TL14, test pits 1, 3	-
B129 -	Subsurface artefact occurrence	-	TL14, test pit 8	-
B130 -	Subsurface artefact occurrence	-	TL23, test pit 9	-
B131 -	Subsurface artefact occurrence	-	TL26/27, test pit 11	-
B132 -	Subsurface artefact occurrence	-	TL32, test pits 3,4	-

Site number/type		Number of surface stone artefacts recorded	Test location and test pit numbers	Type of ground surface exposure
B133 -	Subsurface artefact occurrence	-	TL32, test pits 9, 10	-
B134 -	Subsurface artefact occurrence	-	TL37, test pits 1,2,4, 5	-
B135 -	Subsurface artefact occurrence	-	TL4, test pit 5	-

19.3.4.1 Surface recordings

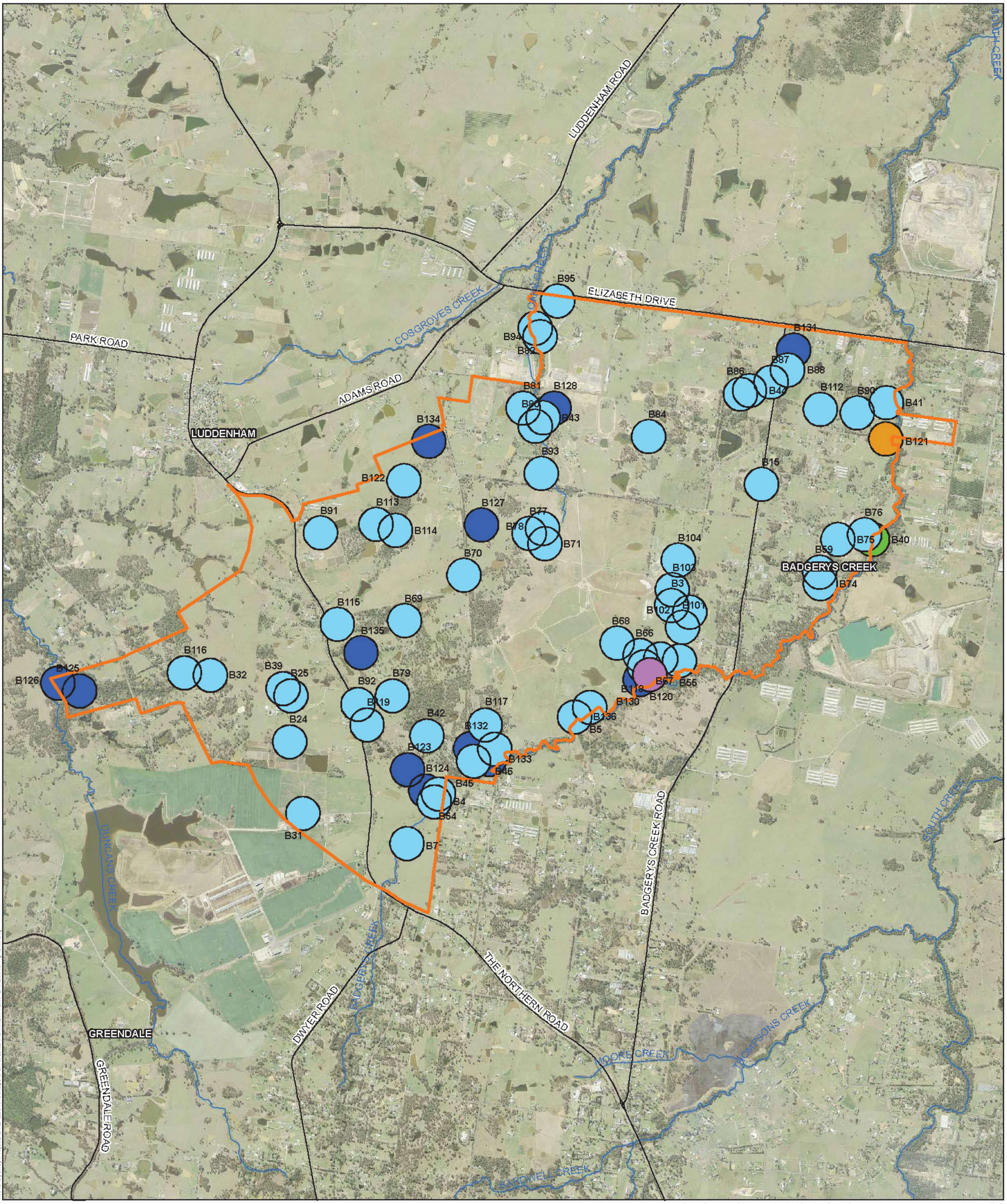
Details of the nine new surface sites recorded during the field surveys are provided in Table 19–3.

Table 19–3 Details of new surface recordings

Site number/type	Description	Artefacts
B113 – Surface artefact occurrence	• Open context artefact occurrence of at least 20 surface artefacts exposed along an eroded vehicle track and dam wall. • Artefacts situated on a low gradient minor (first order) spurline, and low rise, situated between and just upstream of the confluence of two second order streamlines (tributaries of Cosgroves Creek). • Situated in a basal slope valley context. • Artefacts located over an area of approximately 150 x 30 metres. • Subsurface archaeological potential away from exposures and eroded surfaces assessed to be high.	Chert flakes, silcrete flakes, quartz flake and possible axe
B114 – Surface artefact occurrence	• Open context artefact occurrence of at least ten surface artefacts exposed along an eroded track and creek edge. Artefacts situated on low gradient slopes adjacent to, and the western banks of, a secondary order streamline (a tributary of Cosgroves Creek). • Situated in a basal slope valley context. • Artefacts located over an area of approximately 110 x 20 metres. • Subsurface archaeological potential away from exposures and eroded surfaces assessed to be high.	Chert and silcrete flakes
B115 – Surface artefact occurrence	• Open context artefact occurrence of at least 20 artefacts exposed within a disturbed area in a former church yard. • Artefacts situated on the crest of a prominent fourth order ridgeline where it intersects with a major watershed fifth order ridgeline. • Artefacts located over an area of approximately five by five metres. • Subsurface archaeological potential away from exposures and disturbed ground is assessed to be high.	Quartz flakes
B116 – Surface artefact occurrence	• Open context artefact occurrence of at least two artefacts exposed on an eroded vehicle track which steeply traverses low to moderately graded mid slopes on the side of a spurline. • Site situated upslope of a dam which impounds a second order streamline (tributary of Duncans Creek). • Artefacts located approximately five metres apart. • Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be low.	Quartz flake, chert flakes

Site number/type	Description	Artefacts
B117 – Surface artefact occurrence	• Open context artefact scatter of at least three surface artefacts exposed in erosion scalds along a low gradient crest of a first order spurline. • Exposures situated along the edge of a group of trees. • Spurline crest faces south and descends to a narrow portion of the Badgerys Creek valley floor. • Site is situated in a mid-slope valley context. • Artefacts located approximately eight metres apart. • Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be high.	Basalt flake, basalt hammerstone, silcrete flake
B118 – Surface artefact occurrence	• Open context artefact occurrence of at least two surface artefacts exposed on a recently ploughed track on the southern edge of a ploughed field. • Site is situated just above the break-of-slope of a broad crest of a third order ridgeline, approximately 150 metres north of Badgerys Creek. • Artefacts located approximately one metre apart. • Subsurface archaeological potential is assessed to be moderate, although repeated ploughing of this landform may have significantly disturbed the vertical context of subsurface artefacts.	Quartz flakes
B119 – Surface artefact occurrence	• Open context artefact occurrence of at least two artefacts exposed in a scoured area on the eastern side of a gate situated between a house paddock and the paddock behind (to the east). • Artefacts situated on a first order spurline located between, and just upstream of, the confluence of a third and a second order streamline (tributaries of Badgerys Creek). • Site situated in a basal slope valley context. • Subsurface archaeological potential away from exposures and eroded surfaces is assessed to be moderate to high.	Chert flake
B120 – Grinding grooves	• Four grinding grooves located on a series of small sandstone outcrops situated on, and just below, the break-of-slope of a mid-valley context ridge-side bench. • Bench is relatively narrow (around 40 metres wide), faces south, and extends for approximately 400 metres along the middle portion of a third order ridgeline which rises 26 metres above the creek. • Grinding grooves are located on a discontinuous and low surface outcrop of Minchinbury sandstone which is mostly exposed on the steep slope immediately downslope of the bench. • Grooves are located on three separate sandstone outcrops, two with one definite groove each and the (western most) third with two definite and two probable grooves. • Sandstone outcrops form part of an east–west aligned group of low, near ground level outcrops, and extend across a distance of 33 metres. • Located in Test Location 23. No subsurface artefacts were detected on the bench. One stone artefact was detected at this test location, and this was situated on basal slopes 4.5 metres above Badgerys Creek (site B130).	
B121 – Surface and subsurface artefact occurrence	• Open context artefact occurrence of at least two surface artefacts. • Site located on alluvial flats adjacent to Badgerys Creek, in a valley floor context. • Artefacts, approximately five metres apart, visible in erosion scalds in a road reserve at	Silcrete flakes

Site number/type	Description	Artefacts
	the eastern end of Pitt Street.	
B122 – Surface artefact occurrence	• Open context artefact occurrence of a single surface artefact exposed on the wall of an agricultural dam which impounds a third order streamline (tributary of Cosgroves Creek). • Site situated in a valley floor context and in relative proximity to the natural course of the creek line. • Subsurface archaeological potential away from the disturbed ground of the dam wall and impoundment is assessed to be moderate to high.	Silcrete flake



LEGEND

Airport site

gg - grinding groove

sao + ssao - surface and subsurface artefact occurrence

st - scarred tree

sao - surface artefact occurrence

ssao - subsurface artefact occurrence

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

0 0.25 0.5 1
Kilometres

Figure 19-3 - Total Aboriginal sites recorded at the airport site, to date

19.3.4.2 Subsurface recordings

Aboriginal artefacts were recovered from 10 of the 11 test locations. A total of 91 artefacts were recovered from the 39 test pits. A summary of the test location artefact numbers is provided in Table 19–4.

Table 19–4 Summary of artefact recovery data from test locations

Test location	Number of artefacts	Broad scale landform	Fine scale landform
1	0	Major watershed ridgeline	Crest/upper slope
4	1	Secondary watershed ridgeline	Crest
6	10	Mid slope, basal slope, valley floor	Minor spur crest, slope, alluvial flats
8/10	4	Mid slope, basal slope, valley floor	Minor spur crest, alluvial flats
9	36	Basal slope, valley floor	Slope, alluvial flats
13	1	Secondary spurline crest	Knoll, crest, shoulder
14	8	Mid slope, basal slope, valley floor	Minor spur crest, elevated rise
23	1	Upper slope, mid slope, basal slope	Break-of-slope, slope, minor spur crest, fan
26/27	17	Floor, valley floor, basal slope, upper slope	Alluvial flats, slope
32	7	Mid slope, basal slope, valley floor	Minor spur crest, alluvial flats, alluvial terrace
37	6	Valley floor, basal slope	Elevated rise/terrace, minor spur crest

19.3.4.3 Artefact analysis

A detailed analysis of the stone artefacts recovered during the test pit excavations is presented in Appendix M1 (Volume 4). The conclusions of the analysis are summarised below.

- Subsurface artefacts were unevenly distributed between the different excavated areas, with the majority of areas yielding relatively few artefacts, and a small number of the excavated areas being relatively rich.
- Assemblages from all excavated areas were dominated by silcrete over other raw materials and by unretouched flakes over other artefact types.
- Retouched artefacts make up 12 per cent of the combined artefact assemblage, with the majority of these being backed artefacts.
- The majority of flakes in the combined assemblage have little or no dorsal cortex. Flakes are generally small in size, with a diverse variety of platform types. It is inferred from this that the flake assemblage was produced from small parent rocks, which had been heavily reduced in size and were being exploited as a valuable resource.
- There is no evidence that the production of flakes within the study area was geared toward the preferential production of any particular flake morphology.

- The analysis of landform variables relative to the tested subsurface archaeological resource provided the following findings:
  - subsurface artefact density is unevenly distributed between landform categories, with valley floors and alluvial flats having significantly higher artefact densities than other landforms;
  - subsurface artefact density is significantly higher in lower valley contexts than it is in middle and upper valley contexts;
  - subsurface artefact density is positively correlated with the order of the closest drainage line, and with the order of the largest drainage line within 100 metres;
  - subsurface artefact density is inversely correlated with elevation, with lower lying areas having higher densities of subsurface artefacts. These areas are also associated with higher order drainage lines;
  - subsurface artefact density is inversely correlated with watershed spurline order, with areas associated with lower spurline orders having higher artefact densities. Low order spurlines are generally associated with higher order drainage lines; and
  - as a general inference from multiple lines of data, subsurface artefacts are associated with areas likely to have had easier access to sources of water.

19.3.4.4 Archaeological sensitivity of the airport site

The average areal incidence of subsurface artefacts (artefacts per square metre) according to key landform units was found to provide an effective means of gauging archaeological sensitivity across the airport site. Landforms with a relatively high average artefact incidence (defined to be equal to or greater than one artefact per square metre) at the airport site are:

- valley floor;
- basal slopes;
- first order spurlines;
- within 100 metres of a second order streamline;
- within 100 metres of a third order streamline; and
- within 100 metres of a fourth order streamline.

See Section 19.3.1 for further detail on these landform units.

19.3.5 Consultation

This section presents the results of the stakeholder consultation undertaken for the current assessment.

19.3.5.1 Aboriginal cultural values

The Aboriginal stakeholders consulted for this assessment have identified the airport site as a place of Aboriginal cultural significance and continuing cultural connection.

The reasons for this include:

- **Material evidence of occupation.** The presence of archaeological sites throughout the airport site is a manifest link with their ancestors, with a past way of life and with a continuing cultural association with the land. Archaeological sites are a tangible component of cultural identity and traditional ownership. In this regard, all archaeological sites are considered by stakeholders to have cultural significance, regardless of their size, complexity or archaeological interpretation. The relationship between the position of an artefact and its surrounding landscape also has cultural significance. This is often expressed by stakeholders when they specify that after analysis, salvaged artefacts should be returned to 'their country'.
- **Cultural landscape values.** Although information relating to remembered traditional events in specific places has not been provided, many stakeholders state that the airport site landscape has cultural significance according to traditional lore. A number of landscape features, including prominent ridgelines and the Badgerys Creek corridor, can be interpreted with reference to traditional knowledge held by various custodians. Many stakeholders expressed the view that there would have been areas and features that would have held special significance, including relationships to stories and lore associated with gender roles.
- **Significant plants, animals and resources.** The continuing presence of native animals and plants, and the habitat they require, is considered to be an important part of the cultural significance of the airport site. These are important as traditional sources of food, medicine and raw materials, and for the specific stories and lore associated with them. Some stated examples of significant resources were yams, fresh water mussel, possums, tree timber and bark, and the water from Badgerys Creek. Areas of remnant native vegetation and the riparian corridors of the main creek lines were specifically referenced in this regard.
- **Educational value.** Many stakeholders made reference to the need to educate young people about their culture, lore and traditions. The conservation of Aboriginal sites so that they can be accessed for teaching and interpretation is considered to be an important part of maintaining cultural identity, practice and continuity. The educational values of the Badgerys Creek sites in general, and of the grinding groove site (B120) and the scarred tree (B40) in particular, were recognised by many stakeholders. Similarly, the remnant natural vegetation and riparian corridors across the study area were seen as important educational resources.
- **A disappearing heritage.** A repeated concern expressed by stakeholders was the cumulative impact on Aboriginal sites caused by the continuing urban and industrial development of Sydney across the Cumberland Plain. Given the loss of sites to date, the remaining sites, such as those at the airport site, are now recognised to have cultural value because of their increasing rarity, the need to retain artefacts and sites in their natural landscapes and original locations, and their ability to support the relationship with the land and the sense of cultural identity.

The Aboriginal stakeholders were consistent in acknowledging the importance of information gained from archaeological recording and analysis. Examples given include the evidence of radiocarbon dating, and the ability to identify past patterns of behaviour, occupation, adaptation, and technological and social change. Archaeological information is seen as complementary to remembered tradition and lore, and evidence from historical records.

While the value of the archaeological method, and the information it generates, is recognised as clearly distinct from Aboriginal cultural evaluation, it is also acknowledged by Aboriginal stakeholders that the potential of a site or an archaeological deposit to provide information about the past has high Aboriginal cultural value.

19.3.5.2 Non-Aboriginal stakeholder views

Liverpool City Council and the NSW OEH recommended the following issues be considered in the Aboriginal cultural assessment:

- cultural landscape and recording of social history;
- cumulative impacts;
- managing artefacts which would remain on-site during the proposed development of the airport site; and
- potential provision of a keeping place and alternative forms of cultural interpretation.

Further details regarding the issues raised during consultation are included in Appendix M1 (Volume 4). Additional comments received during the public consultation process for the EIS are summarised in Volume 5.

19.3.6 Assessments of heritage value

The results of the assessments of heritage value are summarised below, with further detail provided in Appendix M1 (Volume 4).

19.3.6.1 Individual site assessments

Artefact occurrences comprise 72 of the 74 recorded sites at the airport site. Fifteen of these include confirmed subsurface archaeological deposits and 48 have been assessed as having moderate or high subsurface archaeological potential.

Thirty-five of these recordings (49 per cent of artefact occurrences) comprise a single artefact and nine recordings include more than 10 artefacts. The highest number of artefacts recorded is 64, from the 2014 surface reinspection of site B80 by AMC (AMC 2014). The next highest is 38 from site B121, of which 36 were recovered from test pits. Based on the maximum artefact count across the various inspections and tests at each site, there are 371 stone artefacts associated with the recorded sites within the airport site.

Fifty-one of the artefact recordings are assessed as having the potential to yield information that will contribute to an understanding of Australia's cultural history. All are considered to have a strong association with a cultural group for social, cultural or spiritual reasons, and form part of indigenous tradition.

There is one recording of a scarred tree at the airport site (B40) which has been assessed as being of possible Aboriginal origin. Although the condition of the tree and the scar is poor, the tree retains a tree-ring record of regrowth following the scarring event. Scarred trees are relatively rare on the Cumberland Plain and represent strong cultural associations and connection with indigenous tradition. Despite the poor condition of the tree and scar, it is still considered to have potential to yield information that will contribute to the understanding of Australia's culture.

There is one recording of a grinding groove site at the airport site (B120). This site consists of at least four grinding grooves on a series of small sandstone outcrops on the edge of a hill side bench, 14 metres above, and around 100 metres from Badgerys Creek. The site is a rare example of grinding grooves located on Minchinbury sandstone within the Cumberland Plain.

An assessment of each site is provided in Table 8.1 in Appendix M1 (Volume 4).

19.3.6.2 The archaeologically sensitive landscape

The results of the test excavation programme, in combination with the surface survey results, have confirmed an interrelated distribution of archaeological sensitivity which is graded and distributed according to key landform variables. Key factors in combination are proximity to water, the order (here used as an approximation of size and degree of permanence) of the water source, locally elevated ground and first order spurlines within valley floor and basal slope contexts, low gradients and aggrading depositional contexts.

Landforms and zones in which relatively higher subsurface artefact incidences have been detected (defined in this study as one or more artefacts per square metre) comprise just under half (48 per cent) of the airport site. The highest average subsurface artefact incidence was 3.1 artefacts per square metre, from select topographic contexts on the valley floor. The valley floor accounts for 10 per cent of the airport site.

Highest potential artefact occurrences on the valley floor are predicted to occur within 100 metres of third, fourth and fifth order streamlines. These fluvial corridors account for 17 per cent of the airport site (approximately 316 hectares) and occur roughly equally across the valley floor and basal slope landform categories. The latter two categories also contain the greatest potential for subsurface archaeological deposits, and for potentially rare and higher value archaeological deposits.

A total of 280 stone artefacts have been recorded from the surface of the airport site. The predicted assemblage of subsurface artefacts within the landforms with relatively high artefact incidence would far exceed this number. The predicted archaeological resource within the identified sensitive archaeological landscape must, therefore, be a foundation component of any assessment of the cultural heritage values within the airport site.

Uncommon, rare or endangered aspects of Australia's cultural history

The predicted and collective subsurface archaeological resource present across the airport site is not considered to be outstanding in terms of artefact incidence or the technological diversity of the sampled assemblages. The content and variability of the analysed artefact assemblage remains consistent with the predictive model for the Cumberland Plain, and the resource can generally be regarded as characteristic of archaeological material from upper catchment and watershed regions of the Cumberland Plain.

The planned and continuing urban development of the Cumberland Plain will further affect the upper catchment landscapes that include the airport site. As the proportion of undeveloped land decreases, this cumulative impact is expected to confer an increasing degree of rarity to the remaining archaeological record. Based on this outline, the predicted archaeological resource of the airport site is assessed as an endangered aspect of Aboriginal cultural history.

Potential to yield information that will contribute to an understanding of Australia's cultural history

The predicted archaeological resource within the airport site has considerable potential to yield information that will contribute to an understanding of the Aboriginal cultural history of the Sydney Basin. Based on the evidence of the sampled archaeological deposits, the airport site provides a potential opportunity to conduct systematic archaeological research on a representative sample of sites within an upper catchment landscape. This resource, and the opportunity to investigate it as a whole, will become increasingly limited in the future. Such research would complement previously conducted large area archaeological investigations that have typically occurred in lower catchment landscapes and in association with higher order drainage lines.

The distribution of aggrading landforms across the valley floor and basal slopes, and at a lesser and finer scale across the remainder of the airport site, provides potential for encountering rarer sites, such as cultural deposits associated with buried former land surfaces. Although this potential is considered to be highly limited and difficult to quantify using stage one test excavation methodologies, a review of geotechnical borehole data indicates scope for addressing this potential in future studies (see to Appendix M1 (Volume 4) for further detail).

Association with a cultural group for social, cultural or spiritual reasons

Based on statements made consistently by all stakeholders, the remaining Aboriginal archaeological record across the airport site has a strong association with persons who identify as Darug, or as Darug descendants. This association is expressed both in terms of cultural identity and a spiritual dimension. The latter may relate to the memory or 'presence' of Darug ancestors, and a belief that artefacts 'belong to', and should remain in, the 'country' where their makers and users left them. The presence of artefacts within the soil matrix, and as a part of the landscape itself, is often referenced as evidence of traditional ownership and a cultural relationship with country. Aboriginal stakeholders frequently state that all archaeological sites, ranging from single artefacts to large assemblages, are considered to have cultural significance in this way.

Importance as part of Indigenous tradition

Based on statements by Darug stakeholders, all Aboriginal sites within the airport site, including those not yet detected (the predicted archaeological resource) are important to a wider regional tradition that remembers and celebrates the Darug relationship with their land. This relationship is described both in terms of a long history (thousands of years), and as a continuing living tradition. The Macquarie Dictionary defines 'tradition' to be 'the handing down of statements, beliefs, legends, customs, etc., from generation to generation, especially by word of mouth or by practice' (Butler 1988:1798). The Aboriginal sites on the airport site are an integral part of a cultural landscape which acts as the foundation for this remembrance.

19.4 Assessment of impacts during construction

Construction of the proposed Stage 1 development would affect at least 39 Aboriginal sites, as listed in Table 19–5. All of these sites contain artefact occurrences.

Table 19–5 Aboriginal heritage sites directly affected by construction of the Stage 1 development

Development area	Affected surface sites	Total
Construction impact zone	B15, B24, B25, B32, B39, B43, B44, B69, B70, B71, B77, B78, B79, B80, B81, B82, B84, B86, B87, B88, B91, B92, B94, B95, B101, B102, B104, B112, B113, B114, B115, B116, B119, B122, B127, B128, B129, B131, B134	39

With regard to the predicted subsurface archaeological resource, construction of the proposed Stage 1 development would directly affect approximately 514 hectares of archaeologically sensitive landform. This constitutes about 29 per cent of the airport site. These landform categories, and their affected proportions, are presented in Table 19–6.

The Stage 1 development would directly affect all of the archaeologically sensitive landforms associated with the airport site's three north flowing, third and fourth order tributary drainage lines. A portion of the riparian corridor within the airport site along Badgerys Creek would be protected within an environmental conservation zone. The archaeological resource within this zone would also be protected by this zoning.

All of the higher relief and prominent topography of the airport site would be transformed into a level and graded platform. This would alter and remove the natural topography that acts as a medium for Aboriginal people to 'read' and experience the Aboriginal cultural values of the land.

Table 19–6 Archaeologically sensitive landforms within the airport site

Landform	Extent within airport site (hectares)	Extent within Stage 1 construction impact zone (hectares)
Riparian corridor (100 metres either side of drainage line)	369.6	261.0
Ridge and spur crests	120.3	69.0
Valley floor	184.0	50.4
Basal slopes	214.2	133.7
Total	888.1	514.1

19.5 Assessment of impacts during operation

Impacts during operation of the proposed Stage 1 development would be limited to indirect impacts on adjacent and nearby sites. All known sites within approximately 500 metres of the construction impact zone of the Stage 1 development consist of artefact occurrences. The heritage values of sites of this type are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the Stage 1 development would be low.

19.6 Greater Blue Mountains World Heritage Area

The Aboriginal cultural heritage values of the Greater Blue Mountains World Heritage Area are not included within the area's currently registered World Heritage values. They do, however, complement the world heritage area's listed biological values. There is little potential for the proposed airport to directly affect the Aboriginal cultural heritage values of the Greater Blue Mountains Area.

Indirect impacts on values potentially include those associated with the temporary loss of contextual value from periodic exposure to low level aircraft noise or visual intrusion of aircraft arriving at or departing from the proposed airport. These impacts could potentially affect the experience of those visiting sites, such as rock shelters and open sites, where there is an expectation or requirement for a quiet and natural surrounding environment. Aboriginal sites within this category could include publicly accessible sites, sites at which traditional Aboriginal activities are performed and sites within wilderness zones.

A limited number of sites have been developed or interpreted for public visitation in the Blue Mountains National Park, including Shaws Creek, Burralow, Red Hands Cave, Campfire Creek, Kings Tableland, Lyre Bird Dell and Asgard Swamp (DECC 2009c; Attenbrow 2010).

Wilderness zones form part of the current management zoning in the Greater Blue Mountains Area and incorporate objectives such as the conservation of 'pre-European' landscapes with minimal historical and European intrusion, including aircraft noise and vapour trails (DECC 2009c).

Based on the above discussion, any potential impacts from the proposed airport that may affect Aboriginal cultural heritage values of the Greater Blue Mountains Area would be indirect in nature and would likely relate to low levels of aircraft noise and visual intrusion from aircraft.

Impacts on the Greater Blue Mountains World Heritage Area are assessed in detail in Chapter 26.

19.7 Mitigation and management measures

An Aboriginal Cultural Heritage Construction Environmental Management Plan (CEMP) will be prepared and approved prior to commencement of the survey and salvage programmes detailed in Table 19–7. The plan will be developed in consultation with Aboriginal stakeholders and relevant government agencies. The plan will include both short and long term strategies, and address actions required prior to, during and after construction.

Mitigation and management of impacts during operation will also be incorporated into the Biodiversity, Land and Safety Operational Environmental Management Plan (OEMP) to be approved prior to commencement of operation of the proposed airport.

The plans will collate the mitigation and management measures itemised in Table 19–7. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Table 19–7 Mitigation and management measures

Issue	Mitigation measures	Timing
Aboriginal stakeholder consultation	The Aboriginal Cultural Heritage CEMP will contain an Aboriginal stakeholder consultation and engagement plan that specifies the nature and frequency of consultation throughout the design and construction phase for the proposed airport. The aims of the consultation are to: • inform on, and provide an opportunity for feedback regarding, all matters relating to the mitigation and management of Aboriginal cultural heritage values across the airport site; • provide a forum for organising future stakeholder participation in mitigation and management activities; • provide opportunities to comment on all policy and documentation drafted in regard to the mitigation and management of Aboriginal cultural values; and • provide an opportunity for Aboriginal stakeholders to participate in field actions involving the mitigation and management of Aboriginal cultural values. The Aboriginal stakeholder consultation and engagement plan wilkl be developed in conjunction with the broader Community and Stakeholder Engagement CEMP as outlined in Chapter 28 (Volume 2b) Table 28–20.	Pre-construction Construction
Conservation of heritage sites	The possible scarred tree (B40) and the grinding groove site (B120) will be conserved in situ within an Environmental Conservation Zone at the airport site. A low barrier fence, which does not obstruct pedestrian traffic, would be erected around specific heritage sites as is necessary to demarcate the area as a no-go zone for vehicles. The barrier would be situated so that it does not intrude upon the immediate visual and landscape quality of the heritage sites and their surrounds.	Pre-construction Operation
	The Environmental Conservation Zone will be managed for the protection and conservation of known and predicted Aboriginal heritage sites and values consistent with the objectives of that zone to enhance, restore and protect the cultural values of the land.	Pre-construction Operation
	The Environmental Conservation Zone will be managed in accordance with the Aboriginal cultural heritage mitigation and management measures established in the Aboriginal Cultural Heritage CEMP with the conservation of known and predicted Aboriginal heritage sites as one of the principal objectives	
Recording and salvage of heritage sites	A targeted and selective archaeological surface survey would be conducted within those areas of the construction impact zone not previously subject to surface survey (and excluding highly disturbed areas) before commencement of Main Construction Works. The aim of this survey is to identify all visible surface Aboriginal sites for recording and management prior to commencement of Main Construction Works.	Pre-construction Construction
	A comprehensive archaeological inspection of surface sandstone outcrops across the construction impact zone would be conducted before activities related to Main Construction Works. This action has the aim of appropriately recording and salvaging stone surfaces with evidence of Aboriginal markings.	Pre-construction
	Archival recording of the possible scarred tree (B40) and grinding groove site (B120) would occur before the start of any ground disturbance works within the area of these Aboriginal heritage sites or before Main Construction Works commence, whichever occurs first. This has the objective of providing a baseline record and information upon which to develop a conservation management plan for these sites.	Pre-construction

Issue	Mitigation measures	Timing
	An oral history will be recorded with the aim of preserving memories and stories from Aboriginal people relating to the airport site and its district. It is intended that this record would serve as an archive and a resource for future interpretation of the Aboriginal heritage values of the site.	Pre-construction Construction
	A selective salvage programme will be conducted of surface artefacts recovered across known Aboriginal artefact occurrences in the construction impact zone, with the aim of avoiding damage from activities related to Main Construction Works. This action would address strongly held concerns of Aboriginal stakeholders about the protection of artefacts from construction impacts. The collection programme would be conducted using an archaeological methodology and the resulting assemblage would be integrated into the archaeological analysis of salvaged material, where appropriate.	Pre-construction Construction
	A selective archaeological salvage programme will be conducted in the construction impact zone. The objective of the programme is to manage impacts to archaeological or scientific values by recovering and analysing a representative sample of surface and subsurface archaeological material from the areas subject to construction impact. The programme will aim to: • recover archaeological material from all landform types based on a systematic and representative sampling matrix; • recover additional archaeological material from areas with assessed relatively higher archaeological value, with the objective of providing a large enough artefact population for statistical analysis and from which robust results can be derived; and • apply archaeological excavation methodologies which are appropriate to the expected archaeological resource and the objectives of the salvage. As part of designing the salvage programme, consideration will be given to the feasibility of integrating relevant and existing geotechnical data into the process of determining the location and scope of the salvage programme.	Pre-construction Construction
Protocols for discovery of artefacts and human remains	Protocols will be developed and implemented for the unanticipated discovery of Aboriginal objects, and for the discovery of any suspected human remains for all Main Construction Works involving ground disturbance.	Pre-construction Construction
	A protocol will be developed for the management of topsoil assessed as likely to contain a relatively high density of Aboriginal artefacts, and which would otherwise be impacted by construction activities. The aim of this protocol is to manage excavation, storage and placement of this material in a culturally appropriate manner that minimises potential impact to the Aboriginal cultural values resident in these artefacts from activities related to Main Construction Works. Any excavated material will be placed within the Environmental Conservation Zone where possible. The protocol will be developed in consultation with Aboriginal stakeholders.	Pre-construction Construction
Induction training	Training in the identification of Aboriginal artefacts and management of Aboriginal heritage values will be included in compulsory induction courses for site workers. The content of this component will vary according to the stage of construction. After the completion of major cut and fill actions, training may focus on the management of spoil where there is a risk of impacting artefacts, and on no-go areas, where relevant.	Pre-construction Construction

Issue	Mitigation measures	Timing
Commemoration of Aboriginal heritage	The Aboriginal cultural heritage values of the airport site will be commemorated. Options for consideration may include: • the use of Darug words and language in the naming of places and infrastructure; • the dedication of various spaces and places for the placement of art and interpretive elements, storage and display of cultural items, and/or the conduct of cultural activities; and • the provision of public access and interpretive facilities at Aboriginal sites conserved in situ within the Environmental Conservation Zone (such as for sites B40 and B120), subject to safety and security requirements.	Pre-construction
Curation and repatriation of heritage items	One or more areas of open ground will be reserved within the Environmental Conservation Zone, as required, and managed for the primary purpose of repatriation of salvaged Aboriginal cultural material through reburial. The area(s) will be selected and managed in consultation with Aboriginal stakeholders. This provision is to accommodate the repatriation of cultural material for which it is not considered necessary by Aboriginal stakeholders to store above-ground, or to retain access for cultural purposes, interpretation, education or research.	Pre-construction Construction
	Following the completion of archaeological description and analysis, Aboriginal cultural material salvaged from the airport site will, in the first instance, be stored at an appropriate place to be determined in consultation with Aboriginal stakeholders and relevant government agencies. The longer term storage of material not to be repatriated through reburial, and potentially material salvaged from other developments in Western Sydney and the Cumberland Plain, will be managed in consultation with Aboriginal stakeholders, the NSW Office of Environment and Heritage, and relevant Australian and local government agencies, with the aim of establishing, with the support and collaborative action of governments and other stakeholders, an Aboriginal cultural heritage 'keeping place' that would provide secure, above ground storage of artefacts and enable future access for cultural purposes, interpretation, education or research.	Pre-construction Construction

19.8 Conclusion

Construction of the proposed Stage 1 development will affect at least 39 Aboriginal heritage sites recorded at the airport site, all of which comprise artefact occurrences. Construction activities will also affect approximately 514 hectares of archaeologically sensitive landforms.

Impacts during operation of the Stage 1 development will be limited to indirect impacts on adjacent and nearby sites. The heritage values of these sites are unlikely to be vulnerable to indirect impacts such as loss of context. Consequently, the operational impacts of the Stage 1 development will be low.

Mitigation and management measures will be implemented to minimise the impacts on cultural heritage. These measures include the conservation of heritage sites, recording and salvage of heritage sites, the commemoration of cultural heritage values at the airport site, curation and repatriation of heritage items, and protocols for the discovery of artefacts and human remains.

20 European heritage

The assessment of European heritage identified 20 European heritage items at the airport site and an adjacent site[6] plus an additional 22 heritage items in the surrounding area. The identified European heritage items generally have local significance and potential Commonwealth Heritage value given their presence on Commonwealth land.

The identified items reflect the historical context of the airport site and European settlement more generally, including early attempts to develop local agricultural and pastoral economies and the emergence of settled village communities.

The revised draft Airport Plan indicates that most existing structures and certain infrastructure across the airport site will be removed and/or demolished to facilitate the Stage 1 development, precluding preservation of European heritage items in situ.

European heritage items at the airport site will be documented and salvaged before construction activities commence, where feasible and prudent. Measures to mitigate and manage impacts on European heritage will be collated in environmental management plans before construction and operation. Other measures to mitigate and manage impacts to European heritage values at the airport site include consideration of the preparation of an oral history of the site.

20.1 Introduction

This chapter provides a review of the European heritage values in localities potentially affected by the development of the proposed Western Sydney Airport. The chapter draws on a comprehensive assessment of European heritage (see Appendix M2 (Volume 4)).

The assessment addresses the Australian Government's environmental assessment requirements for European and other heritage aspects of the proposed airport development together with comments and recommendations from the Heritage Division of the NSW Office of Environment and Heritage.

The assessment of European heritage draws upon the results of previous assessments and documentation for the airport site and augments this information with further research, site investigations, test excavation and analysis.

As such, this assessment draws on European heritage investigations that have been undertaken extensively at the airport site through the preparation of two prior environmental impact statements.

The assessment has identified a number of items of local significance within or in the vicinity of the airport site. The assessment considers the significance of all heritage items and recommends mitigation and management measures for all items potentially affected by the proposal.

[6] It is possible that part of the development may be included on an associated site. Where developments for matters such as HIAL are located outside of the airport site on land over which the Australian Government has rights such as an easement permitting the development, the Airport Plan will authorise the carrying out of these developments in accordance with s 96L of the Airports Act and that area of land is an 'associated site'. References in this report to the airport site include any associated sites unless otherwise stated.

20.2 Methodology

20.2.1 Historical sites

The overall approach to the assessment involved the identification of heritage items within and around the airport site through a review of previous heritage studies, searches of relevant heritage registers and schedules, and a field survey informed by a predictive landscape model.

The significance of each heritage item was assessed and the potential for direct and indirect impacts associated with the proposed airport were considered for each item.

The following tasks were undertaken to describe the existing environment at the airport site and to assess the impact of the proposed airport with regard to European heritage:

- review of relevant heritage legislation;
- review of background information including previous thematic studies, field surveys and assessments undertaken during previous assessments of the airport site;
- searches of all available historic heritage registers, including the World Heritage List, National Heritage List, Commonwealth Heritage List, State Heritage Register, Heritage and Conservation registers for State government agencies (known as Section 170 registers), local environmental plans, National Trust of Australia List, Register of the National Estate, Historic Heritage Information Management System and the Australian Institute of Architects Register of Significant Architecture in NSW;
- literature review including previous archaeological reports, heritage studies, conservation management plans and regional and local history documents and maps;
- preparation of a thematic history for the site and surrounds;
- field survey of the airport site to identify known historic heritage items, unrecorded historic heritage items and to assess the potential for any unrecorded historic heritage items, as informed by a predictive landscape model;
- consultation with relevant local councils and the NSW Office of Environment and Heritage;
- further targeted surveys and test excavation of selected areas to record identified historic heritage items and determine heritage curtilage of the items;
- assessment of the significance of identified European heritage items including cumulative impacts on historic heritage and cultural landscapes; and
- development of mitigation and management measures for affected items.

20.2.2 Archaeological assessment

Evaluation of the historical archaeological potential of the airport site was based on a consideration of historical information about the development and occupation of the airport site, physical evidence observed during field surveys and identified areas of previous disturbance.

A broad approach to the identification of potential archaeological evidence was adopted based on a predictive model, which assumes that historical archaeological remains are generally located close to occupation and activity areas.

The assessment of archaeological impacts was prepared based on historical research, a field survey and the results of test excavation. Background information and the assessed significance of identified sites were primarily based on historical research. Field survey results were used to assess the condition of the historical archaeological sites.

20.2.3 Assessment of significance

Statements of significance for the assessed heritage items were drawn from Commonwealth and State statutory and non-statutory heritage registers and supplemented with additional research.

European heritage items identified at the airport site were assessed against Commonwealth Heritage criteria (Department of the Environment and Water Resources 2007), which align closely with State heritage criteria (NSW Heritage Office 2001). The criteria are shown in Table 20–1.

The criteria were considered with regard to the history and physical evidence of each identified heritage item. The criteria detailed in the International Council on Monuments and Sites *Burra Charter* (2013) are very similar to the Commonwealth Heritage criteria and, as such, they are not considered separately. Each identified heritage item within the airport site was also considered with regard to the *Australian Historic Themes Framework* (Australian Heritage Commission 2000).

The Commonwealth Heritage criteria have been considered in this assessment for the purpose of describing the identified heritage values. It is not strictly necessary to consider those criteria for the purposes of this assessment. All heritage values (as defined in section 528 of the EPBC Act) are relevant to this assessment, whether or not they meet the Commonwealth Heritage criteria.

Table 20–1 Commonwealth and State heritage criteria

Category	Commonwealth criteria	State criteria
Events and processes	Criterion (a) the place has significant heritage value because of the place's importance in the course, or pattern, of Australia's natural or cultural history.	Criterion (a) an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).
Rarity	Criterion (b) the place has significant heritage value because of the place's possession of uncommon, rare or endangered aspects of Australia's cultural or natural history.	Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).
Research	Criterion (c) the place has significant heritage value because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history.	Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).
Principal characteristics of a class	Criterion (d) the place has significant heritage value because of the place's importance in demonstrating the principal characteristics of: i. a class of Australia's natural or cultural places, or ii. a class of Australia's natural or cultural environments.	Criterion (g) an item is important in demonstrating the principal characteristics of a class of NSW's: i. cultural or natural places; or ii. cultural or natural environments.
Aesthetic	Criterion (e) the place has significant heritage value because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.	Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
Creative or technical achievement	Criterion (f) the place has significant heritage value because of the place's importance in demonstrating a high degree of creative or technical achievement at a particular period.	Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).

Category	Commonwealth criteria	State criteria
Social	Criterion (g) the place has significant heritage value because of the place's strong or special association with a particular community or cultural group for social, cultural or spiritual reasons.	Criterion (d) An item has strong or special associations with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
Associative	Criterion (h) the place has significant heritage value because of the place's special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.	Criterion (b) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
Indigenous tradition	Criterion (i) the place has significant heritage value because of the place's importance as part of indigenous tradition.	NSW law provides separately for indigenous heritage (see the *National Parks and Wildlife Act 1974).*

20.2.4 Legislative and policy framework

The assessment has been completed in the context of the Commonwealth legislative framework with reference to the principles and objectives of NSW policy, where appropriate.

20.2.4.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework for the protection of matters of national environmental significance. These matters include World Heritage properties, National Heritage places and Commonwealth Heritage places. The EPBC Act also provides for the protection of the environment generally, where actions are undertaken by the Commonwealth or on Commonwealth land. The environment in this context includes the heritage values of a place.

World Heritage properties are listed on the World Heritage List administered by the UNESCO. National Heritage places are places of outstanding value to the nation and are listed on the National Heritage List. Commonwealth Heritage places are places owned or controlled by Commonwealth entities that have Commonwealth Heritage values and are listed on the Commonwealth Heritage List.

The heritage value of a place is defined under the EPBC Act as including the place's natural and cultural environment having aesthetic, historic, scientific or social significance, or other significance, for current and future generations of Australians.

Approval from the Environment Minister is required for controlled actions which will, or are likely to, have a significant impact on items and places included on the World Heritage List, National Heritage List or Commonwealth Heritage List. Approval is also required for an action undertaken by the Commonwealth or on Commonwealth land which is likely to have a significant impact on heritage values, even if those values are not included in one of these lists.

The EPBC Act also prescribes obligations for Commonwealth agencies that own or control properties that have, or might have, one or more National or Commonwealth Heritage values. Obligations include taking all reasonable steps to assist in the identification, assessment and monitoring of values and preparation of management plans for any identified values in line with the Commonwealth Heritage management principles and National Heritage management principles. Commonwealth agencies must similarly take all reasonable steps to ensure their actions are not inconsistent with the *Australian World Heritage management principles* or any plans in force for a World Heritage property.

The Commonwealth Heritage List is an instrument for managing places on Commonwealth owned or leased land with heritage significance. According to guidelines issued by the Australian Heritage Commission, the relevant significance threshold for the satisfaction of Commonwealth Heritage criteria is local heritage significance. This level of significance would not strongly support in situ conservation in contrast to places with state or National heritage significance.

Site preparation activities for the proposed Stage 1 development would directly impact all identified European heritage items at the airport site. As such, it is not intended that any identified items would be nominated for inclusion on the Commonwealth Heritage List.

The assessment of European heritage values does not represent an actual, proposed or recommended nomination for inscription of the Commonwealth Heritage List.

20.2.4.2 Environmental Planning and Assessment Act 1979

The NSW *Environmental Planning and Assessment Act 1979* is the main law regulating land use, planning and development in NSW. The Act enables the making of local environmental plans, which commonly provide for the protection of locally significant heritage items and heritage conservation areas. The local environmental plans that are relevant to the airport site or surrounds are the *Liverpool Local Environmental Plan 2008* and the *Penrith Local Environmental Plan 2010*. Both plans contain lists of items of European heritage significance.

20.2.4.3 Heritage Act 1977

The NSW *Heritage Act 1977* (Heritage Act) provides protection for heritage places, buildings, works, relics, moveable objects, precincts and archaeological sites that are important to the people of NSW. These include items of Aboriginal and non-Aboriginal heritage significance. Where these items have particular importance to the people of NSW, they are listed on the State Heritage Register.

Section 170 of the Heritage Act requires NSW Government departments and agencies to maintain a Heritage and Conservation Register, commonly known as a Section 170 Register. These registers include items of Aboriginal and non-Aboriginal heritage significance.

20.3 Existing environment

20.3.1 Historical context

European settlement around Badgerys Creek, including Luddenham and Bringelly, began with land grants to settlers for the purpose of establishing large rural estates in 1809. It was intended that these rural estates would contribute crops and livestock to feed the colony's growing population. Grantees included James Badgery (804 acres in 1809 at South Creek), Robert Lowe (1,000 acres in 1812 at Bringelly) and John Blaxland (6,710 acres of land in 1813 which he named 'Luddenham Estate'). Smaller grants were made to Sarah Howe, Edward Powell, Ellis Bent, D'Arcy Wentworth and Thomas Laycock (Keating 1996). These rural estates were highly successful, producing wheat and breeding cattle, sheep and horses.

The end of transportation and the consequent withdrawal of convict labour signalled the start of a decline in the fortune for the area. A severe drought from 1838 to 1840 resulted in wheat crop failure for two consecutive years. This was followed in 1841 by an economic depression due in part to a crash in wool prices and a reduction in British investment capital (Keating 1996). The increasing demand for land close to the growing population centres, the collapse of viable wheat farms after an outbreak of rust, and the de-population of the area as small tenant farmers moved in search of better land, culminated in the subdivision of many large estates into smaller allotments.

The most obvious effect of the downturn in the area was the sale and subsequent subdivision of Luddenham Estate. The breakup and sale of Luddenham Estate between 1859 and 1864 has been identified as the beginning of the next phase in the area, which saw the subdivision of the original grants.

Subdivisions of the mid-nineteenth century changed the pattern of land settlement in the region by breaking up the larger estates into much smaller farming lots and laying out uniform streets and allotments in a regular grid. In many instances, this supplanted an existing irregular alignment of informal roads and paddock fence lines. The subdivisions were set out by private surveyors often working on different estates.

As a result of subdivision, small-scale farmers were attracted to the area. Improvements were made, orchards and vineyards planted, and cottages built (Paul Davies Pty Ltd 2007). For instance, Franz Anschau and his family established a 200 acre vineyard south of Luddenham village in the late 1850s, complete with wine cellars, a substantial home and a working farm with sheep (Camden News 1954).

Land advertised as 'Luddenham Village' was offered for sale in 1859. Luddenham Village was located along the eastern boundary of The Northern Road and featured one acre and half acre blocks. In 1859, the central and western portions of Luddenham Estate had been surveyed (3,515 acres) and the survey of the eastern district (within the airport site), which represented the balance of the estate at 4,158 acres, followed in 1862. At the time of the 1859 survey, 2,000 acres of the estate were under cultivation, which over the following decades appears to have been managed by tenant farmers (Sydney Morning Herald 25 May 1859; Paul Davies Pty Ltd 2007).

Population figures at Luddenham are difficult to determine but by 1860, the local community warranted the establishment of a local school (Sydney Morning Herald 2 October 1860), and a post office followed in 1872. The village was close to Lawson's Thistle Inn and provisions were made for a church and a public reserve (Neustein and Associates 1992). Immediately surrounding the village, allotments of no more than 75 acres were offered, while lots of 100 – 300 acres were offered further east to the boundary of Badgerys Creek (AMC 2014). In 1862, the remainder of the western and central divisions around Lawson's Thistle Inn was also auctioned (Kinhill Stearns 1985, Keating 1996).

By 1872 there were 29 residents, and the village offered a range of services including two blacksmiths, a bootmaker, a butcher and an inn (Lawson's Thistle Inn). Rural life revolved around farming, but Anschau had established his winery at his property 'Steinberg' and five local people were employed in the timber trade as sawyers and wood splitters (Paul Davies Pty Ltd 2007).

In 1885, Luddenham Estate was purchased by a syndicate of Sydney land developers and re-subdivided to form a patchwork of semi-rural allotments in freehold title. From this time, the village of Luddenham developed as a centre for civic services.

The small rural Luddenham Village provided the surrounding estates with a focal point and Luddenham soon established itself as a viable settlement. A small weatherboard Methodist school was established in 1857 and was replaced with a more substantial brick school in 1862 (Keating 1996, Godden Mackay 1997). Luddenham Post Office was opened on 1 March 1872 and played an important role in the village, serving as a money order office from January 1885, acquiring a telephone and telegraph service from August 1905, and creating a Commonwealth Savings Bank Office in April 1914 (Hopson and Tobin 1995). Both the Luddenham Uniting Church and Progress Hall were established in the 1880s (AMC 2014).

In comparison to Luddenham, neither Bringelly nor Badgerys Creek developed well defined village centres, despite being offered for sale on similar terms.

Around the turn of the century, the main alternative land use to grazing and cropping in the area was orchards. City families, displaced by the depression of the 1890s, were attracted by the subdivision of the large estates into smaller manageable land parcels. The subdivisions, many between three and 10 acres, were designed to encourage settlement in the area. Reasonable deposits and easy repayments belied the trouble that many of these new farmers were to face. Inexperience, seasonal changes and small lots combined to make life difficult on the land.

Roads to Sydney such as Mulgoa Road (now Elizabeth Drive) and Bringelly Road were in poor condition, while the closest railway station was located 12 miles away at St Marys (Donald and Gulson 1996:9, Godden Mackay 1997). There was no easy access to waterways for taking perishable goods to market, so the area tended to be used for fruit growing, grazing and the production of milk for the local Liverpool area. Small orchards dominated land use on the smaller properties, while dairy farms and some vine growing occupied other farms (Godden Mackay 1997, Neustein and Associates 1992, Kinhill Stearns 1985).

William Longley was one such farmer in the Badgerys Creek district who established an extensive and well-known fruit orchard after purchasing land during the first Luddenham subdivision of 1859. The Longley family grew fruit in the district for over 50 years before their estate was sold, together with their home and household furniture, in 1912 (Camden News 1912). Other orchards of the period included those belonging to the Anschaus, Booths, Outridges, Leggos and Smiths.

Often, farmers in the area supplemented their farm income with a trade such as carting, shoemaking, coach building or stints at the local brick pits (Keating 1996). To service the small Badgerys Creek community, a butcher's shop operated from 1886, a public school was opened on Badgerys Creek Road in 1895, and a post office was established in 1896 (Paul Davies Pty Ltd 2007; Liverpool City Council 2012). St John's Anglican Church and Badgerys Creek Uniting (Methodist) Church serviced local residents and were constructed in the early 1900s (AMC 2014). Despite the modest development in the area, Badgerys Creek remained essentially rural and sparsely populated throughout the nineteenth century.

By 1904, the areas of Badgerys Creek, Luddenham and Bringelly were moderately settled and a Parliamentary Standing Committee was established for the purpose of determining the viability of a railway between Mulgoa and Liverpool (AMC 2014). The proposed railway never eventuated and the districts of Badgerys Creek and Bringelly remained sparsely populated, retaining their rural character. It was noted that in the 1900s, there were still large areas available for purchase around Badgerys Creek and Nicholson Park Estate in Luddenham (Donald and Gulson 1996).

Local government representation was forced on Badgerys Creek by the NSW Government in 1906 through the establishment of Nepean Shire.

In 1916, Cecil Vicary purchased a portion of D'Arcy Wentworth's Greendale estate for the purpose of establishing a dairy, grazing land and a vineyard (AS11). The property on the south-western side of The Northern Road, opposite Anschau's vineyard, had served as a working farm from the 1880s and featured a slab homestead, a woolshed and shearers' quarters. Originally a sideline to running the sheep and dairy farm, the first grapes were planted in 1917 and commercial production began in 1923, though dairy cows were reared until the early 1940s (AMC 2014). In the 1930s at the height of production, 65 hectares of land were cultivated, though production began declining from the late 1930s (AMC 2014).

From the 1920s, further settlement occurred in Badgerys Creek when portions of James Badgery's early grant were subdivided under the provisions of the *Soldier Settlement Act 1919*. Exeter House was at that time in the ownership of the Stivens family, who later sold a portion of the Exeter estate to Ern Kent (AMC 2014). In the 1930s, Kent sold his property to Peter Nobbs, who moved into the homestead with his family to pursue dairying (Donald and Gulson 1996). In 1936, a large area with frontage to South Creek was acquired by the Commonwealth of Australia for a CSIRO animal health research station, known as McMaster's Field Station, which was also used for a short time as a field station for research into radio astronomy. The site was sold by the CSIRO in 1996 (Paul Davies Pty Ltd 2007). Also in 1936, the Veterinary Department of the University of Sydney—in association with the McGarvie Smith Institute—purchased and developed a 160 hectare property at Badgerys Creek for the training of veterinary students in animal husbandry (Paul Davies Pty Ltd 2007).

A number of research facilities were established at Badgerys Creek and its surrounds in the 1950s, including the Overseas Telecommunication Commissions's Bringelly Radio Receiving Station Complex and the Australian Air Force Radio Receiving Station in 1952–55. Rural land use intensified in the 1960s with the establishment of dairy and poultry farming, beekeeping, timber and market gardening operations, and horse and dog training, but the district saw little development thereafter.

The districts of Badgerys Creek, Luddenham and Bringelly retain a great deal of their former rural character. Though subdivision and development of large estates has occurred, early slab cottages, substantial homesteads, cisterns, sheds, vineyards and small rural allotments remain. Market gardens, working farms, vineyards and close knit village communities reflect the district's rural development.

20.3.2 European heritage items

A review of prior assessments, heritage listings and a field survey identified 20 European heritage items at the airport site and an additional 22 heritage items in the surrounding area. The identified European heritage items within the airport site are listed in Table 20–2 while the identified European heritage items in the vicinity of the airport site are listed in Table 20–3. All of the identified items are mapped in Figure 20–1.

20.3.2.1 Prior assessments

The airport site has been subject to a number of past European heritage assessments including the *Second Sydney Airport Site Selection Programme: Draft Environmental Impact Statement* (Kinhill Stearns 1985) and subsequently *Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) for inclusion in the *Draft Environmental Impact Statement: Second Sydney Airport Proposal* (PPK 1997). Twenty-one of the identified European heritage items within and around the airport site were considered in these prior assessments. These European heritage items are listed and described in Table 20–2 and Table 20–3 and are mapped in Figure 20–1.

Preliminary field investigations undertaken to inform the referral of the proposed airport under the EPBC Act (AMC 2014) reflected these earlier findings and identified an additional eight European heritage items within and around the airport site. These European heritage items are listed and described in Table 20–2 and Table 20–3 and are mapped in Figure 20–1.

20.3.2.2 Commonwealth listings

None of the European heritage items identified within and around the airport site are inscribed on the World Heritage List, National Heritage List or Commonwealth Heritage List.

The Greater Blue Mountains Area, approximately seven kilometres from the airport site at its closest point, is inscribed on the World Heritage List and the National Heritage List (for its World Heritage values) and is therefore a matter of national environmental significance under the EPBC Act. The one million hectare area was inscribed on the World Heritage List for its outstanding universal value, which is characterised by its:

- representation of the evolutionary adaptation and diversification of the eucalypts in post-Gondwana isolation on the Australian continent; and
- outstanding diversity of habitats and plant communities and a significant proportion of the Australian continent's biodiversity, especially its scleromorphic flora.

Potential impacts on the Greater Blue Mountains World Heritage Area are assessed in Chapter 26.

The Greater Blue Mountains Area also contains various European heritage items including evidence of rural settlement, mining and transportation. The proposed airport is not expected to impact on these European heritage items, directly or indirectly.

20.3.2.3 NSW listings

No European heritage items of State significance were identified within the airport site; however, a State significant farmhouse complex is situated near the airport site. The site is described in Table 20–3 and mapped in Figure 20–1.

20.3.2.4 Local listings

Fourteen European heritage items identified within and around the airport site are listed on the Liverpool Local Environmental Plan 2008. The following three items are within the airport site:

- St John’s Anglican Church group;
- Badgerys Creek Public School; and
- Vicary’s Winery group.

Another eight European heritage items listed on the Penrith Local Environmental Plan 2010 are situated in the vicinity of the airport site. These and the other sites in the vicinity of the airport site are listed and described in Table 20–3 and are mapped on Figure 20–1.

A brick cottage at 406 Park Road, Luddenham listed on the Penrith Local Environmental Plan 2010 is not included in Table 20–3 as it is demolished and is not of archaeological significance. There is therefore negligible potential for impacts and this European heritage item is not assessed further.

20.3.2.5 Field survey

A field survey of the airport site was undertaken to validate and build on the information from prior assessments and in various European heritage registers. The survey approach was informed by a predictive landscape model that considered the types of sites identified in prior research as well as the historic context of the area (see Section 20.3.1).

Evidence of early land grants and associated development were predicted, in line with the researched historical context of Badgerys Creek and Luddenham (see Section 20.3.1). This included evidence of the development of farms, orchards, vineyards, cottages, roads, schools and churches. These predictions were consistent with prior assessments and were validated through the field survey. The potential for evidence of convict settlement and Aboriginal–European contact at the airport site was recognised; however, no such evidence was observed.

The previously identified European heritage items within the airport site were included in the survey. Archaeological excavation was necessary at Orange Hill to characterise subsurface structural features and other remains. The excavation initially revealed a scattering of bricks—some whole, mostly broken. Following the removal of the bricks, an arranged course of sandstone blocks was uncovered, thought to be flagging or foundations of a building. Other evidence of occupation, including ceramics, glass, metal, a bead and a brass button with a military-style insignia, was also recovered during the test excavation at Orange Hill.

The results of the field survey and archaeological excavation, in conjunction with the review of prior research and listings, informed the assessment of heritage significance included in Table 20–2.

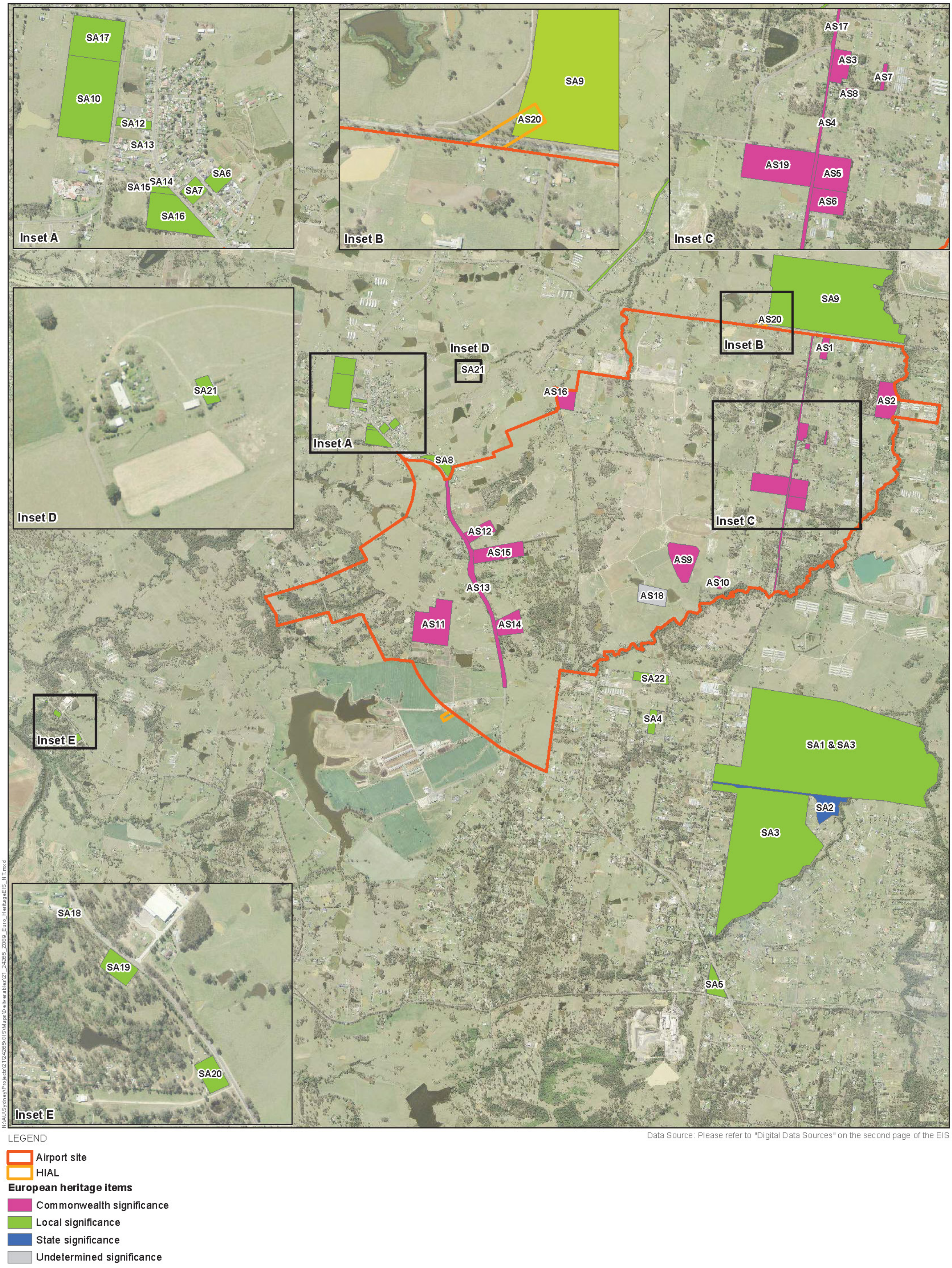


Figure 20-1 - European heritage items within and surrounding the airport site

Table 20–2 European heritage items within the airport site and associated site

Item	Map ID	Location	Description	Significance	Listing	Reference
Pennell's property	AS1	2170 Elizabeth Drive, Badgerys Creek	Pennell's property is likely to contain subsurface remains of an early farm homestead.	Local (Commonwealth)	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey
Gardiner Road farm complex	AS2	5 Gardiner Road, Badgerys Creek	Gardiner Road farm complex comprises an early twentieth century farm cottage and outbuildings.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
Badgerys Creek Public School	AS3	Corner of Pitt Street and Badgerys Creek Road, Badgerys Creek	Badgerys Creek Public School is a small rural school containing elements from the early twentieth century. The school has been damaged by vandalism following its closure in 2014.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Badgerys Creek butchery	AS4	Lot 51A Badgerys Creek Road, Badgerys Creek	Badgerys Creek butchery was one of two retail outlets in Badgerys Creek and had been operating for over a hundred years prior to its demolition in the 1990s.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Badgerys Creek post office	AS5	Lot 52 Badgerys Creek Road, Badgerys Creek	Badgerys Creek post office operated between 1894 and 1989. No surface elements of the post office remain; however, subsurface remains are likely.	Local (Commonwealth)	–	Historic research Field survey
Saw pit	AS6	61 Badgerys Creek Road, Badgerys Creek	Although marked on the 1859 map of Luddenham, there is very little observable evidence of the saw pit due to overgrowth and use of the site as a dam.	Local (Commonwealth)	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey

Item	Map ID	Location	Description	Significance	Listing	Reference
Badgerys Creek Uniting Church and cemetery	AS7	15 Pitt Street, Badgerys Creek	Badgerys Creek Uniting Church was the first formal place of worship at Badgerys Creek, opening in 1898 followed by the cemetery in 1927. The church was removed from the site in the early 1990s. The cemetery has two marked graves and could contain further unmarked graves.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
St John's Anglican Church and cemetery	AS8	30 Pitt Street, Badgerys Creek	St John's Anglican Church was built in the early 1900s. The church was removed or demolished after 1992. The cemetery contains at least 27 graves, while the church yard retains a small monument comprising a plaque, small brick base and corrugated iron roof.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Braeburn homestead	AS9	55 Longleys Road, Badgerys Creek	Braeburn was a farm homestead circa 1910. The homestead and associated shed were demolished in the late 1990s.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Orange Hill homestead	AS10	5 Jagelman Street, Badgerys Creek	Orange Hill was a farm homestead thought to be a predecessor to Braeburn. Two wells and a number of subsurface sandstone bricks were identified by test excavation at the site.	Local (Commonwealth)	–	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey
Vicary's Winery	AS11	1935 The Northern Road, Luddenham	Vicary's Winery was a farm property in the late 19th century. The site features a slab homestead circa 1860s and woolshed circa 1880s. The site was converted to a dairy and vineyard in the early 20th century.	Local (Commonwealth)	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014) Field survey

Item	Map ID	Location	Description	Significance	Listing	Reference
Well	AS12	1972 The Northern Road, Luddenham	The undated sandstone well sits within a more recently constructed homestead. The presence of such a well is rare in the local area.	Local (Commonwealth)	–	Field survey (personal communication)
The Northern Road alignment within the airport site	AS13	The Northern Road, Luddenham	The Northern Road is a very early road alignment. The route is recorded in an edition of the *Sydney Gazette* dated 1821 and a map of Bringelly dated 1834. The alignment of The Northern Road has deviated in some areas of the airport site since that time.	Local (Commonwealth)	–	Historic research *Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
Anschau Vineyard, Steinberg and grave(s)	AS14	1845–1875 The Northern Road, Luddenham	Anschau Vineyard operated from the late 1800s. No evidence of the vineyard remains; however, blacksmith tools and remains of a homestead have been identified. A possible grave suspected to belong to a member of the Anschau family is also present at the site.	Local (Commonwealth)	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014), Field survey
St Francis Xavier Church and cemetery	AS15	1966 The Northern Road, Luddenham	St Francis Xavier Church was built in 1912 while it is probable that the associated cemetery was established earlier. The contents of the church and graves were relocated to a new site at Greendale in the 1990s.	Local (Commonwealth)	–	Historic research Field survey
Jackson Road cottage	AS16	Lot 2 Jackson Road, Luddenham	Jackson Road hosted a farm cottage and several ancillary structures circa 1890. The cottage and structures remain at the site.	Local (Commonwealth)	–	Field survey
Badgerys Creek Road alignment within the airport site	AS17	Badgerys Creek Road, Badgerys Creek	Badgerys Creek Road alignment has been noted on maps since the 1850s and has not changed substantially since that time.	Local (Commonwealth)	–	Field survey Historic research
Spredenberg	AS18	55 Longleys Road, Badgerys Creek	Spredenberg features in a map of Luddenham Estate dated 1859 with a house visible in an aerial photograph dated 1947. The site is overgrown, confounding validation of its heritage.	Unknown	–	*1859 Map of the Eastern Division of Luddenham Estate* Field survey

Item	Map ID	Location	Description	Significance	Listing	Reference
Howe residence	AS19	Corner Badgerys Creek Road and Longleys Road, Badgerys Creek	The Howe residence is thought to have been occupied from the early 19th century. Potential homestead remains were identified at the site including wooden posts, bricks, corrugated iron and a potential well site.	Local (Commonwealth)	–	Field survey Personal communication
McGarvie Smith University Farm	AS20[a]	124 Elizabeth Drive, Badgerys Creek	The McGarvie Smith University Farm is considered to have heritage significance for its historic, associative and technical values. The farm was established as a place to teach animal husbandry to veterinary students at the University of Sydney and has associations with Sir Frederick Tout.	Local	*Penrith Local Environmental Plan 2010*	-

[a] It is proposed that the Commonwealth will acquire an easement or other interest over this land for the purposes of high intensity approach lighting. Where developments for matters such as this are located outside of the airport site on land over which the Australian Government has rights such as an easement permitting the development, the Airport Plan will authorise the carrying out of these developments in accordance with s 96L of the Airports Act on the land as an 'associated site'.

Table 20–3 European heritage items in the vicinity of the airport site

Item	Map ID	Location	Significance	Listing	Reference
Former Overseas Telecommunications Commission site group	SA1	Badgerys Creek Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Kelvin Park complex	SA2	30 The Retreat, Bringelly	State	State heritage register *Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Two RAAF water tanks	SA3	Badgerys Creek Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Mount Pleasant homestead	SA4	3 Shannon Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

Item	Map ID	Location	Significance	Listing	Reference
Bringelly Public School group	SA5	1205 The Northern Road, Bringelly	Local	*Liverpool Local Environmental Plan 2008*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Willmington Reserve	SA6	17 Jamison Street, Luddenham	Local	*Liverpool Local Environmental Plan 2008*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Public School	SA7	The Northern Road, Luddenham	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Lawson's Inn[a]	SA8	Lot 2 DP 623457	Local	*Liverpool Local Environmental Plan 2008*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
McGarvie Smith University Farm	SA9[b]	124 Elizabeth Drive, Badgerys Creek	Local	*Penrith Local Environmental Plan 2010*	National Heritage List[b]
Brick cottage	SA10	21–55 Campbell Street, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Road alignment	SA11	Luddenham Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	–
Weatherboard cottage	SA12	3065–3067 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Weatherboard cottage	SA13	3075 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Luddenham Progress Hall	SA14	3091–3095 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

Item	Map ID	Location	Significance	Listing	Reference
Luddenham Uniting Church and cemetery	SA15	3097–3099 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
St James Anglican Church and cemetery	SA16	3101–3125 The Northern Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997), *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Showground	SA17	428–452 Park Road, Luddenham	Local	*Penrith Local Environmental Plan 2010*	*Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Shadforth Monument	SA18	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Private dwelling (former St Mark's Anglican Church Group, including church cemetery)	SA19	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Greendale Roman Catholic Cemetery	SA20	Greendale Road, Greendale	Local	*Liverpool Local Environmental Plan 2008*	–
Vertical slab dairy	SA21	Lot 10, Adams Road, Badgerys Creek	Local	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)
Evergreen homestead	SA22	Off Derwent Road, Bringelly	Local	–	*Technical Paper 12: Non-Aboriginal Cultural Heritage* (Godden Mackay 1997) *Badgerys Creek Initial Environmental Survey: Historic Heritage* (AMC 2014)

[a] Lawson's Inn is incorrectly recorded in the Liverpool Local Environmental Plan 2010 as occurring within the airport site.

[b] McGarvie Smith University Farm was nominated for the National Heritage List; however, the nomination is now ineligible. This European heritage item is nonetheless considered to have local significance.

20.3.3 Summary

The review of prior reports, historical studies, databases and the surveys undertaken as part of the assessment identified 20 European heritage items within the airport site, and an additional 22 European heritage items around the site.

The identified European heritage items reflect the historical context of the airport site and European settlement more generally, including early attempts to develop local agricultural and pastoral economies and the emergence of settled village communities.

Because the identified items are of local heritage significance and are located on Commonwealth land, they are considered to be of Commonwealth Heritage significance, excluding Spredenberg (AS18) which was not classifiable and part of McGarvie Smith University Farm (AS20) which is proposed to be leased. The location of all identified items is shown in Figure 20–1.

The cultural significance of the airport site as a whole is characterised by the following.

- The region developed as a centre of agricultural production in the nineteenth century. The site was associated with cropping and later vineyards and orchards.
- The site includes Blaxland's early land grant, Luddenham Estate. This land grant and subsequent subdivision represent some of the early attempts to develop an agricultural and pastoral economy in Australia. These farmlands have continued in rural use and, due to the integrity of subdivision patterns, provide insight into early agricultural production.
- The site is crossed by The Northern Road and Badgerys Creek Road, which have historic associations with development in Badgerys Creek and the region.
- The site retains longstanding historic associations with nineteenth and early twentieth century markets for the supply of meat and livestock for metropolitan Sydney. Remnant tracts of cleared grazing land at Badgerys Creek continue to provide insight into this economic activity.
- The site includes a public school which demonstrates the development of public education from the late 1800s. The scale, material and design of the school buildings reflect the evolving fortunes of Badgerys Creek, education reform, the local community and architectural styles.
- The emergence of a settled village and farm community at Badgerys Creek in the last half of the nineteenth century is historically associated with the breakup of the large estates for closer settlement. This is demonstrated in street alignments, subdivision patterns, dwellings, churches and cemeteries, community gathering places, recreation grounds, park reserves, and places for education.

20.4 Assessment of impacts during construction

Site preparation activities will take place prior to the Main Construction Works for the proposed Stage 1 development. Site preparation activities will require the removal of structures from the airport site, thereby precluding the in situ preservation of European heritage items.

A range of measures is proposed to mitigate and manage potential impacts to particular European heritage items at the airport site (see Section 20.6).

Indirect impacts of construction on European heritage items surrounding the airport site would be limited to altered landscapes, views and ambience. These impacts are not expected to be significant and would not require implementation of management and mitigation measures.

20.5 Assessment of impacts during operation

European heritage items at the airport site will be removed before the start of operation. As such, operation of the proposed Stage 1 development would not directly impact European heritage items. Indirect impacts to European heritage items surrounding the airport site would be limited to altered landscapes, views and ambience. These impacts are not expected to be significant and would not require implementation of management and mitigation measures.

20.6 Mitigation and management measure

A European and Other Heritage Construction Environmental Management Plan (CEMP) will be developed as part of the construction environmental management framework set out in Chapter 28 (Volume 2b). The plan will require approval prior to the commencement of Main Construction Works.

The plan will collate measures to mitigate and manage potential impacts on European cultural heritage values. Measures proposed to be considered in the plan are included in Table 20–4. Some measures proposed, while recorded in the CEMP, are expected to be implemented before the plan is approved as structures may be demolished and/or removed as part of Preparatory Activities.

Table 20–4 Mitigation and management measures

Issue	Measure	Timing
European heritage management plan	The following measures will be implemented in the manner identified in Chapter 6 of Appendix O (Volume 4) for the respective European and other heritage items (i.e. not all measures will apply to each item) under the supervision of a suitably qualified archaeologist: • further targeted archaeological investigation will be undertaken to record subsurface remains and infer the layout, occupants and activities of certain European heritage places; • archival recording will be undertaken, including photographic records and measured drawings in their local context for future reference, having regard to the guidelines How to Prepare Archival Records of Heritage Items (NSW Heritage Office 1998) and Guidelines for Photographic Recording of Heritage Items Using Film or Digital Capture (NSW Heritage Office 2006); • an inventory of moveable items will be prepared to record information such as the location, designer, creator, use and owner of items such as tools of trade or machinery; • cultural plantings will be investigated to identify and collect samples of plant varieties that have local or historic botanical significance, including plant varieties that are characteristic of the area or not otherwise broadly planted; • options will be explored for potential relocation of identified European heritage structures to preserve intact surface structures; and • identified European heritage structures will be demolished in a staged and careful manner that reveals information about their construction, renovation, finishes and so on, which would be recorded.	Preparatory Activities Pre-construction Construction
Cemeteries relocation	A Cemeteries Relocation Management Plan will be submitted for approval by the Infrastructure Minister or an SES Officer in the Department of Infrastructure and Regional Development prior to the disinterment (removal) and reinterment (relocation) of grave sites from the airport site.	Preparatory Activities
Heritage awareness	Heritage awareness training will be provided to all workers involved in site preparation and construction of the proposed airport.	Preparatory Activities Pre-construction
Unexpected finds	A procedure will be developed to be followed in the event that European heritage items are discovered during site preparation or construction.	Pre-construction
Unexpected finds	Recognising the possibility of unmarked graves occurring, a procedure will be developed and followed in the event that human remains are discovered at the airport site during construction.	Pre-construction
Cultural significance of the airport site	An oral history will be prepared as a measure to preserve the heritage value of the airport site. This could include descriptions and reminiscences by people closely associated with the site.	Pre-construction Construction
Cultural significance of the airport site	The European and other heritage values of the site will be recognised in the detailed design of the airport, for example, through onsite archiving and curation of heritage items, and public display materials.	Pre-construction

20.7 Conclusion

The assessment of European heritage identified 20 European heritage items at the airport site and an additional 22 heritage items in the surrounding area. All of the identified European heritage items at the airport site will be directly affected by site preparation prior to Main Construction Works for the proposed Stage 1 development. The mitigation and management of European heritage will ensure, as far as practicable, that the heritage values of the airport site are identified, archived, relocated or otherwise preserved.

21 Planning and land use

The site for the proposed airport is located within Badgerys Creek and Luddenham, in the Liverpool local government area. The Australian Government acquired approximately 1,780 hectares of land for the proposed airport in the 1980s and 1990s. Planning for the proposed airport and surrounding land uses has been ongoing for a number of decades, across all levels of government.

In developing the Western Sydney Priority Growth Area (previously part of the South West Priority Growth Area and the Broader Western Sydney Employment Area) around the proposed airport site, the NSW Government and local councils have taken into consideration the potential opportunities and impacts from the proposed airport. Implementation of these strategic planning approaches is expected to result in surrounding land uses transitioning from rural-residential and agricultural to urban. The proposed airport development would contribute to this process.

Existing rural residential, agricultural, recreational, community and extractive industry land uses on the airport site would also be removed where required to support the development of the airport. Infrastructure improvements to key roads and railways would also facilitate land use change in the broader region.

Measures to manage land use and planning impacts are proposed, including mitigation measures for employment land use conflict, zoning rationalisation, integration of operational airspace controls and aircraft noise protection as well as infrastructure corridor protection. Through successful implementation of these measures, the proposed airport and its surrounds would become a focus for employment-generating land uses in Western Sydney, creating jobs for the new residents of the Western Sydney Priority Growth Area and the broader Western Sydney area.

21.1 Introduction

The proposed airport would affect the existing and potential future uses of surrounding land. This chapter considers potential impacts of the construction and operation of the Stage 1 development. This assessment builds on previous studies and considers how the proposed Stage 1 development would affect surrounding rural, agricultural, employment and recreational lands.

The need for a second Sydney airport—and its potential location at Badgerys Creek—have been subject to consideration over a number of decades. As such, planning by successive Australian, State and local governments reflects the potential for an airport at the airport site.

This chapter considers the prospect of rezoning surrounding land, or making additional land use controls, to deal with potential impacts of the proposed airport. Controls are also considered to manage safety, noise, lighting, air quality and local traffic impacts.

21.2 Methodology

A specialist report on planning and land use impacts of the proposed airport was prepared for this EIS (see Appendix N (Volume 4)). The broad methodology adopted for the preparation of the planning and land use assessment included:

- inspection and analysis of the key characteristics of the airport site and surrounding land;
- review of existing Commonwealth and NSW legislation applying to the airport site and surrounding land;

- review of strategic land use plans relevant to the airport site and surrounding land to identify NSW Government objectives for development of the area;
- consultation with planning staff in local councils within the vicinity of the airport site to confirm applicable land use plans, policies and assessment considerations;
- review of relevant sections of other technical reports prepared for the EIS;
- assessment of the likely impacts of the airport proposal on surrounding land uses; and
- recommendations for mitigation measures to minimise the impacts of the proposal.

The planning and land use assessment has been prepared in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued in January 2015.

21.3 Existing environment

The airport site is located within the localities of Badgerys Creek and Luddenham, within the Liverpool local government area (LGA). The northern boundary of the airport site adjoins the Penrith LGA boundary. The site is situated about 60 kilometres west of the Sydney central business district and 50 kilometres west of Sydney (Kingsford Smith) Airport.

Commencing in the mid-1980s the Australian Government acquired approximately 1,780 hectares of land for the airport site. The current Australian Government land holding comprises over 20 lots, with the majority of the land located in a consolidated title (1,667 hectares).

Prior to commencement of operation of the Stage 1 development, the Australian Government will consider acquisition of additional land or interests in land—such as easements—for properties which are located either within the footprint of the airport proposal, or which are otherwise required for airport operational matters. Where developments for matters such as aircraft navigational safety (e.g. runway lighting or instrumentation) are located outside of the airport site on land over which the Australian Government has rights such as an easement permitting the development, the Airport Plan will authorise the carrying out of these developments as ancillary developments (see s96C and s96L of the *Airports Act 1996*).

21.4 Existing land uses

21.4.1 Airport site

The majority of the airport site comprises low density rural residential and agricultural land uses. Rural residential tenancies range from approximately one to 40 hectares in area. Agricultural land uses include cattle grazing and horticulture.

In addition to rural residential and agricultural land uses, the following built features are also found on the airport site:

- the former Badgerys Creek Primary School (closed in December 2014);
- Badgerys Creek Park;
- three gravesites (St Johns Anglican Church, Badgerys Creek Uniting Church, Anschau family grave (Luddenham), and a former gravesite at St Francis Xavier Church); and
- a quarry (Blue Sky Mining).

Badgerys Creek flows along the southern and eastern boundary of the airport site, and Oaky Creek originates in the centre of the site and flows northwards. Both creeks drain to South Creek and the Hawkesbury River.

The airport site supports a variety of vegetation types and is contained within the 'Cumberland Plain' Mitchell Landscape. This landscape comprises low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast, with vegetation characterised by grassy woodlands and open forest dominated by Grey Box (*Eucalyptus moluccana*) and Forest Red Gum (*Eucalyptus tereticornis*) and poorly drained valley floors with forests of Cabbage Gum (*Eucalyptus amplifolia*) and Swamp Oak (*Casuarina glauca*).

The airport site contains a number of internal roads, all of which (except for The Northern Road) were compulsorily acquired by the Australian Government in July 1991. The following roads within the site are currently maintained by Liverpool Council under an agreement with the Australian Government:

- Anton Road
- Badgerys Creek Road
- Ferndale Road
- Fuller Street
- Gardiner Road
- Jackson Road
- Jagelman Road
- Leggo Street
- Longleys Road
- Pitt Street
- Taylors Road
- Vicar Park Lane
- Winston Close

It is noted that Willowdene Avenue also crosses the site in part. This road is not owned by the Commonwealth or proposed to be acquired.

The arterial roads that currently service the site are:

- Elizabeth Drive – a classified road which forms the northern border of the airport site;
- The Northern Road – a classified road which intersects the western part of the airport site on a north-west to south-east alignment; and
- Badgerys Creek Road – a local road which intersects the eastern part of the airport site on a north to south alignment, connecting Elizabeth Drive to The Northern Road.

21.4.2 Surrounding land

The airport site is located within Liverpool LGA, with the northern airport site boundary coinciding with the southern boundary of the Penrith LGA at Elizabeth Drive. Beyond the immediate LGAs, Blue Mountains LGA lies to the west; Wollondilly, Camden and Campbelltown LGAs lie generally to the south; and Bankstown, Fairfield and Blacktown LGAs lie generally to the east of the airport site.

21.4.3 Liverpool local government area

The village of Luddenham is located immediately west of the airport site, generally straddling The Northern Road between Park Road and Adams Road. As of 2012, Luddenham village contained 224 properties with a population of 819 (Liverpool Council). Luddenham village comprises neighbourhood retail shops and low density residential housing with average lot sizes of around 500 square metres.

Luddenham also has two large recreation reserves (Luddenham Showground and Sales Park) and two primary schools (Holy Family Primary School and Luddenham Public School). The Hubertus Country Club directly adjoins the north-western boundary of the airport site. Rural residential properties of up to 10 hectares surround the village.

To the north-east and east of the airport site are the localities of Badgerys Creek and Kemps Creek. The Badgerys Creek riparian corridor defines the eastern boundary of the site. The land to the east of Badgerys Creek is largely used for agriculture, including the Ingham's Multiplication Farm (poultry farm). The recreational areas of Kemps Creek Nature Reserve and the Western Sydney Parklands are also located to the east of the airport site.

South-west of the airport site in the locality of Greendale, land use is predominantly large-lot rural residential. Some agricultural activities are present, including the Leppington Pastoral Company and the University of Sydney Research Farms. The area contains the largest landholdings within the Liverpool LGA with many properties exceeding 40 hectares in size (Liverpool Council 2012).

Bringelly is located about 4.5 kilometres south of the airport site and is characterised by large-lot residential properties. The 2012 Liverpool Rural Lands Study recommended 775 hectares of land be converted from RU1 to RU4 rural zoning in order to further limit fragmentation of the land in Bringelly, with a minimum lot size of 10 hectares. A decommissioned Royal Australian Air Force Telecommunications facility and the Boral Bringelly Brickworks are also located in Bringelly.

21.4.4 Penrith local government area

Land uses are predominantly rural residential in the vicinity of Badgerys Creek to the north of the site. Adjoining the northern boundary of the airport site, north of Elizabeth Drive, is a cattle grazing farm adjacent to a landfill facility. The area north of the airport is drained by two creeks, Cosgroves Creek and Badgerys Creek, which are identified as 'Environmental Conservation' areas in the *Penrith Local Environmental Plan 2010* (Penrith LEP).

About three kilometres north of the airport site is the site of the proposed Sydney Science Park. The area was rezoned in July 2015 from RU2 Rural Landscape to B7 Business Park, B4 Mixed Use and RE1 Public Recreation. The objectives of the rezoning are to accommodate research and development employment, education, and supporting retail and residential uses. The Sydney Science Park would form part of the Western Sydney Priority Growth Area (see to Section 21.5.4 for further details).

About five kilometres north of the airport site is the Twin Creeks estate. The 340 hectare estate comprises an 18-hole golf course, function centre, restaurant and more than 200 dwellings.

The localities of Kemps Creek and Mount Vernon are located to the north-east of the airport site. These localities largely comprise rural residential dwellings with average lot sizes of 10 hectares. Lot sizes decrease in the eastern part of Mount Vernon, east of Mamre Road. These localities are drained by two creeks—South Creek and Kemps Creek—which are identified as ‘Environmental Conservation’ areas in the Penrith LEP.

The Defence Establishment Orchard Hills is located approximately nine kilometres north of the airport site and is used for storage, distribution and Defence explosive ordnance training.

21.5 Planning for the proposed airport and surrounds

21.5.1 Australian Government legislation and regulation

21.5.1.1 Environment Protection and Biodiversity Conservation Act 1999

The Department of Infrastructure and Regional Development submitted a referral under the EPBC Act for the development of the proposed airport on 4 December 2014. The Department of the Environment invited public comment on the referral for 12 business days.

On 23 December 2014, a delegate of the Minister for the Environment determined the proposed airport to be a controlled action. The referral decision instrument identifies the following controlling provisions under the EPBC Act as being relevant for this proposal:

- world heritage properties (sections 12 and 15A);
- national heritage places (sections 15B and 15C);
- listed threatened species and communities (sections 18 & 18A); and
- Commonwealth actions (section 28).

The delegate also determined that the proposed airport development would be assessed by the preparation of an EIS. As a result of recent amendments to the Airports Act, approval of the proposed airport under Part 9 of the EPBC Act is not required, but an EIS must be prepared and an Airport Plan for the proposed airport must be determined before the development can proceed.

21.5.1.2 Airports Act 1996

The proposed airport would be developed and operated under the Airports Act. The Airports Act has been amended to provide for an Airport Plan, which is a transitional planning instrument for the Stage 1 development as a greenfield airport site. This amendment provides a single and transparent environment and development approval for the proposed airport. The Airports Act amendment provides for the preparation of an Airport Plan which is determined by the Infrastructure Minister.

In determining the Airport Plan, the Infrastructure Minister must accept any environmental conditions proposed by the Environment Minister, taking into account the EIS. An airport lease would be granted by the Commonwealth to an ALC, which would then become responsible for the airport site.

Leased federal airports are subject to a planning framework set out in the Airports Act. As part of the planning framework, airports are required to prepare a master plan. A master plan is a 20-year strategic vision for the airport site which is renewed every five years. It addresses future land uses, types of permitted development and noise exposure forecasts for the areas surrounding the airport. A master plan also includes an environment strategy which sets out the Airport Lessee Company's (ALC) objectives and proposed approach for managing environmental issues. It is the basis on which the Commonwealth measures the environmental performance of airports and the document by which airport tenants determine their environmental responsibilities.

A master plan must also address the likely effect of proposed on-airport developments on the local and regional economy, and community. This includes an analysis of how proposed developments fit within the planning schemes for commercial and retail development in the area adjacent to the airport.

For the proposed airport, the ALC will be required to submit for approval a full master plan within five years of an airport lease being granted or in such longer period as approved by the Infrastructure Minister. Part 2 of the Airport Plan will provide the planning framework for the airport until the first master plan is in place.

21.5.1.3 Convention concerning the protection of the World Cultural and Natural Heritage

Australia is a State Party to the World Heritage Convention which aims to promote cooperation to protect heritage around the world that is of outstanding universal value. The World Heritage Convention is implemented by the World Heritage Committee, which among other functions, establishes the World Heritage List—a list of properties that have outstanding universal value.

The Greater Blue Mountains Area was inscribed on the World Heritage List in 2000. Nations that are parties to the World Heritage Convention agree to use their own resources to protect their World Heritage properties as far as possible.

21.5.1.4 Australian Standard 2021

The Australian Standard 2021:2015 *Acoustics – Aircraft noise intrusion – Building siting and construction* (AS 2021) provides guidance on the siting and construction of buildings in the vicinity of airports to minimise aircraft noise intrusion. The guidance provided by AS 2021 is based on the predicted level of aircraft noise exposure at a given site using the Australian Noise Exposure Forecast (ANEF) system.

The NSW Government and local councils give effect to AS 2021 in land use planning for new development in environmental planning instruments, and as a necessary consideration in building siting and design as part of the assessment of new development applications within the noise impact zone of airports.

21.5.1.5 Role of Airservices Australia

Airservices Australia provides air traffic control, aviation rescue and firefighting as well as other related services to the aviation industry. This includes maintaining technology used by the industry for navigation and surveillance, and aircraft flight path and noise monitoring.

21.5.2 National Airports Safeguarding Framework

The National Airports Safeguarding Framework (NASF) is a nationally agreed set of guidelines implemented by each State and Territory that aims to:

- improve community amenity by minimising aircraft noise-sensitive developments near airports including through the use of additional noise metrics and improved noise-disclosure mechanisms; and
- improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

The NASF comprises seven key planning principles:

- Principle 1: The safety, efficiency and operational integrity of airports should be protected by all governments, recognising their economic, defence and social significance;
- Principle 2: Airports, governments and local communities should share responsibility to ensure that airport planning is integrated with local and regional planning;
- Principle 3: Governments at all levels should align land use planning and building requirements in the vicinity of airports;
- Principle 4: Land use planning processes should balance and protect both airport and aviation operations as well as community safety and amenity expectations;
- Principle 5: Governments will protect operational airspace around airports in the interests of both aviation and community safety;
- Principle 6: Strategic and statutory planning frameworks should address aircraft noise by applying a comprehensive suite of noise measures; and
- Principle 7: Airports should work with governments to provide comprehensive and understandable information to local communities on their operations concerning noise impacts and airspace requirements.

The NASF guidelines provide comprehensive information and recommendations relating to six airport safeguarding matters. The NASF guidelines are:

- Guideline A: Measures for Managing Impacts of Aircraft Noise;
- Guideline B: Managing the Risk of Building Generated Windshear and Turbulence at Airports;
- Guideline C: Managing the Risk of Wildlife Strikes in the Vicinity of Airports;
- Guideline D: Managing the Risk of Wind Turbine Farms as Physical Obstacles to Air Navigation;
- Guideline E: Managing the Risk of Distractions to Pilots from Lighting in the Vicinity of Airports; and
- Guideline F: Managing the Risk of Intrusions into the Protected Airspace of Airports.

21.5.3 Protection of operation airspace surfaces

Protecting the immediate airspace around airports is essential to ensuring and maintaining a safe operating environment and to provide for future growth. An obstacle limitation surface (OLS) is designed to provide protection for aircraft operating in visual flight conditions. It is a series of virtual surfaces around a runway, which establish the height limits for objects in and around an airport. It identifies the lower limits of an airport's airspace, which should be kept free of obstacles that may endanger aircraft during take-off, preparation to land and landing.

The OLS for the proposed airport is being developed based on the indicative long term layout as identified in the revised draft Airport Plan. The OLS is expected to be declared under the Airports (Protection of Airspace) Regulations in the second half of 2016. The OLS will be protected under Part 12 of the Airports Act and the Airports (Protection of Airspace) Regulations 1996.

The declaration of an OLS will also enable local councils and land use planning authorities to incorporate the protected airspace as appropriate in their land use planning instruments.

The Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS) provide for the establishment of surfaces to protect aircraft during take-off, landing or manoeuvring and when aircraft are operating in non-visual conditions. The PANS-OPS surfaces are generally above the OLS and are designed to safeguard an aircraft from collision with obstacles when an aircraft's flight may be guided solely by instruments, such as in conditions of poor visibility.

Structures, trees or other activities that intrude into these surfaces are potential obstacles to aircraft, and therefore a potential safety hazard, and must be controlled. Under the Airports (Protection of Airspace) Regulations, PANS-OPS surfaces are also protected from intrusions. Over time the declaration process for the proposed airport will include proposed PANS-OPS surfaces, in order to protect these from intrusions.

The PANS-OPS for the proposed airport will be developed and declared in response to the formal flight path design prior to commencement of operations.

21.5.4 NSW Government legislation

The NSW planning legislative framework consists primarily of the *Environmental Planning and Assessment Act 1979* (the EP&A Act), the *Environmental Planning and Assessment Regulation 2000* and the following three key instruments which are made under the EP&A Act:

- State environmental planning policies (SEPPs) – these policies outline the NSW Government's approach to dealing with particular planning issues. They can be either site or subject specific. Often SEPPs provide land zoning and development controls, designate particular types of development for State or regional planning governance, or add specific requirements for existing development processes;
- local environmental plans (LEPs) – each local government area has a LEP to guide development and protect natural resources within LGAs. LEPs are prepared by local councils and made by the NSW Minister for Planning. Most follow a standard form and include mainly standard provisions, which are applied to the particular circumstances of the relevant LGA. LEPs are the primary source of land use zoning and local regulation. LEPs are generally subordinate to SEPPs; and

- local planning directions, issued by the Minister for Planning under section 117 of the EP&A Act, which provide direction on matters that planning proposals need to address.

21.5.5 State Environmental Planning Policies

A summary of SEPPs that are relevant to planning and land use around the proposed airport is presented in Table 21–1.

Table 21–1 Applicable State Environmental Planning Policies

State environmental planning policy	Provision
State Environmental Planning Policy (Sydney Region Growth Centres) 2006 (Growth Centres SEPP)	This policy aims to coordinate the release of land for residential, employment and other urban development in the North West and South West Growth Centres of Sydney. The proposed airport site is located adjacent to the South West Growth Centre. The Growth Centres SEPP provides development controls for the land in the vicinity of the airport site.
State Environmental Planning Policy (Infrastructure) 2007 (Infrastructure SEPP)	This policy aims to facilitate the effective delivery of infrastructure across the State.
State Environmental Planning Policy (Western Sydney Employment Area) 2009 (WSEA SEPP)	This policy establishes the Western Sydney Employment Area (WSEA) to provide businesses in Western Sydney with land for industry and employment generating uses, including transport and logistics, warehousing and commercial office space. The WSEA lies to the north of the airport site.

21.5.6 Local Environment Plans

21.5.6.1 Liverpool

Land use zones

The airport site is located within the Liverpool LGA. The Liverpool Local Environmental Plan 2008 (Liverpool LEP) sets out the land use controls and matters for consideration for development within the Liverpool LGA, and follows the Standard Instrument format.

The majority of the airport site is zoned SP1 – Special Activities (Commonwealth) under the Liverpool LEP. Surrounding land zones are RU1 – Primary Production (east and west) and RU4 Primary Production Small Lots (south-east).

Noise management

The LEP includes a provision (clause 7.18) for development in areas subject to potential aircraft noise from the proposed airport. This clause responds to the Minister's section 117 direction for noise management. Under clause 7.18:

- development consent is required for the erection of a building on land where the ANEF shown on the Liverpool LEP Airport Noise Map exceeds 20 if it is erected for residential purposes or for any other purpose involving regular human occupation;
- the following development is prohibited unless it meets the requirements of AS 2021 with respect to interior noise levels:
  - residential accommodation on land where forecast noise exposure levels exceed 20 ANEF; and

- business premises, entertainment facilities, office premises, public administration buildings, retail premises and tourist and visitor accommodation on land where forecast noise exposure levels exceed 25 ANEF.

- the following development is prohibited:
  - educational establishments, hospitals and places of public worship on land where forecast noise exposure levels exceed 20 ANEF;
  - dwellings on land where forecast noise exposure levels exceed 25 ANEF (other than development consisting of the alteration, extension or replacement of an existing dwelling house where the development is consistent with the objectives of this clause); and
  - business premises, entertainment facilities, office premises, public administration buildings, retail premises and tourist and visitor accommodation on land where forecast noise exposure levels exceed 30 ANEF.

21.5.6.2 Penrith

Land use zoning

The Penrith Local Environmental Plan 2010 (Penrith LEP) sets out the land use controls and matters for consideration for development within the Penrith LGA, and follows the Standard Instrument format. Surrounding land to the north of the airport site is zoned RU2 Rural landscape under the Penrith LEP.

There are three urban settlements in proximity to the project area within the Penrith LGA. These are at Luddenham, Twin Creeks and Kemps Creek.

To the west of the site is Luddenham village, which spans Penrith and Liverpool LGAs. Development under the Broader Western Sydney Priority Growth Area would likely lead to land use transition in Luddenham village (see to Section 21.5.4). The applicable land use zones for Luddenham village under the Penrith LEP are:

- R5 Large Lot Residential;
- R2 Low Density Residential;
- RU5 Village;
- B1 Neighbourhood Centre; and
- RE1 Public Recreation.

Twin Creeks Golf and Country Club is located about five kilometres north of the airport site. This locality comprises 200 large-lot residential dwellings and a golf course, and is zoned E4 Environmental Living.

Kemps Creek is to the east of the site, with a small village cluster within the RU4 Rural Small Holdings zoned land and a cluster of smaller-lot rural residential properties in the E4 Environmental Living zone at Mount Vernon.

Oaky Creek and Badgerys Creek to the north of the site are zoned E2 Environmental Conservation.

Noise management

Clause 7.9 of the Penrith LEP includes provisions for noise management (similar to the Liverpool LEP). Under this clause, development in the vicinity of the airport site must have regard to the use or potential future use of the site as an airport and must not have an adverse impact on the development or operation of an airport.

Clause 7.9 applies to development that is on land near the airport site and is in an ANEF contour of 20 or greater. Prior to determining a development application to which this clause applies, Penrith Council must:

- consider whether the development would result in an increase in the number of dwellings or people affected by aircraft noise;
- consider the location of the development in relation to recommended development types within ANEF zones, as outlined in AS 2021; and
- be satisfied that the development would meet AS 2021 with respect to interior noise levels for the purposes of:
  - if the development will be in an ANEF contour of 20 or greater—child care centres, educational establishments, entertainment facilities, hospitals, places of public worship, public administration buildings or residential accommodation; and
  - if the development will be in an ANEF contour of 25 or greater—commercial premises, hostels, or hotel or motel accommodation.

21.5.6.3 Fairfield

Noise management

Whilst Fairfield City Council is yet to adopt any LEP controls for the management of aviation noise, Council adopted an interim policy in May 2014. The interim policy sets out ‘deemed to comply’ requirements for acoustic proofing measures for residential development in Horsley Park and Cecil Park.

These requirements apply to all forms of new residential accommodation (as defined under the Fairfield LEP 2013) permitted in zones RU1 – Primary Production, RU2 – Rural Landscape, RU4 – Primary Production Small Lots, RU5 – Village. The requirements also apply to alterations and additions to existing residential accommodation.

21.5.7 Local planning directions

Under section 117(2) of the EP&A Act the NSW Government issues directions which the relevant consent authority should consider when preparing a planning proposal for a new (or amending) LEP. Relevant section 117 Directions are listed in Table 21–2.

Table 21–2 Applicable section 117 directions

Direction	Objective	Requirement
3.5 Development near licensed aerodromes (issued July 2009)	The objective of this direction is to ensure the effective and safe operation of aerodromes, uncompromised by development. It is also to ensure development for residential purposes incorporates appropriate mitigation measures so that the development is not adversely affected by aircraft noise.	A planning proposal that rezones land in the vicinity of an airport must include a provision to ensure that development meets AS 2021 regarding interior noise levels. The planning authority must also consult with the Commonwealth and take into account relevant development standards such as height limitations. Development which is compatible with the operation of an aerodrome must be permissible with consent.
5.8 Second Sydney Airport: Badgerys Creek (issued in 2005; re-issued July 2009)	The objective of this direction is to avoid incompatible development in the vicinity of any future second Sydney Airport at Badgerys Creek.	Planning proposals must not contain provisions that enable the carrying out of development, either with or without development consent, which could hinder the potential for development of a Second Sydney Airport. It should be noted that this direction was made by the minister in 2005, prior to the consolidation of section 117 directions in July 2009. This direction applies to land within the boundaries of the proposed airport site and the 20 ANEF contour of the 1985 Second Sydney Airport Draft EIS within Fairfield, Liverpool, Penrith and Wollondilly local government areas.
7.1 Implementation of A Plan for Growing Sydney (issued 14 January 2015)	The objective of this direction is to give legal effect to the planning principles, directions and priorities for subregions, strategic centres and transport gateways contained in A Plan for Growing Sydney.	Planning proposals shall be consistent with the NSW Government's A Plan for Growing Sydney published in December 2014.
7.2 Implementation of Greater Macarthur Land Release Investigation (effective 22 September 2015)	The objective of this direction is to ensure development within the Greater Macarthur Land Release Investigation Area is consistent with the Greater Macarthur Land Release Preliminary Strategy and Action Plan (the Preliminary Strategy).	This direction applies to planning proposals within the Greater Macarthur Land Release Investigation Area in Campbelltown City Council and Wollondilly Shire Council areas. Planning proposals shall be consistent with the Preliminary Strategy published in September 2015.

21.5.8 Strategic planning initiatives

21.5.8.1 A Plan for Growing Sydney

A Plan for Growing Sydney (the Metropolitan Plan) (DP&E 2014) is the NSW Government's 20-year strategic development plan for the Sydney Metropolitan Area. This strategic planning document sets out the NSW Government's vision of Sydney as a strong global city and a great place to live. It provides direction for Sydney's productivity, environmental management and liveability. To deliver upon these directions, the Metropolitan Plan identifies the location of future housing, employment, infrastructure and open space areas. An element of the Metropolitan Plan outlines how the proposed airport would transform Western Sydney.

Action 1.4.1 of the Metropolitan Plan aims to improve transport links and create a new services centre and industrial precinct to support the growth of the proposed airport. The proposed airport would transform and drive future investment and jobs growth in Western Sydney. In order to protect and promote the proposed airport, the NSW Government plans to:

- ensure adequate development controls are provided for areas affected by aircraft noise and airspace to provide for future aviation needs;
- preserve land for complementary airport-related activity including a jet fuel pipeline to service the proposed airport and freight-related uses; and
- identify and preserve future transport and infrastructure corridors and related sites in the vicinity of the proposed airport.

Accordingly, the proposed airport is appropriately identified in and compatible with the broader strategic planning for Sydney.

The NSW Government seeks to develop strategic employment corridors to service the proposed airport and capitalise on the airport development. In order to promote employment growth, under Action 1.4.2 of the Metropolitan Plan the NSW Government will:

- facilitate an enterprise corridor from Leppington to the proposed airport along Bringelly Road, potentially linked to a future extension of the South West Rail Link. A flexible and innovative regulatory environment will be developed to enable a wide range of commercial activities to take advantage of transport access to this precinct and its proximity to the airport, Leppington and the future population of the South West Growth Centre (now the Western Sydney Priority Growth Area);
- facilitate development opportunities that can leverage off improved transport connections, including improvements to Elizabeth Drive, The Northern Road and Bringelly Road;
- investigate how improved transport connections, associated with the proposed South West Rail Link extension between the proposed airport to the western line will influence land use planning; and
- preserve the land needed for a major intermodal terminal and for a related Western Sydney Freight Line between Port Botany and the Western Sydney Employment Area (and new Western Sydney Priority Growth Area).

In January 2016 the NSW Government established the Greater Sydney Commission (GSC) as a new dedicated agency with responsibility to drive the delivery of the Metropolitan Plan.

Under the *Greater Sydney Commission Act 2015* (NSW), the Metropolitan Plan is deemed to be the Regional plan for the Greater Sydney Region. The GSC has responsibility for coordinating and driving the delivery of all actions in the Regional plan.

The GSC will review the Metropolitan Plan before the end of 2017 and at the end of every subsequent five-year period.

District plans are being prepared for each of the six districts identified in A Plan for Growing Sydney and public exhibition of these plans will commence before 27 January 2017. Once District plans are in place, local councils are required to review their LEPs and give effect to the relevant District plan.

21.5.8.2 Western Sydney Priority Growth Area

The Western Sydney Priority Growth Area is a strategic planning initiative that aims to provide jobs, homes and services in the land around the proposed airport. The extent of the Western Sydney Priority Growth Area is shown in Figure 21–1.

The Western Sydney Priority Growth Area is expected to be the primary planning initiative to coordinate housing and employment growth in the area and promote compatible developments around the airport site. This will help to maximise the benefits and minimise the impacts of the proposed airport.

An accompanying Land Use and Infrastructure Strategy is under development to guide new infrastructure investment, identify new homes and jobs close to transport, and coordinate services in the Western Sydney Priority Growth Area. A new special infrastructure contribution levy will be established to cover the cost of regional road infrastructure, strategic land use planning costs and environmental protection measures.

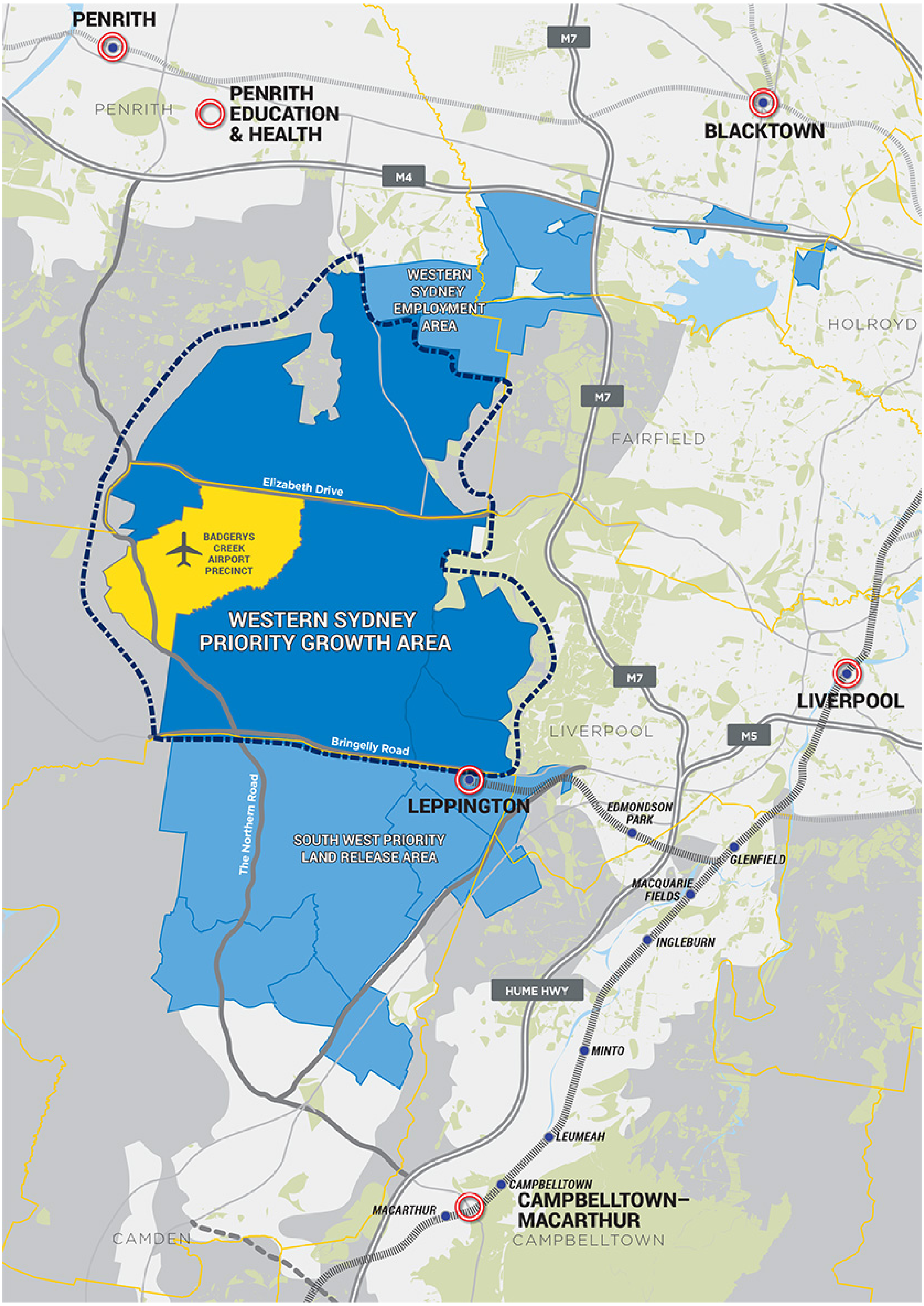


Figure 21–1 Western Sydney Priority Growth Area

21.5.8.3 Western Sydney Employment Area

The Western Sydney Employment Area is a strategic planning initiative that aims to provide businesses in Western Sydney with land for industry and employment including transport, logistics, warehousing and office space. The Western Sydney Employment Area is adjacent to the Western Sydney Priority Growth Area and is shown in Figure 21–1.The Western Sydney Employment Area would provide opportunities for residents of Western Sydney to work locally.

Previously the NSW Government had intended to extend the Western Sydney Employment Area to the south, including the area which is now the airport site. Following the Australian Government announcement in April 2014 to locate an airport at Badgerys Creek, the plans for the extension of the Western Sydney Employment Area were replaced with the introduction of the Western Sydney Priority Growth Area which will be focussed on ensuring compatible employment and housing development around the airport site.

21.5.8.4 South West Priority Growth Area

The South West Priority Growth Area is a strategic planning initiative dedicated to providing housing in Western Sydney. The associated land release area is adjacent to the Western Sydney Priority Growth Area and is shown in Figure 21–1 (labelled as South West Priority Land Release Area).

The South West Priority Growth Area involves development of communities in precincts including Oran Park, Turner Road, East Leppington, Austral and Leppington North, Edmondson Park and Catherine Fields. Collectively the developments would create around 40,000 residences along with local amenities such as schools, public parks, employment areas and town centres. Planning is ongoing for other precincts such as Lowes Creek and Marylands.

21.5.8.5 North West Priority Growth Area

The NSW Government established the North West Priority Growth Area in 2005 to encourage sustainable planning on Sydney's urban edge and provide housing in the north-west of Sydney that is close to employment, schools and other services. The supply of housing generated by the initiative is expected to put downward pressure on housing costs.

The North West Priority Growth Area is approximately 10,000 hectares in size and over time, approximately 70,000 new dwellings will be built. The NSW Government has also planned upgrades to transport infrastructure to support new housing.

21.5.8.6 Greater Macarthur Priority Growth Area

The NSW Government released a preliminary strategy and proposed amendments to *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* in late 2015 to incorporate land in Menangle Park, Mount Gilead and Wilton as future residential and employment areas in Sydney's far south. The preliminary strategy identifies opportunities to deliver up to 35,000 homes in Menangle Park and Mount Gilead and in a new town at Wilton. The Greater Macarthur Priority Growth Area in relation to the proposed airport, Western Sydney Priority Growth Area and South West Priority Growth Area is shown in Figure 21–2.

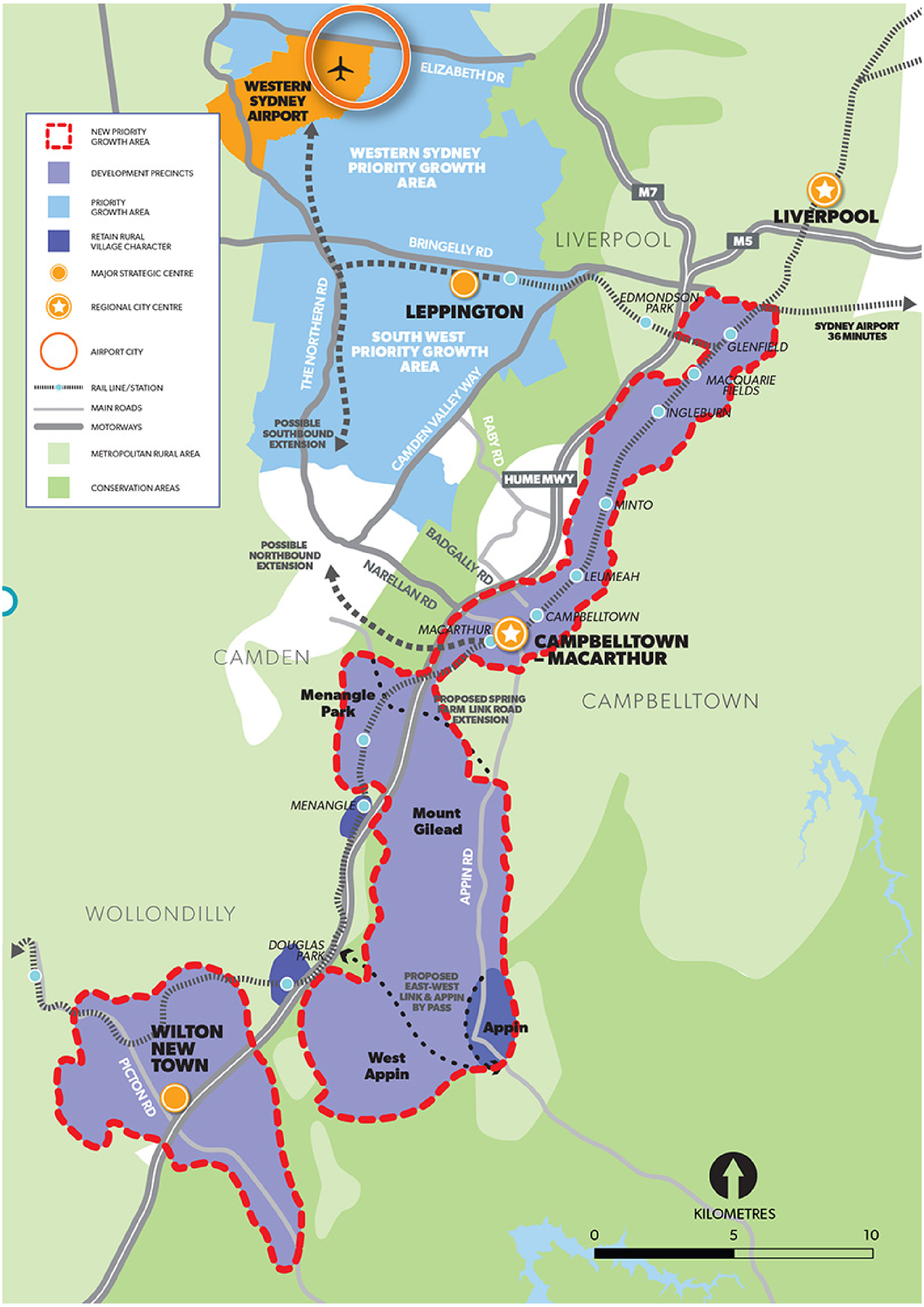


Figure 21–2 Greater Macarthur Priority Growth Area

21.5.9 Infrastructure projects

21.5.9.1 Western Sydney Infrastructure Plan

The Australian and NSW governments are currently delivering a plan to improve transport infrastructure in Western Sydney. The Western Sydney Infrastructure Plan seeks to ensure that the proposed airport would be supported by high quality transport infrastructure for the efficient movement of passengers, employees and freight. The Australian Government's contribution of $2.9 billion to the Western Sydney Infrastructure Plan includes funding for the following works:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road, including realignment of the road around the western boundary of the airport site;
- construction of a new four-lane motorway between the M7 Motorway and The Northern Road;
- upgrade of Bringelly Road to a minimum of four lanes from Camden Valley Way to The Northern Road;
- building the Werrington Arterial Road between the M4 Motorway and the Great Western Highway;
- upgrade of the Ross Street and Great Western Highway intersection at Glenbrook; and
- a $200 million local roads package.

21.5.9.2 Future Rail Access

For the proposed airport to reach its long term capacity, rail services would be required at the airport site at an appropriate point in its development. The Stage 1 development does not currently anticipate a rail service because the recently approved road network upgrades have been assessed as adequate to support anticipated airport demand for at least a decade after operations commence. The Australian Government recognises, however, that rail could provide a benefit to passengers and employees using the airport as well as the broader Western Sydney Region.

For this reason, the Australian and NSW governments are undertaking a Joint Scoping Study on the Rail Needs for Western Sydney, including the proposed airport. The Scoping Study will consider options for future rail links, including decisions about timing and rail service options, both directly to the airport site and within the Western Sydney region. The Scoping Study will also consider what it would take to have rail on the airport site by the time the airport is operational.

21.5.9.3 Outer Sydney Orbital

Transport for NSW is investigating suitable corridors for the Outer Sydney Orbital. The Outer Sydney Orbital would provide a north-south connection for a future motorway, freight rail, and where practical, may be co-located with the South West Rail Link Extension.

The proposed alignment would be located to the west of the airport site, possibly connecting the M5 South West Motorway to the M4 Western Motorway.

The airport site is immediately east of the corridor investigation area. Transport for NSW has committed to take into consideration the development of the future airport by coordinating and working closely with relevant government agencies in assessing corridor options for the Outer Sydney Orbital. The corridor provides the opportunity for multimodal linkages for employment, freight and passenger movements directly related to the proposed airport.

21.6 Assessment impacts during construction

The incidental land use and planning impacts which may occur during the construction phase of the proposal are assessed in the relevant (noise, air quality and traffic) impact assessment chapters of this EIS (Chapters 10, 11, 12 and 15).

Changes to land uses within the footprint of the airport site would occur with the commencement of construction of the proposed airport and continue throughout its operation. Potential impacts associated with land use changes at the airport site are discussed in the following section on operational impacts.

21.7 Assessment of impacts during operation

Having regard to the existing environment, strategic planning at the local and regional scale, and the scope of the proposal, the following likely impacts on land use and planning from the proposed airport have been assessed.

21.7.1 Land use impacts

21.7.1.1 Rural residential lands

Since the mid-1990s, land use planning controls have been in place to protect against the likely impacts of a potential airport at Badgerys Creek. The impacts of the proposed airport on sensitive surrounding land uses would likely be reduced by the considered application of land use zones and development controls that are largely already in place through planning instruments for the South West Priority Growth Area, Western Sydney Employment Area and local council planning controls.

The implementation of developments consistent with State regional planning strategies will inevitably change the character of the area surrounding the airport site. The proposed airport is expected to accelerate the transition from rural-residential to urban land uses. Airport operations would increase passenger and freight road traffic, and result in increased aircraft noise and air quality impacts. The social impact assessment provides further details on these impacts and the socio-economic benefits expected from the proposed development (see Chapter 23).

21.7.1.2 Agricultural lands

Development of the proposed airport and associated urban expansion in Western Sydney over the next few decades would necessitate the loss of productive agricultural land that is close to the Sydney market. This loss of agricultural activity would occur both within the direct footprint of the proposed airport itself and within surrounding lands as land uses transition from rural to urban. Ongoing regional urbanisation is facilitated by the NSW Government’s Metropolitan Plan which recognises the role of the proposed airport in transforming and driving future investment and jobs in Western Sydney.

Existing agricultural activities located in the Cumberland Basin are provided a competitive advantage due to their proximity to the Sydney market. Locational factors of agricultural activities in Western Sydney are seldom related to environmental or other factors of production. Agricultural activities which are currently located in areas affected by urban transition in Western Sydney would be displaced to alternate urban fringe locations. The Metropolitan Plan identifies other rural lands within or close to the Sydney metropolitan area which may be used as alternate agricultural sites. The Department of Primary Industries is also managing this transition, and released an Industry Action Plan for Agriculture in November 2014 which addresses related issues.

21.7.1.3 Employment lands

The Broader WSEA was established directly in response to the announcement by the Australian Government in 2014 that the site for the proposed airport would be the Commonwealth-owned land at Badgerys Creek. The NSW Government's subsequent announcement of the Western Sydney Priority Growth Area, which includes the area previously identified as the Broader WSEA, supports the creation of new employment opportunities and services for local residents in areas around the airport site and in the existing Western Sydney Employment Area.

The proposed airport would be a mutually beneficial land use, creating demand for employment generating activities and transport infrastructure required for freight and logistics.

The land use plan in the revised draft Airport Plan identifies land use zones for retail and commercial development within the airport site. Though specific businesses and activities are yet to be confirmed, the impacts of these proposals on the proposed airport and surrounding lands would be subject to a separate approval process under the Airports Act. This may include a requirement for a Major Development Plan to be prepared, depending on the nature of proposed development.

21.7.1.4 Recreational lands

Badgerys Creek Park would be removed as part of the development of the airport.

Aircraft overflights may result in visual and noise impacts on the following recreational reserves and areas:

- Twin Creeks Golf and Country Club;
- Ropes Creek Reserve (Erskine Park);
- Eastern Creek Raceway;
- Sydney International Equestrian Centre (Horsley Park);
- Western Sydney Parklands (Horsley Park);
- Calmsley Hill City Farm (Abbotsbury); and
- Sales Park (Luddenham);
- Bents Basin State Conservation Area (Greendale); and
- Burragorang Recreation Area (Silverdale).

The Twin Creeks Golf and Country Club is predicted to be exposed to more than 10 noise events above 70 dBA on average each day and Bents Basin State Conservation Area is forecast to experience night time noise levels above 60 dBA, which could affect camping. Impacts on recreational lands are not currently addressed under AS 2021.

The noise assessment of the Stage 1 development is documented further in Chapter 10. Impacts on the Greater Blue Mountains World Heritage Area are assessed in Chapter 26.

21.7.1.5 Airport site land use zone

Most of the airport site is currently zoned SP1 – Commonwealth Activities under state planning instruments. The Department of Infrastructure and Regional Development will work with NSW DP&E to allow for any parts of the airport site not currently zone SP1 to be rezoned.

21.7.2 Airport operations

21.7.2.1 Airspace development controls

As discussed in Section 21.5.3, protecting airspace on and around airports is essential to maintaining a safe operating environment. OLS and PANS-OPS surfaces will be identified for the proposed airport as part of ongoing operations planning.

The OLS, which is generally lower than the PANS-OPS, serves as a first filter for assessing the operational impact of an obstacle. Subject to an assessment, obstacles may need to be lowered, removed or marked and/or lit and noted in aeronautical publications.

PANS-OPS are established to protect stages of flight during take-off, landing or manoeuvring and when aircraft are operating in non-visual conditions. 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 OLS and PANS-OPS for the proposed airport would be prescribed airspace under the Airports (Protection of Airspace) Regulations 1996. Part 12 of the Airports Act regulates building and other activities within prescribed airspace. The Department of Infrastructure and Regional Development will liaise with the NSW DP&E and relevant local councils to seek the adoption of the necessary OLS and PANS-OPS designs in applicable State environmental planning instruments to ensure future development does not impede safe aircraft operations in accordance with the National Airports Safeguarding Framework.

21.7.2.2 Public safety zones

Public safety zones (PSZs) are areas of land at the ends of runways, within which development may be restricted in order to control the number of people on the ground at risk of injury or death in the event of an aircraft accident on take-off or landing. While Australia has an excellent aviation safety record there will always be some risk associated with flying and operation of aircraft at or around airports. The use of PSZs can further reduce the already low risk of an air transport accident affecting people near airport runways.

While there is no current ICAO standard for PSZs, some jurisdictions, such as Queensland, already have in place planning guidelines or policies that consider these risks. In the absence of any nationally agreed guidance, a nominal 1,000 m, trapezoid-shaped clearance off the end of each runway threshold is identified in the indicative layouts at Figure 5–1 and Figure 5–3 of Chapter 5 (Volume 1) to cover the area of highest safety risk.

Where a PSZ is identified, additional scrutiny might be considered for new developments that:

- increase residential use and population density in the zone;
- attract large numbers of people, such as retail or entertainment developments;
- involve institutional uses, such as schools and hospitals;
- involve the manufacture or depot storage of noxious and hazardous materials; and
- attract significant static traffic.

21.7.2.3 Aircraft noise

Land use planning by the NSW Government and local councils over the last two decades has had a high regard to the potential for aircraft noise from a proposed airport at Badgerys Creek. Planning around the airport site has anticipated the potential impacts of aircraft noise by locating a substantial buffer of employment-generating development areas near the site's boundaries.

As discussed previously, the NSW Minister for Planning's section 117 directions have required the adoption of planning controls in local environmental plans based on the 1985 EIS noise exposure forecast. Following this approach, Liverpool Council prepared a Rural Lands Strategy in 2012 that recommended not expanding Luddenham village beyond its current extent as it may be impacted by aircraft noise from the proposed airport.

For land use planning purposes, aircraft noise impacts are measured using the Australian Noise Exposure Forecast (ANEF) measure (see to Chapter 10). The aircraft overflight noise technical report prepared for the EIS (see Appendix E1 (Volume 4)) provides Australian Noise Exposure Concept (ANEC) noise contour maps, which show forecast aircraft noise exposure levels for hypothetical future scenarios, based on indicative flight tracks and airport operating modes. It is expected that an endorsed ANEF noise exposure chart will be produced as part of the future airspace and flight path design process (see Chapter 7 (Volume 1)). This process will be completed prior to the commencement of operations at the proposed airport. The proposed ANEF—based on forecast long term operations—will provide an updated noise exposure map to guide future land use planning. Table 21–3 identifies the recommended development types within ANEF zones, as outlined in AS 2021.

Table 21–3 Building Site Acceptability Based on ANEF zone (AS 2021)

Building Type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hotel, motel, hostel	Less than 25 ANEF	25 to 30 ANEF	Greater than 30 ANEF
School, university	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF
Hospital, nursing home	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF

Building Type	ANEF zone of site		
	Acceptable	Conditionally acceptable	Unacceptable
Public building	Less than 20 ANEF	20 to 30 ANEF	Greater than 30 ANEF
Commercial building	Less than 25 ANEF	25 to 35 ANEF	Greater than 35 ANEF
Light industrial	Less than 30 ANEF	30 to 40 ANEF	Greater than 40 ANEF
Other industrial	Acceptable in all ANEF		

A number of areas surrounding the airport site are identified as affected by noise generated by aircraft operations and are within the ANEC contours calculated for this EIS. The NSW DP&E and relevant local councils will be consulted to ensure applicable environmental planning instruments are amended to include the revised ANEF forecast when it is completed.

The implementation of *Guideline A: Measures for Managing Impacts of Aircraft Noise* under the NASF provides additional guidance for managing future operational noise impacts through land use planning and development controls around the airport.

21.7.2.4 Lighting

The proposed airport lighting is expected to have minimal impact on the adjoining land uses.

The proposed runway orientation limits the possible areas that could be affected by airport approach lighting and runway lighting. An easement will be required where high intensity approach lighting protrudes beyond the site boundary.

The location of terminal buildings and other infrastructure on the southern side of the runway provides a buffer to surrounding sensitive land uses, which would reduce the impact of light emitted from these buildings. Implementation of LED apron lighting and directional external lighting would also reduce potential impacts to surrounding land.

Potential lighting impacts such as light spill and skyglow are discussed further in the landscape and visual amenity assessment in Chapter 22.

Lighting intensity restrictions will apply for non-aviation activity, such as road lighting, in the immediate vicinity of the runways. The maximum intensity of light sources where they have the potential to cause confusion or distraction to pilots within a 6 km radius of an airport may be determined under regulation 94 of the *Civil Aviation Regulations 1988*.

21.7.2.5 Air quality

Chapters 12 and 13 of the EIS provide an assessment of local and regional air quality impacts and associated health effects. New South Wales strategic planning and land use zoning under local environmental planning instruments provide for employment generation and other less sensitive land uses in areas adjoining the airport site. These uses reduce the potential for local air quality impacts on future sensitive receivers in the vicinity of the site.

Operations at the proposed airport would contribute to the cumulative impact on regional air quality from aircraft operations, road traffic, industrial emissions and other regional sources. The zoning of non-residential land uses in the vicinity of the airport would reduce the potential for impacts from airport emissions in these areas. Mitigation measures for both local and regional air quality are provided in the respective chapters of the EIS.

21.7.2.6 Traffic and transport

As outlined in the traffic and transport assessment (see Chapter 15), several local road improvements are planned for or are underway in the vicinity of the airport site.

The current alignment of The Northern Road would be partially acquired for the construction of the proposed airport. Planning work is underway under the Western Sydney Infrastructure Plan to upgrade and realign The Northern Road off the airport site. In addition, Roads and Maritime Services and Transport for NSW are undertaking corridor studies for a new M12 Motorway between The Northern Road and the M7 Westlink Motorway. The corridor for the new motorway generally parallels the alignment of Elizabeth Drive.

Badgerys Creek Road would be partially closed as part of the development of the airport site. Minor internal roads within the Commonwealth-owned land are being closed when they are no longer required.

As noted in Section 21.5.9.2, rail services would be required at the airport site at an appropriate point in its development for the proposed airport to reach its long term capacity. The Stage 1 development does not currently anticipate a rail service because the recently approved road network upgrades have been assessed as adequate to support anticipated airport demand for at least a decade after operations commence. The Australian and NSW governments are undertaking a Joint Scoping Study on the Rail Needs for Western Sydney, including the proposed airport. The Scoping Study will consider the best options for future rail links, including decisions about timing and rail service options, both directly to the airport site and within the Western Sydney region.

Planning for rail connections at the proposed airport is being undertaken in close consultation with Transport for NSW so that Airport infrastructure considerations are aligned with Transport for NSW's planning for its rail network, including the proposed extension of the South West Rail Link. Access for rail across the airport site and for one or more stations in the terminal precinct will be preserved. The rail line will be predominantly underground through the airport site to avoid critical infrastructure and will be consistent with the aviation layout and staging of the airport development while optimising ease of access for passengers. The rail alignment will preserve sufficient space for two independent rail services of two tracks each and with passenger access to the airport terminal and to a business park if required.

Subject to the findings of the Joint Scoping Study, a final rail alignment will be determined in consultation with the NSW Government. Depending on the alignment and preferred timing to develop rail services, work may be required during the Stage 1 development to either commence construction or to future-proof the corridor. Such work is expected to be subject to a separate approval process.

21.7.2.7 *Jet fuel pipeline*

A jet fuel pipeline may service the proposed airport in the future. Transport for NSW is working on developing options for a fuel pipeline corridor into the airport site. It is envisioned that a pipeline corridor would be protected by 2018 following public consultation in 2017. This would ensure that a route for the pipeline is available when required. This work is being undertaken in consultation with the Department of Infrastructure and Regional Development. Arrangements for access to the fuel pipeline, which may involve an easement, would be required for maintenance access and as a public safety measure. This may include planning controls restricting development on and adjacent to the pipeline.

21.7.3 Additional land acquisition

Although much of the land required for the construction of the airport has been acquired by the Australian Government, a small amount of additional land may be needed to meet operational safety and construction requirements.

The land use plan for the proposed airport identifies parcels of land that may be acquired prior to the commencement of substantial works on the airport site.

An easement or other interest will be required where high intensity approach lighting protrudes beyond the site boundary at the northern end of the first runway during the Stage 1 development and at the south-western end of the second runway during the long term development.

21.8 Mitigation and management measures

Consultations will occur with relevant State and local government agencies to maximise the effectiveness of planning interventions, infrastructure projects and other policies and programmes undertaken by the NSW Government and local councils related to the proposed airport. These consultation activities are summarised in Table 21–4. These activities are captured as part of the Community and Stakeholder Engagement Plan to be developed and approved prior to commencement of airport operation as described in Chapter 28 (Volume 2b).

Table 21–4 Mitigation measures

Issue	Mitigation measure	Timing
Operational airspace	Ensure protected airspace under the Airports (Protection of Airspace) Regulations 1997 is identified in appropriate environmental planning instruments.	Pre-operation
Noise	Ensure appropriate noise management controls are included in applicable environmental planning instruments with reference to *AS 2021-2015 Acoustics – Aircraft noise intrusion – Building siting and construction* and noise guidelines under the National Airports Safeguarding Framework.	Pre-operation
Corridor protection – rail	Identify opportunities for corridor protection for the provision of future rail connection to the airport site.	Pre-operation
Corridor protection – fuel pipeline	Identify opportunities for protecting a corridor for a future fuel pipeline.	Operation

21.9 Conclusion

The proposed airport would be a dominant feature in the region that would contribute to changing the rural character of Badgerys Creek and surrounding lands. This land use outcome has been anticipated in Commonwealth, NSW and local government strategic planning for the area over several decades and is formalised through a number of strategic employment and growth areas which include the airport site. The Australian Government will continue to work closely with State government agencies and local councils to ensure regional and local land use planning complements the future operation of the proposed airport and limits incompatible land uses in the vicinity of the airport site.

The proposed airport development would facilitate a range of infrastructure projects flagged by government to support Western Sydney's growth into the future. The proposed airport development would also be a focus for employment generating development in Western Sydney, creating jobs for the new residents of the nearby Priority Growth Areas.

22 Landscape and visual amenity

The airport site and surrounds is typified by gently undulating landform within a highly modified landscape. The overall landscape character is open and rural with expansive views possible from surrounding hill tops and higher elevations to the west. The area's character is also defined by cleared pastureland, and large lot residences (both single and double storey) set back from the road network and punctuated with exotic planting. Patches of remnant vegetation exist within the airport site, particularly along creek lines, road edges and near farm dams.

The construction of the Stage 1 development is likely to have temporary visual impacts for the nearest sensitive receivers in Luddenham and Bringelly. This would be largely due to the visual effect of earthworks and the presence of construction plant, equipment, stockpiling areas and storage areas. Viewpoints that are further away would have more restricted views of the site and would therefore be less affected.

During operation, the potential for moderate to high visual impacts as a result of overflights have been identified for Luddenham, Elizabeth Drive, Lawson Road and Mount Vernon. Lower level impacts as a result of overflights were identified for areas to the south of the airport site including Silverdale Road, Bents Basin State Conservation Area and Dwyer Road.

Operational lighting is likely to have low impacts on sensitive receivers due to topography, existing vegetation, building design, lighting design and runway configuration.

Mitigation measures have been proposed to minimise visual impacts during construction and operation. These include design measures as well as investigating opportunities for retention of existing vegetation and revegetation in suitable areas.

22.1 Introduction

This chapter provides a review of the visual and landscape values for the airport site and surrounding locality. The chapter draws upon a comprehensive visual assessment undertaken for the proposed Stage 1 development which is included as Appendix N (Volume 4). The assessment considers the visibility of the proposed airport from key vantage points in the surrounding locality and the potential impacts on the visual and landscape character of the area.

The assessment addresses the requirements of the EIS guidelines issued by the Commonwealth Department of the Environment and Energy for consideration of landscape and visual impacts associated with the proposal. The visual impact of aircraft overflights on the Greater Blue Mountains World Heritage Area is considered in Chapter 26.

22.2 Methodology

The methodology for the visual impact assessment has been adapted from the approach developed by NSW Roads and Maritime Services as set out in the *Environmental Impact Assessment Practice Note – Guideline for Landscape Character and the Visual Impact Assessment and Guidelines for Landscape Visual Impact Assessment* (RMS 2013). The assessment focuses on the effect on visual amenity including specific viewpoints in the surrounding area.

The guidelines establish an assessment process for visual impact by reference to the sensitivity of the area and the magnitude (or visual effect) of the proposal in that area.

Visual sensitivity refers to the character of a setting, the quality of a view and how critically a change to the existing landscape would be viewed from various viewpoints. For example, users of recreation areas view the surrounding landscape as part of their leisure experience and would consider view changes to the landscape more critically than others.

The visual magnitude (or visual effect) of a development is the degree of contrast between the development and the pre-existing landscape.

The visual impact of a proposal is determined by considering both the sensitivity of the receivers and the magnitude of impact as indicated in Figure 22–1. The combination of visual sensitivity and visual magnitude results in specific levels of impacts for each receiver.

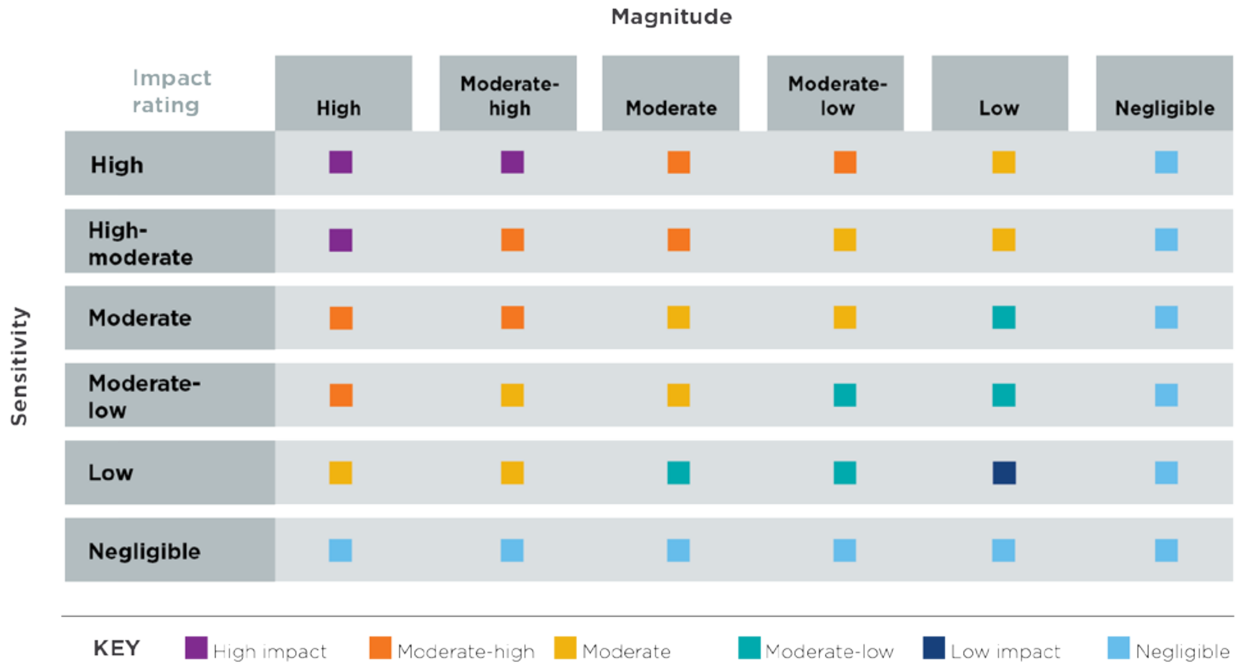


Figure 22–1 Landscape character and visual impact grading matrix

The assessment considers the visibility of the proposed airport from representative viewpoints, identifies visual sensitivity and then assesses visual impact. The viewpoints selected for assessment are intended to represent a range of typical views found within the area, including those viewpoints where a reduction in visual amenity would have some visual impact due to:

- the duration of the view (residents in surrounding suburbs would receive longer duration views in comparison to motorists passing on busy roads);
- the importance of visual amenity to the experience of the location (visitors to recreational areas are likely to place greater value on visual amenity than staff at an industrial estate); or
- where there are large numbers of potential viewers (such as motorists on busy roads).

The visual impacts of the construction and operation of the Stage 1 development are considered in this chapter. Potential visual impacts associated with the long term development are considered in Chapter 38 (Volume 3).

22.3 Existing environment

22.3.1 Site context

The airport site and surrounding areas include ridgelines and rolling hills within the visual context of the Blue Mountains to the west, which provides the backdrop for many views from the east.

The site landscape is typically gentle and undulating within a highly modified landscape. The overall landscape character is open and rural with views determined by both landform and vegetation, with expansive views possible from surrounding hilltops and higher elevations to the west. The area's character is also defined by cleared pastureland and large lot residences (both single and double storey) set back from the road network and punctuated with exotic planting. Patches of remnant vegetation exists within the airport site, particularly along creek lines, road edges and near farm dams.

Immediately north of the site, farm buildings are generally well set back from Elizabeth Drive. The area north of Elizabeth Drive is rural pasture land with scattered remnant vegetation, farm dams and open views of the landscape. North-east of the airport site is a landfill, which is set back and screened from Elizabeth Drive and therefore has only a minor visual presence. Badgerys Creek runs north–south forming the eastern, and part of the southern, site boundary. The remnant vegetation along its edges establishes a natural character which contrasts with the open rural character of the rest of the site. It also screens views to the eastern areas of the airport site from viewpoints further east.

East of the airport site there is a more regular pattern of lots, residences and farm buildings, with smaller lot sizes aligned perpendicular to the streets. Roads in the area have undefined edges and contribute to the overall rural character. A good example can be seen in Photograph 22–1.

Photograph 22-1 View south from Lawson Road

The area south of the airport site near Badgerys Creek Road is characterised by large, rural residential lots and farms on undulating topography. Homes are generally set back from the road and characterised by a mix of remnant vegetation, exotic planting, farm dams and open lawn. An example can be seen in Photograph 22–2.

Photograph 22-2 View west from Badgerys Creek Road

The Bringelly and Greendale areas south and south-west of the airport site are characterised by large lot rural houses, within a mix of remnant native vegetation, exotic tree plantings and mown grass areas. The landscape opens up in areas with views west to the Blue Mountains as shown in Photograph 22–3.

Photograph 22-3 View west from Dwyer Road, Bringelly

Luddenham is the most urbanised of the areas near the airport site. It consists of a retail area accessed from The Northern Road and a residential area to its east. The character of the residential area is shown in Photograph 22–4.

Photograph 22-4 View north-west along Jamison Road, Luddenham

Mount Vernon is a sparsely populated rural suburb approximately five kilometres north-east of the airport site. Much of the suburb consists of an undulating landscape and some rural-residential properties have views over the wider area including to the west toward the airport site and the Greater Blue Mountains World Heritage Area. This is shown in Photograph 22–5.

Photograph 22-5 View south from Mount Vernon Road, Mount Vernon

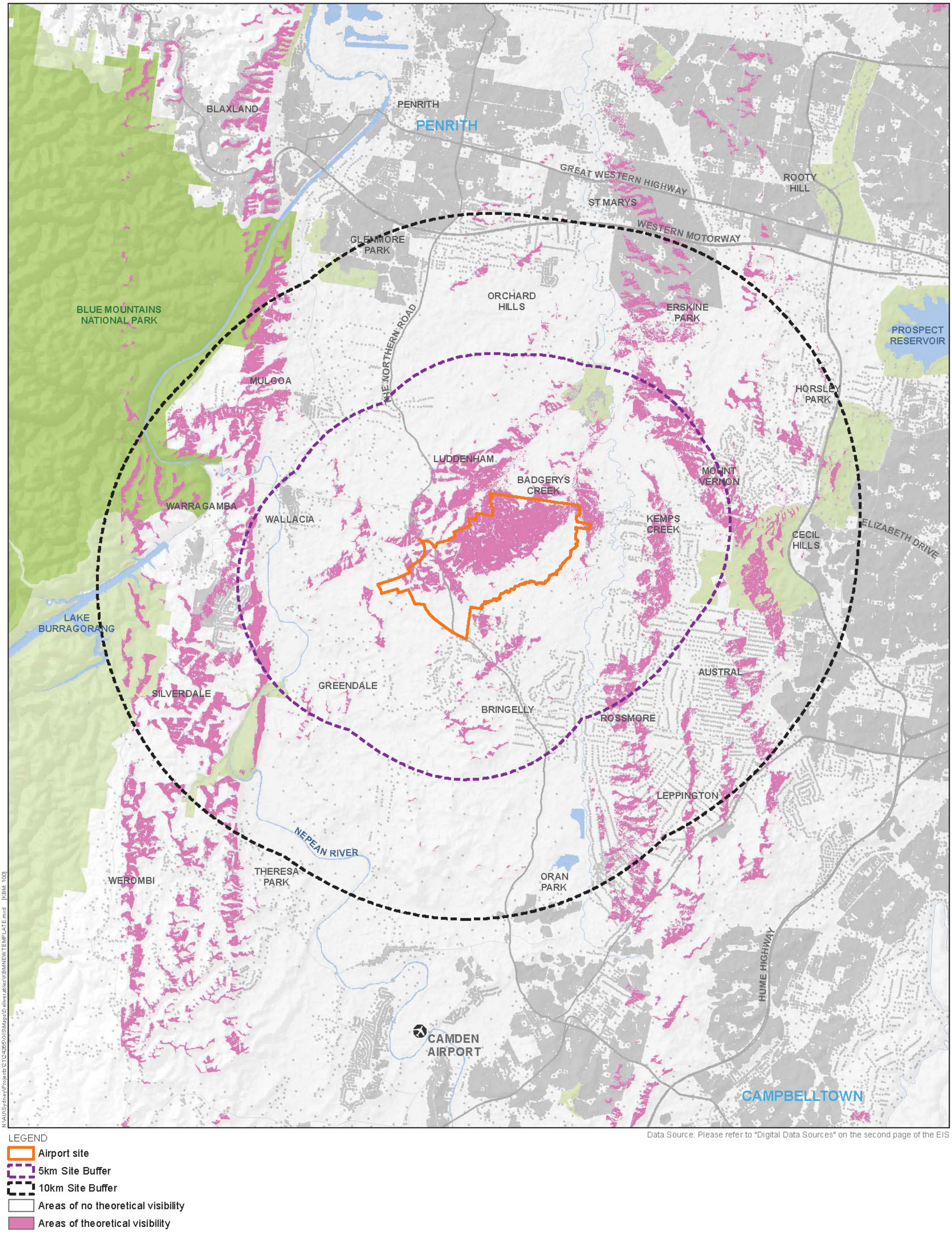
22.3.2 Visual catchment and viewpoints

The visual catchment of a site is the extent of the landscape that can be viewed from the site and the extent of locations from which the site can be seen. Landscape vegetation, land use and landform all play a large role in determining the visual catchment.

The visibility of the airport site was determined for the region, based on the maximum allowable structure heights within the obstacle limitation surface that will be established for the purpose of flight safety. This gave a better understanding of the potential visibility of the proposed airport development and informed the selection of representative viewpoints for analysis.

The assessment of visibility was inherently conservative, as the majority of the buildings expected to be developed as part of the Stage 1 development would be two to three storeys high, falling well below the maximum elevation permitted by the obstacle limitation surface. Figure 22–2 illustrates the visibility of the Stage 1 development.

The airport site would be theoretically visible from the pink shaded areas based on existing topography and the maximum allowed building heights of key buildings and structures that would be constructed, such as the airport control tower, terminal buildings and other major structures. Existing structures or vegetation in the surrounding areas were not taken into account, but their presence would further limit visibility from surrounding sensitive viewpoints.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Figure 22-2 - Visibility of the Stage 1 development

Viewpoints were selected for the assessment to represent a range of typical views found within the area. The details of each viewpoint are provided in Table 22–1, while the location and direction of each viewpoint from the air traffic control tower is shown in Figure 22–3.

The selected viewpoints are considered to represent locations where a reduction in visual amenity would have some visual impact either because of:

- the duration of the view (such as views from residential areas);
- the importance of visual amenity to the land use (such as recreational areas); or
- expected large numbers of potential viewers (such as busy roads).

Table 22–1 Relative heights and distances to representative viewpoints

Viewpoint No.	Location	Approximate height (metres above sea level)	Approximate distance to the air traffic control tower
1	Luddenham Village, east of The Northern Road, Luddenham	100–105	3 kilometres
2	Elizabeth Drive, Badgerys Creek	65–90	2 kilometres
3	Lawson Road, Badgerys Creek	60–65	3 kilometres
4	Badgerys Creek Road, Bringelly	60–75	2 kilometres
5	Dwyer Road, Bringelly	105	5 kilometres
6	Mount Vernon Road, Mount Vernon	80	7 kilometres
7	Rossmore Avenue East, Rossmore	90	7 kilometres
8	Bents Basin State Conservation Area	45	10 kilometres
9	Silverdale Road, Silverdale	210	13 kilometres
10	Warragamba Dam, Warragamba	155	12 kilometres
11	Nepean Lookout, Glenbrook, Greater Blue Mountains World Heritage Area	115	13 kilometres
12	Mount Portal Lookout, Glenbrook, Greater Blue Mountains World Heritage Area	150	14 kilometres
13	Twin Creeks Golf and Country Club, Luddenham	45–50	6 kilometres

LEGEND

- Badgerys Creek site boundary
- Waterways
- Parks and reserves
- Roads
- Viewpoints

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

0 1 2 4 Kilometres

N

Figure 22-3 - Location of viewpoints used for assessment

22.3.3 Assessment of impacts

The assessment of visual impacts for the proposed airport has been completed based upon the methodology for assessing visual sensitivity and visual magnitude as discussed in Section 22.2 of this chapter. Visual sensitivity is based primarily upon the character, land use and quality of views from surrounding viewpoints, and would be relatively consistent throughout each phase of the proposed development. The visual magnitude or effect of the proposed airport would change based on the scale and visibility of activities undertaken during the construction and operation of the Stage 1 development.

This section provides an analysis of the potential activities during construction and operation of the Stage 1 development, which would influence the visibility and magnitude of the visual impact of the proposed airport. The visual impact of the proposed airport from these representative viewpoints is then assessed.

22.3.4 Construction

Construction of the proposed airport would result in substantial changes to the landscape, primarily through major earthworks and the removal of existing vegetation. The area would be modified from an undulating, rural landscape to an essentially flat landscape through a balance of cut and fill during the major earthworks phase. This would occur in the context of an area that has limited capacity to absorb the change due to limited vegetation cover, the form of the land, the frequency of views, and the distance between viewers and the Stage 1 development. While the changes to the landform would become a permanent feature, the visual effect of earthworks, construction plant, equipment, stockpiling areas and storage areas would be temporary and confined to the construction period.

Construction activities include the activities necessary for site preparation and the works involved in the establishment of aviation infrastructure. Major construction activities would consist of erecting security fencing, establishing temporary site facilities, bulk earthworks, topsoil stripping and stockpiling, construction of access roads and services, and the construction of aviation infrastructure.

22.3.5 Operations

22.3.5.1 Airport infrastructure

There would be two general types of visual impacts created by the operation of the Stage 1 development:

- permanent views of the airport site with associated infrastructure including:
  - an at least 35 metre high air traffic control tower;
  - a 3,700 metre long runway and associated taxiway system;
  - passenger terminal and freight buildings;
  - other facilities including aircraft stands, emergency services, aircraft maintenance facilities, navigational aids and lighting; and
- ongoing views of aircraft taking off and landing.

The visual impact for the airport site from representative viewpoints is discussed in Section 22.3.6.

22.3.5.2 Airport lighting

Potential lighting impacts associated with the operation of the proposed airport were considered in a specialised assessment (see Appendix N (Volume 4)).

The revised draft Airport Plan provides an indicative concept design of how an airport may be developed at the airport site. A comprehensive approach to airport lighting would be developed as part of the detailed design of the proposed airport closer to the commencement of operations and will comply with civil aviation regulatory requirements. In this context, this EIS has provided a preliminary assessment of lighting impacts based on information from the Civil Aviation and Safety Authority *Manual of Standards* and *Australian Standard AS 4280: Control of the obtrusive effects from outdoor lighting* (AS 4280). Consideration has also been given to the previous operational lighting impact assessment, performed as part of the *Supplement to Draft Environmental Impact Statement: Second Sydney Airport Proposal* (PPK 1999).

The *Manual of Standards* provides guidance on the design of airport lighting, including cyclic/flashing lighting and approach/runway lighting. The Manual regulates the light above the horizontal plane for lighting near runways to limit pilot confusion and glare. While this does not directly address the obtrusive effects of lighting (because the majority of lighting is directed skyward) visual impacts are anticipated to be minimal.

Taxiway lighting would likely be low intensity and would have a negligible effect beyond the airport boundary. Similarly, runway light fittings would be ground mounted and would likely have low visibility impacts.

The airport beacon light is designed to be at peak intensity between two and eight degrees above the horizontal plane. As the position of the beacon is elevated and the surrounding terrain is relatively flat, it is expected that visual impacts from the beacon light at ground level would be low.

Having regard to the provisions of AS 4280, the lighting for the proposed roads, car parks, apron lighting and other ancillary infrastructure is likely to be low impact, due to the large separation distances to sensitive receivers.

22.3.5.3 Sky glow

Sky glow (brightening of the night sky due to artificial lighting) can affect the work of professional and amateur astronomers and generally limit the community’s ability to observe and appreciate the night sky. Animal populations can also be affected (see Chapter 16). The visual impact assessment identified three ways that sky glow may be generated by the proposed airport:

- Airfield direct light – the main source of sky glow would be from approach and runway lighting, which is designed to be visible from the sky. Ancillary infrastructure would be shielded from above to reduce sky glow;
- Reflected light – sky glow from reflection would be dependent on the lighting illumination level and how reflective nearby surfaces and structures are; and
- Building internal light – sky glow may also occur due to the internal illumination of buildings, which may be visible externally through windows on those buildings.

Sky glow is expected to be minimal from these sources, particularly if appropriate lighting fixtures are selected and oriented.

22.3.5.4 Aircraft and flight paths

As outlined in Chapter 7 (Volume 1), the proposed airport would operate on a 24-hour basis with flights expected to occur during the day and night. Indicative flight paths for the operation of a single runway in the Stage 1 development (in the preferred 05/23 orientation) show that aircraft would land from the south-west and take off to the north-east, or vice-versa.

An assessment of the indicative flight paths shows that aircraft may be directed over a range of visually sensitive areas, including residential areas, recreational areas and national parks, which may result in visual impacts beyond the airport site. Aircraft would be visible flying overhead as well as when they pass through views near the airport site. Both of these types of views are temporary and at varying distances/heights. Accordingly, they would have a range of different impacts on visual receivers.

Arriving and departing aircraft would generally be less prominent the further they are away from the proposed airport. Views of aircraft would also be affected by airport operational patterns which, although generally consistent, could vary depending on wind conditions and other operational factors.

Generally, aircraft at 3,000 feet are not prominent visual features although they are visible from the ground. At 7,000 feet, aircraft are likely to be difficult to discern from ground level and are not considered to be visually obtrusive. For context, an aircraft at 3,000 feet is presented in Photograph 22–6. The expected altitudes of aircraft at various points along their flight paths are presented in Chapter 7 (Volume 1). After take-off aircraft would ascend relatively quickly reaching 5,000 feet above sea level within about 10 kilometres of the airport site and continuing to ascend to over 10,000 feet. Built up areas are mostly at a distance of greater than six kilometres from the airport site and are unlikely to experience significant visual impacts.

Photograph 22-6 Aircraft at approximately 3,000 feet on a clear day at a ground distance of 2.75 kilometres from the viewer

Many aircraft currently approaching and departing Sydney Airport fly over the Blue Mountains. Aircraft arriving and departing from the proposed airport would further contribute to the existing density of flights over the Blue Mountains, and would likely be at lower altitudes compared to aircraft using Sydney Airport. Consequently, aircraft approaching and departing the proposed airport would likely be more visible to residents and visitors in the Blue Mountains.

The impact of aircraft overflights on the Greater Blue Mountains World Heritage Area values and other values are considered separately in Chapter 26 for the Stage 1 development and Chapter 38 (Volume 3) for the long term development.

22.3.6 Representative viewpoints

An assessment of likely visual impacts at representative viewpoints during construction and operation of the Stage 1 development is provided in Table 22–2.

Table 22–2 Impact assessment for representative viewpoints

Viewpoint	Assessment	Impact Level
1. Luddenham Village east of The Northern Road, Luddenham	Sensitivity = Moderate–high This viewpoint is representative of views from the Luddenham commercial and residential area. Views to the south and west would be dominated by the proposed airport development and boundary fence in the foreground. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Moderate–high The existing ridge line south of the Luddenham residential area would assist in restricting views directly south from residents. However, airport development along the western boundary would likely be partially or directly visible by residents and workers. Viewing distance is approximately one kilometre from the western end of the runway and there would be views of aircraft taking off or landing. The surrounding rural landscape has limited capacity to absorb the visual effect of the proposed airport due to limited vegetation cover, landform, frequency of views and the distance between viewers and the proposed airport site.	Moderate-high
2. Elizabeth Drive, Badgerys Creek	Sensitivity = Moderate This viewpoint is representative of views from drivers and passengers of vehicles using Elizabeth Drive. Views are brief but are relatively close to the northern areas of the proposed airport and runway. Magnitude = High The existing landscape character within the airport site would be highly modified by landform changes and removal of the existing vegetation. The scale and nature of the airport site development would be noticeable with views of the Stage 1 development and boundary fence in the foreground. Aircraft would be similarly prominent as flights are expected to be directed over Elizabeth Drive (and the proposed M12 Motorway) from the eastern end of the runway.	Moderate-high

Viewpoint	Assessment	Impact Level
3. Lawson Road, Badgerys Creek	Sensitivity = High This viewpoint is representative of views from rural residences and farms approximately five hundred metres east of the airport site boundary. Views toward the western part of the Stage 1 development may be possible from some properties with the boundary fence in the foreground. There is assumed cultural value placed on the existing rural landscape and the landscape along Badgerys Creek by local residents where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Moderate The clearance of vegetation and overall extent of change in topography is likely to be visible from some properties in this area. Nevertheless, it would not be prominent as the vegetation along Badgerys Creek would be retained as an environmental conservation zone that would obscure much of the airport site. Aircraft movements are expected to be directed to the north and the south, resulting in a lower level of impact than for viewpoints with direct overflights.	Moderate-high
4. Badgerys Creek Road, Bringelly	Sensitivity = Moderate–high This viewpoint is representative of views from rural residences and farms one to two kilometres south of the airport site boundary. Views to the north of the proposed airport and its features may be possible from some properties. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Low–moderate The clearance of vegetation and overall extent of change in topography is likely to be visible from some properties in this area, however it would not be prominent due to vegetation obscuring much of the airport site. Aircraft are expected to be visible as flights are directed in a north-south direction approximately one kilometre to the east of Badgerys Creek Road.	Moderate
5. Dwyer Road, Bringelly	Sensitivity = Moderate–high This viewpoint is representative of views from rural residences approximately two kilometres south of the airport site boundary. There is assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents would be subject to long duration views. Magnitude = Low–moderate During construction and operation, views to the north of the proposed airport are unlikely due to existing obscuring vegetation and topography. Aircraft would be visible as movements are expected to be directed in a north-south direction approximately two kilometres to the east of Dwyer Road.	Moderate
6. Mount Vernon Road, Mount Vernon	Sensitivity = Moderate–high This viewpoint is representative of views from rural properties at elevations higher than Badgerys Creek approximately five kilometres from the airport boundary. Some properties have broad views of areas to the west and possibly of the Blue Mountains and beyond. Sensitivity is derived from the assumed cultural value placed on the existing rural landscape by local residents where visual amenity is important and where residents would be subject to long duration views. Magnitude = Moderate Airport features such as the air traffic control tower as well as aircraft taking off and landing would be visible. Views of some areas within the airport site may be partially screened by vegetation and topography, depending on the elevation and aspect of individual residences. The overall landscape has some capacity to absorb views of the development given the views consist of an existing modified landscape character. Aircraft may be seen but at a distance of over four kilometres away.	Moderate-high

Viewpoint	Assessment	Impact Level
7. Rossmore Avenue East, Rossmore	Sensitivity = Moderate This viewpoint is representative of views from rural residential and agricultural properties approximately seven kilometres from the airport boundary. Properties in this area are at elevations higher than the airport site, some having broad views toward the west and north-west. The visual sensitivity of this location is derived from it being a residential and agricultural area, where visual amenity is important and where residents and workers would be subject to long duration views. Magnitude = Low Changes to the landscape including vegetation clearance, earthworks and new structures, such as the air traffic control tower and terminal, would result in a noticeable change in the view and a reduction in visual amenity. However, this impact would be filtered by local vegetation. Aircraft movements are expected to be visible in the sky at a distance of over five kilometres.	Moderate-low
8. Bents Basin State Conservation Area	Sensitivity = Moderate Some visual sensitivity at this location is derived from the importance of visual amenity due to its use as a state recreation area by visitors and staff. Visitor numbers fluctuate seasonally and are only temporary. At night the location would have a higher degree of sensitivity due to its use for overnight recreation. Magnitude = Low There are no direct views of the proposed airport, however visual receivers are expected to be able to see aircraft in the sky from a distance of approximately two kilometres.	Moderate-low
9. Silverdale Road, Silverdale	Sensitivity = Moderate This visual sensitivity of this location is derived from it being an elevated, rural residential area with broad expansive views over surrounding areas, where visual amenity is important and where residents are subject to long duration views. Residences are located approximately 10 kilometres from the airport site. Magnitude = Low Vegetation clearance for the airport would result in a change in the view and a reduction in visual amenity in the vicinity of this view, particularly from houses that may have an unobstructed view of the Badgerys Creek landscape. The new runway and airport structures would be visible from some residences and limited in others, depending on aspect, topography and vegetation. Visual impacts from aircraft are possible due to the south-west to north-east alignment of the flight path two to three kilometres to the south.	Moderate-low
10. Warragamba Dam Recreation Area	Sensitivity = High Visual sensitivity is derived at this location from the importance of visual amenity due to its use as a recreation, educational and historic area. It is assumed that there is significant value placed on both the natural and cultural landscape by visitors and staff. As Warragamba Dam is an operational facility, workers would be subject to long duration views, however views for visitors to the adjoining recreation area and visitor centre would only be temporary. Magnitude = Negligible There are no direct views of the airport site and aircraft would not be prominent as they are expected to be at a distance of approximately five kilometres from the recreation areas and visitor centre.	Negligible

Viewpoint	Assessment	Impact Level
11. Glenbrook Nepean Lookout	Sensitivity = Moderate–high Visual sensitivity is derived from this location being one of the closest elevated positions to the west of the airport site at approximately 11 kilometres and within the Blue Mountains area. It is assumed that there is significant recreational and cultural value placed on the natural landscape and bush setting by park users. Viewer times may be of a long or short duration and the number of viewers fluctuates seasonally. Magnitude = Low Direct views of the airport construction and operation are prevented by topography and vegetation. Views of aircraft may be possible at a distance of over three kilometres.	Moderate
12. Mount Portal Lookout	Sensitivity – Moderate–high This location is an elevated lookout 12 kilometres north-west of the airport site within the Blue Mountains, and offers broad views over western Sydney on a clear day to the south and west. Visitors may stay for short or long periods and this would fluctuate seasonally. It is assumed that there is significant recreational and cultural value placed on the landscape by visual receivers. Magnitude = Negligible Landform and vegetation in the foreground would largely prevent views of the airport site to the south. There is capacity of the landscape to absorb views of the airport development due to broad landscape views of the existing developed areas to the south and east. Views of aircraft are possible at a distance of more than ten kilometres.	Negligible
13. Twin Creeks Golf and Country Club	Sensitivity = Moderate–high Twin Creeks Golf and Country Club is located approximately six kilometres to the north-east of the airport boundary. The sensitivity of this view relates to its use as a country club and recreational and social hub with a presumed high level of use as well as a residential estate. Many views therefore would be of a long duration. Magnitude = Low–moderate The existing vegetation and landform prevent direct views of the proposed airport site. Aircraft movements are expected to be prominent with the indicative flight path positioned in the vicinity of the golf club and oriented on a north-south alignment.	Moderate

22.4 Mitigation and management measures

A Visual and Landscape Construction Environmental Management Plan (CEMP) will be prepared and approved prior to Main Construction Works for the proposed airport.

Visual impacts will primarily be managed through the construction of the Stage 1 development, however mitigation and management of visual impacts will also be incorporated into the Biodiversity, Land and Safety Operational Environmental Management Plan (OEMP).

The plans would collate the mitigation and management measures itemised in Table 22–3. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

Table 22–3 Mitigation and management measures – landscape and visual amenity

Issue	Mitigation/management measure	Timing
Urban design	To facilitate the appropriate integration of the proposed airport into the surrounding region, and to assist in minimising impacts to community identity and landscape character, the following measures will be implemented throughout the detailed design process: • site and context analysis to inform the early stages of detailed design; and • consultation with NSW Department of Planning and Environment and relevant local councils, on the detailed design of Stage 1 development.	Pre-construction
Airport lighting impacts	Airport lighting impacts will be mitigated through the use of low angle, cut off LED fixtures in the design of airport infrastructure, where practicable.	Pre-construction
Visual disturbance and clutter from fencing	Subject to safety and security requirements, perimeter fencing design would have regard to the following considerations: • avoiding long, straight continuous runs; • avoiding finish and colour that is reflective or brightly coloured; • providing a two metre (minimum) setback from the property boundary to allow for perimeter plantings; and • providing a buffer from riparian corridors along the boundary of the airport site.	Pre-construction
Visual disturbance and clutter from construction	Impacts on the visual character of the landscape during construction will be mitigated though the implementation of the following measures: • large grade cut and fill transitions will be avoided where practicable, particularly near the airport site boundary; • construction plant, machinery and vehicle parking areas will be located as far as practicable from sensitive receivers; • any night lighting required for construction works will be located as far as practicable from sensitive receivers with appropriate screening as required; and • if there is a considerable period of time between the completion of bulk earthworks and construction of aviation infrastructure, earthworks areas will be rehabilitated where it is practical to do so.	Pre-construction
Visual screening	Visual amenity impacts will be mitigated through the use of the following visual screening measures: • retaining existing vegetation on the edges of the construction impact zone, where practicable to provide visual screening; and • retaining existing vegetation outside of the construction impact zone to provide visual screening. Opportunities for native vegetation screening will be investigated, particularly in relation to the identified moderate-high impact viewpoints. The appropriateness and use of vegetation for visual screening will take into consideration bushfire risks, airport safety and security, potential impacts on aviation operations, and opportunities for the reestablishment of endemic native species and ecological communities.	Construction Operation

22.5 Conclusion

The visual impact of the Stage 1 development of the proposed airport has been assessed by applying an accepted visual impact assessment methodology. This has involved consideration of the existing landscape character and views and the effects of construction and operation of the proposed airport.

During construction, the proposed airport would be likely to have temporary visual impacts for the nearest sensitive receivers in Luddenham and Bringelly. Viewpoints further away would have restricted views of the airport site and the visual impact would likely be low to negligible.

During operation, the potential for moderate to high visual impacts as a result of overflights have been identified for Luddenham, Elizabeth Drive, Lawson Road and Mount Vernon. Operational lighting is likely to have low impacts on sensitive receivers due to topography, existing vegetation, building design, lighting design and runway configuration.

Mitigation measures have been proposed where appropriate to minimise visual impacts during construction and operation of the Stage 1 development.

23 Social

The Western Sydney region is diverse, with densely populated and highly urbanised areas, as well as semi-rural, recreational and natural areas. The region is culturally diverse, with strong heritage values (both Indigenous and non-Indigenous), cohesive communities, natural and recreational values, and connections to the employment hubs of the Parramatta and Sydney CBDs.

The major employment, residential and transport infrastructure projects proposed for Western Sydney demonstrate the critical role the Western Sydney region plays in Sydney's future. The proposed airport will be a significant catalyst for increased and faster growth for Western Sydney, as well as growth more broadly in the Greater Sydney metropolitan area.

The proposed airport has the potential to bring significant benefits to the people and economy of Western Sydney. Many of the benefits for the Western Sydney and Greater Sydney communities are expected to relate to economic development and employment opportunities. The project would create jobs for many types of workers of various skills and qualifications, contributing to increased incomes across the Western Sydney region.

As a facilitator of growth and change in Western Sydney, the proposed airport would stimulate further development in regional and local centres, contributing to providing better quality social infrastructure, such as shops, health services, recreation and leisure services. To maximise economic benefits for local residents an Australian Industry Participation Plan and an equal opportunity strategy will be developed to promote the utilisation of local labour, goods and services during the construction and operation of the proposed airport. Additionally, the development of training opportunities in the region undertaken by the NSW Government and local governments would encourage innovation and the creation of new small and large businesses supporting the proposed airport development.

The construction and operation of the proposed airport would likely result in changes to the social amenity and lifestyle of communities both in the vicinity of the airport site, and in Western Sydney more broadly. The rural character of the area would change with the development of the airport, while the amenity of nearby properties and communities (such as Luddenham) would be potentially impacted, particularly by noise.

Measures are proposed to enhance the social and economic opportunities and benefits presented by the construction and operation of the proposed Stage 1 development. These measures would work in parallel with measures proposed in other assessments to mitigate and manage potential amenity impacts including from noise and air emissions.

When considered with other employment initiatives taking place in the region, the opportunities for positive change and improved socio-economic outcomes for Western Sydney are significant.

23.1 Introduction

This chapter assesses the likely social impacts of the construction and operation of the Stage 1 development. This chapter draws on other technical assessments completed, in particular the social impact assessment (Appendix P1 (Volume 4)), property values assessment (Appendix P2 (Volume 4)) and economic assessment (Appendix P3 (Volume 4)).

The assessment has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines). The potential social impacts of the Stage 1 development on surrounding communities are assessed and measures to mitigate and manage those impacts are identified.

23.2 Methodology

The social impact assessment has been undertaken in accordance with the EIS guidelines and industry guidelines developed by the International Association for Impact Assessment, namely the *International Principles for Social Impact Assessment* (Vanclay 2003) and *Guidance for Assessing and Managing Social Impacts of Projects* (Vanclay 2015). The assessment involved the following:

- definition of the study area, incorporating potential affected communities;
- detailed literature review of guidelines, social statistics and strategic planning documents;
- documentation of social baseline, including targeted stakeholder consultation;
- identification and assessment of potential social benefits and impacts; and
- development of measures to enhance social benefits and manage social impacts.

23.2.1 Definition of study area

The study area for the social impact assessment was defined at multiple scales, including the:

- Local study area – communities directly surrounding the airport site that may be directly affected by the proposed airport, such as Arndell Park, Austral, Badgerys Creek, Bringelly, Chatsworth, Cobbitty, Eastern Creek, Erskine Park, Glenfield, Greendale, Horsley Park, Kemps Creek, Leppington, Luddenham, Mount Vernon, Mulgoa, North St Marys, Orchard Hills, Penrith, Prospect, Rossmore, Silverdale, South Penrith, St Clair, St Marys, Theresa Park, Wallacia, Werombi and Werrington;
- Regional study area – Local government areas surrounding the airport site that may experience high social interaction with the proposed airport, but may not be as directly affected. The regional study area is divided into three districts as defined by the NSW Department of Planning and Environment:
  - South West – Camden, Campbelltown, Fairfield, Liverpool, Wollondilly;
  - West – Blue Mountains, Hawkesbury, Penrith; and
  - West Central – Blacktown, Canterbury-Bankstown (part of), Cumberland, Parramatta and The Hills.
- Greater Sydney study area – the wider Sydney area which may be influenced by the proposed airport, predominantly affected in terms of procurement of goods, services and workforce.

23.2.2 Literature review

A detailed literature review was undertaken to inform the social baseline. Literature that was reviewed included guidelines, social statistics and strategic planning documents such as:

- relevant guidelines including;
  - EIS guidelines for Western Sydney Airport;
  - *International Principles for Social Impact Assessment;* and
  - *Guidance for Assessing and Managing Social Impacts of Projects.*
- local government publications such as local environmental plans;

- NSW Government publications, including *A Plan for Growing Sydney*;
- Australian Government publications, including the *Western Sydney Infrastructure Plan*;
- Census 2011 data from the Australian Bureau of Statistics; and
- previous environmental impact assessments for the airport site and other major projects.

23.2.3 Social baseline

A social baseline is a description of the study area that includes a range of information including things like statistics on population and employment as well as community values. It is important to development a social baseline in order to better identify, explain and provide context to the social impacts that are identified and assessed in a social impact assessment.

The social baseline was researched and documented as a product of the literature review and additional tasks including the development of population forecasts and stakeholder consultation.

Population forecasts were required to realistically assess the potential social impacts of the proposed airport into the future. The population forecasts were sourced from the *Western Sydney Population and Demographic Analysis* (SGS Economics and Planning 2015).

Stakeholder consultation was undertaken to supplement information collected through the literature review. Stakeholder consultation involved communications with a variety of stakeholders including:

- NSW Government agencies and emergency services;
- local councils in the region of the proposed airport; and
- other regional organisations such as the Western Sydney Business Chamber.

23.2.4 Social benefits and impacts

Social benefits and impacts were assessed with consideration of the findings of the literature review and development of the social baseline and the guidance provided in the *International Principles for Social Impact Assessment* (Vanclay 2003) and *Guidance for Assessing and Managing Social Impacts of Projects* (Vanclay 2015).

The findings of other technical assessments were also a key input into the social impact assessment, including the aircraft overflight noise assessment (Appendix E1 (Volume 4)), airport ground based noise assessment (Appendix E2 (Volume 4)), local air quality assessment (Appendix F1 (Volume 4)), regional air quality assessment (Appendix F2 (Volume 4)), community health assessment (Appendix G (Volume 4)), surface transport and access assessment (Appendix J (Volume 4)), planning and land use (Appendix N (Volume 4)), landscape character and visual assessment (Appendix O (Volume 4)), property values assessment (Appendix P2 (Volume 4)) and economic impact assessment (Appendix P3 (Volume 4)).

The identified social benefits and impacts were classified within a risk framework as per industry standard practice. The framework and risk ratings are discussed in Appendix P1 (Volume 4).

23.2.5 Mitigation and management measures

Measures to enhance social benefits and manage social impacts were selected based on the identified social benefits and impacts. The measures were identified based on industry standard practice. The measures will be reviewed and modified as necessary to accommodate social change or emergent social issues in accordance with the principles of adaptive management. These principles are reflected in the environmental management plans for the construction and operation of the proposed airport.

The social impact assessment also makes reference to measures to mitigate and manage various amenity impacts identified in other technical assessments as stated in Section 23.2.4.

23.3 Existing environment

23.3.1 Airport site

The airport site is located at Badgerys Creek in the Liverpool local government area. The northern boundary of the airport site adjoins the Penrith local government area. The study area is situated about 50 kilometres west-southwest of the Sydney CBD. The suburb of Badgerys Creek can be accessed via Elizabeth Drive or The Northern Road, both of which are main roads in this area. Kemps Creek and Luddenham are the closest townships.

23.3.2 Land ownership

The airport site is approximately 1,780 hectares in size and located on land acquired by the Australian Government in the 1980s and 1990s. Since the land was acquired, the Australian Government has been leasing properties to private tenants, with a property management agency contracted to manage the properties. Short-term leases have been in place for a number of the properties, as there has been a long-standing possibility of an airport development occurring.

23.3.3 Existing land use

The key existing land uses on the airport site, prior to tenant relocation, are outlined below:

- 139 residential tenancies ranging in area from approximately one to 40 hectares each;
- 16 agricultural tenancies including market gardens growing cucumber, strawberry, Asian herbs and tomatoes, and livestock farming including poultry and cattle grazing;
- eight commercial tenancies including the operator of a shale quarry, vineyard and a Christmas tree farm;
- the former Badgerys Creek Primary School, which was closed by the NSW Department of Education and Communities in December 2014;
- Badgerys Creek Park;
- two cemeteries (St Johns Anglican Church and Badgerys Creek Uniting Church); and
- a Scout hall located on Elizabeth Drive.

23.3.3.1 Social characteristics

Consistent with the semi-rural location of the site, and the Australian Bureau of Statistics (ABS) data for Badgerys Creek, dwellings on the residential tenancies were generally separate houses. The tenancies included a range of household types, including families with children, couples without children, and single households. Tenants were primarily from English speaking backgrounds, with some people from Italian and Maltese backgrounds.

Some tenants were over 65 years of age, a proportion of which were on aged pensions or disability pensions. This is reflected in the lower rate of labour force participation for Badgerys Creek (49 per cent) compared to the wider Liverpool local government area (58 per cent).

Of the 139 residential tenancies, 38 were long term tenants who had been living in the same property for 20 years or more and six tenancies were original land owners who had been leasing properties on the site since they sold to the Australian Government.

The occupations of tenants varied, from those who were self-employed and worked from home, or worked on the land (i.e. agriculture), to professionals, contractors and truck drivers. This is reflected by the employment profile for Badgerys Creek at the 2011 Census, with the top industries of employment being construction (13.3 per cent), agriculture (9.8 per cent) and transport and warehousing (9.2 per cent). The top occupations were managers (18.5 per cent), labourers (16.8 per cent) and technicians and trades (16.8 per cent).

23.3.4 Western Sydney

The existing communities of Western Sydney which make up the regional study area are diverse; from densely populated and highly urbanised areas, to semi-rural, recreational and natural areas. Many communities are known for their cultural diversity, heritage (both Aboriginal and European), strong and cohesive character, and recreational values. The regional study area has a number of employment hubs, such as the regional centres of Penrith and Liverpool, and has major transport connections within the region and to other parts of Greater Sydney.

Western Sydney is undergoing a major transition to a more highly urbanised region. This transition will be accelerated by the various major employment, residential and transport infrastructure projects identified for Western Sydney in addition to the proposed airport (see Section 23.3.6)

The proposed airport, in combination with other major projects and planning initiatives, has the potential to accelerate the investment in employment, housing and transport along with associated changes to communities in Western Sydney.

23.3.5 Population and employment growth

Many areas in Western Sydney have experienced high levels of urban development and population growth over recent years. This is expected to continue, as new areas in Western Sydney are developed, and population density increases around regional and town centres.

The population of Western Sydney is expected to grow significantly. The population is expected to grow 29 per cent by 2030, bringing in the order of one million people into the region (SGS 2015).

A Plan for Growing Sydney (DP&E 2014) focuses heavily on the role of Western Sydney in driving the growth of Sydney and NSW over the coming decades. Along with the development of the region more broadly, the emergence of Parramatta as Sydney's second CBD will further increase

Western Sydney's national and metropolitan influence. The NSW Government proposes that, as well as an employment hub, Parramatta will become an education hub. The Western Sydney University is currently developing a new campus in Parramatta and is planning to increase the capacity of its campus at Rydalmere. Adjacent to Parramatta, the Westmead Health Precinct is one of the largest integrated health, research, education and training precincts in the world. Parramatta CBD will be part of the Global Economic Corridor which will link Port Botany and Sydney (Kingsford Smith) Airport to employment hubs at Norwest and Sydney Olympic Park.

Providing more jobs in Western Sydney is important for creating and maintaining liveable and healthy communities. Although half of Sydney's population lives in Western Sydney, only a third of Sydney's jobs are located in the region, leading to long commutes for many workers. This will be particularly important given the demand for employment in Western Sydney is expected to increase faster than overall demand for employment in Greater Sydney.

As shown in Table 23–1, the labour forces in Western Sydney and Greater Sydney are predicted to grow markedly in the future. In particular, the labour force in Western Sydney is predicted to grow by 66 per cent between 2025 and 2065 while the labour force in Greater Sydney is predicted to grow by 52 per cent over the same period of time.

Table 23–1 Predicted labour force

Area	2025	2030	2065
Western Sydney	1,609,401	1,744,955	2,664,991
Greater Sydney	3,297,664	3,522,912	5,016,069

Employment areas will be key contributors to providing new jobs to meet this projected demand. A number of strategic planning initiatives are planned for Western Sydney (see Section 23.3.6). These areas have been established to provide businesses with land for industry and employment, particularly transport and logistics, warehousing and office space. The areas are located close to major transport and utility services, and are intended to encourage compatible developments near the proposed airport.

23.3.6 Urban growth and major projects

Significant new development is required to support expected population growth. A number of strategic planning initiatives and associated land release areas are planned for Western Sydney that would facilitate urban growth. These include:

- Western Sydney Priority Growth Area;
- Western Sydney Employment Area;
- South West Priority Growth Area;
- North West Priority Growth Area; and
- Greater Macarthur Priority Growth Area.

23.3.6.1 Western Sydney Priority Growth Area

The Western Sydney Priority Growth Area is a strategic planning initiative that aims to provide jobs, homes and services in the land around the proposed airport. A key priority for the Western Sydney Priority Growth Area will be to coordinate the development of employment and housing lands in a way that is compatible with operations at the proposed airport.

An accompanying Land Use and Infrastructure Strategy is under development to guide infrastructure investment in the Western Sydney Priority Growth Area. A key aim of the strategy will be to connect the proposed airport with the regional centres of Penrith and Liverpool.

23.3.6.2 Western Sydney Employment Area

The Western Sydney Employment Area is a strategic planning initiative that aims to provide businesses in Western Sydney with land for industry and employment including transport, logistics, warehousing and office space.

Previously the NSW Government had intended to extend the Western Sydney Employment Area to the south, including the area which is now the airport site. Following the Australian Government announcement in April 2014 to locate an airport at Badgerys Creek, the plans for the extension of the Western Sydney Employment Area were replaced with the introduction of the Western Sydney Priority Growth Area which will be focussed on ensuring compatible employment and housing development around the airport site.

23.3.6.3 South West Priority Growth Area

The South West Priority Growth Area is a strategic planning initiative dedicated to providing housing in Western Sydney. The supply of housing generated by the initiative is also expected to place downward pressure on housing costs.

The South West Priority Growth Area involves development of communities in precincts including Oran Park, Turner Road, East Leppington, Austral, Leppington North, Edmondson Park and Catherine Fields. Collectively the developments would create around 40,000 residences along with local amenities such as schools, public parks, employment areas and town centres. Planning is ongoing for other precincts such as Lowes Creek and Marylands.

23.3.6.4 North West Priority Growth Area

The North West Priority Growth Area is a strategic planning initiative dedicated to providing housing in Western Sydney. The supply of housing generated by the initiative is expected to put downward pressure on housing costs.

The North West Priority Growth Area involves development of communities in precincts including Alex Avenue, Riverstone, Marsden Park, Box Hill, Colebee, Cudgegong Road Station, North Kellyville and Schofields. Collectively the developments would create around 47,000 new residences along with local amenities such as schools, public parks, employment areas and town centres. Planning is ongoing for other new precincts such as Riverstone East, Vineyard, Marsden Park North and West Schofields.

23.3.6.5 Greater Macarthur Priority Growth Area

The Greater Macarthur Priority Growth Area is a strategic planning initiative for urban renewal, land release and infrastructure development around the Campbelltown-Macarthur Regional City.

The area would create opportunities for jobs and homes in Menangle Park and Mount Gilead as well as a new town centre at Wilton and is expected to provide up to 33,000 new homes and 30,000 readily accessible jobs. The area would also facilitate the urban renewal of seven train station precincts from Glenfield to Macarthur.

23.3.6.6 Urban renewal projects

The renewal of established areas is also a key strategy for the NSW Government to provide increased housing and jobs in Sydney, with the focus on transport corridors and around strategic centres. A number of areas in Western Sydney have been identified as priority urban renewal areas including:

- Glenfield to Macarthur Urban Renewal Corridor – located in Campbelltown local government area, with the area around seven train stations being investigated for redevelopment and provision of new homes. The corridor will form part of the planning for the Glenfield Macarthur Priority Growth Area (see Section 23.3.6);
- Greater Parramatta to Olympic Peninsula Urban Renewal Area – largely located across City of Parramatta Council, work has already begun on revitalising Wentworth Point and Carter Street, and plans are being developed for Camellia; and
- Sydney Metro Northwest Priority Urban Renewal Corridor – located between the Cherrybrook and Cudgegong Road stations of the planned Sydney Metro line. The corridor will form part of the planning for the Northwest Priority Growth Area (see Section 23.3.6).

23.3.6.7 Major transport infrastructure projects

A number of major transport projects are in various stages of planning and construction throughout Greater Sydney, which will connect communities in Western Sydney to various centres and the central business districts of Parramatta and Sydney City.

Joint Scoping Study of Rail Needs for Western Sydney

The Australian and NSW governments are undertaking a Joint Scoping Study of Rail Needs for Western Sydney, including the proposed airport. The Scoping Study will consider the best options for future rail links, including decisions about timing and rail service options, both directly to the airport site and within the Western Sydney region. The Scoping Study will also address the question of providing rail to the airport site in time for the Stage 1 development.

Planning for rail connections at the airport is being undertaken in close consultation with Transport for NSW. This will ensure that airport infrastructure considerations are aligned with Transport for NSW's planning for its rail network, including the proposed extension of the South West Rail Link.

Subject to the findings of the Scoping Study, a final rail alignment to the airport will be determined in consultation with the NSW Government. Depending on the alignment and preferred timing to develop rail services, work may be required during the Stage 1 Development to either commence construction or to future-proof the corridor. Any such work is expected to be subject to a separate approval process.

Western Sydney Infrastructure Plan

Under the Western Sydney Infrastructure Plan, the Australian and NSW governments are investing $3.6 billion in a number of road upgrades and new roads in Western Sydney to support the proposed airport and improve road connections in Western Sydney. The package includes:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road;
- construction of the M12 Motorway running east-west between the M7 Motorway and The Northern Road;
- upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way;
- construction of the Werrington Arterial Road between the M4 Motorway and the Great Western Highway;
- upgrade of Ross Street and the Great Western Highway intersection at Glenbrook; and
- a $200 million package for local roads upgrades.

Together, the package of new roads and upgrades aims to ease congestion and relieve pressure on existing roads while improving connections between major hubs (DIRD 2015).

Outer Sydney Orbital

The Outer Sydney Orbital is a corridor being investigated by the NSW Government to provide a north-south connection for a future motorway, freight rail, and where practical a passenger rail line. The corridor would provide increased capacity for the road network to improve accessibility to housing and employment, and the freight rail would connect from Port Kembla to the South Line, Western Line and Northern Line. The area under investigation starts at the North West Priority Growth Area in the north, finishes in the south near Picton in the Wollondilly local government area, and is located to the west of the airport site.

WestConnex

The WestConnex project includes road widening and tunnel works over 33 kilometres to provide faster and more reliable transport between Western Sydney, central Sydney, Sydney (Kingsford Smith) Airport and Port Botany. The project is planned to reduce congestion on Parramatta Road, provide greater capacity for freight and passenger movements across Sydney, and allow for urban renewal of this corridor.

23.4 Assessment of impacts during construction

Construction of the Stage 1 development would generate a range of positive and negative social impacts, including economic value-add and employment, population redistribution and housing, social amenity and lifestyle (associated with noise, air quality, and other impacts), community health, social infrastructure and emergency services.

Due to the scale and nature of the development, in most cases construction impacts are not predicted to result in significant social impacts.

23.4.1 Economic value-add and employment

Construction of the Stage 1 development is predicted to generate a range of economic and employment impacts directly through investment and employment, and indirectly through demand generated by the proposed airport and the workforce on the airport site. The economic and employment impacts of the proposed airport are summarised in more detail in Chapter 24.

The economic impacts can be expressed in terms of value-add, which is the dollar value of outputs minus the dollar value of inputs. Construction of the Stage 1 development would value-add about $2.3 billion to the Greater Sydney economy over the construction period with about 83 per cent or $1.9 billion of that in the economy of Western Sydney. These values include direct investment as well as indirect effects produced by demand from the proposed airport and the workforce on the airport site. This beneficial increase in economic activity would attract business activity from other parts of Greater Sydney, NSW and Australia.

The employment impacts can be expressed in terms of jobs required directly for the construction effort and indirect jobs supported by demand for goods and services generated by the proposed airport and the workforce at the airport site. During the peak year of construction, the proposed airport would directly support around 760 full-time equivalent jobs and indirect support around another 2,420 full-time equivalent jobs throughout Greater Sydney. The majority – about 84 per cent – of these jobs would be in Western Sydney.

The economic and employment impacts of the proposed airport would likely have beneficial effects on household incomes that could improve quality of life and living conditions. Business activity and infrastructure investment attracted to Western Sydney by the proposed airport may also improve the quality and variety of social services and infrastructure available. These positive social benefits would be expected to continue into the operation of the Stage 1 development.

The diversity of jobs created by the operation of the proposed Stage 1 development would also provide options for job seekers to gain employment in their preferred industry, rather than other avenues of employment. In this way the construction of the Stage 1 development would present opportunities to increase job satisfaction for those either directly or indirectly employed as a result.

23.4.2 Population redistribution and housing

23.4.2.1 Population redistribution

The construction of the proposed airport is expected to occur against a background of significant population growth as discussed in Section 23.3.3. The construction of the proposed airport would contribute to this growth. The associated redistribution of population growth into Western Sydney from elsewhere in Sydney, NSW and the rest of Australia is discussed in Section 23.5.2.2.

23.4.2.2 Housing and accommodation

Employment directly created by the proposed airport is not expected to affect availability of housing and accommodation substantially. However, it is likely that the broader urbanisation of Western Sydney including the proposed airport would create significant additional demand for housing. A number of strategic planning initiatives by the NSW Government are planned in Western Sydney to deal with the anticipated demand. It is expected that such regional planning initiatives would accommodate increases in housing demand attributable to the proposed airport.

23.4.3 Social amenity and lifestyle

This section considers the potential impacts of construction of the Stage 1 development on social amenity and lifestyle with reference to impacts identified in other assessments, including:

- noise and vibration (see Chapter 11);
- air quality (see Chapter 12);
- traffic, transport and access (see Chapter 15);
- planning and land use (see Chapter 21); and
- landscape and visual amenity (see Chapter 22).

23.4.3.1 Noise and vibration

Noise and vibration impacts can reduce the amenity of spaces where people live and work or visit for recreation. Noise generated by construction would be centred on the airport site, while vehicles travelling to and from the airport site would also generate noise on the external road network and surrounding area. Modelling for the EIS shows that increased noise from construction traffic is predicted to be less than 2 dBA. This change in noise level is unlikely to be discernible.

Construction of the Stage 1 development is not expected to generate noise levels at residences outside the airport site in excess of limits defined in the Airports (Environment Protection) Regulations 1997 (AEPR). Noise and any consequential amenity impacts associated with construction activities would be transitory and vary depending on location and timing of works.

Although noise in excess of the limits defined in the AEPR is not predicted, noise would be audible at offsite locations near where construction activities are being conducted. Even if it does not interrupt certain activities, noise or the prospect of noise has the potential to cause annoyance, stress and anxiety. As a result, construction noise may reduce social amenity and the rural/semi-rural residential lifestyle for areas close to the airport site. However, these impacts are unpredictable in the sense they affect people differently (or not at all) and can be highly subjective.

Vibration resulting from pile driving or rock blasting would be managed to ensure the comfort and amenity of surrounding residents. Relevant standards that would apply to the conduct of these activities are identified in Chapter 11.

A Noise and Vibration Construction Environmental Management Plan would be developed and approved prior to commencement of Main Construction Works for the proposed airport. This plan will address requirements for notifying residents of construction activities with the potential to affect their amenity due to noise and vibration. The construction noise assessment, including proposed noise and vibration mitigation measures, is discussed in more detail in Chapter 11.

23.4.3.2 Air quality

Air quality impacts can reduce the amenity of spaces where people live and work or visit for recreation. Construction emissions are expected to be temporary and isolated in nature and would be readily controlled with the implementation of standard mitigation and management measures. The air quality assessment and mitigation measures are discussed in more detail in Chapter 12.

The main source of air emissions during construction would be dust from bulk earthworks and construction of infrastructure for the Stage 1 development. Dispersion modelling of construction dust from bulk earthworks and construction of infrastructure indicated that emissions would meet the relevant air quality criteria at all identified sensitive receptors outside the airport site. Emissions would also be readily controlled with the implementation of standard measures such as the watering of exposed surfaces and covering of stockpiled material. The movement of construction vehicles on the external road network could also generate dust emissions from tyres or uncovered loads. Additional measures such as speed controls would be included to control dust emissions from vehicles.

Although dust is not expected to exceed air quality criteria at identified sensitive receptors, there is potential for dust to be noticed on occasion or accumulate on surfaces such as cars or furniture. The physical evidence of dust or the potential for dust could affect residents and their lifestyle, leading to behaviours such as closing windows or doors to reduce exposure to dust. The potential for these social amenity and lifestyle impacts to occur would be effectively minimised with the implementation of air quality mitigation measures, as outlined in Chapter 12.

23.4.3.3 Traffic, transport and access

The major roads surrounding and connecting to the airport site include the M7 Motorway, The Northern Road, Elizabeth Drive, Bringelly Road, Badgerys Creek Road, Adams Road and Mamre Road. The existing road network can experience capacity constraints during peak times but is not seriously congested, ranging between Level of Service A (free flowing) and Level of Service D (close to the limit of stable flow).

The construction phase would lead to an increase in traffic of around 1,254 additional vehicle movements per day on the road network surrounding the airport site. Traffic modelling indicates this would equate to about 150 to 160 additional vehicles per hour during peak periods on Elizabeth Drive, which is expected to be the primary access route for construction traffic

Predicted increases in traffic are not expected to deteriorate the level of service on Elizabeth Drive or the broader strategic road network; however, minor decreases in level of service are predicted on stretches of Cowpasture Road and Luddenham Road. Temporary road closures may also be required to facilitate safe movement of oversized vehicles during construction.

Impacts on level of service are not expected to be sufficient to destabilise the flow of traffic and as such are not expected to represent a serious inconvenience to local residents. Although temporary road closures have the potential to inconvenience local residents, this inconvenience would be brief and alternate routes would be available to destinations outside of the airport site.

The primary social impact would be inconvenience from the increase in construction traffic which may in turn increase commute times. Increased commute times could affect residents travelling to and from home, work, school, health care facilities or other places. The increased commute times could represent an inconvenience to residents in transit and their families, dependants, colleagues or others depending on the circumstances.

Potential impacts would be mitigated and managed through a Traffic and Access Construction Environmental Management Plan. This plan will address requirements for notifying residents and commuters of planned temporary road closures or disruptions. The traffic, transport and access assessment, including proposed mitigation measures, is discussed in more detail in Chapter 15.

23.4.3.4 Land use, landscape character and visual impact

The planning and land use impacts of the Stage 1 development would essentially involve the transition of the airport site and surrounding area from rural residential and agricultural lands to more developed land uses. The construction of the proposed airport is expected to occur against a background of significant urban development as discussed in Section 23.3.3. The construction of the proposed airport would contribute to this development and the transformation of the landscape character of the region – from rural residential and agricultural landscape to a more urbanised and commercial setting. Planning and land use impacts and associated mitigation measures are discussed in further detail in Chapter 21 and landscape character and visual impacts and mitigation measures are discussed in Chapter 22.

The land use, landscape character and visual impacts would occur as part of a broader transition of Western Sydney which has been taking place for a number of decades and is represented in the various strategic planning initiatives discussed in Section 23.3.4. The social implications of the transition are discussed in Section 23.5.3.

The level of visual impact experienced at a particular location would depend on various factors including its distance from the airport site, its elevation and its sensitivity to change including its cultural or recreational value. Construction would likely have greater visual impact at receivers to the north of the airport site such as Luddenham and Elizabeth Drive due to their proximity to airport infrastructure. Rural residential areas at higher elevations such as Mount Vernon, Silverdale and Rossmore would experience moderate to low visual impact due to their views of the airport site.

Impacts to land use, landscape character and visual amenity have a social dimension in the sense they can reduce the amenity of spaces where people live and work or visit for recreation. Visual impacts in particular could reduce people's enjoyment of these places and the value they place on them. Social amenity and lifestyle impacts would be mitigated and managed during construction to the extent practicable through implementation of measures outlined in Chapter 21 and Chapter 22.

The overall impact to social amenity and lifestyle would persist as the airport proceeds into operation and the broader region undergoes widespread development. The persistence of these impacts into operation is discussed in Section 23.5.6.

23.4.4 Human Health

The health risk assessment discussed in Chapter 13 identifies the predicted health risks associated with construction of the Stage 1 development. There are a number of potential pathways by which the airport development may influence human health, and the assessment focusses on the key issues of air quality, surface water and groundwater.

The health risk assessment concludes that there would be minimal impacts on human health during construction. Increased health risks due to particulate matter would be very low. Construction noise is predicted to be well below acceptable limits and the level of health risks associated with ground and surface water would be low. Given the relatively short time period for construction, the predicted health risks are unlikely to be realised. Further to this, mitigation measures proposed in the EIS would further minimise any potential health impacts.

Despite the generally low level of health risk posed by the proposed airport, the perception of these or other health risks may trigger stress and anxiety in people. These effects may occur in parallel with annoyance, stress and anxiety over other potential impacts to social amenity and lifestyle (see Section 30.3.1 (Volume 3)). These concerns highlight the importance of community engagement regarding health and other key issues prior to the construction and operation of the Stage 1 development.

Measures regarding ongoing community engagement are discussed in Section 23.7, while potential health impacts are discussed further in Chapter 13.

23.4.5 Social infrastructure

Social infrastructure may include health care facilities, educational institutions and recreational facilities. This infrastructure is often provided by a variety of government agencies, local councils, non-government organisations, community groups, and private industry.

The construction of the proposed airport is expected to occur against a background of significant population growth and urban development as discussed in Section 23.3.3. The construction of the proposed airport would contribute to this growth and as such would contribute to growing demands on social infrastructure. This potential impact would be realised over a significant period of time and is discussed in Section 23.5.5 with regards to the operation of the Stage 1 development.

Overall, the forecast increase in construction workers during construction of the proposed airport is unlikely to lead to demand for social infrastructure in areas near the proposed airport (e.g. child care, emergency services, medical services, schools). It is anticipated that construction workers would largely be residents of Western Sydney or Greater Sydney and would continue to access social infrastructure in their area of residence. Any increase in demand is expected to be small and would be temporary due to the nature of the construction work. As such, substantial impacts to other users of social infrastructure are not expected.

23.4.5.1 Recreational assets

The construction of the proposed airport would involve the removal of Badgerys Creek Park which is located on the airport site. Impacts at other recreational assets are not expected to occur during construction of the Stage 1 development given its temporary timeframe and localised impacts.

23.4.6 Emergency services

The construction of the proposed airport, including the presence of a relatively large workforce at the airport site, could require responses from emergency services in the event of an incident.

The lead construction contractor of the airport would be expected to develop and implement safety protocols including an emergency response plan in collaboration with all NSW emergency services to guide the response in the event of an incident occurring. It is anticipated that the emergency response plan would cover the immediate emergency response, provision of basic medical services and first aid and as well as preventive activities such as fire management.

The Department of Infrastructure and Regional Development has prepared a Bushfire Management Plan to guide management activities at the site in the interim period prior to construction. It is expected that management practices established at the site through this plan would be carried forward as necessary through construction and operation.

23.5 Assessment of impacts during operation

Operation of the Stage 1 development would generate a similar range of positive and negative social impacts as outlined for construction. Impacts would include economic value-add and employment, population redistribution and housing, social amenity and lifestyle (associated with noise, air quality, and other impacts), human health, social infrastructure and emergency services. In most cases social impacts (both positive and negative) associated with operation of the proposed airport are predicted to be larger than impacts associated with construction.

23.5.1 Economic value-add and employment

Operation of the Stage 1 development is predicted to generate a range of economic and employment impacts directly through investment and employment, and indirectly through demand generated by the proposed airport and the workforce at the airport site. These impacts are expected to benefit the region as it will shape growth in Greater Sydney to be more balanced, sustainable and inclusive of Western Sydney and its regions. The economic assessment is summarised in more detail in Chapter 24.

The economic impacts are presented for the year 2031 in order to ensure consistency with data provided by external sources as described in Appendix P3 (Volume 4).

As outlined in Chapter 24, operation of the Stage 1 development in 2031 alone would value-add about $77 million in Western Sydney, $145 million in the rest of Greater Sydney and $23 million in the rest of NSW. These values would include about $140 million in household income in 2031.

The increased value-add in Western Sydney, the rest of Sydney and the rest of NSW, as well as a reduction in value-add for the rest of Australia, reflects the economic activity that is attracted to Sydney and NSW from all over the country and the widespread economic impacts generated by the proposed airport development. It should be noted that it is not possible for the economic modelling to predict the sources of this redistributed economic activity, particularly as it would depend on numerous economic factors at the time of operation. However, this redistribution of economic activity is not considered likely to affect any one particular region or community. It is also important to note that the proposed airport is nonetheless predicted to generate net economic benefit for Western Sydney, Greater Sydney and Australia. As such, the social implications of the redistribution of economic activity are not considered to be significant.

The Stage 1 development would impact on other industries in Western Sydney, potentially diminishing agriculture and manufacturing due to competition for land and cost of labour and increasing tourism and demand of accommodation (hotels/motels) in the region.

Airports are one of the most important employment hubs in Australia, generating diverse employment opportunities, including jobs in transport, postage, warehousing, administration, safety, retail, accommodation, food services, manufacturing, professional and technical services, information media and telecommunications (BITRE 2013). These jobs tend to be evenly stratified across jobs classifications and educational qualifications.

As outlined in Chapter 24, the operation of the Stage 1 development in 2031 would directly support around 8,730 direct full-time equivalent jobs in airport operations. A further 4,440 direct full-time equivalent jobs could also be generated from commercial activities at the business park areas on the airport site should an airport-lessee company choose to develop a business park. The development of a business park on the airport site is outside the scope of the EIS and would be subject to separate approvals. The availability of jobs and increase in economic activity are expected to drive economic and employment growth in Western Sydney.

The operation of the Stage 1 development would present opportunities for improvement in the quality of life, living conditions, and job satisfaction for those either directly employed or otherwise indirectly economically affected by the proposed airport.

The economic and employment benefits of the proposed airport would boost household incomes that could improve quality of life and living conditions of those affected. The diversity of jobs created by the operation of the Stage 1 development would also provide options for job seekers to gain employment in their preferred industry, rather than other avenues of employment.

Around 30 per cent of Western Sydney's workforce travel to other parts of Sydney for work. The proposed airport would also potentially reduce long travel times experienced by many residents by creating job opportunities closer to their place of residence. This would represent a lifestyle improvement as it would provide workers with more time to engage in other activities. The reduction in travel times may also represent a saving in living expenses for those affected.

Lastly, business activity and infrastructure investment attracted to Western Sydney by the proposed airport may also improve the quality and variety of social services and infrastructure available to residents. Multiple developments are in various stages of planning and development as part of initiatives such as the Australian Government's *Western Sydney Infrastructure Plan* and NSW Government's *A Plan for Growing Sydney*.

23.5.2 Population redistribution and housing

23.5.2.1 Population redistribution

The operation of the proposed airport is expected to occur against a background of significant population growth as discussed in Section 23.3.3. The operation of the proposed airport would contribute to this growth. The population distribution analysis undertaken as part of the economic assessment in Chapter 24 indicated that by 2031, land use changes resulting from the Stage 1 development would redistribute an additional 17,900 residents to Western Sydney.

Population redistribution into Western Sydney would likely increase demographic and cultural diversity in the region. To some extent, this process is already occurring with the movement of young people, particularly young families, to Western Sydney. The changes in cultural diversity may be particularly pronounced in areas to the west of the airport site, where many communities presently have relatively low cultural diversity.

23.5.2.2 Housing and accommodation

The workforce directly employed in the operation of the Stage 1 development is not expected to substantially affect availability of housing and accommodation in the region. The majority of the Stage 1 development workforce are expected to be residents of the Western Sydney or Greater Sydney region who would commute to work from their existing residences.

It is not possible to accurately predict exactly how many workers and their families would move to the area specifically due to work opportunities at the proposed airport versus those who would move to the region for the other opportunities afforded by the general development and growth of Western Sydney. However, as the total workforce required for the proposed airport during the Stage 1 development is only a proportion of the total labour pool available and forecast for the Western Sydney region, it can be assumed that there would be a small number of workers at the proposed airport who may choose to move to the region. This would generate a small demand for long term housing in Western Sydney. It is possible that this small demand for housing from the proposed airport Stage 1 operational workforce could be absorbed by the significant amount of housing development proposed for the Western Sydney region.

As identified in the social impact assessment, Western Sydney offers housing that is more affordable compared to the rest of Sydney. It is likely that the overall population growth in Western Sydney (with the proposed airport as a catalyst) may increase overall demand for long term housing potentially creating housing availability and affordability issues, which may particularly disadvantaged groups who are already vulnerable. A number of strategic planning initiatives, including significant housing developments, are planned in Western Sydney to deal with the anticipated demand. The increase in demand for housing coupled with potential change in average property values (see Section 23.5.2.3) has the potential to generate housing availability and affordability issues, particularly for already disadvantaged groups.

23.5.2.3 Property values

The potential effect on property prices associated with aircraft noise (among other factors) is documented in a number of Australian and international studies. The property values assessment presented in Appendix P2 (Volume 4) provides a comprehensive assessment of potential property price effects on lower density, large-lot land holdings similar to those found at Badgerys Creek. Comparable examples including Melbourne (Tullamarine and Avalon) and Perth airports were analysed for a potential relationship between price and noise effects.

The property values assessment failed to establish a statistically significant relationship between noise exposure and property prices of large lot land. Possible reasons for this might include the lesser significance of the dwelling in the context of large land areas, land used for primary production may be less affected by noise and/or the wider range of factors influencing price that cannot be analysed.

A potential reduction in property values could affect a range of properties given the nature of the development and the scale of the noise envelope. The effect would differ depending on location and individual circumstances. Analysis of long run house prices in Sydney since 1991 found no appreciable difference in growth rate between median prices in suburbs subject to noise in excess of 20 ANEF and those in similar areas not exposed to aircraft noise.

In the 12-month period following the Australian Government announcement that Badgerys Creek was the preferred site for a new airport for Western Sydney, there was a spike in house prices in areas closer to the airport site. Analysis of long term growth rates of residential sales in the suburbs around Badgerys Creek between 1991 and 2015 indicates that despite short-term fluctuations, property prices have increased at a similar rate to dwellings across Sydney. Rather than suffering a slowing of growth as a result of concerns relating to environmental impacts, residential prices in the suburbs around Badgerys Creek grew strongly in the period following the Australian Government announcement, increasing by almost 24 per cent, which was substantially greater than the average increase in both Western Sydney and the Sydney metropolitan region.

These general trends of increasing property values in Western Sydney are likely to be contributing to housing stress and affordability issues for local communities. The increase in property values shown to occur since the announcement of the proposed airport further contribute to these issues.

23.5.3 Social amenity and lifestyle

This section considers the potential impacts of the Stage 1 development on social amenity and lifestyle with reference to impacts identified in other assessments, including:

- noise and vibration (see Chapters 10 and 11);
- air quality (see Chapter 12);
- traffic, transport and access (see Chapter 15);
- planning and land use (see Chapter 21); and
- landscape and visual amenity (see Chapter 22).

23.5.3.1 Noise

Based on the findings of the aircraft overflight noise assessment (see Chapter 10) and the ground-based operations noise assessment (see Chapter 11), the proposed airport could impact the existing lifestyle and social amenity of some communities across Western Sydney depending on the design, availability and use of alternative airport operating modes and strategies.

Communities potentially most impacted by aircraft overflight noise include Badgerys Creek, Luddenham, Bringelly, St Marys, Erskine Park, Greendale, Silverdale, Horsley Park, and parts of Blacktown. Many of these areas—particularly Luddenham, Greendale, Silverdale, Kemps Creek, Mount Vernon and Horsley Park—are semi-rural large-lot suburbs with low population densities.

Ground-based noise from the proposed airport would also affect communities in proximity to the airport site, particularly Luddenham, Bringelly and Greendale. These localities are all semi-rural or small townships with lower population densities compared to other parts of the Liverpool and Penrith local government areas.

An indicative ‘worst case’ representation of the operational noise envelope is shown in Figure 23–1, including ground noise and overflight noise. The analysis uses the following noise metrics:

- N70 noise contour (with 5–10 flights during the day and night period exceeding 70 dBA);
- N60 noise contour (with 5–10 flights during the night period exceeding 60 dBA); and
- engine run-up with no noise enclosure during the Stage 1 development.

It is noted that N70 and N60 contours are more extensive than would occur during actual operations as they are a composite of the ‘Prefer 05’ and ‘Prefer 23’ operating strategies developed for the aircraft overflight noise assessment. The selected strategy determines the preferred end of the runway for aircraft take-off and landing. The contours represent a worst case scenario in this sense, showing a larger area of impact than would be expected from actual operations based on the indicative flight path design.

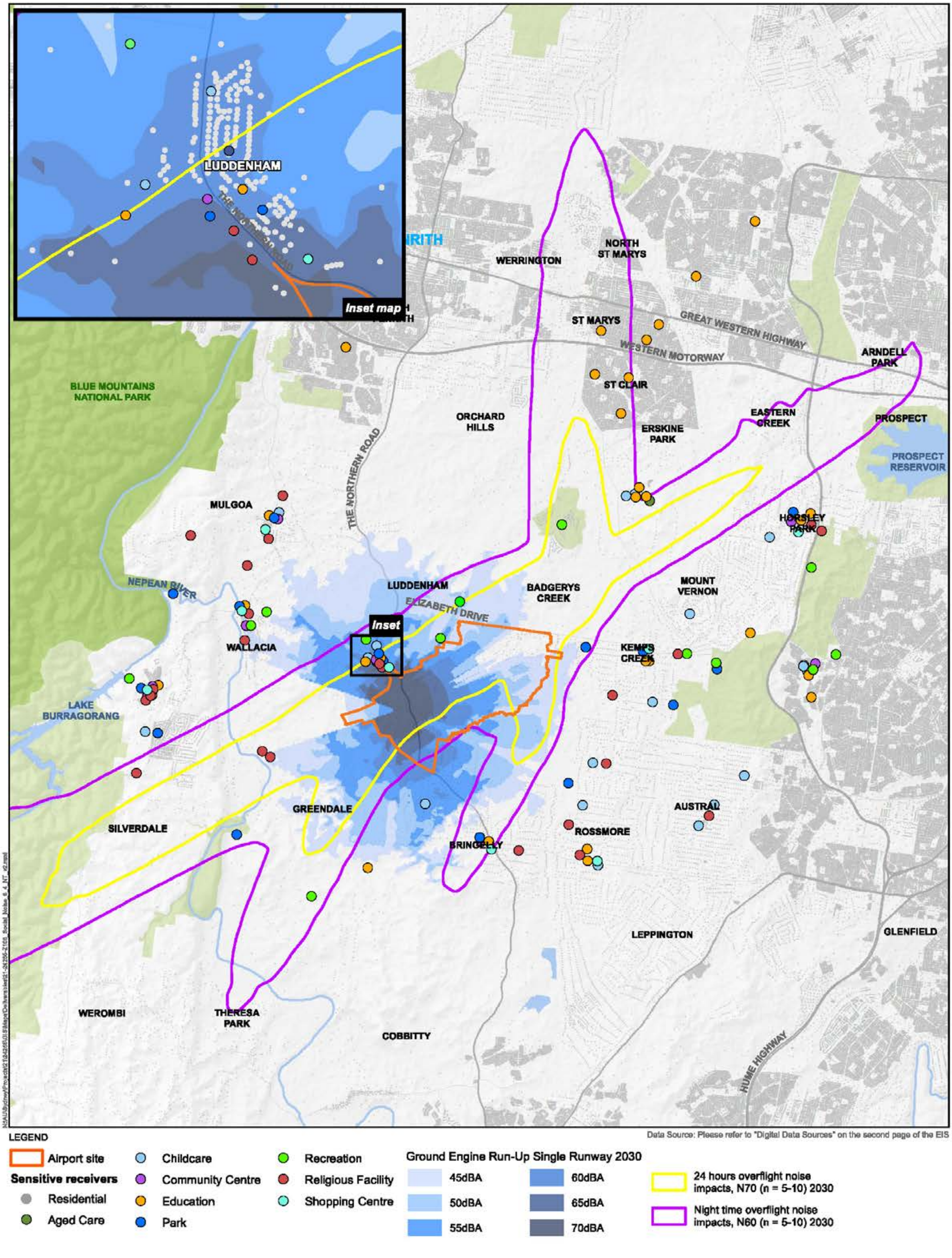


Figure 23-1 - Social infrastructure and residences potentially affected by worst case operational noise envelope – Stage 1 operations

Noise has the potential to adversely affect the social amenity and lifestyle experienced by communities in the vicinity of the proposed airport and its arrival and departure flight paths. Noise could intermittently interrupt conversation or other activities such as television viewing or listening to the radio. Night-time noise would also have the potential to disturb sleep to varying degrees.

Noise would also potentially impact the attentiveness and enjoyment of children during school hours, and hence their cognitive development. High noise exposure levels at churches, parks or recreation facilities may diminish the value the community places upon such social infrastructure.

Even if it does not interrupt particular activities, noise or the prospect of noise has the potential to cause annoyance, stress and anxiety. These psychological effects can have flow-on effects into other areas of life within the family and community. These impacts are unpredictable in the sense they affect people differently (or not at all) and can be highly subjective.

Aside from frequency or intensity of the noise, the seriousness of the impact and the response of individuals would be dependent on a range of factors, some also subjective. These include:

- prior exposure to aircraft noise;
- lifestyle and work factors; and
- habituation over time.

Prior exposure to aircraft noise would potentially reduce the perceived seriousness of the impact. The emergence of aircraft noise where there previously was none would more reasonably be expected to trigger a negative response than an increase in flights on an existing flight path.

Lifestyle factors such as place of work, work hours and the nature of work would also be relevant. For people who work away from home, noise may be experienced solely in the work or the home environment. Noise could trigger a negative response in people at home, particularly at times of rest or recreation, but also in people who work at home. Shift workers may also be affected by the level and frequency of noise events during the daytime.

Airports necessarily are located in proximity to urban development. As such, there are numerous examples around the world of communities that are affected by aircraft noise. The response of individuals to increased noise varies. People may choose to close windows or doors in order to reduce ambient noise levels, which would in some cases be unlike their current semi-rural practices where they would leave the windows open for light and fresh air.

Actual or perceived issues may cause individuals to move away from an area affected by aircraft noise. They may also influence the choice of those planning to relocate to areas subject to aircraft noise. It is reasonable to assume that, over a period of time, residents who are more sensitive to noise tend to move out of noise affected areas, to be replaced by individuals who are genuinely less sensitive to noise or who are willing, on balance, to accept higher noise levels. There would, nevertheless, be individuals unable to relocate and who would continue to be annoyed by aircraft overflight noise over time.

Actual or perceived noise issues may affect behaviours, including the patronage at social infrastructure. Noise impacts would also diminish the value people attach to the use of recreational spaces, as increased noise would disturb the peace and serenity of some areas. The Bents Basin State Conservation Area and Gulguer Nature Reserve are recreational areas predicted to experience several overflights each day above 60 dBA.

The mitigation and management of noise impacts from aircraft overflights and ground-based operations are important considerations for the detailed planning and operational phases of the proposed airport development. The future airspace and flight path design process will optimise flight paths taking into account the safety of all aircraft and airspace users across the Sydney basin, aircraft operation efficiency and opportunities to minimise noise and amenity impacts on all potentially affected communities, sensitive receivers and the environment. All feasible noise abatement and noise respite opportunities will be assessed throughout the design process. Mitigation measures to address aircraft overflight noise and ground-based operations noise are described in detail in Chapter 10 and Chapter 11 respectively.

23.5.3.2 Air quality

This section outlines the social and amenity issues associated with the predicted air quality impacts from the operation of the Stage 1 development. The assessment of social impacts is based on the local air quality assessment and regional air quality assessment which are discussed in detail in Chapter 12.

Air quality impacts can reduce the amenity of spaces where people live and work or visit for recreation. The operation of the proposed airport may lead to minor reductions in air quality for communities close to the airport site, including the townships and surrounding areas of Luddenham, Wallacia, Mulgoa, Greendale, Badgerys Creek, Rossmore, Mount Vernon, Kemps Creek and Badgerys Creek. Air emissions from the Stage 1 development have been assessed with reference to a range of criteria, including those established for the protection of human health.

In general, the main source of emissions would be exhaust emissions from increased background road traffic associated with the broader urbanisation of Western Sydney, depending on the pollutant. These background emissions are largely independent of the proposed airport. In terms of emissions from the airport site itself, aircraft movements are predicted to be the largest on-site source of emissions, followed by the operation of auxiliary power units (APUs) and ground support equipment (GSE). Road traffic generated by trips to and from the airport site would form a relatively small proportion of emissions.

Dispersion modelling of airport emissions during the operation of the Stage 1 development indicated that air quality would meet current air quality criteria at all identified sensitive receptors for the assessed pollutants, including nitrogen oxides, particulate matter, carbon monoxide, sulfur dioxide and air toxics. Odour from aircraft exhaust was similarly predicted to be below detection levels. Predicted concentrations of particulate matter ($PM_{2.5}$) did however exceed a planned NEPM-AAQ objective for 2025 at a number of sensitive receptors – however this is primarily attributable to background concentrations independent of the proposed airport.

Ozone is another key emission of the proposed airport and is a recognised air quality issue in the Western Sydney. The regional air quality assessment predicted that the operation of the Stage 1 development would contribute to ozone concentration levels, although this contribution is predicted to be marginal given existing ozone levels. The assessment indicated that ozone would exceed the relevant air quality criteria for ozone of 100 parts per billion whether or not the proposed airport was developed.

Actual or perceived air quality issues associated with the proposed airport and the broader urbanisation of Western Sydney do have the potential to affect social amenity and lifestyle in Western Sydney. The primary social impact of air emissions relates to human health. This potential impact includes both the direct human health effects caused by inhalation of emissions over extended periods of time and the stress and anxiety the knowledge of these potential impacts can cause. These potential impacts are discussed further in Section 23.5.4.

Aside from the potential human health impacts, social amenity and lifestyle impacts on affected communities are limited. Emissions to air are not expected to directly disrupt the day to day activities comprising life, work and recreation in Western Sydney. Some changes in behaviour could be expected as a result of perceived changes in air quality, due to the proposed airport and more generally the broader urbanisation of the region. Changes in behaviour could include residents choosing to keep windows or doors of their residences to reduce their exposure to air pollution. The gradual nature of changes in air quality would not be expected to influence the choice of individuals planning to relocate to or from Western Sydney.

Overall, social amenity and lifestyle impacts associated with air quality emissions from operation of the proposed airport are expected to be minimal. Mitigation measures outlined in Chapter 12 will reduce air quality impacts and, by extension, the associated social amenity and lifestyle impacts. It is noted that improvements in emissions standards over coming decades, for both aircraft and road vehicles, would have the potential to further improve air quality at the local and regional scale.

23.5.3.3 Traffic and access

Operation of the Stage 1 development would lead to an increase in traffic on roads surrounding the site. These impacts are outlined in detail in the traffic, transport and access assessment outlined in Chapter 15. Traffic impacts would be expected to affect the social amenity and lifestyle of these semi-rural areas. It is important to note that the increases would occur in combination with substantial increases in background traffic attributable to the broader urbanisation of Western Sydney that would occur independently of the proposed airport.

The primary social impact of increased traffic is increased commute times. Increased commute times could affect residents travelling to and from home, work, school, health care facilities or other social infrastructure. The increased commute times could represent an inconvenience to residents in transit and their families, dependants, colleagues or others depending on the circumstances.

The degree of these social impacts would largely depend on the implementation of strategic transport initiatives to cope with the expected growth and urbanisation of Western Sydney, of which the proposed airport would be a component. This includes the development of transport infrastructure, including road and rail, the provision of public transport services, and long term transport and urban planning. With the implementation of these initiatives, serious road capacity issues, and associated social amenity and lifestyle impacts, would be minimised.

It is also important to note that a large proportion of the population from the Western Sydney region currently undertake long commutes on a daily basis to access work opportunities. As outlined in Section 23.5.1, employment opportunities created by the Stage 1 development would potentially reduce travel times, offering prospects for improved lifestyle by allowing workers more time for leisure activities and family.

23.5.3.4 Land use, landscape character and visual impacts

This section outlines the social amenity and lifestyle impacts that would be associated with the impacts of the Stage 1 development on planning and land use (discussed in Chapter 21) and landscape character and visual (discussed in Chapter 22).

In general, the operation of the proposed airport is expected to occur against a background of significant urban development as discussed in Section 23.3.3. The operation of the proposed airport would contribute to this development and the transformation of the landscape character of the region – from rural residential and agricultural landscape to a more urbanised and commercial setting.

The planning and land use impacts of the Stage 1 development would essentially involve the continued growth of regional centres and transition of surrounding rural residential and agricultural lands to more developed land uses. This transition is represented in a number of current strategic planning initiatives discussed in Section 23.3.4.

In addition to these planning initiatives, development surrounding the airport would be shaped by long standing planning restrictions in place to prohibit incompatible development. Restrictions of this type have been reflected in planning by successive Australian, State and local governments given the long standing commitment to develop an airport at the airport site.

The proposed airport would contribute to these land use transitions. Furthermore, the realisation of the business development land use zones in the airport site land use plan (see Chapter 4 (Volume 1)) would provide additional supply for development a range of employment oriented land uses.

The level of visual impact experienced at a particular location would depend on various factors including its distance from the airport site, runways, lighting and flight paths as well as its elevation and its sensitivity to change including its cultural or recreational value.

Key findings from the visual assessment include that:

- the proposed airport development would substantially modify the existing rural landscape and visual quality of the area to a more urbanised character;
- most visual impacts would be on areas to the immediate north such as Luddenham and Badgerys Creek due to their relative proximity to the airport as well as areas to the south of the airport such as Bringelly, Greendale and Bents Basin due to aircraft overflights;
- surrounding rural residential areas at higher elevations such as Mount Vernon, Silverdale and Rossmore would experience moderate to low visual impact due to views of the airport site. The impact would, however, be increased by aircraft overflights; and
- visual impacts at selected important cultural and recreational areas, such as the Bents Basin State Recreation Area, would range from moderate to high due to the high sensitivity ratings of the viewpoints and the effect of aircraft overflights.

The ongoing transition of Western Sydney, and the land use, landscape and visual impacts of the airport would have social amenity and lifestyle impacts. In particular, these changes would result in a progressive transition in communities from quiet, rural or village lifestyles to more urban lifestyles commensurate with urban development and population growth.

Impacts to landscape character and visual amenity have a social dimension in the sense they can reduce the amenity of spaces where people live and work or visit for recreation. Visual impacts could reduce people's enjoyment of these places and the value they place on them.

Individual experience of these changes would be largely subjective. Established or long term residents who have experienced the change first hand would be more likely to regard it negatively than more recent residents or other who travel to Western Sydney for work or otherwise. In particular, some residents, both long term and relatively recent, may also view the transition of land use and landscape character as positive, or be indifferent to it, given the associated benefits of social and economic benefits of living in an urbanised area with better access to employment, shops, services, and social infrastructure.

23.5.4 Human health

Human health risks associated with air quality, noise and water quality impacts from operation of the proposed airport are discussed in Chapter 13. The predicted increases in health risks would generally be within or at the upper bound of national and international standards of acceptability, with the exception of the health risks associated with NO_2. As noted in the air quality assessment in Chapter 12, a significantly large contributor to air quality impacts, and therefore health risks, is background emissions from urban development and road vehicles external to the airport site. In addition, the health risks are very small when compared to those from existing air pollution.

In relation to noise, the health risk is generally low and within acceptable limits. The assessment indicates that noise from aircraft overflight and ground operations may lead to a small increase in sleep disturbance for communities around the airport site. The assessment found that noise is not predicted to increase the risk of cardiovascular disease and that noise impacts on learning and cognitive development in children are largely within acceptable limits.

Although the predicted increase in health risks for the community are low and largely within acceptable limits, it is possible that a combination of actual and perceived impacts from noise, air quality and associated health risks may lead to social impacts.

Some residents may make different housing choices such as moving to other areas where health impacts are perceived to be lower, subject to housing availability, affordability and other considerations. It is also possible that parents of children attending education institutions and child care facilities impacted by ground operation and aircraft noise may be concerned about the impacts and consider other options for schooling in the area. Real and perceived health risks have the potential to change how people react to certain situations and strain family and social relations.

As part of the development and change of Western Sydney, the proposed airport may have a long term impact on the social determinants of health for some community members. The social determinants of health are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems (WHO, 2016).

In additional to the negative impacts on health as outlined above and in Chapter 13, the proposed airport may also result in reduced lifestyle and social amenity for some community members, particularly those living in areas close to the airport site (see Section 23.5.3). Such amenity and lifestyle impacts may also affect the health and wellbeing of community members.

However, as outlined earlier, the proposed airport is predicted to increase employment opportunities and household incomes, improve access to transport infrastructure and increase access to social infrastructure including health services. Collectively, these factors could provide socio-economic benefits to some community members, and therefore also lead to positive community wellbeing and health impacts.

23.5.5 Social infrastructure

Social infrastructure may include health care facilities, educational institutions and recreational facilities. This infrastructure is often provided by a variety of government agencies, local councils, non-government organisations, community groups, and private industry.

The economic assessment (see Chapter 24) found that operation of the proposed airport would lead to a redistribution of population growth across Greater Sydney. In particular, the proposed airport would lead to a modest population increase in Western Sydney as residents who would have otherwise lived in other parts of Sydney, move to Western Sydney to be located closer to employment and services associated with the proposed airport.

Projected increases in population would result in additional demand on social infrastructure in areas near the airport site. Consultation with the NSW Department of Education and Communities in particular indicated that some workers at the proposed airport may prefer for their children to attend schools close to their workplace. Workers at the proposed airport may also choose to utilise medical services, child care facilities, exercise facilities and the like in the vicinity of their place of employment.

The amenity impacts discussed in Section 23.5.3 such as noise, air quality, traffic and visual impacts, would potentially occur at social infrastructure such as education institutions and health care facilities.

Potential impacts on social infrastructure would likely be offset by the expansion of social infrastructure as part of the broader urbanisation of Western Sydney. Furthermore, the predicted urban growth in Western Sydney, of which the proposed airport is a part, has the potential to improve the availability and quality of social infrastructure over time.

23.5.5.1 Recreational assets

Flight paths may result in visual and noise impacts on some recreational reserves in the Western Sydney region. Stakeholder consultation during the preparation of the EIS identified that some recreational areas may be more sensitive to aircraft noise and visual impacts.

The following recreational spaces are identified to be within the regional study area:

- Twin Creeks Golf and Country Club;
- Ropes Creek Reserve (Erskine Park);
- Eastern Creek Raceway;
- Sydney International Equestrian Centre (Horsley Park);
- Western Sydney Parklands (Horsley Park);
- Calmsley Hill City Farm (Abbotsbury);
- Sales Park (Luddenham);

- Bent Basin State Conservation Area (Greendale);
- Burragorang Recreation Area (Silverdale);
- Gulguer Nature Reserve;
- Mulgoa Nature Reserve;
- Warragamba Sportsground; and
- the Blue Mountains.

These recreational areas are valued for their environmental and amenity values, and these values may be impacted by overflight noise. Areas such as the Bents Basin Recreational Area in Greendale, Burragorang State Conservation Area and a small part of the Western Sydney Parklands and Prospect Nature Reserve would be located under standard departure and arrival flight paths and are predicted to experience a relatively high number of overflights each day. The amenity of these areas, in rural or more isolated locations, is likely to be reduced for users.

Residents and visitors to the Blue Mountains value the quiet and peaceful nature of the area. An increase in the frequency and intensity of noise in the area would potentially disturb the serenity of the area and disrupt the enjoyment of the natural environment. As aircraft overflights in the Blue Mountains will be at relatively high altitude (typically over 5000 feet), maximum noise levels are not anticipated to exceed 55 dBA. Although audible, these noise levels would be lower than those levels predicted for areas closer to the proposed airport that could interrupt conversation or daily activities such as watching television.

Noise levels may also be reasonably expected to reduce over time as a result of improved aircraft engine design and technology advancements, which would further limit potential amenity impacts.

23.5.6 Emergency services

As a major airport and transport gateway, the Stage 1 development is expected to increase demand for emergency services. The increase in demand may occur as a result of incidents at the proposed airport, increased traffic on the surrounding road network, or health issues discussed in Section 23.5.4. Emergency services will be required to adapt and respond to the need of the community of Western Sydney as it grows. This increased demand would occur within the context of larger demand increases associated with the broader development of Western Sydney. As such, the proposed airport is not expected to place excessive pressure on emergency services.

Operational safety protocols including an Emergency Response Plan would be developed and implemented for the proposed airport. It is anticipated this would occur in collaboration with relevant Australian and NSW emergency services to cover emergency response, first aid and basic medical services, fire prevention, firefighting equipment and security.

An Airservices Australia Aviation Rescue Fire Fighting Service station is proposed for the Stage 1 development, with a mutual aid agreement with the Rural Fire Service expected to be in place before airport operations commence. Should local resources be required to assist with an emergency situation at the proposed airport, it is likely NSW Fire and Rescue would manage and re-distribute its resources as appropriate. NSW Ambulance does not expect an onsite station to be provided at the airport site and does not expect airport operations to directly impact its ability to service the local community.

23.6 Summary of key social benefits and impacts

The key social and economic benefits and impacts arising from the construction and operation of the Stage 1 development are summarised in Table 23–2 and Table 23–3.

Table 23–2 Summary of social and economic benefits

Social and economic benefits	Construction	Operation
Construction of the Stage 1 development would value-add an estimated $2.3 billion to the economy of Greater Sydney, with about 83 per cent or $1.9 billion generated in Western Sydney. Operation of the Stage 1 development would value-add an estimated $77 million to the economy of Western Sydney, $145 million across the rest of Greater Sydney and $23 million elsewhere in NSW in 2031 alone. Increasing economic benefits would be generated in subsequent years of operation, commensurate with growing annual passenger patronage.	✓	✓
The proposed airport development would generate a number of jobs in Western Sydney and Greater Sydney, including: • About 3,180 person years of employment directly and indirectly in Greater Sydney during construction, with about 64 percent or 2,660 generated in Western Sydney; and • About 13,170 FTE jobs at the airport and onsite business park during operation and an additional 6,900 FTE jobs in Western Sydney attributable to flow-on economic effects.	✓	✓
Business growth and development in other industry sectors such as construction, utilities, trade, transport and services, accommodation, retail, professional services and public administration is forecast. This is anticipated to occur from the sourcing of goods and services for the proposed airport as well as through indirect and induced economic impacts.	✓	✓
New areas of land surrounding the airport site may become available for transport and logistics, warehousing and office space. This may lead to economic growth and Western Sydney becoming more attractive to businesses.	-	✓
The proposed airport will provide employment opportunities closer to home for the residents of Western Sydney, reducing their travel time and offering improved lifestyle and amenity.	✓	✓
The proposed airport may contribute to population growth of an additional 17,900 persons in Western Sydney by 2031. The regional population will continue to grow with new residents likely to be younger people attracted to employment opportunities and more affordable housing opportunities.	-	✓
Change to a more urban character and urbanised lifestyle may attract people from culturally diverse backgrounds, altering the existing demographic profile of some areas of Western Sydney which may currently have lower levels of diversity.	-	✓
There is a potential for increasing demand for accommodation facilities (hotels/motels) and associated services (entertainment) close to the proposed airport. Stakeholder consultation has indicated that Western Sydney has the capacity to develop these to meet demand.	-	✓
The majority of the construction and operational workforce is expected to be sourced from Western Sydney and Greater Sydney. Some technical specialists may be sourced from other parts of Australia or internationally, and may require temporary short or long term accommodation. It is expected that existing or proposed accommodation in Western Sydney would accommodate this demand.	✓	✓
Some workers at the airport may choose to move from other parts of Sydney or outside of Sydney to areas in Western Sydney, resulting in a small increase in demand for housing.	-	✓

Social and economic benefits	Construction	Operation
The forecast increase in workers may result in increased demand for social infrastructure in areas near the proposed airport (e.g. child care, emergency services, medical services, schools) stimulating further growth in the region. It is anticipated that future social infrastructure provision should have capacity to meet future demand as a result of the long timeframe of development allowing appropriate planning by service providers.	-	✓

Table 23–3 Summary of social impacts

Social impacts	Construction	Operation
Changes to land use in Western Sydney due to the Stage 1 development and broader urbanisation may result in competition for land and labour and a consequential decline in industry sectors such as agriculture and manufacturing. Trends show these industries are in decline in Western Sydney.	-	✓
Increase in housing prices associated with the announcement of the proposed airport may lead to increased rental prices which may lead to housing affordability issues in parts of Western Sydney.	✓	✓
Communities may experience a reduction in amenity as a result of aircraft overflight noise and/or airport operational noise. Amenity impacts will depend on a number of factors including, but not limited to: the future operating strategy of the proposed airport, the distance of a community from the airport, the height of aircraft over a community, the frequency of aircraft overflights, and the existing lifestyle and amenity characteristics.	-	✓
Aircraft overflight noise and visual intrusion may reduce the recreational or wilderness values of areas such as Bents Basin State Recreation Area, as well as impact on the Greater Blue Mountains World Heritage Area.	-	✓
Reduced social amenity and change to the rural and semi-rural residential lifestyle may occur for areas close to the airport site as a result of construction and/or operational ground-based noise.	✓	✓
Reduced amenity of sensitive social infrastructure may occur as a result of operational ground-based noise in areas close to airport site including Bringelly Child Care Centre.	-	✓
The uncertainty over the location of flight paths and airport operating modes that may be adopted could cause anxiety among the local community. This could be exacerbated due to the timeframes required to develop and certify a comprehensive airspace design for the proposed airport.	✓	-
Reduced air quality at semi-rural communities close to the airport site may occur. However, emissions from airport operations will be within permissible levels.	-	✓
Most air quality impacts as a result of construction activities would be contained within the airport site boundary. Vehicles travelling on unsealed roads and transporting materials onto the road network may lead to temporary air quality impacts.	✓	-
Increase in traffic on roads surrounding the site, road closures and diversions during construction may lead to inconvenience, congestion and delays for local road users.	✓	-
Increase in traffic on roads surrounding the airport site may occur during Stage 1 operations. However, with the planned upgrades of roads and introduction of new roads in areas surrounding the site, the increase in traffic is not expected to result in capacity issues.	-	✓
Reduced visual amenity for areas that are close to the airport site and close to improved road infrastructure may occur due to a permanent change in the landscape from semi-rural to a more urbanised character.	✓	✓
Reduced amenity for areas to the north and south of the site may occur due to visual impacts from the proximity of overflights.	-	✓

Social impacts	Construction	Operation
Reduced amenity for recreational areas surrounding the airport site due to aircraft noise.	-	✓
The Stage 1 development would present health risks associated with exposure to air pollutants and noise, including respiratory disease, cardiovascular disease, sleep disturbance and impacts on childhood learning and cognitive development.	-	✓
Concerns about health impacts may lead to some residents making different housing choices. Parents may also choose to move children from educational institutions near the site.	-	✓
Decreasing housing availability and affordability issues in some areas, potentially due to the proposed airport and broader urbanisation of Western Sydney, may lead to inadequate affordable housing options for socially disadvantaged groups.	-	✓

23.7 Mitigation and management measures

This section identifies proposed measures to enhance the social and economic opportunities and benefits presented by the construction and operation of the Stage 1 development.

A Community and Stakeholder Engagement Plan would be prepared prior to Main Construction Works and operation of the Stage 1 development respectively. Local communities, particularly those nearest the proposed airport, would be a focus of community and stakeholder engagement given their potential for concerns about potential impacts including noise. The plans would collate the mitigation and management measures discussed in this section and itemised in Table 23–4. These and other environmental management plans are discussed in further detail in Chapter 28 (Volume 2b).

The purpose of the mitigation and management measures presented in Table 23–4 is to maximise the social and economic benefits of the proposed airport and to minimise negative social impacts outlined in this chapter. These measures would be in addition to the implementation of measures proposed in other assessments including the noise assessments (see Chapter 10 and Chapter 11), air quality assessment (see Chapter 12), health risk assessment (see Chapter 13), the planning and land use assessment (see Chapter 21), and the visual impact assessment (see Chapter 22).

Table 23–4 Mitigation measure

Issue	Recommended mitigation measure	Timing
Stakeholder engagement on social impacts	Engagement will occur with relevant government agencies and organisations to inform their planning allocation of funding to programmes that may be impacted by operation activities. Relevant government agencies and organisations may include local councils, state government agencies, educational facilities, agencies and organisations responsible for affordable housing and other social services, emergency services, and peak bodies representing businesses and non-government organisations. This will include engagement on issues such as: • potential housing and accommodation requirements for the operation workforce and potential effects on housing and other social services; • potential employment opportunities for local residents; • potential business opportunities for local businesses; and • plans for development on the airport site and how this might impact local and state government land use planning around the airport site.	Pre-construction Construction Pre-operations Operation
Process for complaints	To enable members of the community to make a complaint, the following measures will be taken: • an airport website will be established to provide the community with up-to-date information on operation activities and provide the name and contact details for the person(s) responsible for managing complaints; • the name and contact details of the person(s) responsible for managing complaints will be displayed on signs at multiple locations along the airport site boundary; and • multiple channels will be established to allow for complaints to be made including a 1800 toll free number, email, online form, and postal address.	Construction Operations
Complaints response protocol	A complaints response protocol will be developed to ensure that complaints are adequately responded to within a reasonable amount of time. The protocol will ensure that: • complaints are responded to within 48 hours of receipt, whenever possible; • complaints are investigated in an appropriate manner and timeframe; • any trends are identified so they can better inform corrective actions; • the complainant is informed about the outcomes of the investigation and any corrective action implemented; and • complaints made in relation to aircraft noise are directed to the Airservices Australia Noise Complaints and Information Service.	Construction Operations
Complaints register	A complaints register will be established to record all complaints made about construction and operation activities and their impacts. The complaints register will include the following information: • the nature of the complaint, including the event or activity which is the basis of the complaint; • the response provided to the complainant; and • any corrective action or further environmental measures taken. The complaints register will be made available to the Department of Infrastructure and Regional Development when asked. Complaints made in relation to aircraft noise will be directed to the Airservices Australia Noise Complaints and Information Service for consideration and action and will be recorded in the complaints register as such.	Construction Operations

Issue	Recommended mitigation measure	Timing
Local employment	To maximise local employment and business opportunities throughout construction and operation, the following measures will be implemented: • an Australian Industry Participation Plan that includes consideration of local industry participation; and • an equal opportunity policy that includes training and suitable employment opportunities for Indigenous people and people with disadvantages.	Construction Operation

23.8 Conclusion

The construction and operation of the proposed airport would result in both positive and negative social impacts. The Stage 1 development is predicted to result in significant economic and employment opportunities for the Western Sydney region, as well as wider economic benefits throughout the Greater Sydney area. Benefits would be accrued beyond the aviation industry, and extend to businesses and employees in industries such as construction, utilities, trade, transport, accommodation, retail professional services and administration.

The rural character of the local area would transition to a more urban character with the development of the airport and the implementation of various strategic and regional planning initiatives. Noise from aircraft overflights and ground-based operations at the airport would affect the amenity currently experienced by local communities. Impacts on the social amenity and lifestyle of the people of Western Sydney more broadly would vary between communities, depending on proximity to the airport site, and their location with respect to flight paths.

The future airspace and flight path design process will optimise flight paths taking into account the safety of all aircraft and airspace users across the Sydney basin, aircraft operation efficiency and opportunities to minimise noise and amenity impacts on all potentially affected communities, sensitive receivers and the environment.

Social infrastructure may be put under stress during the construction of the proposed airport and during the early stages of operation. However, as urbanisation advances in the region, additional services would be expected to come online to meet demand.

Mitigation and management measures have been proposed to maximise the social and economic benefits of the proposed airport and to minimise negative social impacts. These measures would be in addition to the implementation of measures proposed in other assessments and would be incorporated into the Environmental Management Framework through community and stakeholder engagement measures and sustainability measures as outlined in Chapter 28 (Volume 2b).

24 Economic

The construction and operation of the proposed airport is expected to generate significant economic and employment effects which will grow commensurately with the forecast increase in passenger demand over time. Overall, the Western Sydney region is expected to benefit from these effects and would experience a significant share of the increased economic activity and employment opportunities generated by the proposed airport.

Over the construction period, the Stage 1 development is forecast to create employment opportunities and value-add for the economy. In particular, construction of the Stage 1 development would:

- create about 3,180 full-time equivalent (FTE) jobs directly and indirectly in Greater Sydney during the peak of construction activity. Approximately 84 per cent of these jobs would be created in Western Sydney, including in the peak year of construction about 760 FTE direct onsite jobs, 1,240 FTE jobs in the supply chain and 660 FTE jobs through consumption effects;
- create about $2.3 billion in value-add across Greater Sydney during the construction period, with approximately $1.9 billion or 83 per cent of that value-add being created in Western Sydney.

During operation of the Stage 1 development, the proposed airport is expected to continue its role as a substantial source of economic and employment opportunities in the region. Operation of the Stage 1 development in 2031, for example, would:

- create about 8,730 FTE direct onsite jobs;
- potentially create a further 4,440 FTE onsite jobs within business parks on the airport site;
- generate about $77 million in value-add for Western Sydney;
- generate about $145 million in value-add for the rest of Greater Sydney; and
- drive growth in business profits, productivity and household income.

As a major infrastructure project, the proposed airport has the potential to redistribute employment and population growth toward Western Sydney. While this may result in relatively slower employment and population growth in other parts of Sydney, it will also contribute to more balanced and sustainable growth. Similarly, the proposed airport is expected to result in a slight reduction in value-add, business profits and worker productivity in areas outside of NSW as economic activity is redistributed towards Western Sydney.

24.1 Introduction

This chapter provides a review of the potential economic effects that could be expected as a result of the construction and operation of the Stage 1 development. The chapter draws on the findings of an analysis of economic impacts undertaken to inform this EIS and addresses the requirements of the EIS Guidelines. The economic analysis is included in Appendix P3 (Volume 4).

The EIS Guidelines include a requirement to assess both the positive and negative economic impacts associated with the proposed airport. This includes consideration at the local, regional and national level of the expected economic costs and benefits and employment opportunities likely to be generated during construction and operation.

The economic impacts of the proposed airport are expressed in terms of a number of standard economic metrics including:

- full-time equivalent (FTE) employment – representing one year of employment at full-time;
- person-years – a measure of employment effort; ten people employed for one year or one person employed for ten years would equate as ten person-years;
- economic value-add – the value of the economic output of an activity minus the value of the economic inputs required for the activity; on a large scale equivalent to gross regional product;
- industrial effects – indirect employment and value-add due to demand for goods and services created by an activity, such as demand for construction materials;
- consumption effects – indirect employment and value-add due to demand for goods and services from the workforce employed directly or indirectly by an activity;
- business profit – the share of value-add in real returns to business owners and investors;
- household income – the share of value-add in income received in household wages;
- worker productivity – value-add generated per worker per year; and
- net imports – the balance of the real value of exports and imports in a region, representing both domestic, inter-regional trade and international trade.

24.2 Methodology

This section provides an overview of the methodologies used to identify and assess economic and employment impacts. These methodologies are described further in Appendix P3 (Volume 4).

24.2.1 Construction

The employment and value-add effects from the construction of the Stage 1 development were assessed in terms of FTE employment, economic value-add and indirect industrial and consumption effects.

Direct employment during construction was estimated based on the indicative construction schedule and component activities. Indirect jobs were projected with industry standard economic multipliers for industrial and consumption effects. Economic value-add was similarly estimated with industry standard economic multipliers in the REMPLAN input-output economic model.

24.2.2 Operation

The employment and value-add of the operation of the Stage 1 development were assessed in terms of FTE employment, economic value-add and indirect industrial and consumption effects. The assessment was conducted with the aid of a land use econometric model and a computable general equilibrium model.

Direct employment during operation was estimated as part of airport planning. The estimate was validated by a benchmarking exercise that determined the average FTE employment per million annual passengers across a number of other airports in Australia and internationally.

Employment at business parks at the airport site during operation was estimated by applying a ratio of employees to the floor space of proposed land uses. This approach is consistent with the approach taken in *A Study of Wilton and RAAF Base Richmond for Civil Aviation Operations* (Department of Infrastructure and Transport 2013).

The land use econometric model was used to determine the resulting employment and population densities in and around the airport site and Western Sydney. The model considered factors including accessibility of employees to places of employment, accessibility of employers to employees, connectivity of supply chains between businesses and other factors such as the availability of public amenities and attractions. The model was developed from the base spatial units developed by the NSW Bureau of Transport Statistics, which reflect population mobility.

The computable general equilibrium model represents transactions between individuals, business and government. These transactions can involve consumption, labour, capital, property and trade. The model was used to predict economy-wide impacts including employment and value-add plus other metrics including business profit, household income, worker productivity and net imports at the regional, state and national scale.

The results of the land use econometric model and computable general equilibrium model were presented at a number of spatial scales, including:

- Greater Sydney – which includes both Western Sydney and the rest of Sydney;
- Western Sydney which includes the following local government areas (LGAs):
  - South West – Liverpool, Fairfield, Camden, Campbelltown and Wollondilly;
  - West – Penrith, Hawkesbury, Blue Mountains; and
  - West Central – Blacktown, Canterbury-Bankstown, Cumberland, Parramatta, The Hills.
- the rest of Sydney – which is comprised of the remaining Greater Sydney LGAs that are not included in Western Sydney;
- the rest of NSW – which is comprised of all areas within NSW but outside of Greater Sydney; and
- the rest of Australia – which is comprised of all states and territories outside of NSW.

24.3 Existing environment

24.3.1 Overview

The airport site is located within Badgerys Creek and Luddenham, about 50 kilometres west of the Sydney central business district (CBD) in Western Sydney.

Western Sydney is the third largest regional economy in Australia. With a population of about two million, it is home to about nine per cent of Australia's population and makes up 47 per cent of the residents of Greater Sydney. The population is also expected to grow quickly with a further one million residents expected by 2030 (SGS 2015).

The economy of Western Sydney is heavily reliant on manufacturing, which is in decline and is forecast to continue to decline in the future. Many residents in Western Sydney are forced to travel long distances for higher pay professional jobs in other parts of Sydney, which also contributes to existing congestion problems on the Greater Sydney road network.

Despite the size and predicted growth in the region, there is recognised economic inequity between Western Sydney and Greater Sydney. Although around half of the Greater Sydney population resides in Western Sydney, it has only a third of total jobs. Around 30 per cent of Western Sydney's workforce travel to other parts of Sydney for work.

This job deficit is expected to increase as the population of Western Sydney grows while the majority of jobs continue to be generated in the Sydney CBD. Western Sydney also has relatively low household incomes, averaging about 90 per cent of Greater Sydney.

The NSW Government's *A Plan for Growing Sydney* (DP&E 2014) focuses heavily on the role of Western Sydney in driving the growth of Sydney and NSW over coming decades. In particular, it identifies that an additional 400,000 jobs will be required in Western Sydney over the next 25 years to slow the job deficit. The plan also identifies Parramatta as the second CBD in Greater Sydney supported by regional centres including Liverpool, Campbelltown-Macarthur and Penrith. These areas are envisaged as centres for jobs, transport and services.

Western Sydney is nonetheless undergoing a major transition to a more highly urbanised region, evidenced by numerous major residential and transport infrastructure initiatives such as the Australian Government's Western Sydney Infrastructure Plan, NSW Government's priority growth areas, multiple road and rail projects and the proposed airport.

The above initiatives are discussed further in Chapter 21 and Chapter 23.

24.4 Assessment of impacts during construction

24.4.1 Employment

24.4.1.1 Western Sydney

The number of FTE jobs expected to be generated within each construction sector, by type of activity and for each financial year during the construction of the Stage 1 development, is presented in Table 24–1 and Table 24–2. As shown, construction of the Stage 1 development at its peak would create about 760 FTE jobs in Western Sydney – increasing to 2,660 jobs when indirect industrial and consumption effects are also considered.

The cumulative employment impact is measured in 'person-years' which represents the total amount of work effort that would be needed to complete the construction of the proposed airport. The Stage 1 development is expected to support a total of about 11,350 person-years of employment in Western Sydney over the duration of construction, including about 3,230 person-years of direct employment and a further 8,120 person-years of indirect employment from industrial and consumption effects.

Table 24–1 Direct onsite FTE jobs during construction in Western Sydney

Employment type	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total (person years)
Site preparation (Civil)	52	141	103	15	26	61	28	-	427
Aviation (Civil)	-	-	27	159	128	114	74	104	605
Site preparation (Contract administration)	4	14	22	23	21	12	2	-	97
Site preparation (Supervisory and management)	16	48	78	80	73	44	7	-	346
Aviation (Contract administration)	-	-	3	40	97	113	107	60	419
Aviation (Supervisory and management)	-	-	4	55	135	157	148	84	583
Aviation (Building)	-	-	-	74	124	256	217	82	754
TOTAL	72	203	236	446	605	758	583	330	3,231

Note: Y1 = year one, Y2 = year two, etc.

Table 24–2 Direct and indirect FTE jobs during construction in Western Sydney

Employment type	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total (person years)
Direct jobs	72	203	236	446	605	758	583	330	3,231
Indirect jobs									
Industrial effect	117	331	386	729	988	1,238	953	540	5,281
Consumption effect	63	178	207	391	530	664	511	290	2,834
TOTAL	251	712	828	1,565	2,123	2,660	2,047	1,160	11,346

Note: Y1 = year one, Y2 = year two, etc.

The expected annual contribution to employment in Western Sydney over the construction period is shown Figure 24–1.

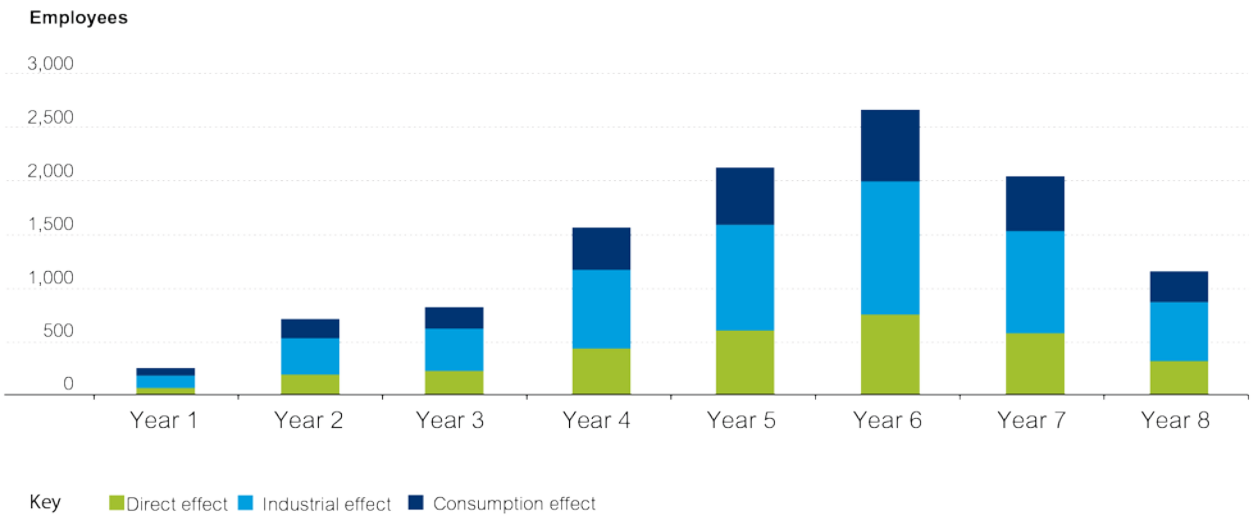


Figure 24–1 Direct and indirect FTE jobs during construction in Western Sydney

24.4.1.2 Greater Sydney

The potential economic footprint across the Greater Sydney region (including Western Sydney) associated with the construction of the Stage 1 development is summarised in Table 24–3. The table presents the number of FTE jobs expected to be generated in the Greater Sydney region in each financial year during the construction period.

When the Greater Sydney region is included in the analysis, the expected employment impact associated with the construction of the Stage 1 development is higher as more indirect jobs are captured within this larger geographical area. Despite this, most of the employment impact is expected to remain within the Western Sydney region.

The Greater Sydney employment footprint is expected to reach about 3,180 FTE jobs during the construction peak. Over the construction period this would result in about 13,560 person-years of employment generated across Greater Sydney. This means that approximately 84 per cent of all direct and indirect jobs generated by the proposed airport during construction are forecast to be located in Western Sydney.

Table 24–3 Direct and indirect FTE jobs during construction in Greater Sydney (including Western Sydney)

Effects (FTE jobs per year)	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total (person years)
Direct jobs	72	203	236	446	605	758	583	330	3,231
Indirect jobs									
Industrial effect	130	369	429	810	1,099	1,377	1,060	600	5,874
Consumption effect	99	179	325	614	833	1,043	803	455	4,451
TOTAL	300	850	990	1,870	2,537	3,178	2,446	1,386	13,556

Note: Y1 = year one, Y2 = year two, etc.

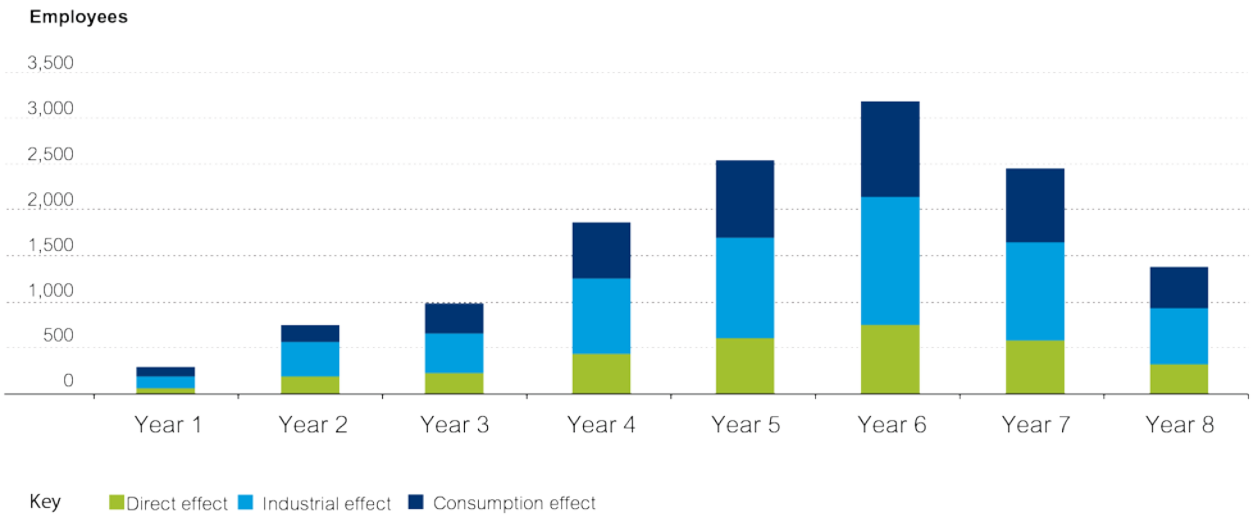


Figure 24–2 Direct and indirect FTE jobs during construction in Greater Sydney (including Western Sydney)

24.4.2 Economic value-add

24.4.2.1 Western Sydney

The potential economic footprint related to the construction of the Stage 1 development is summarised in Table 24–4. The table presents the forecast economic contribution expected for the Western Sydney region in each year in terms of millions of dollars of value-add.

Table 24–4 Potential economic value-add during construction in Western Sydney

Contribution	Value-add ($ million)								
	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total
Direct contribution	16	44	52	98	132	166	128	72	707
Indirect contribution									
Industrial effect	17	47	55	104	141	176	136	77	751
Consumption effect	10	28	33	62	84	105	81	46	446
TOTAL	42	119	139	263	356	446	344	195	1,904

Note: Y1 = year one, Y2 = year two, etc.

Value-add during construction of the Stage 1 development is estimated to be $446 million during the peak year of construction – including $166 million in direct value-add and $281 million in indirect value-add created by industrial and consumption effects. The total value-add over the entire construction period is estimated to reach around $1.9 billion.

The expected annual contribution to value-add over time for the Western Sydney region is shown in Figure 24–3.

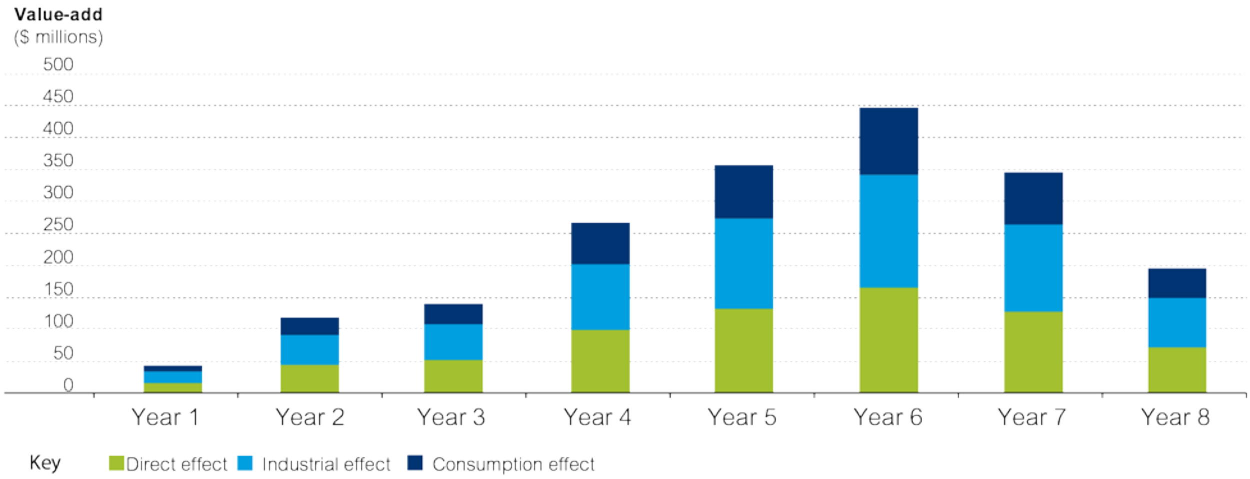


Figure 24–3 Potential economic value add during construction in Western Sydney

24.4.2.2 Greater Sydney

The potential economic footprint across the Greater Sydney region associated with the construction of the Stage 1 development is summarised in Table 24–5. The table presents the value-add that would be generated for the Greater Sydney region in each year during construction.

Table 24–5 Potential economic value-add from construction in Greater Sydney (including Western Sydney)

Contribution	Value-add ($ million)								
	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Total
Direct contribution	16	44	52	98	132	166	128	72	707
Indirect contribution									
Industrial effect	19	55	64	121	165	206	159	90	880
Consumption effect	16	45	52	99	134	168	129	73	716
TOTAL	51	145	168	318	431	540	416	235	2,304

Note: Y1 = year one, Y2 = year two, etc.

Similar to employment impacts, the value-add footprint for Greater Sydney would be larger than that for Western Sydney, reaching up to $540 million in the peak year of construction and up to $2.3 billion over the construction period – about 83 per cent of which would be generated in Western Sydney.

The expected annual contribution to value-add over the construction period for the Greater Sydney region is shown in Figure 24–4.

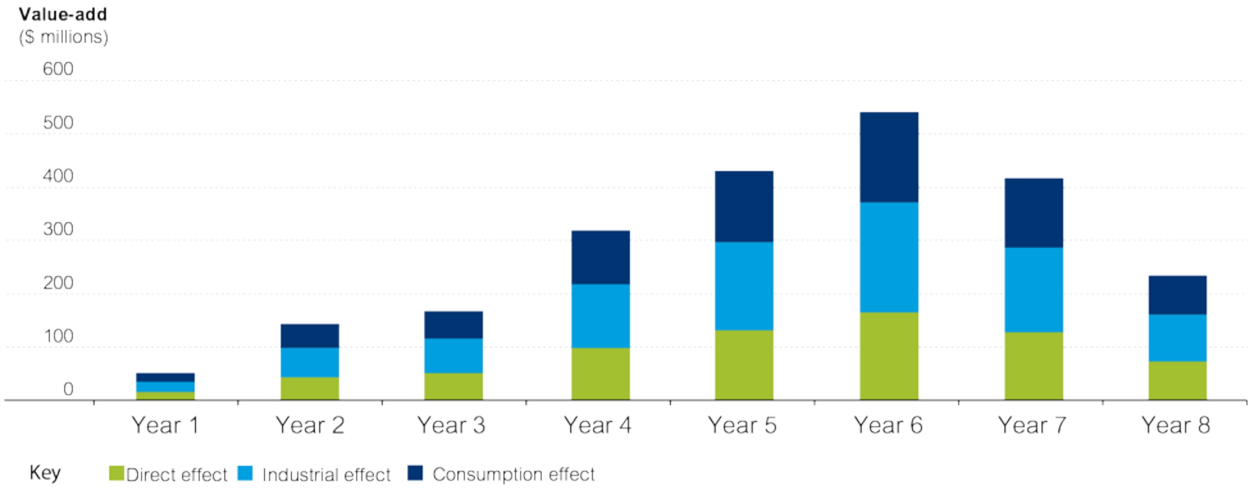


Figure 24–4 Potential economic value add from construction in Greater Sydney (including Western Sydney)

24.5 Assessment of impacts during operation

24.5.1 Economic value-add

The Stage 1 development of the proposed airport would result in economic effects for Western Sydney and the wider region. These effects would benefit industries beyond the aviation sector, and extend to businesses and employees in industries such as construction, utilities, trade, transport, accommodation, retail, professional services, tourism and hospitality, and administration. These effects would have flow-on benefits to individuals through increased household income and greater access to employment opportunities.

The economic impacts associated with the Stage 1 development are commensurate with the 10 million annual passengers forecast to be accommodated. As the proposed airport grows beyond 10 million annual passengers it is predicted that the economic benefits would also increase. An overview of the potential economic impacts associated with the long term development is presented in Chapter 39 (Volume 3).

Table 24–6 provides an overview of the economic impacts associated with operation of the Stage 1 development. The figures presented are for the year 2031 in order to ensure consistency with data provided by external sources as described in Appendix P3 (Volume 4).

Table 24–6 Potential economic impacts of operation in 2031 (undiscounted 2015 $AUD)

Metric	Western Sydney	Rest of Sydney	Rest of NSW	Rest of Australia	Total
Value-add ($ millions)	$77	$145	$23	-$39	$205
Business profits ($ millions)	$27	$42	$11	-$8	$73
Productivity per worker ($/worker)	$90	$95	$20	-$4	$17
Household income ($ millions)	$44	$50	$15	$32	$140
Net imports ($ millions)	$23	-$36	$5	$55	$47

In 2031 the operation of the proposed airport could generate an additional $205 million in value-add per year across Australia. Of this, approximately $77 million would be generated in Western Sydney alone. There is a reduction in value-add in the rest of Australia (outside NSW), reflecting the proposed airport’s role in attracting economic activity to the region, however this reduction is small given the overall size of the Australian economy. The increase in value-add is supported by increases in productivity per worker, averaging $90 per worker in Western Sydney and $95 per worker in the rest of Sydney.

The operation of the Stage 1 development would also result in economic benefits for business in the regions surrounding the airport site. In 2031 the proposed airport would generate an additional $27 million in profits for businesses in Western Sydney and $42 million in increased profits for businesses in the rest of Sydney. There are smaller positive benefits to the rest of NSW and a small negative impact on the rest of Australia, again reflecting the proposed airport’s role in redistributing economic activity to Western Sydney and the broader metropolitan area.

In relation to household income, the proposed airport would generate $44 million and $50 million in additional household income for Western Sydney and the rest of Sydney. It is expected there would be significant regional spill-overs, with a substantial share of gains in the rest of Australia.

24.5.2 Direct employment

Airports are one of the most important employment hubs in Australia, generating diverse employment opportunities – including jobs in transport, postage, warehousing, administration, safety, retail, accommodation, food services, manufacturing, professional and technical services, information media and telecommunications (BITRE 2013). These jobs tend to cover a wide range of job classifications and educational qualifications (BITRE 2013).

In 2031 the operation of the proposed airport is expected to generate a total of 13,170 FTE jobs on the airport site. This would include approximately 8,730 FTE jobs directly associated with the operation of the proposed airport, and 4,440 FTE jobs in the manufacturing, business services and consumer services sectors as part of the non-aeronautical developments that may occur within a business park on the airport site.

A breakdown of the expected employment can be seen in Table 24–7.

Table 24–7 Onsite FTE jobs during operation of the Stage 1 development (2031)

Category	Employment (FTE) in 2031
Direct airport jobs	8,730
Onsite business park	4,440
Total	13,170

24.5.3 Employment distribution

The land use econometric model (see Section 24.2.2) estimates the change in employment growth that would occur across Greater Sydney as a result of the operation of the Stage 1 development.

Potential changes in employment growth are expected to be driven by:

- changes in access to new or relocated firms (measured by the number of jobs) resulting from the redistribution of employment to areas around the airport site;
- changes in access to workers and customers resulting from the change in population associated with the development of the proposed airport; and
- increases in employment zones in the area surrounding the proposed airport due to changes in land use and increased commercial and business development areas.

A summary of the expected effects of the proposed airport on employment growth in 2031 is presented in Table 24–8. As shown, the Sydney West district is anticipated to see the largest increase in employment across Western Sydney in 2031. The Sydney South West and Sydney West Central districts are also likely to experience employment increases.

Overall, areas around the airport site that currently have very little employment growth would see large proportional increases, with an additional 6,900 FTE jobs in Western Sydney. This growth is additional to employment at the proposed airport and business park discussed in Section 24.5.2.

The strongest population growth is estimated to occur in the following LGAs:

- Penrith;
- Blue Mountains; and
- Wollondilly.

The land use econometric model assumes these increases in employment growth are caused by the redistribution of employment growth from elsewhere in Greater Sydney. Employment as a whole is predicted to grow in the future, meaning this redistribution represents slowed employment growth in some areas rather than a net reduction in employment.

Table 24–8 Additional employment growth caused by the proposed airport in 2031

Region	Additional employment growth in 2031
Western Sydney	6,900
Sydney South West	2,000
Sydney West	3,000
Sydney West Central	1,900
Rest of Sydney	-7200
Rest of NSW	300

24.5.4 Population distribution

The land use econometric model (see Section 24.2.2) also estimates the change in population growth that would occur across Greater Sydney as a result of the operation of the Stage 1 development.

Potential changes in population growth would be driven by:

- changes in access to jobs as a result of increased employment opportunities in the region;
- increased attractiveness of travel zones that would be closer to a major airport (with the introduction of the proposed airport), and
- amenity impacts to the immediate surrounding area (noise, visual, and other amenity issues) and changes in surrounding land uses that may reduce population densities.

A summary of the effects of the proposed airport on population is provided in Table 24–9. The table shows that land use change due to the Stage 1 development would result in an additional 17,900 residents in Western Sydney. The strongest population growth is estimated to occur in the following LGAs:

- Penrith;
- Blue Mountains;
- Blacktown;
- Wollondilly; and
- Camden.

The district of Sydney West is anticipated to see the largest increase in additional population in 2031 as a result of the Stage 1 development. This strong growth would be expected as a result of some redistribution of population growth from the rest of Sydney, the rest of NSW, and the Sydney West Central district. As a result of these impacts, areas outside of Western Sydney (rest of Sydney and rest of NSW) are expected to experience slower population growth.

The land use econometric model used in the assessment (see Section 24.2.2) assumes these increases in population growth are caused by the redistribution of population growth from elsewhere in Greater Sydney. Population as a whole is predicted to grow in the future, meaning this redistribution represents slowed population growth in some areas rather than a net reduction in population.

Table 24–9 Additional population growth caused by the proposed airport in 2031

Subregion	Additional population growth in 2031
Western Sydney	17,900
Sydney South West	4,900
Sydney West	16,200
Sydney West Central	-3,200
Rest of Sydney	-14,000
Rest of NSW	-3900

24.6 Mitigation and management measures

Overall, the economic impacts of the proposed airport are expected to benefit the local, regional and national economies. These benefits would increase commensurate with passenger demand.

It is recognised that these positive economic impacts may result in positive and negative social impacts and these have been discussed further in the social impact assessment in Chapter 23. The social impact assessment also includes a number of mitigation measures to enhance the economic and social benefits and minimise negative social impacts of the proposed airport.

24.7 Conclusion

The construction and operation of the Stage 1 development would have positive impacts on the economy at a local, regional, and national scale. Western Sydney in particular will experience the majority of these positive impacts, with substantial increases in value-add and employment.

The construction and operation of the proposed airport would result in significant direct employment at the airport site. In the peak year of construction, the proposed airport would directly employ about 760 FTE workers and indirectly support another 2,420 FTE jobs. In 2031, the operation of the proposed airport would directly employ about 8,730 FTE workers and potentially generate another 4,440 FTE jobs in business parks on the airport site.

The operation of the proposed airport would also cause a redistribution of employment growth and population growth to Western Sydney. Not including direct employment at the airport site, in 2031 the operation of the proposed airport would cause the redistribution of 6,900 FTE jobs and 17,900 residents into Western Sydney from other parts of Sydney and NSW.

In terms of economic benefits, construction of the proposed airport would generate about $2.3 billion of value-add for Greater Sydney, about 83 per cent of which would be generated in Western Sydney. In 2031, operation of the proposed airport would value-add about $205 million. Value-add would grow commensurate with passenger demand at the proposed airport.

As people and businesses move to take advantage of these opportunities in Western Sydney, it is expected to result in a corresponding slowing of growth in population, employment and economic value-add in other parts of Sydney. This would not represent an absolute reduction but rather slightly slowed growth. This redistribution will ameliorate the inequity currently experienced in Western Sydney and accordingly facilitate more balanced and sustainable growth.

25 Resources and waste

Construction of the proposed airport would involve clearing and a major bulk earthworks program to achieve a level surface suitable for the construction of airport facilities, along with the use of a range of construction materials. The operational airport would employ a large workforce and service some 10 million passengers each year. As with any large infrastructure project, the construction and operation of the proposed airport would involve the consumption of natural resources and has the potential to generate substantial quantities of waste.

The peak for waste generation would be during construction, when an estimated 202,500 tonnes of waste vegetation and construction materials such as concrete and timber would be generated. During the initial airport operations, an estimated 5,251 tonnes of waste would be generated each year, and would include general waste, food, packaging waste from terminals and waste oils, paints and cleaners from maintenance activities.

Resources and waste from the airport would be sustainably managed by maximising waste avoidance, reduction, reuse and recycling (in accordance with a waste management hierarchy), while mitigating and managing impacts on human health and the environment. Waste management plans would be prepared prior to construction and operation of the airport, which would guide the management of waste during construction and operation.

Consideration would also be given to the achievement of an Infrastructure Sustainability Council of Australia 'As Built Rating' and 'Operations Rating' to promote sustainability – covering the design, construction and operation of the Stage 1 development.

The waste management market in Western Sydney is mature and handles significant volumes of waste from various domestic, commercial and industrial sources across all of Sydney. Waste facilities in Western Sydney have sufficient capacity to handle wastes of the type and volume expected to be generated at the airport site.

25.1 Introduction

This chapter provides an analysis of the resources that would be consumed and waste generated by the construction and operation of the proposed airport. Potential impacts arising from the construction and operation of the proposed airport are characterised and measures to mitigate and manage these impacts are identified.

25.2 Methodology

The following tasks were undertaken to assess resource consumption and waste generation associated with the development of the proposed airport:

- review of waste legislation and policy in order to consider which matters must be complied with and which matters may provide guidance in developing waste management strategies;
- estimation of waste generated by construction and operation of the airport; and
- determination of waste management options.

Resources consumed and waste generated during construction were estimated with reference to data on construction planning and logistics data (see Chapter 6 (Volume 1)) applied to typical waste generation rates for construction of certain types of infrastructure (e.g. roads, runways, hardstands and commercial buildings). These estimates were based on area and took into account certain assumptions such as concrete density and thickness.

Waste that would be generated during operation was estimated by referring to data from a number of existing airports. The airports were selected based on the availability and applicability of waste data. This was used to estimate the types and quantities of waste that may be generated from particular airport facilities at the proposed airport. The researched airport data are summarised in Table 25–1. The types of data typically reported were either:

- amounts for components of waste streams, such as food and cardboard;
- whole amounts for parts of airports, such as terminals and maintenance; or
- amounts of waste for the whole airport.

Outlying values were removed from the collected data, then converted to kilograms per 1,000 passengers and averaged out. The averages were then multiplied by the number of passengers to account for the 10 million annual passengers forecast each year during the Stage 1 development.

Table 25–1 Summary of waste data from researched airports

Airport	Passengers per year (million)	Waste type	Annual volume per 1,000 passengers (kg)
Aberdeen (ABZ), UK (2007)	2.7	General waste	187.0
Adelaide (ADL), Australia (2013)	7.5	General waste	95.7
Athens (ATH), Greece (2005)	14.3	General waste	819.1
		Recyclables	120.0
		Hazardous	24.9
Copenhagen (CPH), Denmark (2005)	24	General waste	144.0
Dubai (DXB), UAE (2004)	21.7	General waste	944.8
Edinburgh (EDI), UK (2007)	8.7	General waste	219.9
Fort Lauderdale (FLL), USA (2004)	10	General waste	477.4 (average)
Los Angeles (LAX), USA (2004)	29		
Portland (PDX), USA (2004)	6.5		
San Francisco (SFO), USA (2004)	36		
Baltimore-Washington (BWI), USA (2004)	21		
Glasgow (GLA), UK (2007)	8.9	General waste	305.1
Heathrow (LHR), UK (2005)	36.1	Non-hazardous	205.4
		Recyclables	24.8
		Hazardous	115.6
		Hazardous liquids	8.6
Melbourne (MEL), Australia (2004)	19	General waste	124.2
Munich (MUC), Germany (2013)	38.7	General waste	231.2
Oakland (OAK), USA (2007)	13.6	General waste	31.5
Southampton (SOU), UK (2007)	1.9	General waste	226.8
Stanstead (STN), UK (2007)	23.8	General waste	263.1
Toronto (YYZ), Canada (2005)	28.6	Non-hazardous	151.0
		Hazardous	1.4

25.3 Legislation and policy

25.3.1 Legislative framework

As a Commonwealth facility, the airport site would principally be governed by Commonwealth legislation. Although this legislation does not explicitly regulate waste, it prescribes duties for airport operators to take all reasonable and practicable measures to avoid polluting as described in Chapter 3 (Volume 1) of this EIS and Part 4 of the Airports (Environment Protection) Regulations 1997. Other relevant laws and regulations administered by the Commonwealth generally relate to national matters such as import, export and quarantine. These laws apply to particular wastes at the airport site and include the:

- *Biosecurity Act 2015*; and
- *Hazardous Waste Act 1989*.

As most waste generated at the airport site would be transported off-site, a range of state laws are also applicable. The principal NSW laws concerning waste are the:

- *Waste Avoidance and Resource Recovery Act 2001*;
- *Protection of the Environment Operations Act 1997*; and
- Protection of the Environment Operations (Waste) Regulation 2014.

Definitions and a summary of key provisions are outlined below.

25.3.2 Biosecurity Act 2015

The *Biosecurity Act 2015* allows the Australian Government to quarantine vessels, persons or goods to protect human health and the environment from pests and disease. Quarantine activities are controlled by the Australian Government Department of Agriculture and Water Resources. The Department is responsible for the clearance of all incoming international aircraft, aircraft waste, passengers and baggage. Quarantine activities at airports typically involve screening of passengers and their baggage using a range of techniques such as x-ray, detector dogs and physical inspection as well as specific waste management requirements. Screening is usually undertaken in designated examination areas after baggage reclaim but can also involve access to airside and apron areas. The Act is supported by regulations which detail provisions regarding offences under the Act and procedural matters on when and how quarantine activities are undertaken.

25.3.3 Hazardous Waste (Regulation of Imports and Exports) Act 1989

The *Hazardous Waste (Regulation of Imports and Exports) Act 1989* implements Australian Government obligations under the Basel Convention and prohibits the export and import of hazardous waste without a permit. A permit may be obtained to export hazardous waste where it can be shown that the waste would be managed in an environmentally sound manner in the country of import.

The Australian Government has banned the export of hazardous waste for disposal in all but exceptional circumstances. Export of hazardous waste for reuse, recycling or recovery is permitted providing certain conditions are met. Consideration may need to be given to the Act if waste materials originating from the airport, such as electronic waste, are exported overseas.

25.3.4 Waste Avoidance and Resource Recovery Act 2001

The *Waste Avoidance and Resource Recovery Act 2001* is the overarching waste management legislation in NSW. The objectives of the Act include encouraging the most efficient use of resources, reducing environmental harm and ensuring resource management decisions are made against a hierarchy that gives preference to waste avoidance and resource recovery. The main provisions of the Act relate to the preparation of waste strategies and extended producer responsibility schemes. The current statutory waste strategy is the NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (EPA 2014a). The waste strategy is explained in Section 25.3.2.

Extended producer responsibility schemes may be made under the Act. The schemes relate to the lifecycle of a product and therefore may apply to the extraction of raw materials for a product, the manufacturing of a product and the consumption of a product, through to disposal and ongoing management requirements. The schemes may apply to producers or consumers of particular products.

Extended producer responsibility schemes in place in NSW are identified in the NSW Extended Producer Responsibility Priority Statement 2010 (DECCW 2010b) and include schemes for waste packaging, mobile phones, agricultural chemicals and containers, polyvinyl chloride, oils and lubricants, and tyres. Consumers such as an ALC would be expected to cooperate in producer responsibility schemes by isolating relevant waste streams for collection.

25.3.5 Protection of the Environment Operation Act 1997

The *Protection of the Environment Operations Act 1997* is the principal environmental protection legislation administered by the NSW Environment Protection Authority. The Act sets out the waste classifications, licensing requirements and other regulatory controls that would be applicable to waste transported from the airport site.

The objectives of the Act include the protection, restoration and enhancement of the quality of the environment and reduction of risks to human health. The main provisions of the Act relate to the grant and oversight of environment protection licences, the control of certain actions which may give rise to pollution and the control of waste management activities. The Act broadly defines 'waste' for the purpose of regulation as:

a. *any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment; or*

b. *any discarded, rejected, unwanted, surplus or abandoned substance; or*

c. *any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance; or*

d. *any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel … in the circumstances prescribed by the regulations; or*

e. *any substance prescribed by the regulations to be waste.*

Schedule 1 of the Act also sets out the waste classification which provides the basis for the NSW *Waste Classification Guidelines* (see Section 25.3.2). The classification of waste under the Act and supporting guidelines is summarised in Table 25–2. Full definitions can be found within the Act, associated Regulations and the Waste Classification Guidelines.

Part 5 of the Act prescribes a range of offences for polluting water, air, noise and land. Part 5.6 of the Act specifically deals with offences relating to land pollution and waste. Relevant offences include the unlawful transporting or depositing of waste, providing false or misleading information about waste, or operating a waste facility without lawful authority.

Table 25–2 Summary of waste classifications in NSW

Waste type	Definition
Restricted solid waste	A substance meeting the specific contaminant concentrations and/or toxicity characteristics defined in the NSW *Waste Classification Guidelines*.
Liquid waste	Under the NSW *Waste Classification Guidelines*, a substance that shows flowing characteristics at an angle of less than 5 degrees above horizontal, and becomes free flowing at or below 60 degrees Celsius or when it is transported.
Special waste	Clinical and related waste, asbestos waste and waste tyres as per the NSW *Waste Classification Guidelines*.
Hazardous waste	Substances that are Class 1 (explosives), Class 2 (gases), Class 5 (oxidising substances and organic peroxides) or Class 8 (corrosives) under the *Transport of Dangerous Goods Code*. Substances under Division 4.1 (flammable solids), Division 4.2 (substances liable to spontaneous combustion), Division 4.3 (substances which emit flammable gas on contact with water) or Division 6.1 (toxic substances) of the *Transport of Dangerous Goods Code*. Containers having previously contained Class 1, 3, 4, 5, 6.1 or 8 dangerous goods under the *Transport of Dangerous Goods Code*. Other materials generated or collected under certain circumstances including coal tar or coal tar pitch waste, lead-acid or nickel-cadmium batteries, lead paint, or otherwise classified as hazardous waste by the NSW Environment Protection Authority and a mixture of any of the above.
General solid waste (non-putrescible)	Numerous wastes other than those listed above. Examples include glass, plastic, concrete, metal, wood, asphalt and non-contaminated excavated material such as soil or gravel.
General solid waste (putrescible)	Numerous wastes other than those listed above. Examples include manure and nightsoil, food waste and domestic waste with putrescible organics.
Trackable waste	Substances listed in Schedule 1 of the Protection of the Environment Operations (Waste) Regulation 2014 (NSW). Asbestos has separate tracking requirements under Part 7 of the Regulation.

25.3.6 Protection of the Environment Operations (Waste) Regulation 2014

The NSW Protection of the Environment Operations (Waste) Regulation 2014 sets out obligations that would apply to waste managers, consigners, transporters and receivers dealing with waste coming from the airport site.

The main provisions of the Regulation relate to the payment of a waste levy by licensed waste receivers, the requirements to track the transportation and disposal of certain types of waste, and specific requirements regarding the transportation and management of asbestos waste.

Schedule 1 of the Regulation lists types of waste that must be tracked during transport and disposal. Obligations to track these wastes apply to consigners, transporters and receivers. The responsibilities of consigners generally relate to ensuring that transporters and receivers of their waste hold the relevant licences to deal with the waste. Part 7 of the Regulation contains provisions for the transportation and management of asbestos waste, including requirements for its containment during transport, reporting requirements for transporters and receivers of asbestos waste, the manner in which asbestos is disposed, and a prohibition on the reuse or recycling of asbestos waste.

25.3.7 Other laws and regulations

Other laws and regulations concerning waste include the following:

- State laws and regulations controlling hazardous substances:
  - the NSW *Explosives Act 2003*;
  - the NSW *Radiation Control Act 1990*;
  - the NSW *Environmentally Hazardous Chemicals Act 1985*; and
  - the NSW *Dangerous Goods (Road and Rail Transport) Act 2008*, which gives effect to the Australian Code for the Transport of Dangerous Goods by Road and Rail; and
- *Product Stewardship Act 2011*, which sets the framework for product stewardship in line with the National Waste Policy (see Section 25.3.2).

25.3.8 Policies, plans and guidelines

A range of policies, plans and guidelines would also apply to waste generated at or transported from the airport site. The main documents are:

- *National Waste Policy;*
- NSW *Waste Avoidance and Resource Recovery Strategy 2014–21*; and
- NSW *Waste Classification Guidelines*.

Definitions and a summary of key provisions are outlined below.

25.3.8.1 National Waste Policy

The *National Waste Policy* is an overarching policy that guides the development of legislation and policy within States and Territories. The objectives of the National Waste Policy include the avoidance and reduction of waste for disposal, management of waste as a resource, and management of waste in a safe, scientific and environmentally sound manner.

The Policy identifies a range of strategies to be implemented by the Australian Government in collaboration with the States and Territories. The strategies include:

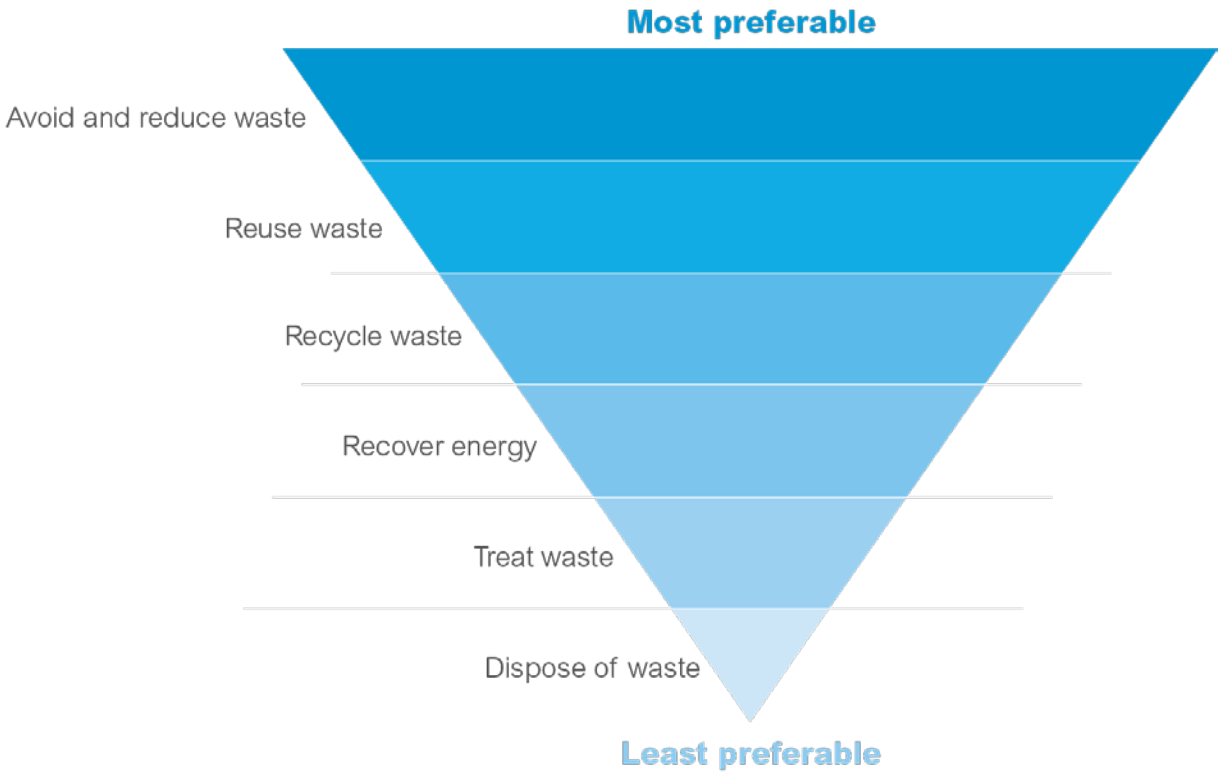
- establishment of Commonwealth product stewardship framework legislation;
- sustainable procurement principles and practices across government operations;
- improvements in waste avoidance and re-use in commercial waste streams; and
- best practice waste management and resource recovery for construction and demolition.

25.3.8.2 Waste Avoidance and Resource Recovery Strategy 2014–21

The current waste strategy under the NSW *Waste Avoidance and Resource Recovery Act 2001* is the *NSW Waste Avoidance and Resource Recovery Strategy 2014–21* (EPA 2014a). The Strategy sets objectives to avoid waste generation, increase recycling, divert waste from landfill, manage problem wastes, reduce litter and reduce illegal dumping. To achieve these objectives, the Strategy assigns the following responsibilities to industry and business:

- avoid and reduce waste through efficiency measures and industrial ecology partnerships;
- separate recycling streams at source to enable collection separate from residual waste;
- work with suppliers to reduce packaging and waste in supply chains;
- implement and maintain best practice resource recovery systems;
- actively seek other businesses that may use waste as a resource;
- ensure waste and recycling streams are taken to appropriate facilities by legitimate operators;
- specify and purchase recycled materials;
- work with other producers to take responsibility for management of problem wastes; and
- comply with regulations.

The Strategy also elaborates on a waste management hierarchy (see Figure 25–1) which supports the objectives of the *Waste Avoidance and Resource Recovery Act 2001*.



Source: NSW Waste Avoidance and Resource Recovery Strategy 2014–21 (NSW EPA 2014a)

Figure 25–1 Waste management hierarchy

Under the waste management hierarchy, it is preferable to avoid or reduce waste by procuring only necessary materials, and consuming materials with limited production or packaging requirements. Reusable or recyclable materials should be considered where waste cannot be avoided. If waste cannot be reused or recycled, efforts should be made to recover energy to maximise its beneficial use prior to its eventual disposal. Waste with harmful characteristics should be treated prior to disposal to minimise its potential to affect human health and the environment.

25.3.8.3 Waste Classification Guidelines

The NSW *Waste Classification Guidelines* (EPA 2014b) expand on the classifications of waste in Schedule 1 of the NSW *Protection of the Environment Operations Act 1997* and Schedule 1 of the NSW Protection of the Environment Operations (Waste) Regulation 2014. The classification of waste is summarised in Table 25–2.

25.3.9 Other policies, standards and codes

Other policies, standards and codes include the following:

- *Australian Code for the Transport of Dangerous Goods by Road and Rail*;
- Australian standards relating to the storage and handling of hazardous substances:
    - *AS 1940-2004 The storage and handling of flammable and combustible liquids*;
    - *AS/NZS 3816:1998 Management of clinical and related wastes*;
    - *AS 2714-1993 The storage and handling of hazardous chemical materials – Class 5.2 substances (organic peroxides)*;
    - *AS/NZS 3833:2007 The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers*;
    - *AS/NZS 4452:1997 The storage and handling of toxic substances*;
    - *AS/NZS 4681:2000 The storage and handling of Class 9 (miscellaneous) dangerous goods and articles*; and
    - *AS/NZS 5026:2012 The storage and handling of Class 4 dangerous goods*.
- Australian standards and guidelines relating to the labelling and signage of waste:
    - *AS 1216-1995 Class labels for dangerous goods*;
    - *AS 1319-1994 Safety signs for the occupational environment*; and
    - *AS 4123.7-2006 Mobile waste containers – Colours, markings, and designation requirements.*

25.4 Resource consumption

Natural resources and construction materials would be used during construction and operation of the Stage 1 development.

25.4.1 Construction

Table 25–3 provides an overview of the types and estimated quantities of resources required during construction. These quantities were developed as part of preliminary construction planning. All quantities and sources would be confirmed during detailed design.

Construction and operation of the Stage 1 development would also consume resources through utilities such as potable water, electricity, gas and fuel. Daily requirements for construction would include up to 1.36 mega litres of water (including approximately 8,600 litres of potable water), 300 kilovolt amperes of electricity and 55 kilolitres of fuel (see Chapter 6 (Volume 1)).

Table 25–3 Natural resources consumed during construction

Activity	Material	Quantity (daily)	Quantity (total)	Potential sources
Earthworks[a]	Water	1.36 ML	650 ML	Existing surface water, farm dams and sediment basins Potable water supply pipes and temporary storage dams
Asphalt	Aggregate (63%)	822 tonnes	450,000 tonnes	Gunlake Marulan Quarry Holcim Lynwood Quarry Boral Peppertree Quarry
	Sand (8%)	380 tonnes	57,000 tonnes	Calga Quarry Kurnell Quarry
	Lime filler (2%)	27 tonnes	14,000 tonnes	Various
	Crusher dust (22%)	279 tonnes	157,000 tonnes	Various
	Bitumen (5%)	70 tonnes	36,000 tonnes	Camellia
Concrete	Cement (13%)	128 tonnes	60,000 tonnes	Boral Cement Australia
	Sand (38%)	373 tonnes	174,000 tonnes	Calga Quarry Kurnell Quarry
	Aggregate (44%)	434 tonnes	200,000 tonnes	Gunlake Marulan Quarry Holcim Lynwood Quarry Boral Peppertree Quarry
	Fly ash (1%)	42 tonnes	19,300 tonnes	Various
	Admixture (0.1%)	1 tonne	460 tonnes	Various
Machinery operation	Fuel/diesel	55,000 litres	–	Banksmeadow Silverwater

[a] Earthworks would involve the redistribution of approximately 22 million m^3 of fill material, including approximately 2 million m^3 of topsoil, around the airport site

25.4.2 Operation

Operation of the proposed airport would demand significantly lower quantities of resources than construction. The Stage 1 development operating at 10 million annual passenger movements would require an estimated daily average of 1.6 mega litres of potable water; estimated maximum daily demand of 16.7 megavolt amperes of electricity; estimated daily average of 156 gigajoules of gas; and maximum daily demand of 2.7 mega litres of aviation fuel.

Use of resources would be minimised through the implementation of sustainable design principles in the design of the proposed airport, careful procurement planning to encourage the efficient operation of plant and equipment and avoid excess consumption of fuel and other utilities.

25.5 Waste generation

Construction of Stage 1 of the airport would generate approximately 202,500 tonnes of waste in total. About 5,251 tonnes of waste would be generated each year during Stage 1 operation. Waste during construction is estimated in Section 25.5.1 while waste during operation is estimated in Section 25.5.2.

A contamination assessment of the airport site has identified the potential for hazardous materials, including asbestos to be present. The removal of existing structures, and any associated management of asbestos or contamination, would be carried out on behalf of the Department of Infrastructure and Regional Development in accordance with relevant legislation and regulations (see Section 25.6). Further information on land contamination can be found Chapter 17.

25.5.1 Construction

Construction at the airport site would generate a range of waste from surplus or offcut construction materials, clearing and the demolition of existing infrastructure.

The airport site would largely be cleared of existing structures prior to construction. As such, demolition waste is expected to be limited. The main activity generating demolition waste during construction would be clearing vegetation. Removal of The Northern Road and other roads at the airport site would generate waste asphalt. Fill material from demolition would be used in bulk earthworks.

Any residual hazardous waste, including asbestos, identified at the site would be managed in accordance with the relevant legislation.

TransGrid is investigating potential options to relocate the existing above ground high voltage electricity transmission line as an underground cable, which would require a separate environmental approval. Generation of waste through this process would form part of the environmental assessment for that approval. Consultation would also occur with Airservices Australia to ensure the proposed relocation does not affect operations at the proposed airport.

Following these site preparation activities, construction waste would be generated by the construction of roads, runways, taxiways, aprons and buildings. The main waste streams generated by these activities would be general solid wastes including:

- excess and broken bricks;
- leftover concrete;

- plasterboard and fibre cement offcuts;
- carpet, tiling and insulation leftovers and offcuts;
- leftover metal from concrete reinforcements;
- metal sheet offcuts;
- plastic (pipework offcuts and packaging);
- soil (leftover bedding material); and
- timber (formwork and offcuts).

Table 25–4 quantifies the estimated volumes of waste that would be generated by demolition and construction activities for the Stage 1 development. As shown, the total volume of waste generated during construction would be of the order of 202,500 tonnes. In addition to the identified construction waste, about 24,000 litres of domestic waste water and sewage would be generated each day. Waste would be stored at the airport site for collection by suitably licensed waste contractors for offsite management.

Table 25–4 Waste generated during construction of Stage 1 development

Activity	Waste classification	Tonnes (total)
Clearing	Green waste	65,000[a]
Removal of roads	General solid waste	3,000[b]
Removal of transmission line	General solid waste	90
Road construction	General solid waste	78,000[c]
Runway construction	General solid waste	6,100[d]
Taxiway and apron construction	General solid waste	18,400[e]
Building construction	General solid waste	32,000[f]
Total	–	202,500

[a] Assumed biomass for woodland (Ximenes et al. 2012) and grassland (Yunusa et al. 2012); 1 tonne per m^3
[b] Approximately 3 km of road with a width of 10 m to a depth of 0.1 m
[c] Approximately 31 km of roads with a width of 10.5 m
[d] Approximately 341,000 m^2 of runways, taxiways and aprons and associated paved areas to a depth of approximately 0.43 m, an assumed wastage rate of 5 per cent; 0.83 tonnes per m^3
[e] Approximately 1 million m^2 of runways, taxiways and aprons and associated paved areas to a depth of approximately 0.43 m, an assumed wastage rate of 5 per cent; 0.83 tonnes per m^3
[f] Approximately 250,000 m^2 of buildings

25.5.2 Operation

The majority of waste generated during operation would be from staff, retailers and passengers in the terminal complex. An estimated two-thirds of waste could be generated in these areas, while up to a third could be generated from satellite buildings and aircraft stands along with engineering and maintenance.

The main waste streams generated during operation of the airport include the following:

- general solid waste (non-putrescible) – including waste cardboard, glass, green waste, metals, paper, plastics, wood and electronic waste (including toner and printer cartridges);
- general solid waste (putrescible) – including food waste and animal waste; and
- hazardous wastes – including waste batteries, fertilisers, fuels, herbicides, oils, pesticides, paints, solvents, cleaners, clinical and pharmaceutical waste, and waste tyres.

The anticipated quantities of waste generated by the proposed airport operating at 10 million annual passenger movements during operation of the Stage 1 development are outlined in Table 25–5. An estimated 101 tonnes of waste would be generated on average each week or 5,251 tonnes each year.

In addition, approximately 2.7 mega litres of domestic waste water would be generated each day and treated at an onsite facility. Treated water in excess of recycled water demand would be irrigated to land, while an estimated 0.1 mega litres of sludge generated for daily collection by disposal trucks. Irrigation of treated water is discussed in Section 25.6.4.

Table 25–5 Waste generated during operation of Stage 1 development

Waste classification	Tonnes each week	Tonnes each year
General solid waste	79.0	4,108
General solid waste (recyclable)	13.7	710
Hazardous waste	6.7	348
Hazardous waste (liquid waste)[a]	1.6	85
Total	101	5,251

25.6 Waste management

Waste must be managed appropriately to mitigate and manage potential impacts on human health and the environment. If not managed appropriately, waste has the potential to create a range of impacts. The potential impacts of inappropriately managed waste are listed in Table 25–6.

Waste management plans would be developed as part of the environmental management framework for the proposed airport discussed in Chapter 28 (Volume 2b). The plan would collate measures to manage resource consumption and waste generation and would be developed in consultation with the relevant State authorities including the NSW Environment Protection Authority (EPA). The waste management plans are explained further in Section 25.6.1.

Consideration would also be given to the achievement of an Infrastructure Sustainability Council of Australia 'As Built Rating' and 'Operations Rating' to promote sustainability – covering the design, construction and operation of the Stage 1 development.

Table 25–6 Potential impacts of improperly managed waste

Waste type	Potential impacts
Green waste	Fire hazard, spread of weeds, visual impact, harbouring of pest species
General solid waste	Visual impact, localised increases in pH (concrete sediment), leachate (waste metal), attraction of pest species (food waste), odour (food waste)
Hazardous wastes	Land contamination, toxicity to plants and animals, degradation of water resources

25.6.1 Waste management plans

A Waste and Resources Environmental Management Plan (CEMP) and Operational Environmental Management Plan (OEMP) would be prepared prior to Main Construction Works and operation of the Stage 1 development respectively. The plans would collate measures to manage waste and thus avoid, mitigate and manage impacts to human health and the environment. The plans would define processes to track waste quantities, roles and procedures for the handling of waste at the airport site, and processes for the continual improvement of airport waste management.

The plans would collate measures to manage resource consumption and waste generation and would be developed in consultation with the relevant State authorities including the NSW EPA. The measures contained in the waste management plan would reflect the industry standard waste management hierarchy as per the NSW *Waste Avoidance and Resource Recovery Act 2001* (see Section 25.3.1) as well as relevant standards such as those for hazardous substances (see Section 25.3.2).

The plans would also align with standard sustainable procurement policies with consideration of product lifecycles, recyclable content, minimal/returnable packaging and on site recyclability. Agreements with tenants, contractors and suppliers would require compliance with the plans.

Measures to avoid and reduce waste in the waste management plans would include:

- efficient utilisation of resources to reduce consumption;
- optimisation of detailed designs to avoid unnecessary resource consumption;
- implementation of high efficiency water systems to reduce water consumption;
- procurement policies that preference recyclable, minimal and/or returnable packaging; and
- procurement of necessary materials in bulk to minimise packaging waste.

Measures to reuse and recycle waste in the waste management plans would include:

- reuse of green waste and topsoil for site landscaping;
- reuse of waste streams including metals, oils and solvents;
- recycling of waste streams including brickwork, metals, plasterboard, plastics and timber;
- contract terms with suppliers that specify recyclable content and returnable packaging; and
- co-operation in stewardship programs for compatible waste streams including pallets.

Measures to recover and treat waste would include recovery (prior to reuse) of compatible waste streams including metals, oils, solvents, brickwork, metals, plasterboard, plastics and timber. Hazardous wastes or asbestos identified during construction and operation would be managed consistently with the NSW Protection of the Environment Operations (Waste) Regulation 2014.

Residual waste that cannot be avoided, reduced, reused, recycle, recovered or treated would be collected by a licensed contractor for disposal at a licensed facility (see Section 25.6.5).

25.6.2 Waste storage area

A central waste area (or areas) would be established during construction, at which waste (including recyclables) would be stored. Some materials would be stored in stockpiles while others would be stored in bins. Stockpiles and bins would be appropriately labelled, managed and monitored.

During operation, waste generated at the airport site would be collected in bins located throughout the terminal complex and elsewhere. Purpose-designed containment equipment for sharps and other special or hazardous wastes would be situated at relevant facilities. Waste would then be collected and stored at the waste storage area.

The waste storage area would allow for the separation of waste streams based on their management requirements, and would therefore include:

- wheeled bins;
- front lift bins;
- bulk bins and skips;
- bulk material storage bays;
- hazardous waste storage areas;
- bunded bulk storage for fuels and oils;
- balers for cardboard or plastic; and
- battery storage containers.

The waste storage area may also include facilities to recycle, recover or treat waste such as:

- anaerobic digestion for recovery of energy from organic waste;
- a waste to energy facility for recovery of energy from quarantined waste; and
- a composting facility for processing of garden and food waste.

Waste would be routinely collected from the waste storage area and transferred to appropriately licensed waste management facilities described in 25.6.5.

25.6.3 Quarantine areas

The proposed airport would meet the definition of a landing place under the *Biosecurity Act 2015* and would therefore be subject to quarantine regulations. Waste to be quarantined would include food waste and other organic material, or non-washable material such as packaging that comes into contact with quarantine material. Waste generated by the proposed airport operating at 10 million annual passenger movements during the Stage 1 development includes an estimated 580 tonnes of quarantine material per year.

Quarantine waste would be managed in accordance with the requirements of the relevant quarantine authority, presently the Australian Government Department of Agriculture and Water Resources.

For example, under current biosecurity requirements, quarantine waste is stored in a secure quarantine area, within purpose built biosecurity bins. Consistent with quarantine operations at other airports, waste would be placed in cold storage if kept for more than 48 hours. Once cleared by the quarantine authority, quarantine waste would be sterilised on-site by autoclave prior to disposal at an appropriately licensed facility.

25.6.4 Effluent disposal by subsurface irrigation

An estimated 2.5 ML of wastewater per day would be generated during operation of the Stage 1 development. Wastewater would be reticulated to a treatment facility before being recycled or irrigated at the airport site. The wastewater treatment process is expected to utilise membrane biological reactor technology, which produces high quality reclaimed water suitable for a range of beneficial reuses. Recycling opportunities include the use of reclaimed water in maintenance of plant and infrastructure, industrial cooling processes or landscaping. It is expected that irrigation of excess reclaimed water would occur on land previously disturbed by the construction of the Stage 1 development, such as grassed areas between aprons and taxiways and landscaped areas. Irrigation areas would be designed and operated in accordance with the relevant guidelines and management practices discussed in Section 25.6. Further information is provided in Chapter 17.

25.6.5 Waste management facilities

The waste management market in Western Sydney has matured to manage a large volume of waste from various domestic, commercial and industrial sources. About 12 million tonnes of waste is generated in Sydney each year. Major solid waste streams in the region include:

- industrial waste from light industry such as manufacturing, warehousing and transport;
- agricultural waste including pesticides and herbicides;
- commercial waste from businesses, shopping centres and retailers;
- special waste including from hospitals; and
- general domestic waste from residential households.

There are many waste management facilities situated in the Western Sydney region. These facilities would provide a range of options for reuse, recycling, recovery and treatment of waste generated at the airport. Table 25–7 lists the identified waste management facilities.

The quantities and types of waste generated by the proposed airport are expected to be within the capacity of the various waste management facilities in the Western and Greater Sydney regions. Recyclable materials that have been separated at source (cardboard, glass and other containers, food organics) could be collected by contractors and taken to facilities specifically designed to either consolidate them for transportation to reprocessing facilities, or to sort them for transportation to such facilities. Non-recyclable wastes could be taken to transfer stations, or direct to landfills or to alternative waste processing facilities for disposal or treatment respectively.

Table 25–7 Waste management facilities

Facility	Type of waste	Operator	Address	Council
Brandown landfill	Landfill disposal of non-putrescible wastes. Hazardous, putrescible and other waste not accepted.	Brandown Pty Ltd	Lot 9 Elizabeth Dr, Kemps Creek	Penrith
Elizabeth Drive Landfill Facility	Landfill disposal of non-putrescible wastes. Some hazardous waste but no putrescible waste accepted.	Suez Environment	1725 Elizabeth Dr, Kemps Creek	Penrith
Erskine Park Landfill	Landfill disposal of non-putrescible wastes. Does not accept asbestos, putrescible waste, contaminated soils or hazardous waste.	Transpacific Cleanaway	Quarry Rd, Erskine Park	Penrith
Lucas Heights Resource Recovery Park	Landfill disposal of putrescible wastes including some hazardous waste	Suez Environment	New Illawarra Road, Lucas Heights	Sutherland
Eastern Creek Resource Recovery Park	Landfill disposal of putrescible wastes including some hazardous waste	Suez Environment	Wallgrove Road, Eastern Creek	Blacktown
Clyde Transfer Terminal	Transfer station for disposal of putrescible wastes. No other waste accepted.	Veolia Environmental Services (Australia) Pty Ltd	322 Parramatta Road, Clyde	Cumberland
Wetherill Park Resource Recovery Facility	Transfer station for disposal of putrescible wastes including some hazardous waste	Suez Environment	20 Davis Rd, Wetherill Park	Fairfield
Seven Hills Waste & Recycling Centre	Transfer station for disposal of putrescible wastes including some hazardous waste	Suez Environment	29 Powers Road, Seven Hills	Blacktown
Visy Blacktown MRF	Materials recovery facility for recyclables. No other waste accepted.	Visy Recycling	9 Bessemer St, Blacktown	Blacktown
Visy Smithfield MRF	Materials recovery facility for recyclables. No other waste accepted.	Visy Recycling	158-160 McCredie St, Smithfield	Cumberland
Camellia Resource Recovery and Treatment Facility	Food organics processing facility. No other waste accepted.	Suez Environment	Grand Ave, Camellia	Parramatta
ANL Badgerys Creek	Garden organics processing facility. No other waste accepted.	Australian Native Landscapes	210 Martin Rd, Badgerys Creek	Liverpool
Genesis Recycling Facility	Non putrescible waste processing facility. Does not accept food waste, liquid, medical and chemical wastes	Dial-A-Dump (Ec) Pty Ltd	Honeycomb Drive, Eastern Creek	Blacktown
Suez Advanced Waste Treatment Facility	Mixed waste processing facility. Accepts mixed waste containing organics and separated food and organic waste.	Suez Environment	1725 Elizabeth Drive, Kemps Creek	Penrith
UR-3R	Mixed waste processing facility. Accepts mixed waste containing organics and separated food and organic waste.	Global Renewables Limited	Wallgrove Rd, Eastern Creek	Blacktown

25.7 Mitigation and management measures

An overview of the framework for managing waste and resources during construction and operation are listed in Table 25–8.

A Waste and Resources Construction Environmental Management Plan (CEMP) will be approved prior to the commencement of Main Construction Works for the proposed airport. The Waste and Resources CEMP will collate the mitigation and management measures itemised in Table 25–8.

A Waste and Resources Operation Environmental Management Plan (OEMP) will be developed prior to commencement of Stage 1 operations and would update the Waste and Resources CEMP prepared as part of the CEMF for applicability to the operational phase of the proposed airport.

Table 25–8 Mitigation and management measures

Issue	Measure	Timing
Waste avoidance	The following measures will be implemented to avoid and reduce waste: • efficient utilisation of resources to reduce consumption; • optimisation of detailed designs to avoid unnecessary resource consumption; • implementation of high efficiency water systems to reduce water consumption; • procurement policies that preference recyclable, minimal and/or returnable packaging; and • procurement of materials in bulk, where practicable, to minimise packaging waste.	Construction Operation
Reuse and recycling	The following measures will be implemented to reuse and recycle waste: • reuse of green waste and topsoil for site landscaping; • reuse of waste streams including metals, oils and solvents; • recycling of waste streams including brickwork, metals, plasterboard, plastics and timber; • contract terms with suppliers that specify recyclable content and returnable packaging; and • co-operation in stewardship programmes for compatible waste streams including pallets.	Construction Operation
Waste recovery	Measures to recover and treat waste will include recovery (prior to reuse) of compatible waste including metals, oils, solvents, brickwork, metals, plasterboard, plastics and timber.	Construction Operation
Hazardous Wastes	Hazardous wastes or asbestos identified during construction and operation will be managed consistently with the Protection of the Environment Operations (Waste) Regulation 2014 (NSW).	Construction Operation
Waste Storage & Disposal	A central waste area (or areas) would be established during construction, at which waste (including recyclables) would be stored. Some materials would be stored in stockpiles while others would be stored in bins. Stockpiles and bins would be appropriately labelled, managed and monitored. Residual waste that cannot be avoided, reduced, reused, recycle, recovered or treated will be collected by a licensed contractor for disposal at a licensed facility.	Construction Operation
Illegal dumping	An illegal dumping prevention strategy will be developed as part of the Waste and Resources CEMP. The strategy will outlined measures to be undertaken to minimise the risk of illegal dumping on the airport site and will be developed in consultation with the NSW Environment Protection Authority and relevant local councils.	Construction Operation
Resource use	The Sustainability Plan and the associated sustainability measures will help to ensure that resources are used efficiently and waste is minimised as detailed in Chapter 28 (Volume 2b).	Construction

25.8 Conclusion

The total volume of waste generated during construction of the Stage 1 development would be in the order of 202,500 tonnes, while an estimated 5,251 tonnes of waste would be generated each year during Stage 1 operations.

A combination of on-site and off-site management measures would provide a range of options to reuse, recycle, recover and treat waste generated at the proposed airport. A waste management plan would be prepared prior to construction and operation of the proposed airport, which would collate measures to manage waste and thus avoid and mitigate impacts to human health and the environment.

The quantities and types of waste generated by the airport would be readily manageable through the implementation of the waste management plan, and within the capacity of the various waste management facilities in the Western and Greater Sydney regions.

26 Greater Blue Mountains World Heritage Area

The Greater Blue Mountains World Heritage Area (GBMWHA) covers 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest. The site constitutes one of the largest and most intact tracts of protected bushland in Australia and is noted for its representation of the evolutionary adaptation and diversification of the eucalypts in post-Gondwana isolation on the Australian continent. The Greater Blue Mountains Area was inscribed on the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage List in 2000 for its outstanding universal value, including representative examples of the evolution of Eucalyptus species (World Heritage Listing Criterion ix) and diversity of habitats and plant communities (Criterion x). In addition to the features recognised by the World Heritage Committee as having World Heritage value, the GBMWHA has a number of other important values which complement and interact with these values including: recreation, tourism, wilderness, scenic, cultural heritage, scientific and aesthetic values. The Greater Blue Mountains Area was added to the National Heritage List in 2007 in recognition of its national heritage significance.

Potential impacts on the World Heritage, National Heritage and other values of the Greater Blue Mountains Area from the construction and operation of the proposed airport were assessed against the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013a). The GBMWHA is approximately seven kilometres from the proposed airport at its closest point. There would be no direct impacts on the values of the GBMWHA associated with the construction of the airport. Indirect noise, air quality and visual amenity impacts on the GBMWHA from aircraft overflights have been assessed in detail.

Based on the preliminary airspace design, aircraft passing over locations within the GBMWHA are generally expected to be at an altitude greater than 5,600 feet above sea level and most would be more than 10,000 feet above sea level. Indicative flight paths at altitudes of less than 5,000 feet above sea level are limited to the eastern boundary of the Blue Mountains National Park, which is predicted to experience 50 to 100 flights per day in around 2030.

A number of tourism and recreation areas within the GBMWHA were selected as representative sites to conduct the impact assessment. No flights are expected to occur below approximately 6,500 feet above local ground level in the vicinity of these identified sensitive areas. At these altitudes, aircraft are likely to be difficult to discern from ground level and are not considered to be visually obtrusive.

Generally across the GBMWHA, aircraft maximum noise levels are not expected to exceed 55 dBA. Noise modelling has taken into account the topography of the area and the height of aircraft above ground level. Echo Point at Katoomba would not experience maximum noise levels above 50 dBA, and the majority of other selected sensitive areas are predicted to only be affected by aircraft noise levels above 55 dBA during the infrequent operation of the Boeing 747.

Fuel dumping is a very rare event and has been assessed as unlikely to have an impact on the GBMWHA. In 2014 there were only 10 instances of civilian aircraft jettisoning fuel in Australia, representing approximately 0.001 per cent of all aircraft movements in Australia.

Mitigation and management of potential noise impacts would be achieved through the implementation of flight planning and airspace design. The measures would include requirements regarding flight paths, flight altitude and operational parameters for different aircraft. The potential noise and amenity impacts from aircraft flying over wilderness areas of the GBMWHA, and Aboriginal sites promoted for public visitation, would be considered in the future development of formal flight paths for the proposed airport, subject to requirements for safe and efficient aircraft operations. This assessment concludes that the proposed airport would not have a significant impact on the GBMWHA or its recognised World Heritage values.

26.1 Introduction

This chapter considers the potential impacts of the proposed airport on the World Heritage and National Heritage values and other values of the Greater Blue Mountains World Heritage Area (GBMWHA) and National Heritage place. The chapter draws upon detailed environmental and social assessments undertaken for the proposed airport which are included in Volume 4 as well as the relevant assessment chapters in Volume 2a and 2b.

The assessment has been carried out in accordance with the *Guidelines for the Content of a Draft Environmental Impact Statement – Western Sydney Airport* (EIS guidelines) issued by the Commonwealth Department of the Environment.

In this chapter, the term Greater Blue Mountains Area is used to refer to the area inscribed on the World Heritage List in 2000 for its outstanding universal value. The term Greater Blue Mountains World Heritage Area, or GBMWHA, is generally used elsewhere.

26.2 Methodology

The assessment of impact on the GBMWHA involved:

- identification of the property's World Heritage and National Heritage values, as outlined in the Statement of Outstanding Universal Value;
- identification of other values that complement and interact with the property's World Heritage and National Heritage values;
- collation of baseline environmental information including baseline noise levels and aircraft flight paths associated with Sydney Airport;
- assessment of impacts on World Heritage and Natural Heritage values and integrity of the World Heritage property based on the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance (DoE 2013a) and the property's Statement of Outstanding Universal Value;
- assessment of impacts on other values of the Greater Blue Mountains Area; and
- a statement of significance of the identified impacts.

26.3 Existing environment

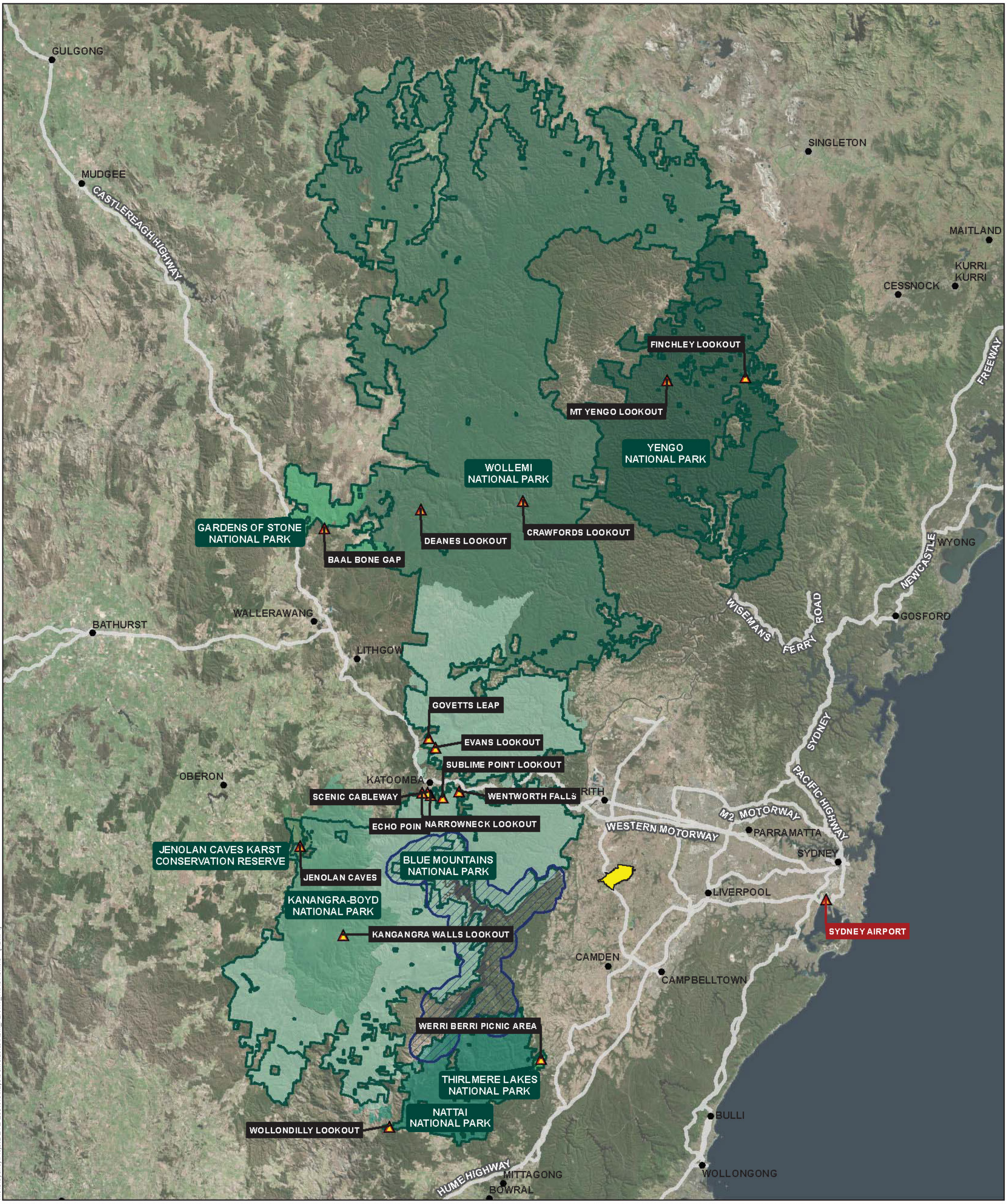
26.3.1 Greater Blue Mountains World Heritage Area

At its closest point, the GBMWHA is approximately seven kilometres from the airport site. The GBMWHA covers 1.03 million hectares of sandstone plateaus, escarpments and gorges dominated by temperate eucalypt forest (UNESCO 2015). The GBMWHA constitutes one of the largest and most intact tracts of protected bushland in Australia and is noted for its representation of the evolutionary adaptation and diversification of the eucalypts in post-Gondwana isolation on the Australian continent (UNESCO 2015). The Greater Blue Mountains Area was inscribed on the World Heritage List in 2000. This listing formally recognises that the area has outstanding universal value under the World Heritage Convention.

The GBMWHA comprises eight protected areas (see Figure 26–1):

- Blue Mountains National Park;
- Wollemi National Park;
- Yengo National Park;
- Nattai National Park;
- Kanangra-Boyd National Park;
- Gardens of Stone National Park;
- Thirlmere Lakes National Park; and
- Jenolan Caves Karst Conservation Reserve.

The GBMWHA provides a significant representation of Australia's biodiversity with 10 per cent of the country's vascular flora and significant numbers of rare or threatened species (UNESCO 2015). In addition to its outstanding eucalypts, the area also contains ancient, relict species of global significance including the Wollemi pine (*Wollemia nobilis*), one of the world's rarest species that was thought to have been extinct for millions of years (DoE 2015d). The few surviving trees are known only from three small populations located in remote, inaccessible gorges within the Greater Blue Mountains (DoE 2015d).



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

- Airport site
- Greater Blue Mountains World Heritage Area
- Drinking Water Catchment – No Entry Area

0 5 10 20
Kilometres

Figure 26-1 - Greater Blue Mountains World Heritage Area

26.3.2 Outstanding universal value

26.3.2.1 World Heritage values

The Greater Blue Mountains Area was inscribed on the World Heritage List because it satisfies two of the criteria for natural values of outstanding universal value. While the criteria for outstanding universal value have changed over time, the underlying concepts have remained constant (UNESCO 2015). The two criteria for which the property is listed are criterion ix and criterion x.

Criterion ix

Criterion ix is defined in the *Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO 2015) as follows:

> *to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.*

The GBMWHA includes outstanding and representative examples of the evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation in a relatively small area of the Australian continent (UNESCO 2015). It is a centre of diversification for Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation (UNESCO 2015). The GBMWHA includes primitive species of outstanding significance to the evolution of the planet's plant life such as the Wollemi pine and the Blue Mountains pine (*Pherosphaera fitzgeraldii*). These are examples of ancient, relict species with Gondwanan affinities that have survived past climatic changes and demonstrate the highly unusual juxtaposition of Gondwanan taxa with the diverse scleromorphic flora (UNESCO 2015).

Criterion x

Criterion x is defined in the *Operational Guidelines for the Implementation of the World Heritage Convention* (UNESCO 2015) as follows:

> *to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.*

The GBMWHA includes an outstanding diversity of habitats and plant communities and a significant proportion of the Australian continent's biodiversity, especially its scleromorphic flora, (UNESCO 2015). As described above, the GBMWHA includes primitive and relict species with Gondwanan affinities and supports many plants of conservation significance including 114 endemic species and 177 threatened species (UNESCO 2015). Habitat diversity has also resulted in an outstanding representation of Australian fauna with more than 400 vertebrate taxa recorded (of which 40 are threatened) including 52 native mammals, 265 bird species (one third of the Australian total), 63 reptile species and more than 30 frog species (UNESCO 2015).

26.3.2.2 Integrity

In addition to meeting at least one of the criteria for outstanding universal value, a World Heritage property listed for natural values also needs to meet conditions of integrity. Integrity is a measure of the 'wholeness and intactness' of the natural heritage and its attributes (UNESCO 2015). Examining the condition of integrity requires assessing the extent to which the property:

- includes all elements necessary to express its outstanding universal value;
- is of adequate size to ensure the complete representation of the features and processes that convey the property's significance; and
- suffers from adverse effects of development and/or neglect (UNESCO 2015).

The Statement of Outstanding Universal Value for the GBMWHA states that the eight protected areas that comprise the listed property are of sufficient size to protect the biota and ecosystem processes, although the boundary has several anomalies that reduce the effectiveness of its one million hectare size. These anomalies are explained by historical patterns of clearing, private land ownership and topography such as escarpments that act as barriers to potential adverse impacts from adjoining land (UNESCO 2015).

A number of historical land uses have affected the integrity of the area in the past including Warragamba Dam, cattle grazing, logging, land clearing, coal mining, oil shale mining, military activities and fire regimes (IUCN 1999). However, active management has reduced these impacts and the landscape is in recovery (IUCN 1999).

The World Heritage property is largely protected by adjoining public lands of State forests and State conservation areas. Additional regulatory mechanisms serve to further protect the integrity of the GBMWHA. These include the statutory wilderness designation of over 65 per cent of the property, part of the closed and protected catchment for Lake Burragorang (Warragamba Dam) and additions to the conservation reserves that comprise the area (UNESCO 2015).

The plant communities and habitats within the GBMWHA occur almost entirely as an extensive, mostly undisturbed matrix almost entirely free of structures, earthworks and other human intervention (UNESCO 2015). Because of its size and connectivity to other protected areas, the area will continue to provide opportunities for adaptation and shifts in range for flora and fauna species within it. The area's integrity depends upon the complexity of its geological structure, geomorphology and water systems, which have created the conditions for the evolution of its outstanding biodiversity (UNESCO 2015).

Aboriginal people from six language groups continue to have a custodial relationship with the area through ongoing practices that reflect both traditional and contemporary presence (UNESCO 2015). Sites of Aboriginal occupation, including important rock art provide physical evidence of the longevity of the strong Aboriginal cultural connections with the land. The conservation of these associations contributes to the integrity of the GBMWHA (UNESCO 2015).

26.3.2.3 *Protection and management*

All properties inscribed on the World Heritage List must have adequate protection and management mechanisms in place, the nature of which can vary so long as they are effective (DSEWPC 2012). In most cases, both the Australian and State or Territory governments are responsible for managing and protecting Australia's World Heritage properties, with State and Territory agencies taking responsibility for on-ground management where relevant.

World Heritage properties are protected under the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act) and are considered 'matters of national environmental significance'. The EPBC Act provides for the development and implementation of management plans for world heritage properties, which describe aspects of the property and how it will be managed.

The New South Wales Office of Environment and Heritage manages the GBMWHA. The GBMWHA is protected and managed primarily under the following State legislation:

- *National Parks and Wildlife Act 1974 (NSW)*, and
- *Wilderness Act 1987 (NSW).*

Other relevant legislation includes the New South Wales *Threatened Species Conservation Act 1995*, the *Environmental Planning and Assessment Act 1979,* the *Sydney Water Catchment Management Act 1998* and the *Heritage Act 1977*.

The Greater Blue Mountains World Heritage Area Strategic Plan (DECC 2009c) provides a framework for the property's integrated management, protection, interpretation and monitoring. The key management objectives set out in the Strategic Plan provide the philosophical basis for the management of the area and guidance for operational strategies, in accordance with requirements of the World Heritage Convention and its Operational Guidelines (UNESCO 2015). These objectives are also consistent with the Australian World Heritage management principles, contained in regulations under the *EPBC Act* (UNESCO 2015).

The Strategic Plan (DECC 2009c) identifies the following threats to the integrity of the area:

- uncontrolled and inappropriate use of fire;
- inappropriate recreation and tourism activities, including development of tourism infrastructure;
- invasion by pest species including weeds and feral animals;
- loss of biodiversity and geodiversity;
- impacts of human enhanced climate change; and
- lack of understanding of heritage values.

26.3.3 National Heritage place

The Greater Blue Mountains Area was one of 15 World Heritage properties included in the National Heritage List in 2007. The National Heritage values identified for the listing are the same as the values recognised for the World Heritage area. As such the following assessment against the World Heritage values is taken to address both the World Heritage and National Heritage values of the Greater Blue Mountains Area.

26.3.4 Other values of the Greater Blue Mountains Area

In addition to the attributes recognised by the World Heritage Committee as having World Heritage value, the Greater Blue Mountains Area has a number of other important values which complement and interact with its World Heritage values (DECC 2009c). Protection of these values is considered to be integral in managing individual protected areas and the GBMWHA as a whole (DECC 2009c). Table 26–1 provides a summary of the values, identified by the NPWS in the GBMWHA Strategic Plan, that contribute to the overall values of the area.

Table 26–1 Other important values of the GBMWHA

Value	Description
Geodiversity and biodiversity	In addition to the outstanding biodiversity of the GBMWHA, the area also has a diversity of landscapes and geological features including the most extensive sandstone canyon system in eastern Australia. The site also contains karst landscapes with several cave systems including Jenolan Caves, the world's oldest open cave system. Other features include prominent basalt-capped peaks, quaternary alluvial deposits and perched perennial freshwater lakes.
Water catchment	The GBMWHA protects a large number of pristine and relatively undisturbed catchment areas, some of which make a substantial contribution to maintaining high water quality in a series of water storage reservoirs supplying Sydney and adjacent rural areas.
Indigenous heritage values	Although no comprehensive surveys have been undertaken, known Aboriginal sites within the area are widespread, diverse and include landscape features of spiritual significance and rock art sites. Given the wilderness nature of the area and the limited survey to date, there is high potential for the discovery of further significant Aboriginal sites.
Historic heritage values	The GBMWHA includes numerous places of historic significance some of which date back to the early years of European settlement and exploration in Australia. Recorded sites demonstrating post-1788 human use are associated with rural settlement, pastoral use, timber getting, mining, transport routes, tourism and recreation. The sites include small graziers' huts, logging roads, stock routes and the ruins of mines.
Recreation and tourism	The GBMWHA has high recreational values due to the area's intrinsic beauty, natural features and accessibility from major population centres. Recreational opportunities are wide ranging and include canyoning, bushwalking, rock climbing, nature observation, caving, picnicking, camping and photography. The regional economy surrounding the GBMWHA is increasingly supported by tourism with the area contributing directly and indirectly to the employment, income and output of the region.
Wilderness	The high wilderness quality of much of the GBMWHA constitutes a vital and highly significant contribution to its World Heritage values and has ensured the integrity of its ecosystems and the retention and protection of its heritage value. The wild and rugged landscapes, diverse flora and fauna, and opportunities for solitude, self-reliant recreation and reflection are attributes that promote inspiration, serenity and rejuvenation of the human mind and spirit. Such experiences are valued by individuals and society.
Social and economic	The regional economy surrounding the GBMWHA is increasingly supported by tourism. The reserves within the GBMWHA have considerable social and economic value and contribute directly and indirectly to the employment, income and output of the regional economy. While visitation data for specific locations would be highly variable, given the broad range of uses and vast area of the property, it is expected that overall visitation to the GBMWHA is increasing—reflecting the region's importance as a tourist destination.
Research and education	The GBMWHA is ideal for research and educational visits due to the variety of ecological communities, landscape and associated cultural sites. The high scientific value reflects what has been discovered and what remains to be discovered as large gaps in knowledge remain in regard to Aboriginal use and occupation of the area and the ecological needs of threatened species and communities.
Scenic and aesthetic	Dramatic scenery within the GBMWHA includes striking vertical cliffs, waterfalls, ridges, escarpments, uninterrupted views of forested wilderness, extensive caves, narrow sandstone canyons and pagoda rock formations.

Value	Description
Bequest, inspiration, spirituality and existence	Combining a number of the above values, the GBMWHA offers attributes that promote inspiration, serenity and rejuvenation of the human mind and spirit. These feelings are valued by individuals and society and inspire a number of creative endeavours including philosophy, painting, literature, music and photography. The contributions have, and continue to, promote a sense of place for Australians who desire such places to be protected.

Source: NSW NPWS 2009

26.3.5 Wilderness areas

Wilderness areas comprise one of the key features of the GBMWHA. These areas are located primarily in the northern section of the property. The National Wilderness Inventory (AHC 2003) identifies 83.5 per cent of the GBMWHA as wilderness area.

The identified wilderness areas exclude the northern portions of both the Blue Mountains National Park and Kanangra-Boyd National Park associated with the Katoomba region.

26.3.6 Land use and cumulative impacts

Historical uses have had a cumulative impact on the Greater Blue Mountains Area. These include cattle grazing, logging, coal and oil shale mining, military activities, and clearing for farming and roads. Construction of Warragamba Dam created Lake Burragorang, which supplies approximately 70 per cent of Sydney's water requirements and covers an area of about 75 km^2. The reservoir does not form part of the World Heritage property. While there remains evidence of these past activities, associated impacts are being reduced by active management and landscape recovery.

The GBMWHA is split in two by a central corridor of urban development, including a major highway and rail infrastructure that connects the region and areas further west to Greater Sydney. The majority of the city's 80,000-strong population resides along the spine of development either side of the Great Western Highway. Blue Mountains City Council predicts that the city's population will grow to 82,869 by 2036, an increase of over 5 per cent (Blue Mountains City Council 2016).

The GBMWHA Strategic Plan states that the property's mostly rugged terrain and close proximity to urban development adds to the difficulty of implementing on-ground measures to control strategic threats to its World Heritage values. These include measures such as fire management, pest animal and weed control, storm water control and the regulation of access.

A large number of freehold properties adjoin the GBMWHA. Land uses adjacent to or near the World Heritage property include tourism facilities, grazing, forestry, agriculture, manufacturing and mining. The GBMWHA Strategic Plan identifies siltation of streams, pesticide drift from aerial spraying, fire, straying cattle and companion animals and the spread of exotic plants and animals as potential threats posed by these land uses.

State agencies and local government implement management measures such as monitoring, restoration, pollution reduction and pest control strategies to reduce the impact of surrounding land uses on the GBMWHA.

26.3.7 Key sensitive tourist and recreation areas

In 2015, the Blue Mountains received 843,000 domestic overnight visitors, 102,000 international overnight visitors, and nearly 2.6 million domestic daytrip visitors (Destination NSW 2016).

Key sensitive tourism and recreation areas were selected for this assessment based on the identification of important attractions and associated viewing locations within the GBMWHA (Table 26–2). The assessment considered the remoteness, accessibility and accommodation options as an indication of the type of tourism and recreational experiences available at each location.

The Great Western Highway provides the primary access to a majority of lookouts and other destinations included in the table. These areas and attractions are also potentially accessed by other transport infrastructure including rail and Katoomba airfield and numerous smaller sealed and unsealed roads.

Table 26–2 Key sensitive tourist and recreational areas, viewing locations and accessibility

National park	Key attractions	Key viewing locations	Location	Accessibility	Accommodation
Blue Mountains National Park	Jamison Valley including the Thee Sisters	Echo Point Lookout, Sublime Point Lookout, Perrys Lookdown, Evans Lookout, Mt Hay, Lockleys Pylon, Pulpit Rock Lookout, Gladstone Lookout, Moya Point Lookout, Sunset Rock Lookout, Cleary Memorial Lookout, Honeymoon Lookout, Queen Elizabeth and Drum Lookouts, Scenic Cableway and Scenic Railway, Narrowneck Lookout, Castle Head Lookout, Cahills Lookout, Peckmans Plateau Lookout, Eaglehawk Lookout, Hildas Lookout, Norths Lookout, McMahons Lookout, Peckmans Plateau Lookout, Norths Lookout, Nepean Narrows Lookout, Nepean Gorge Lookout, Nepean Lookout, Freds Lookout, Erskine Lookout, Mt Portal Lookout, Rileys Lookout, The Rock Lookout Greenfields Lookout, Melville Lookout, Wynnes Rocks Lookout, Point Pilcher Lookout, Du Faurs Lookout, Mt Banks Lookout, and Walls Lookout.	Katoomba	Sealed road	Hotels, motels, guesthouses, bed and breakfasts, cabins, cottages, caravan parks.
	Wentworth Falls waterfall	Wentworth Falls lookout	Wentworth Falls	Sealed road	Retreat, guesthouses, bed and breakfasts, cabins, cottages.
	Grose Valley	Evans lookout Govetts Leap lookout	Blackheath	Sealed road	Hotel, motel, bed and breakfasts, cabins, cottages, caravan park
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Views from walking tracks such as National Pass, Federal Pass, Mt Solitary, and Narrowneck Firetrail	Southern sections of the park	Sealed roads and unsealed roads, vehicular tracks, walking tracks	Campgrounds within park
Wollemi National Park	Wilderness Bushwalking, rock climbing, canoeing, picnicking	Deanes lookout Crawfords lookout	Non-specific	Unsealed roads, vehicular tracks, walking tracks	Campgrounds within park
Yengo National Park	Wilderness Bushwalking, horse riding, trail bike riding, picnicking	Finchley lookout Mt Yengo lookout	50 km south-west of Cessnock	Unsealed roads, walking tracks	Campgrounds within park – tent, camper trailer, vehicle

National park	Key attractions	Key viewing locations	Location	Accessibility	Accommodation
Nattai National Park	Wilderness Bushwalking, remote camping	Wollondilly lookout Starlights trail Couridjah Corridor walk	30 km north of Mittagong	Vehicular tracks, walking tracks	No facilities within park. Remote backpack camping only at Emitts Flat.
Kanangra-Boyd National Park	Kanangra Walls Mount Cloudmaker	Kanangra-Boyd lookout, Kowmung Lookout, Rigby Rock Lookout, Moorilla Lookout, Mt Dingo Lookout, and Kanangra Walls Lookouts	50 km south-east of Oberon	Unsealed road from park entrance	Boyd River Campground – tent, camper trailer, caravan, vehicle
	Wilderness, bushwalking, rock-climbing, trail bike riding, picnicking and remote camping	Non-specific	Southern sections of the park	Sealed roads and unsealed roads, vehicular tracks, walking tracks	Campgrounds within park
Gardens of Stone National Park	Baal Bone Gap, four-wheel driving	Baal Bone Gap picnic area	35 km north of Lithgow	Unsealed road requiring 4WD vehicle	No facilities within park. Remote backpack camping only.
Thirlmere Lakes National Park	Birdwatching, picnicking, walking and swimming	Werri Berri picnic area	Couridjah	Sealed road	No facilities within park.
Jenolan Caves Karst Conservation Reserve	Jenolan Caves	Not applicable	Jenolan	Sealed road	Cabins, cottages and hostels

The upper Blue Mountains, with its extensive system of scenic lookouts and walking tracks, is one of the major nature-based tourism destinations in Australia (NPWS 2001). Echo Point at Katoomba is the main lookout over the Jamison Valley, including the Three Sisters rock formation, and attracts around two million visitors each year (NPWS 2001; NSW Government 2015). Other key attractions include Wentworth Falls and the Grose Valley viewed from Govetts Leap lookout and Evans lookout at Blackheath.

The Wollemi wilderness area is primarily accessed at Newnes Plateau Cliffs on the western boundary and via Putty Road on the eastern side of Wollemi National Park. Most campgrounds and park facilities are located within proximity to the park boundaries. While only Dunns Swamp-Ganguddy and Wheeny campgrounds are accessible to caravans, Coorongooba and Newnes campgrounds are open to tent, camper trailer and vehicle camping. Colo Meroo campground is only accessible by foot and is suitable for tent and remote/backpack camping. Deanes lookout (west) and Crawfords lookout (east) are accessible by foot and provide views of the Wollemi wilderness area.

Yengo National Park and wilderness area is accessed via unsealed roads, vehicle tracks and walking tracks. Campgrounds are accessible to tent, camper trailer and vehicle camping. Bushwalking is popular in the park and other popular forms of recreation include horse riding, trail bike riding, mountain bike riding and bird watching. Mt Yengo lookout (west) and Finchley lookout (east) provide views over the Yengo wilderness area.

Nattai National Park offers opportunities for bushwalking and backpack camping in a relatively untouched wilderness environment. Wollondilly lookout near the south-east boundary provides views of eucalypt forests, sandstone cliffs and mountain ranges. Other areas of the park and wilderness areas are accessible via walking tracks.

The Kanangra Walls and wilderness area is the main focus of activity in Kanangra-Boyd National Park. Baal Bone Gap picnic area within the Gardens of Stone National Park is accessible to four wheel drive vehicles. The site includes examples of rock pagoda formations, sheer cliffs and scenic views over Baal Bone Gap. No significant viewpoints were identified within the Thirlmere Lakes National Park or Jenolan Caves Karst Conservation Reserve.

The following areas within the GBMWHA were identified as representative sensitive tourist and recreation areas in relation to potential impacts of the proposed airport development on noise, air quality and visual amenity (see Figure 26–1):

- Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout;
- Grose Valley east of Evans lookout and Govetts Leap lookout;
- the wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park;
- the wilderness area between Mt Yengo lookout and Finchley lookout within Yengo National Park;
- Nattai wilderness area;
- Kanangra Walls and wilderness area east of Kanangra-Boyd lookout; and
- Baal Bone Gap within Gardens of Stone National Park.

26.4 Assessment of impacts during construction

Construction of the proposed airport would involve a range of activities at the airport site. Given the seven kilometre distance between the airport site and the GBMWHA, there will not be any direct or indirect impacts on the GBMWHA arising from airport construction.

A portion of the GBMWHA fronts the Nepean River downstream of its confluence with Duncans Creek. The Duncans Creek catchment only covers approximately 11 per cent of the airport site and the proposed adoption of best-practice water quality control measures during construction of the proposed airport means there is very low potential to impact water quality in the creek and the Nepean River. The remainder of the site discharges to the South Creek catchment which joins the Nepean River downstream of the GBMWHA.

26.5 Assessment of impacts during operations

26.5.1 Direct operational impacts

There would be no direct impacts on the GBMWHA or its values from the operation of the proposed airport.

26.5.2 Indirect operational impacts

Operation of the proposed airport may have several indirect impacts on the GBMWHA, primarily from the overflight of aircraft. These potential impacts include:

- noise;
- air quality; and
- visual amenity.

26.5.2.1 Noise

The NSW *Industrial Noise Policy* (INP) (EPA 2000) provides guidance on acceptable noise exposure levels in rural areas incorporating wilderness areas. However, unlike aircraft noise levels, which represent maximum noise values associated with a single noise event, the INP criteria are based on equivalent continuous noise levels produced by industrial noise sources. Accordingly, the INP criteria are not relevant to this assessment.

No other specific aircraft noise criteria for conservation and wilderness areas have been developed. In Australia, assessments of new airport developments use the 70 dBA L_{Amax} and 60 dBA L_{Amax} noise exposure levels as impact thresholds for day and night time operations respectively. The overflight noise assessment for this EIS shows that the GBMWHA is largely outside the area predicted to experience aircraft noise at or above these threshold values (see Chapter 10).

In recognition of the natural amenity values of the GBMWHA, the EIS identifies areas of the World Heritage property that are predicted to experience noise levels above 50 dBA L_{Amax} and 55 dBA L_{Amax} for single event flights. Noise levels between 50 dBA and 55 dBA are equivalent to quiet conversational noise.

The noise modelling methodology is described in detail in Appendix E (Volume 4). Noise modelling of the GBMWHA incorporates the topography of the area and as such, the height of aircraft above ground level as they overpass the GBMWHA. This captures the variance in noise across peaks and valleys within the GBMWHA. Noise levels from specific aircraft have been modelled as detailed in Appendix E1 (Volume 4). The highest predicted noise levels are associated with a departing Boeing 747 aircraft, an aircraft type that is generally being phased out by airlines, while the more common and likely future noise levels are represented by a departing Airbus 320.

Figure 26–2 to Figure 26–5 show the indicative noise contours for a single event departure and arrival (for both 05 and 23 directions) for the Boeing 747 and Airbus A320 respectively on all indicative arrival and departure flight paths. The Boeing 747 is the maximum noise event for all aircraft arriving and departing the proposed airport. However, it is important to note that a Boeing 747 flying to the south would only be expected to depart on average once every two days during operation of the Stage 1 development. As shown in Figure 26–2 and Figure 26–3, noise levels above 50 dBA L_{Amax} and 55 dBA L_{Amax} for the Boeing 747 are experienced in some areas of the GBMWHA.

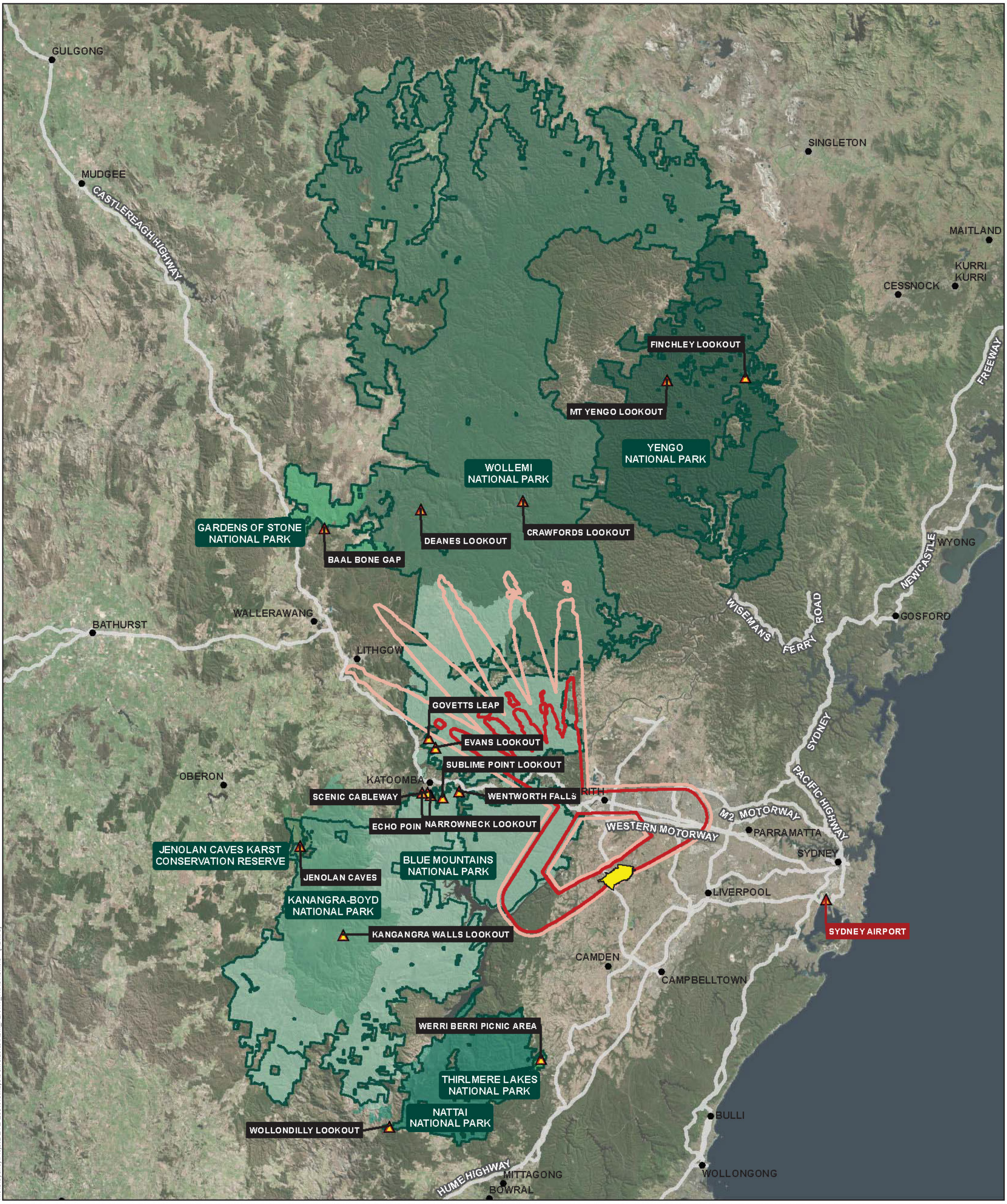
Figure 26–4 and Figure 26–5 indicate that noise exposure levels above 50 dBA L_{Amax} from Airbus A320 aircraft arrivals would be experienced only in the lower Blue Mountains and in southern parts of the GBMWHA during departures. Generally, across the GBMWHA, areas exposed to noise levels above 55 dBA from Airbus A320 operations are limited. As shown in Table 26–3, three of the areas identified for this assessment do not experience noise levels at or above 50 dBA L_{Amax}, and the majority of areas would only be affected by noise above this level during the infrequent operation of the Boeing 747.

No areas of the GBMWHA would experience noise levels above the general assessment level of 70 dBA L_{Amax} on a regular basis during operation of the Stage 1 development for any aircraft type considered (see Chapter 10).

Noise levels over 50 dBA L_{Amax} may be experienced occasionally by users of walking trails within the eastern area of the Nattai wilderness area. However, impacts on recreational users would be moderated by vegetation cover and the natural topography, as most walking trails are located at lower elevations within valley areas and along creeks. Similarly, areas affected by increased noise levels within the Wollemi National Park wilderness area are accessible only on foot and impacts would be reduced by the nature of the steep terrain and vegetation cover.

Table 26–3 Estimated maximum noise levels at key sensitive areas

Area	Single event B747		Single event A320	
	50 dBA	55 dBA	50 dBA	55 dBA
Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout	< 50 dBA	< 55 dBA	< 50 dBA	< 55 dBA
Grose Valley east of Evans lookout and Govetts Leap lookout	Potential > 50 dBA at lookouts	< 55 dBA	< 50 dBA	< 55 dBA
Wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park	Potential > 50 dBA on north-eastern alignment	< 55 dBA	< 50 dBA	< 55 dBA
Wilderness area between Mt Yengo lookout and Finchley lookout within Yengo National Park	< 50 dBA	< 55 dBA	< 50 dBA	< 55 dBA
Nattai wilderness area	Potential > 50 dBA on eastern wilderness area	Potential > 55 dBA on eastern wilderness area	< 50 dBA	Potential > 55 dBA on eastern wilderness area
Kanangra Walls and wilderness area east of Kanangra-Boyd lookout	Potential > 50 dBA on eastern wilderness area	Potential > 55 dBA at lookout	< 50 dBA	< 55 dBA
Baal Bone Gap within Gardens of Stone National Park	< 50 dBA	< 55 dBA	< 50 dBA	< 55 dBA



LEGEND

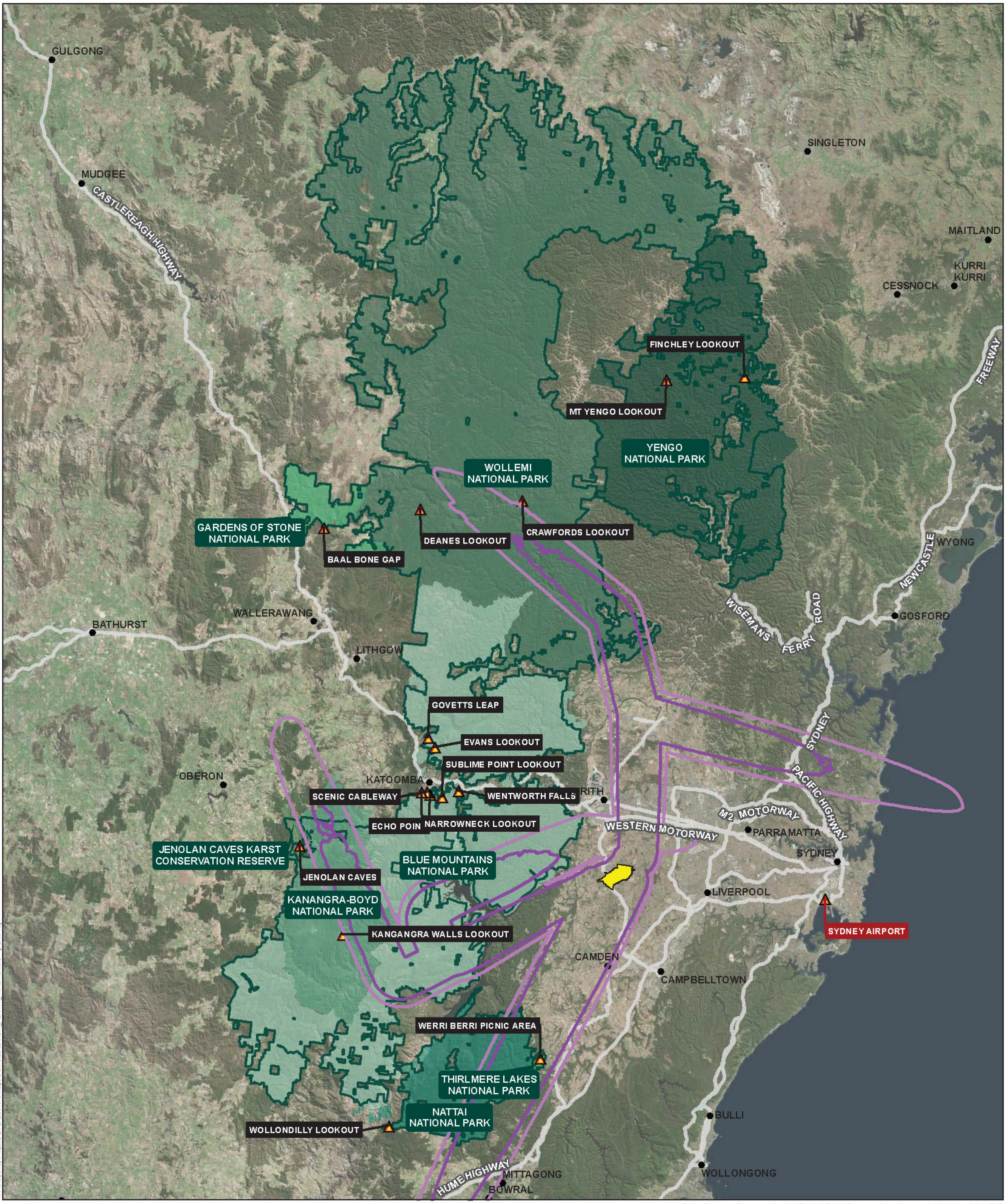
Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Airport site	50 dba LA max noise contour (arrivals)
Greater Blue Mountains World Heritage Area	55 dba LA max noise contour (arrivals)

NB: The indicative arrival flight paths depicted will not be part of the airspace plans for a Western Sydney Airport

0 5 10 20
Kilometres

Figure 26-2 - Single event noise level for a B747 arrival



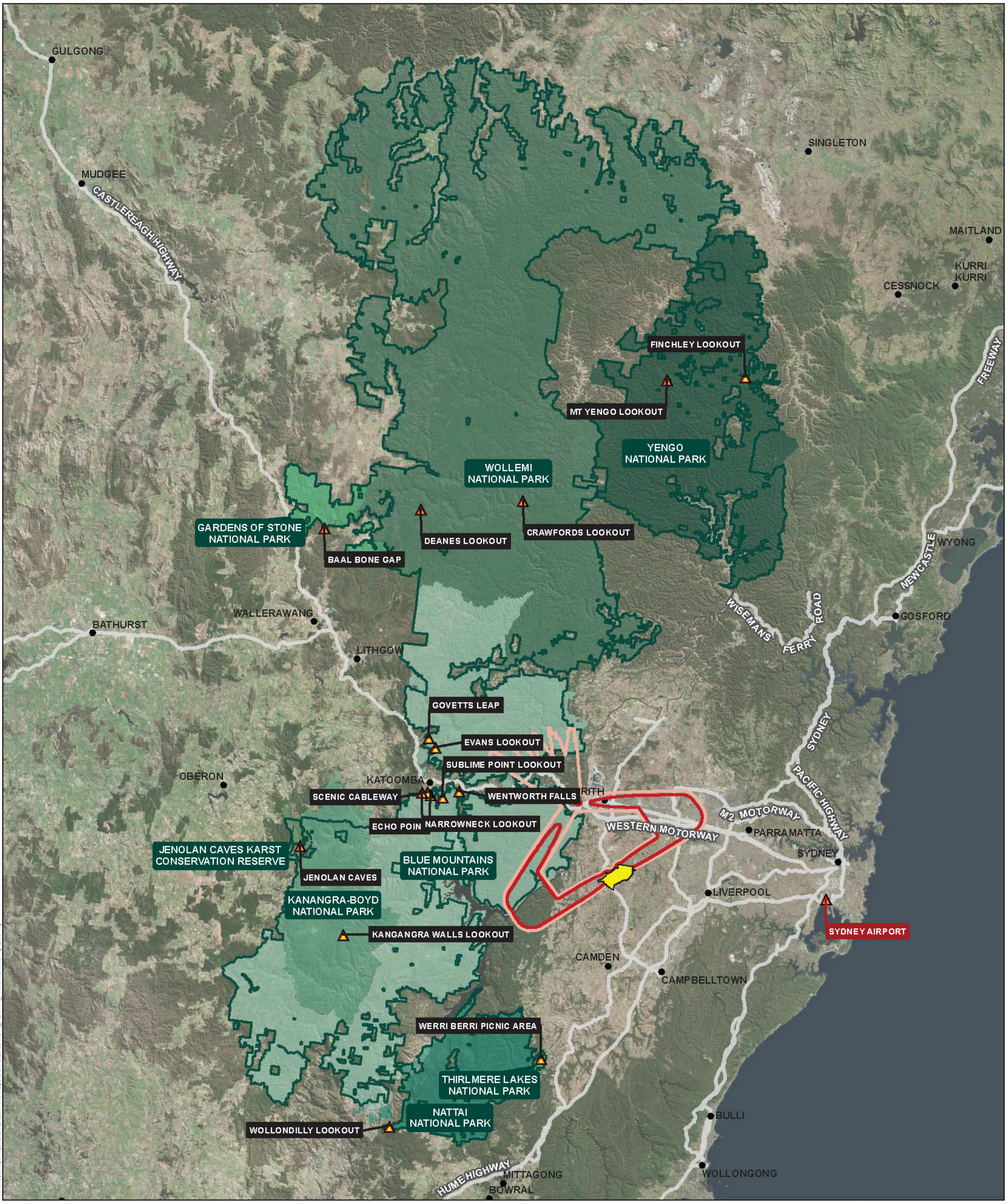
LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

- Airport site
- Greater Blue Mountains World Heritage Area
- 50 dba LA max noise contour (departures)
- 55 dba LA max noise contour (departures)

0 5 10 20
Kilometres

Figure 26-3 - Single event noise level for a B747 departure



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Airport site

Greater Blue Mountains World Heritage Area

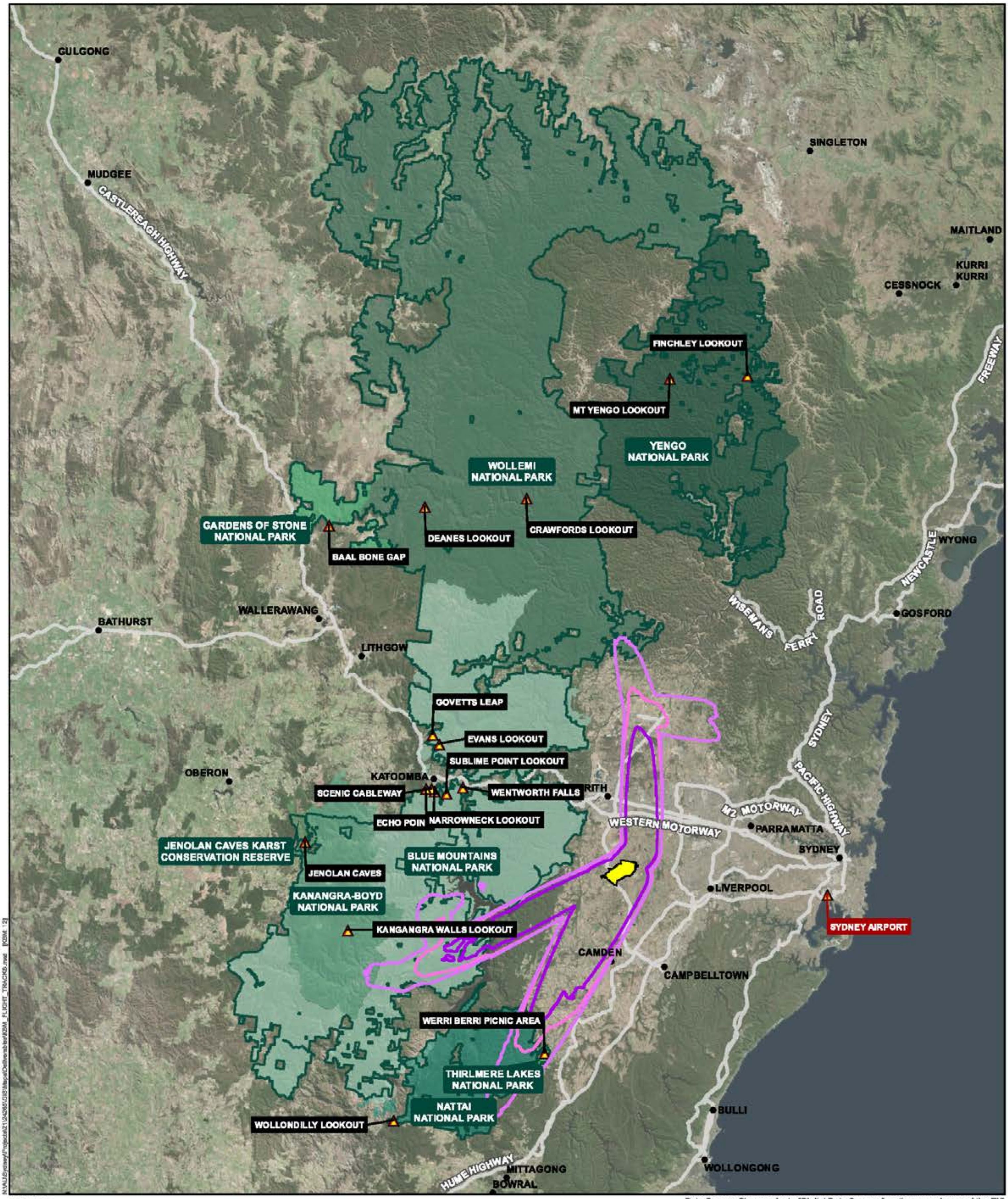
50 dba LA max noise contour (arrivals)

55 dba LA max noise contour (arrivals)

NB: The indicative arrival flight paths depicted will not be part of the airspace plans for a Western Sydney Airport

0 5 10 20
Kilometres

Figure 26-4 - Single event noise level for an A320 arrival



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

- Airport site
- Greater Blue Mountains World Heritage Area
- 50 dba LA max noise contour (departures)
- 55 dba LA max noise contour (departures)

0 5 10 20
Kilometres

Figure 26-5 - Single event noise level for an A320 departure

Noise has been shown to have a variety of impacts on fauna, including changing foraging behaviour, impacting breeding success and changing species occurrences. Very low-flying aircraft can cause flight response in some species, causing them to abandon nests. Other species are known to avoid higher elevation areas where noise levels are higher, potentially resulting in fragmentation of habitat (Ellis, Ellis, & Mindell 1991). Most of these impacts occur when noise levels are greater than 65 dB. Given the altitude at which flights to and from the proposed airport are likely to occur over the GBMWHA, these impacts are unlikely.

While noise would increase above background levels on an intermittent basis, fauna are likely to become habituated to any increase in noise levels in the long term (Conomy et al 1998), particularly as aircraft would not be flying at low altitudes over the GBMWHA. Operation of aircraft at the proposed airport is highly unlikely to permanently alter foraging or breeding behaviour of any fauna species. Any impacts would likely be localised, with impacts occurring under the main flight paths. The majority of fauna within the vast GBMWHA would not be impacted by aircraft noise. As such, noise would not result in a loss of biodiversity and would not interfere with the ecological viability and capacity for ongoing evolution of species within the GBMWHA.

26.5.2.2 Air quality

Air quality impacts relevant to the GBMWHA have been assessed in regard to three principal elements:

- regional air pollutants (ozone);
- contribution to climate change; and
- emissions from fuel jettisoning.

Regional air pollutants (ozone)

Ozone is formed through photochemical reactions of precursor gases. The air quality assessment for the Stage 1 development models emissions of ozone, as well as precursor gases such as nitrogen oxide, volatile organic compounds and carbon monoxide. This assessment is detailed in Chapter 12.

The regional air quality assessment considers the dispersion of ozone across the NSW Greater Metropolitan Region, which includes the GBMWHA.

Background ozone levels in Western Sydney regularly exceed the National Environment Protection Measure (NEPM) guidelines, generally in the summer months. At Bringelly—near the airport site—there have been exceedances of the ozone standards in eight of the past 10 years.

The assessment of the Stage 1 development identified that the peak predicted 1-hour ozone concentrations between the 2030 base case (without the airport) and the 2030 ‘with airport’ case were unchanged and within the error range of the modelling conducted.

International studies have shown that emissions from airport operations are small when viewed in the context of regional emissions inventories (Ratliff et al. 2009). This is supported by data presented in the Air Emissions Inventory for the Greater Metropolitan Region in New South Wales (NSW EPA 2012), which shows that emissions from existing airport operations in Sydney are less than three per cent of total emissions for the Sydney region.

The modelled contribution of emissions from the proposed airport to peak ozone levels is unlikely to be significant in a regional context. Accordingly, changes in ozone levels due to operations at the proposed airport are not expected to impact the amenity of the GBMWHA.

Contribution to climate change

Climate change is identified as a threat to the GBMWHA due to its potential to alter the frequency and intensity of fires and for increased temperatures to impact upon biodiversity and ecosystem function (UNESCO 2015). Greenhouse gas (GHG) emissions are identified as a contributing factor to global climate change.

The proposed airport is expected to contribute approximately 0.11 per cent of Australia's projected 2030 transport-related GHG emission inventory. Given the small percentage of contribution, it is concluded the GHG emissions from the proposed airport would not represent a significant contribution to climate change or to the potential impact of global climate change on the GBMWHA.

Emissions from fuel jettisoning

Emergency fuel jettisoning (commonly referred to as fuel dumping) is a procedure used by an aircraft in certain emergency situations. Aircraft do not jettison fuel as a standard procedure when landing. Indeed, many of the commonly used aircraft in Australia, such as the A320 and the B747, are unable to jettison fuel. The objective of fuel jettisoning is to reduce an aircraft's weight sufficiently to allow it to land safely in an emergency; that is, only a portion of the fuel is jettisoned.

Instances of fuel jettisoning are extremely rare worldwide. In Australian airspace, there were 10 reported instances of civilian aircraft dumping fuel in 2014 from 698,856 domestic air traffic movements and 31,345 international movements (approximately 0.001 per cent of all movements). There are no recorded cases in Australia of fuel jettisoned from civilian aircraft reaching the ground.

The procedure for jettisoning fuel is specified in the En Route supplement of the Aeronautical Information Package published by Airservices Australia as outlined in Chapter 7 (Volume 1). When fuel jettisoning is required, the pilot 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 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 unauthorised jettisoning of fuel in flight is an offence. The Air Navigation (Fuel Spillage) Regulations 1999 prescribe penalties for the unauthorised release of fuel from an aircraft other than in an emergency.

Fuel jettisoning is very unlikely to have any impact on the GBMWHA due to the rarity of such events, the inability of many aircraft to jettison fuel, the rapid vaporisation and wide dispersion of jettisoned fuel and the strict regulations on fuel jettisoning altitudes and locations. In the unlikely event that fuel is required to be jettisoned over land, research indicates that it vaporises and disperses rapidly. Further details are provided in Chapter 12.

26.5.2.3 Visual amenity

The potential for visual amenity impacts has been assessed by reviewing the density and altitude of flights to provide a cumulative measure of the visibility of overflights.

Almost all aircraft approaching or departing the proposed airport would be at an altitude in excess of 5,600 feet above sea level when passing over the GBMWHA. Based on the indicative flight paths used for this assessment, the elevation of aircraft could range as low as approximately 3,700 feet above sea level for arrivals in the 05 direction. However, operations at this altitude would be confined to the eastern edge of the Blue Mountains National Park only. The anticipated altitude of arriving and departing flights is shown on Figure 26–6 and Figure 26–7.

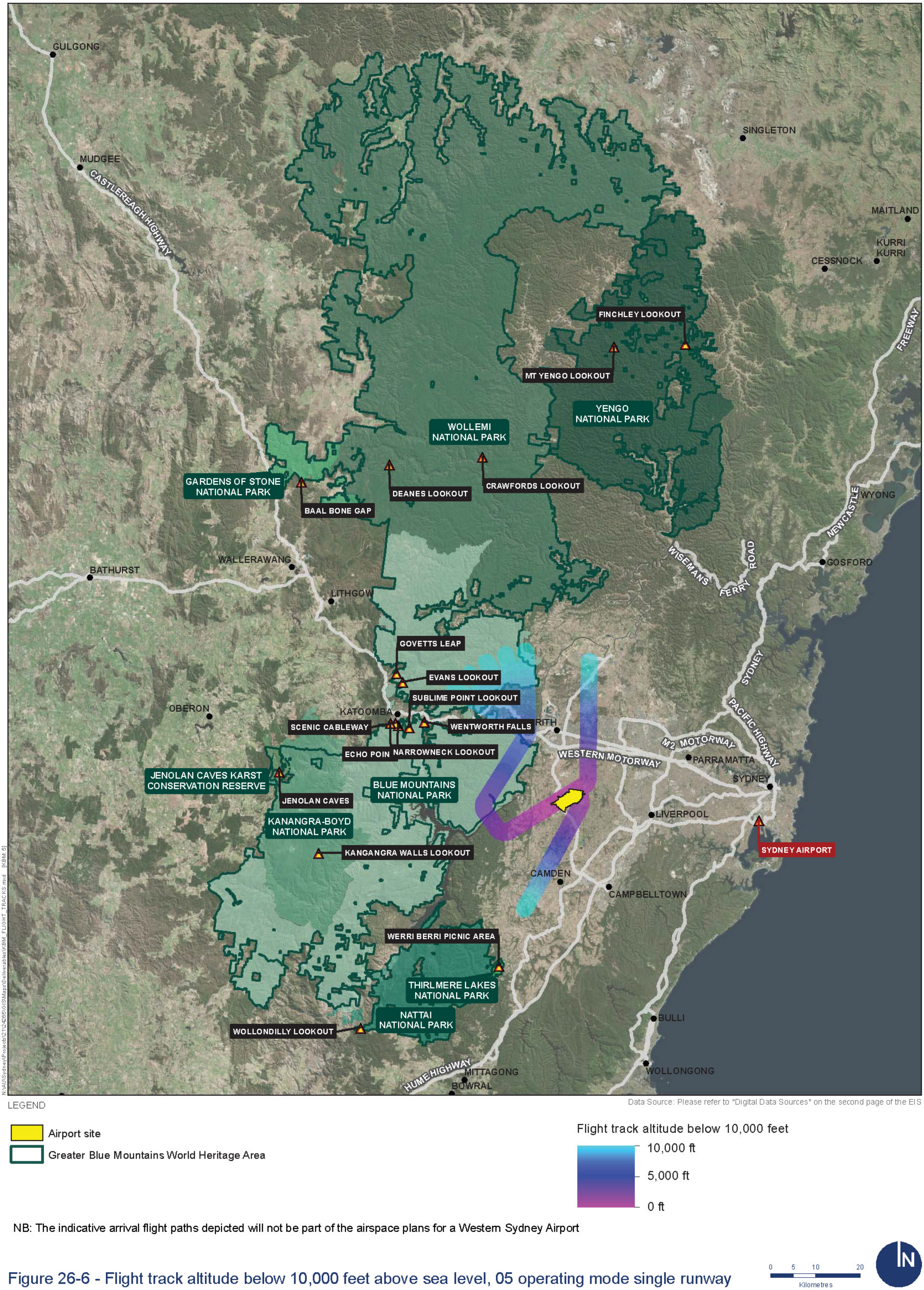
The altitude of key sensitive areas and the average altitude of aircraft above ground level relative to these sensitive areas are shown in Table 26–4. No flights would be expected to occur below around 6,000 feet (approximately 1.8 kilometres) above ground level in the vicinity of the key sensitive areas considered in this assessment.

Table 26–4 provides the predicted altitude of overflights for each sensitive area relative to lookouts locations which are typically at higher elevations within the GBMWHA. Some areas in these key locations, frequented by tourists and recreational users, are at significantly lower altitudes such as the Jamison Valley walking tracks (1,570 feet), the Starlights trail within the Nattai wilderness area (305 feet at Nattai River) and Wollemi Creek within the Wollemi wilderness area (450 feet). The visual impact of aircraft overflights on recreational users in these lower altitude areas will be further reduced compared to the higher altitude sensitive areas considered in this assessment due to the increased separation distance.

Table 26–4 Flight levels above key sensitive areas

Area	Site elevation (ASL)	Flight altitude (ASL)	Aircraft height above ground level
Jamison Valley south of Echo Point lookout and the Scenic Cableway at Katoomba and Wentworth Falls lookout	3,350 feet	> 10,000 feet	> 6,650 feet
Grose Valley east of Evans lookout and Govetts Leap lookout	3,350 feet	> 10,000 feet	> 6,650 feet
Wilderness area between Deanes lookout and Crawfords lookout within Wollemi National Park	3,000 feet	> 10,000 feet	> 7,000 feet
Nattai wilderness area	2,150 feet	> 10,000 feet	> 7,850 feet
Kanangra Walls and wilderness area east of Kanangra-Boyd lookout	3,550 feet	> 10,000 feet	> 6,450 feet
Baal Bone Gap within Gardens of Stone National Park	3,050 feet	> 10,000 feet	> 6,950 feet

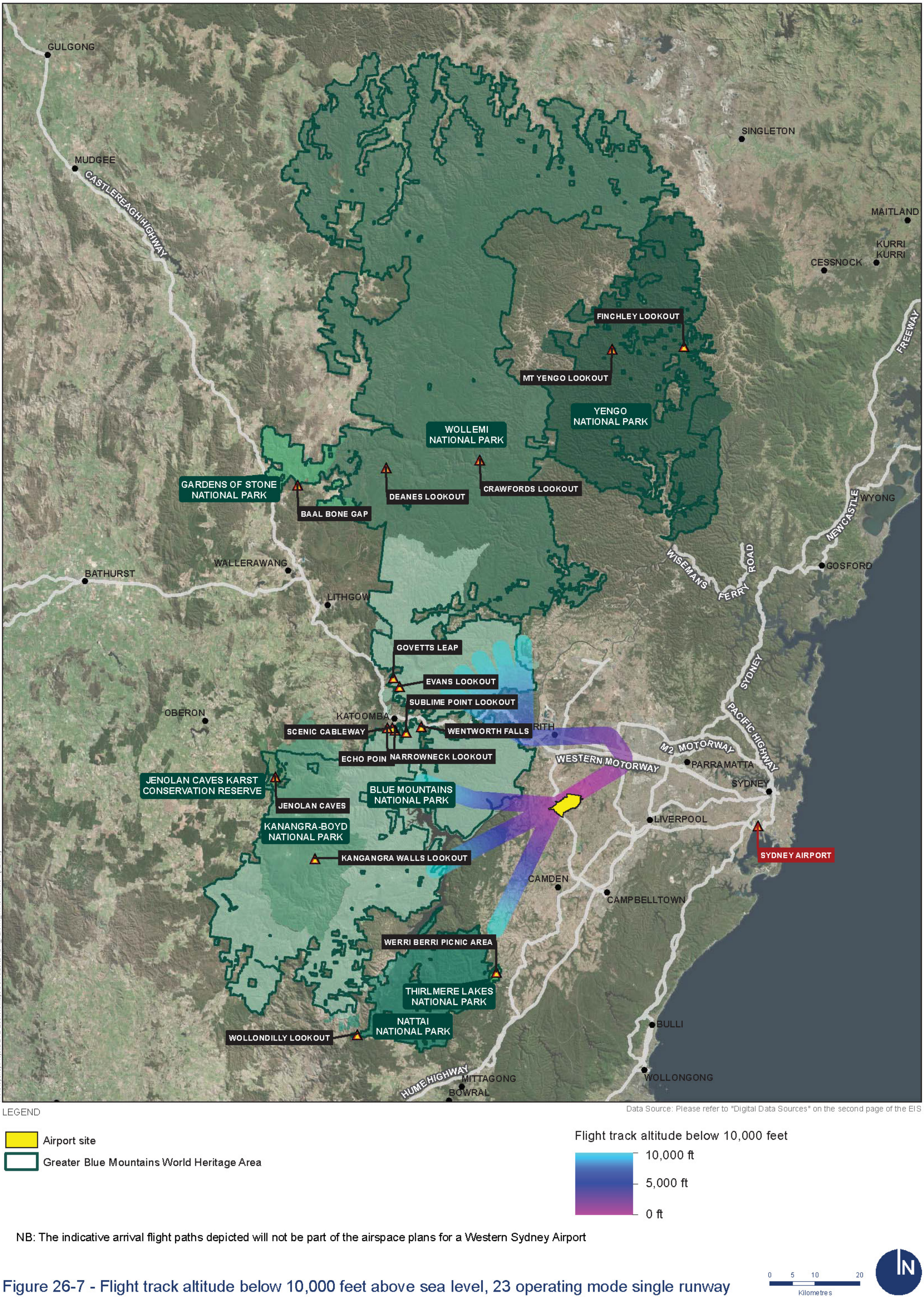
Note: See Figures 26-6 and 26-7 for indicative flight altitudes.



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

NB: The indicative arrival flight paths depicted will not be part of the airspace plans for a Western Sydney Airport

Figure 26-6 - Flight track altitude below 10,000 feet above sea level, 05 operating mode single runway



Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

NB: The indicative arrival flight paths depicted will not be part of the airspace plans for a Western Sydney Airport

Figure 26-7 - Flight track altitude below 10,000 feet above sea level, 23 operating mode single runway

An analysis was undertaken of the number or density of aircraft movements likely to occur over the GBMWHA based on historical flight data provided by Airservices Australia. The density of flights represents the total number of aircraft overflights at all altitudes. Figure 26–8 shows the flight density chart for the 2015 base case (i.e. existing Sydney Airport flights). Figure 26–9 shows both the 2015 Sydney Airport flights as well as arrival and departures at the Stage 1 development assuming a Prefer 23 operating strategy. As illustrated, between one and 10 flights per day currently occur over southern parts of the GBMWHA, with a few specific flight paths experiencing up to 50 flights per day. Most of these aircraft operations are high-altitude commercial flights from Sydney Airport but some flights by low-altitude general aviation aircraft are also represented.

Approximately 200 aircraft movements per day are predicted at the proposed airport in 2030. Figure 26–9 shows the increase in flight density resulting from the addition of flights along the indicative flight paths servicing the proposed airport. In only a few cases, such as the Kanangra-Boyd and Blue Mountains National Parks, are new flight paths established over areas not currently overflown. When viewed in the context of flight altitudes shown in Figure 26–6 and Figure 26–7, the majority of aircraft using the indicative flight paths in these newly-affected areas would be at altitudes exceeding 10,000 feet above sea level.

As shown in Photograph 26-1, aircraft at 3,000 feet are not prominent visual features although they are visible from the ground. When viewed from the key sensitive areas identified in Table 26–4, aircraft are likely to be at least 6,500 feet above ground level. At this altitude, intermittent aircraft movements are likely to be difficult to discern and are not considered to be visually obtrusive.

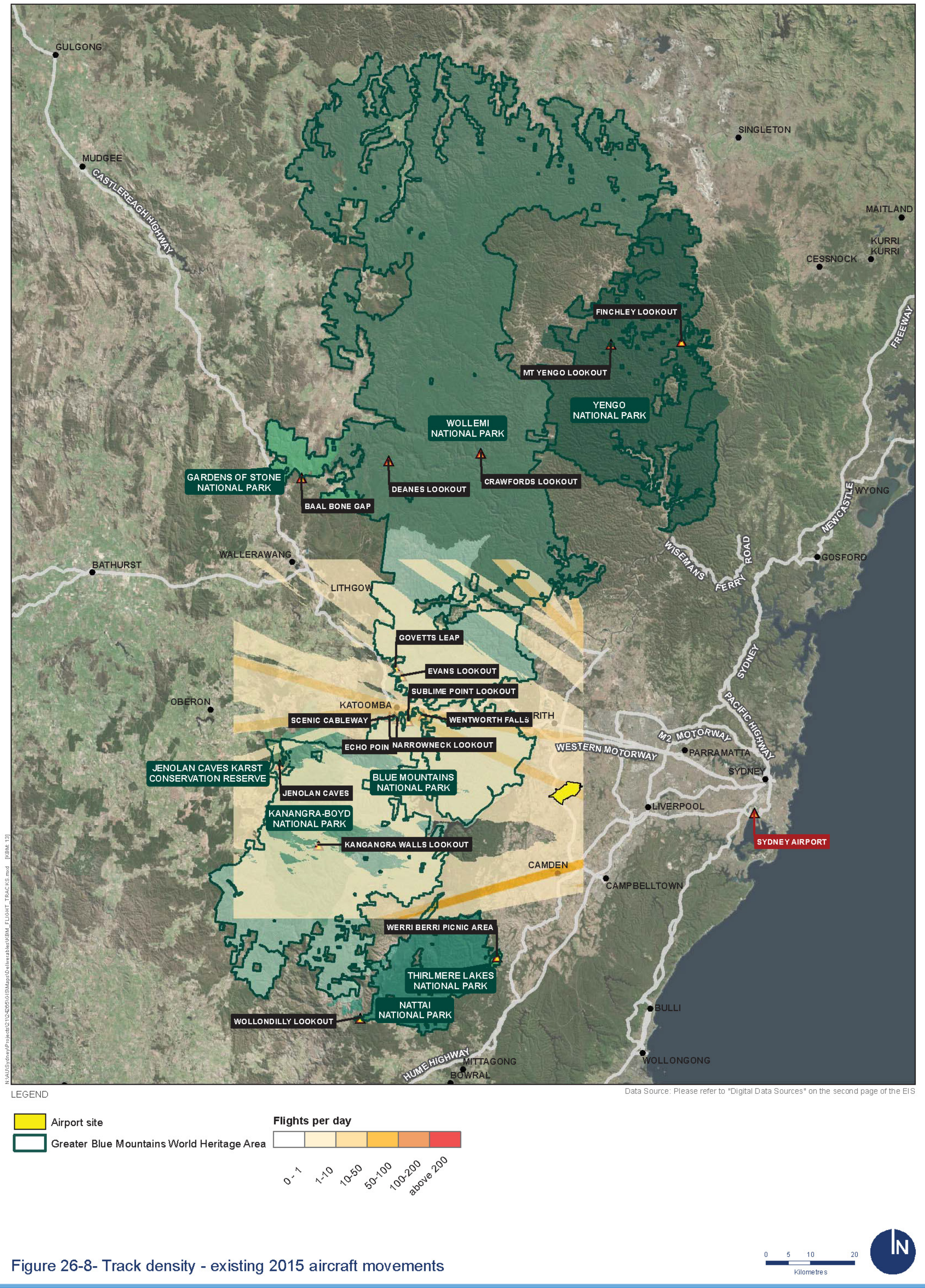
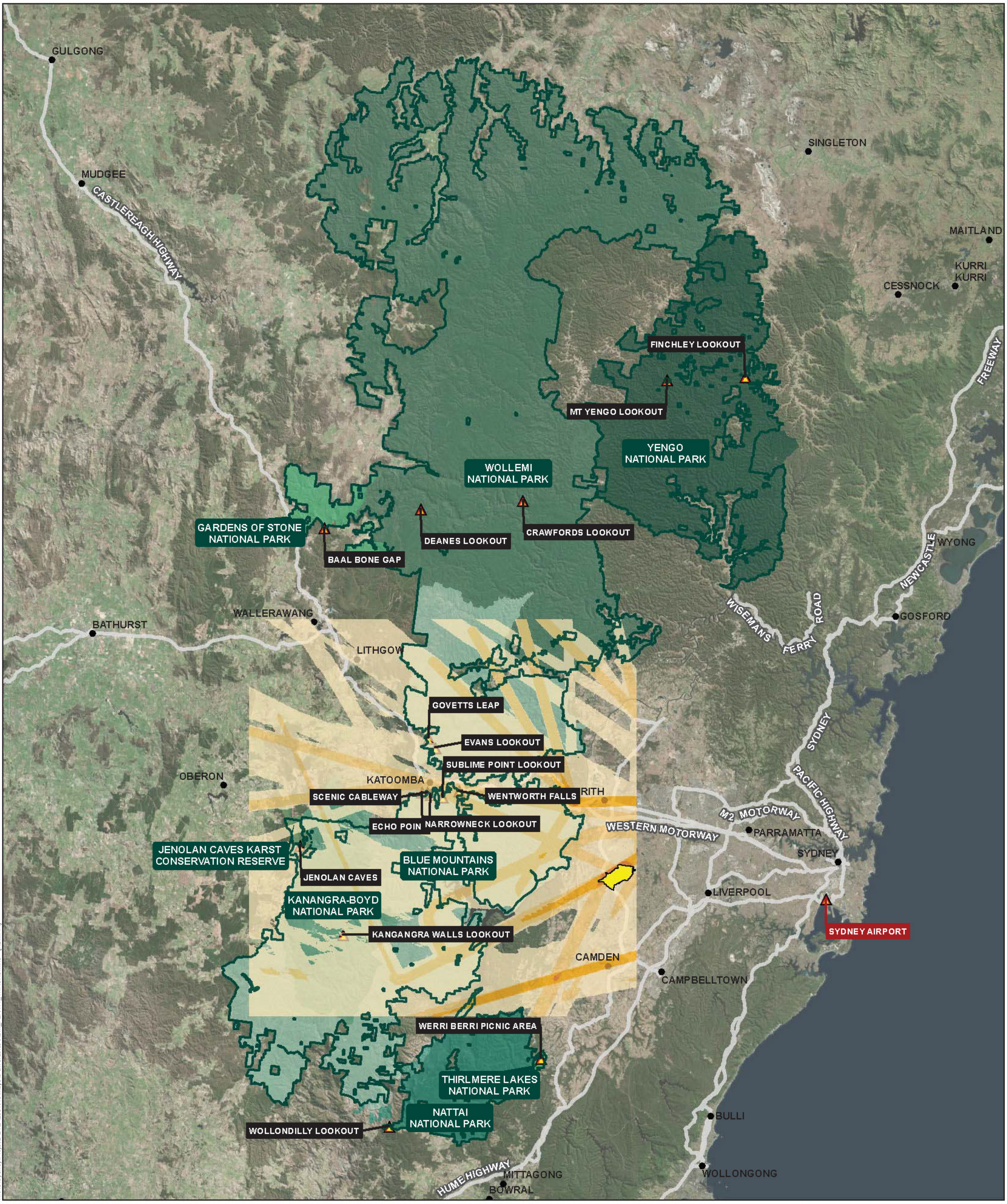


Figure 26-8- Track density - existing 2015 aircraft movements



LEGEND

Data Source: Please refer to "Digital Data Sources" on the second page of the EIS

Airport site

Greater Blue Mountains World Heritage Area

Flights per day

0 - 1, 1-10, 10-50, 50-100, 100-200, above 200

0 5 10 20
Kilometres

Figure 26-9 - Track density, exisitng and WSA 2030 aircraft movements - Prefer 23 operating strategy

Photograph 26-1 Aircraft at approximately 3,000 feet on a clear day at a ground distance of 2.75 kilometres from the viewer

The airport site may potentially be visible from Nepean lookout and Mount Portal lookout – both located between 13 and 14 kilometres from the airport site. A detailed assessment of the visual impact of the airport site is included in Chapter 22.

From these vantage points, the proposed airport would be viewed as a background feature, with closer residential areas at Wallacia, Mulgoa and Glenmore Park being more visually prominent to an observer. The visual prominence of the Stage 1 development would also be reduced by ongoing development in the Western Sydney Employment Area, the South West Priority Growth Area and the Western Sydney Priority Growth Area as well as other major road infrastructure either currently proposed or being planned. The effect of the proposed airport on the visual amenity of the GBMWHA is therefore expected to be very limited.

Amenity could also be influenced by light spill from the proposed development at night resulting in sky glow. During night-time hours, lights from aircraft operations, carparks, apron lighting and other ancillary airport infrastructure may be perceptible in the distance. However, at a landscape level, and having regard to the substantial future urban development planned across the intervening landform of Western Sydney, the proposed airport would be one of many sources of night time light contributing to urban sky glow. This contribution from the Stage 1 development is unlikely to impact amenity in the GBMWHA.

26.5.3 Outstanding universal value

Operation of the proposed airport would have no direct impact on the outstanding universal value of the GBMWHA. Indirect effects on the property's outstanding universal value are expected to be limited to potential noise and air quality impacts. These potential impacts are described and their significance assessed in Table 26–5.

The assessment of significance is based on the requirements of the EPBC Act Significant Impact Guidelines 1.1 – Matters of National Environmental Significance, which state that an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- one or more of the World Heritage values to be lost,
- one or more of the World Heritage values to be degraded or damaged, or
- one or more of the World Heritage values to be notably altered, modified, obscured or diminished.

26.5.4 Other values

Table 26–5 provides an assessment of the potential operational impacts of the proposed airport on the additional values of the GBMWHA identified in the Strategic Plan (DECC 2009c). These values complement and interact with the property's World Heritage values but are not part of the defined natural values for which the property is listed.

Table 26–5 Operational impacts on the outstanding universal value of the GBMWHA

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Criterion (ix) ongoing evolutionary processes	• Outstanding and representative examples of: ▪ evolution and adaptation of the genus *Eucalyptus* and eucalypt-dominated vegetation on the Australian continent; and ▪ products of evolutionary processes associated with the global climatic changes of the late Tertiary and the Quaternary; • Centre of diversification for the Australian scleromorphic flora, including significant aspects of eucalypt evolution and radiation; • Primitive species of outstanding significance to the evolution of the earth's plant life: ▪ Wollemi pine (*Wollemia nobilis*); and ▪ Blue Mountains pine (*Pherosphaera fitzgeralii*).	Impacts on these attributes would only occur if there were direct loss through ground disturbance or significant pollution resulting in loss of habitat or alteration to evolutionary processes. Noise and air emissions represent indirect impacts and given the distance from the airport site and the predicted emission levels, would not pose a threat to these listed values. The assessment of these impacts indicates that noise from overflights would not impact evolutionary processes. Air emissions from airport operations are not considered to represent a material contribution to global climate change which may impact these processes. Direct emissions from fuel jettisoning are rare and fuel evaporates and disperses rapidly before reaching the ground. As such, air emissions would not have an impact on evolutionary processes. Outstanding and representative examples of evolutionary processes relate to pre-historical processes associated with climatic, geological, biological and ecological factors which have shaped the development of the GBMWHA. Similarly, the significant aspects of scleromorphic flora and the existence of primitive species present in the GBMWHA are representative of evolutionary processes. No direct or indirect operational activities would have an impact on these processes in the GBMWHA and, as such, no discernible impact on the attributes under this criterion would likely occur as a result of operation of the proposed airport.	The operation of the proposed airport would not result in direct impacts on the attributes demonstrated within the GBMWHA relevant to evolutionary processes. The indirect impacts of the proposed airport would not result in a World Heritage value being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly, the proposed action would not have a significant impact on the attributes identified for this World Heritage criterion.

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Criterion (x) biological diversity	• Outstanding diversity of habitats and plant communities; • Significant proportion of the Australian continent's biodiversity (scleromorphic flora); • Primitive and relictual species with Gondwanan affinities; • Plants of conservation significance including 114 endemic species and 177 threatened species; and • Habitat that supports 52 mammal species, 63 reptile species, over 30 frog species and about one third of Australia's bird species.	Impacts on these attributes would only occur in the unlikely event of an aircraft crash or from significant pollution resulting in loss of habitat or other effects on biota. Any such impacts would be localised and are unlikely to have a significant impact on biota and habitats. Noise and air emissions represent indirect impacts and given the distance from the airport and predicted emission levels, would not pose a threat to these listed values. The assessment of these impacts indicates that noise from overflights would not impact biological diversity values. While peak noise levels associated with overflights may temporarily disturb species close to operations, flights to and from the proposed airport would generally be more than 6,500 feet above ground level at most locations in the GBMWHA, and noise levels would not exceed 55 dBA. These intermittent noise levels are unlikely to disturb fauna within the GBMWHA. Air emissions from the operation of the proposed airport would not represent a material contribution to climate change which may impact biodiversity. Direct emissions from fuel jettisoning would not impact biological diversity values given the rarity of such events and that fuel is unlikely to reach the ground. An assessment of the potential for the proposed development to impact upon biodiversity is provided in Chapter 15. Based on that assessment, no direct or indirect operational activities would impact upon biological diversity of the GBMWHA and as such, no discernible impact on the attributes under this criterion would likely occur as a result of operation of the proposed airport.	The operation of the proposed airport would not result in direct impacts on the examples of biological diversity present within the GBMWHA. The indirect impacts of the proposed airport would not result in a World Heritage value being lost, degraded or damaged, or notably altered, modified, obscured or diminished. Accordingly the proposed action would not have a significant impact on the attributes identified for this World Heritage criterion.

Criterion/ element	Attributes	Operational impacts	Assessment of significance
Integrity	• Sufficient size to protect the biota and ecosystem processes; • Largely protected by adjoining public lands of state forests and state conservation areas; • Statutory wilderness designation over 83.5 per cent of the property; • Closed and protected catchment for the Warragamba Dam; • Plant communities and habitats occur almost entirely as an extensive, largely undisturbed matrix almost entirely free of structures, earthworks and other human intervention; and • Custodial relationship of Aboriginal people from six language groups through ongoing practices that reflect both traditional and contemporary presence.	The operation of the proposed airport would not directly affect the physical size of the GBMWHA or the adjoining lands. Statutory provisions which provide protection to wilderness areas and the Warragamba Dam would not change. An airport would not directly encroach upon wilderness areas and indirect impacts are not expected to alter the wilderness values for which these areas have been designated under the National Wilderness Inventory. The operation of the proposed airport would have no direct or indirect impact on the plant communities and habitats within the property. The operation of the airport would not directly or indirectly impact the maintenance of Aboriginal cultural practices within the GBMWHA.	The proposed airport would not result in the loss of any elements necessary for the property to express its outstanding universal value. The proposed airport would not reduce the size or change the boundary of the GBMWHA and would not impact on any features and processes that convey the property's outstanding universal value. As described in Section 26.5.5, the proposed airport would not exacerbate existing threats to the integrity of the GBMWHA.

Table 26–6 Operational impacts on other important values of the GBMWHA

Value	Attributes	Operational impacts	Assessment of significance
Geodiversity and biodiversity	• Extensive dissected sandstone plateaus; • Karst landscapes with several cave systems; • Prominent basalt-capped peaks; and • Quaternary alluvial deposits.	Potential impacts on this value would only occur in the unlikely event of an aircraft crash or from significant pollution resulting in loss of biota at a localised level. Any such impacts would be localised and are unlikely to have a significant impact on biota and habitats. No direct or indirect operational activities would have an impact on these processes and as such no impact on this value would occur as a result of operation of the proposed airport.	The proposed airport would not have a significant impact on the geodiversity and biodiversity values associated with the GBMWHA.

Value	Attributes	Operational impacts	Assessment of significance
Water catchment	• Wild rivers; • Pristine and relatively undisturbed catchment areas; and • Substantial contribution to maintaining high water quality.	Potential impacts on this value would only occur if there were direct loss through ground impacts or pollution resulting in harm to a water catchment. A portion of the GBMWHA fronts the Nepean River downstream of its confluence with Duncans Creek. The Duncans Creek catchment only covers approximately 11 percent of the airport site, the majority of which is outside of the footprint of the proposed works. The proposed adoption of best-practice water quality control measures at the airport site means there is very low potential to impact water quality and hydrology in the creek and the Nepean River. The remainder of the site discharges to the South Creek catchment, which joins the Nepean River downstream of the GBMWHA. No direct or indirect operational activities would have an impact on these catchments and waterways, and as such, no impact on these values would occur as a result of operation of the airport.	The proposed airport would not have a significant impact on the water catchment values associated with the GBMWHA.
Indigenous heritage values	• Prominent landscape features with spiritual significance: ▪ Mt Yengo; and ▪ Coxs River and Wollondilly River valleys • Aboriginal rock art; and • Potential for uncovering further significant sites.	Operation of the proposed airport would not directly impact sites within the GBMWHA that have Indigenous heritage values. The only form of indirect impact on cultural heritage values that can be reliably anticipated by this assessment is the temporary loss of contextual value from the periodic intrusion of low levels of aircraft noise. Mt Yengo is located in the north-eastern extent of the GBMWHA and is not expected to be impacted by overflights or noise from aircraft having regard to the noise assessment criteria. Similarly, the Coxs River and Wollondilly River valley are located in areas of little to no predicted noise impact.	The proposed airport would not have a significant impact on the Indigenous heritage values associated with the GBMWHA.
Historic heritage values	• Small graziers' huts; • Cedar logging roads and stock routes; • Ruins of oil shale mines and coal/shale mines; • Road and transport routes; and • Recreation and tourism.	Operation of the proposed airport would not directly or indirectly impact on sites of historic cultural heritage within the GBMWHA. Indirect impacts on recreation and tourism are considered below.	The proposed airport would not have a significant impact on the historic heritage values associated with the GBMWHA.

Value	Attributes	Operational impacts	Assessment of significance
Recreation and tourism	• Canyoning, bushwalking, rock climbing, nature observation, scenic driving, photography; • Picnic sites and basic camping facilities; • Catering, tours, accommodation; and • Direct and indirect contribution to the employment, income and output of the regional economy.	Key recreation and tourism areas have been identified and assessed in regard to potential impacts from operation of the proposed airport. Whilst, based on conservative modelling assumptions, some areas are expected to experience intermittent noise levels above 50 dBA. These areas are limited in the context of the entire World Heritage property. Similarly, visual and lighting impacts are not considered to represent a significant change to existing conditions for recreation and tourism. The major tourism areas around Katoomba and Wentworth Falls would not be significantly impacted by aircraft noise. Increased tourism in the region may be associated with higher levels of road traffic. However, any impacts from airport induced traffic growth are expected to be minor and limited to existing traffic routes. Some increases in tourism development and infrastructure may occur, as a result of increased tourist numbers induced by the proposed airport. However, potential impacts from these facilitated developments can be effectively managed through the implementation of existing management plans for the region.	The proposed airport would not have a significant impact on the recreation and tourism values associated with the GBMWHA.

Value	Attributes	Operational impacts	Assessment of significance
Wilderness	• Extensive natural areas; • Absence of significant human interference; • Opportunity to maintain integrity, gradients and mosaics of ecological processes; • Opportunities for solitude and self-reliant recreation; and • Aesthetic, spiritual and intrinsic value.	The wilderness areas of the GBMWHA are generally associated with the Nattai National Park and the Wollemi National Park. Aircraft operations may also affect the Grose and Kanangra Boyd wilderness areas within the Blue Mountains and Kanangra Boyd National Parks. Access to these areas is generally limited to hikers and low impact tourism. These limitations restrict the number of people within the areas and as such limit the number of people potentially affected. Some areas of Nattai National Park and Wollemi National Park would be affected by noise associated with infrequent overflights of Boeing 747 aircraft, an aircraft type gradually being phased out by airlines. A small proportion of the wilderness areas may be impacted by visual and lighting changes from aircraft overflights; however, these are considered to be insignificant for the vast majority of wilderness areas. The proposed airport would be only one component of an expanding urban area when viewed from distant vantage points and only one of many sources of night time light contributing to urban sky glow.	The majority of aircraft using the proposed airport such as the Airbus 320 (see Figure 26–4 and Figure 26–5) would generally produce peak noise levels below 50 to 55 dBA L_{Amax} when passing over areas of the GBMWHA. Some new generation aircraft such as the Boeing 787 which are already in use in Australia have less noise impact than the A320. It is expected that future generations of aircraft would utilise quieter engine technologies and reduce noise impacts further. In addition, the current generation of larger aircraft (i.e. Boeing 747) are predicted to use the proposed airport infrequently (once every two days on average). Aircraft passing over the majority of wilderness areas of the GBMWHA on approach to or departure from the proposed airport would generally be at least 5,000 to 10,000 feet (and in some cases much more) above ground level and are unlikely to be visually intrusive. Based on these factors it is not expected that a significant impact on wilderness values would occur as a result of the operation of the airport.
Research and education	• High scientific value discovered and undiscovered; • Scientific research into the identification, conservation and rehabilitation of World Heritage values, best management practice and threat abatement; and • Education value for schools and universities.	Operation of the proposed airport is not expected to have an impact on the biological diversity of the GBMWHA and, as such, the availability of the area for scientific investigation and research would not be limited.	The proposed airport would not have a significant impact on the research and education values associated with the GBMWHA.
Scenic and aesthetic	• Vertical cliffs, waterfalls, ridges, escarpments; • Outstanding vistas, uninterrupted views of forested wilderness; • Extensive caves; and • Sandstone canyons and pagoda rock formations.	Aircraft overflying key tourism and recreation areas would be more than 6,500 feet above the relevant ground level and at this altitude, would have limited visual intrusion. Similarly, visual and lighting impacts of the airport are not considered to represent a significant change to existing conditions for scenic and aesthetic amenity.	Based on the altitude of aircraft overflying scenic areas and the distance of the airport site from vantage points within the GBMWHA, it is not expected that a significant impact would occur as a result of the operation of the proposed airport.

Note: values for Social and Economic and Bequest, Inspiration, Spirituality and Existence are addressed in the above table within the values of Recreation and Tourism and Wilderness respectively

26.5.5 Influence on existing threats

Table 26–7 provides a description of the proposed airport's influence on existing threats identified in the GBMWHA Strategic Plan (DECC 2009c).

Table 26–7 Operational impacts on other important values of the GBMWHA

Threat	Project influence
Uncontrolled and inappropriate use of fire	The only risk of fire associated with the operation of the proposed airport would be as a result of an aircraft crash. This would be a very rare and unlikely event and is not considered to be a contributory factor in the overall threat of uncontrolled and inappropriate use of fire. Airport operations would not impact fire fighting or fire hazard reduction burning.
Inappropriate recreation and tourism activities, including development of tourism infrastructure	The proposed airport would provide progressively increasing aviation capacity in the Sydney region, which could also parallel a growth in tourism and visitation to the GBMWHA. Such an increase in tourism may influence the potential for inappropriate tourism development. However, it is very unlikely that the proposed airport would directly contribute to inappropriate development or uncontrolled visitor access particularly within the context of existing management plans which are in place for the World Heritage property. Other factors such as Sydney's expanding population are likely to drive the need for any new management responses to threats posed by increased visitations and tourism infrastructure development.
Invasion by pest species including weeds and feral animals	All aircraft arriving in Australia from overseas are subject to Australian biosecurity requirements administered by the Australian Government. The proposed airport and airlines using it would be required to comply with all Australian laws relating to biosecurity, similar to existing Australian airports. No direct impacts on biodiversity are expected as a result of the proposed airport. It is very unlikely that the proposal would contribute to threats associated with weed and pest species.
Loss of biodiversity and geodiversity	A localised loss of biodiversity and geodiversity would only occur in the unlikely event of an aircraft crash or from significant pollution resulting in loss of habitat or alteration to evolutionary processes. Noise and air emissions from overflying planes are not expected to adversely impact biodiversity or geodiversity. As such the indirect impacts associated with the proposed airport are not considered to be a contributing factor to this threat.
Impacts of human enhanced climate change	The proposed airport is expected to make a marginal contribution to national transport-related GHG emissions. A contribution of 0.11 per cent of GHG emissions to 2030 predicted GHG emissions is considered to be negligible. As such, the proposed airport is not considered to be a contributing factor to this threat.
Lack of understanding of heritage values	This threat would be relevant if no assessment of potential impacts was undertaken. An assessment of heritage values has been undertaken and as such the proposed airport is not considered to be a contributing factor to this threat.

26.6 Mitigation and management measures

Noise modelling and impact assessment for this EIS are based on indicative flight paths and a preliminary analysis of airspace arrangements undertaken by Airservices Australia. Formal design of airspace arrangements and flight paths for the proposed airport would commence after the Airport Plan is determined by the Infrastructure Minister (as detailed in Chapter 7 (Volume 1)). That design process would take account of all relevant factors, including potential environmental impacts on sensitive areas such as the GBMWHA, in determining final flight paths and operating procedures for the proposed airport.

The current assessment based on the indicative flight paths shows that the impacts of the proposed airport on the Greater Blue Mountains, including the World Heritage values of the GBMWHA, are not likely to be significant. Opportunities to further reduce the noise and visual impact from aircraft flying over wilderness and other areas of the GBMWHA would be considered in finalising formal airspace and operational arrangements. This process will also take into account the detailed management plans that are in place for the GBMWHA, including the GBMWHA Strategic Plan.

26.7 Conclusion

The GBMWHA, which is located on the western fringe of the Greater Sydney metropolitan area, is bisected by a major urban and transport corridor. Existing urban development adjoins the boundaries of the GBMWHA and substantial new urban development is envisaged in Western Sydney over the coming decades.

At its closest point, the GBMWHA is approximately seven kilometres from the proposed airport. As such, no direct impacts are expected on World Heritage or National Heritage values from the construction or operation of the proposed airport. Potential indirect impacts on World Heritage and National Heritage values from the operation of the airport were assessed having regard to the attributes identified in the Statement of Outstanding Universal Value for the GBMWHA and the complementary values of the area as defined in the GBMWHA Strategic Plan. The assessment considered noise, air quality and visual amenity from aircraft overflights, lighting and traffic.

The assessment’s findings are that the proposed airport would not have a significant impact on the World Heritage and other values of the GBMWHA. In particular, the indirect impacts of airport operation would not result in an attribute of the property being lost, degraded or damaged, or notably altered, modified, obscured or diminished.

27 Cumulative impact assessment

Cumulative impacts may arise as a result of the development of the proposed airport concurrently or sequentially with other major projects in the region. To identify the likelihood of airport-related cumulative impacts, other significant initiatives and major projects were reviewed including:

- Western Sydney Infrastructure Plan;
- Western Sydney Priority Growth Area;
- Western Sydney Employment Area;
- South West Priority Growth Area;
- Greater Macarthur Land Release Investigation Area;
- the potential expansion of airport operations beyond the proposed Stage 1 development; and
- other major projects identified in the region.

The potential for the proposed airport and other significant initiatives and major projects to generate cumulative impacts was assessed against each of the environmental aspects requiring assessment in the EIS guidelines. The aspects of the environment with the greatest potential for cumulative impacts were considered to be noise, air quality, traffic and transport, biodiversity, Aboriginal heritage and European heritage, social and economic. The potential for construction 'fatigue' to be experienced by communities surrounding the airport and other major projects in the Western Sydney region was also identified as a key risk. There is considered to be minimal potential for cumulative construction noise impacts upon sensitive receivers as a result of the distance from other major projects. The relocation and upgrade of The Northern Road and construction of the M12 Motorway have the highest potential for cumulative noise impacts. The majority of the roads on the anticipated construction haulage routes carry relatively high volumes of existing traffic and the increase in noise from construction traffic is unlikely to be perceptible. Further, aspects of likely noise impacts from additional road projects, such as the M12, have been considered on a preliminary basis in the noise assessment as part of this EIS.

Existing background air quality monitoring data in conjunction with the modelled emissions from the surrounding road network were used in the local air quality assessment. Consideration of the potential for increases in ozone in Sydney's regional airshed was also undertaken as part of the assessment. Predicted emissions would typically be below the respective air quality assessment criteria during construction and operation for both incremental impacts of the airport alone and when considered cumulatively with other surrounding land use and development.

The traffic assessment utilised land use forecasts to model anticipated future traffic generation in the region together with expected traffic from the proposed airport. While there is expected to be additional congestion as a result of the construction of the above projects and developments, the additional vehicle movements associated with the construction and operation of the proposed airport are unlikely to affect the operation of the surrounding road network significantly. Substantial road improvement works are planned as part of the Western Sydney Infrastructure Plan and other planned developments in Western Sydney. These are expected to provide sufficient capacity to cater for the expected passenger and employee traffic demand associated with Stage 1 operations.

The progressive development and urbanisation of Western Sydney has placed increased pressure on biodiversity, and Aboriginal and European heritage values of the region. Development of a biodiversity offsets strategy, consideration of a 'keeping place' and additional archaeological and archival recording would assist in mitigating cumulative impacts.

27.1 Introduction

This chapter provides an assessment of the potential cumulative impacts that may arise as a result of the construction and operation of the proposed airport concurrently or sequentially with other projects in the region.

Cumulative impacts are incremental environmental impacts that are caused by past, present or reasonably foreseeable future activities that, when combined, may have a cumulative effect. When considered in isolation, the environmental impacts of any single project upon a receiver or resource may not be significant. However, the potential impacts may increase when individual effects are considered in combination, either within the same project or together with other projects.

The proposed airport may result in both adverse and beneficial cumulative effects as a result of:

- concurrent or co-located projects under construction;
- regional land use changes;
- off-site infrastructure needed to support the operation of the airport;
- landside transport access to the airport; and
- incremental increases in the capacity of the airport beyond the proposed Stage 1 development.

Another type of cumulative impact is known as construction fatigue. This concept relates to sensitive receivers that experience construction impacts from a variety of projects over a long period of time with few or no breaks between construction periods. Construction fatigue typically relates to amenity impacts from projects that are constructed consecutively or 'back to back'.

This chapter is principally concerned with potential cumulative impacts involving the Stage 1 development. Potential cumulative impacts associated with the long term development and other potential future developments are considered in Volume 3.

27.1.1 Assessment approach

The assessment of cumulative impacts builds upon the detailed assessment of environmental aspects presented in Chapters 10 through to 26 in Volume 2a.

A review was undertaken to identify other significant initiatives or major projects with the potential to interact with the proposed airport. The review included:

- initiatives or projects under construction;
- initiatives or projects with publicly declared financial commitments;
- initiatives or projects that are approved under planning legislation;
- initiatives or projects that are seeking approval under planning legislation; and
- projects included in strategic planning documents related to Western Sydney.

In determining which other projects/initiatives are relevant to the cumulative impacts assessment, the following criteria were taken in account:

- location: the projects are located in proximity to the airport;
- project timeframe: projects likely to be under construction concurrent with the airport (or which would otherwise have a noteworthy operational interaction) were considered; and
- project size: projects were listed on either the NSW Department of Planning and Environment Major Projects Register or local government websites.

Consideration of cumulative impacts was inherently addressed as part of the detailed modelling approach for a number of technical assessments included in Volume 4 of this EIS.

For example, the traffic, transport and access assessment modelled background traffic and other major transport infrastructure projects at the time of operation of the Stage 1 development, while the air quality assessment includes background air quality and emissions from major roadways.

27.2 Major plans and projects considered

There are a number of initiatives and projects in progress or proposed for Western Sydney, which have the potential to generate cumulative impacts/interactions with the proposed Stage 1 development. These initiatives and projects are summarised below.

27.2.1 Western Sydney Infrastructure Plan

The Western Sydney Infrastructure Plan involves the Australian and NSW Governments investing $3.6 billion over 10 years in major Western Sydney road infrastructure upgrades. The plan aims to relieve pressure on existing infrastructure and unlock the economic capacity of the region by easing congestion, reducing travel times and creating local jobs. The plan includes:

- upgrade of The Northern Road to a minimum of four lanes from Narellan to Jamison Road;
- construction of a new east-west four-lane M12 Motorway to provide access and traffic capacity for the proposed airport between the M7 Motorway and The Northern Road, with the retention of Elizabeth Drive for local traffic;
- upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way;
- upgrade of the intersection of Ross Street and the Great Western Highway;
- construction of the Werrington Arterial road; and
- a $200 million package for local roads upgrades.

27.2.2 Western Sydney Priority Growth Area

The Western Sydney Priority Growth Area is a strategic planning initiative that aims to provide jobs, homes and services in the land around the proposed airport. The extent of the Western Sydney Priority Growth Area is shown in Figure 27–1.

An accompanying Land Use and Infrastructure Strategy is under development to guide infrastructure investment in the Western Sydney Priority Growth Area. A key aim of investment will be to connect the proposed airport with the regional centres of Penrith and Liverpool.

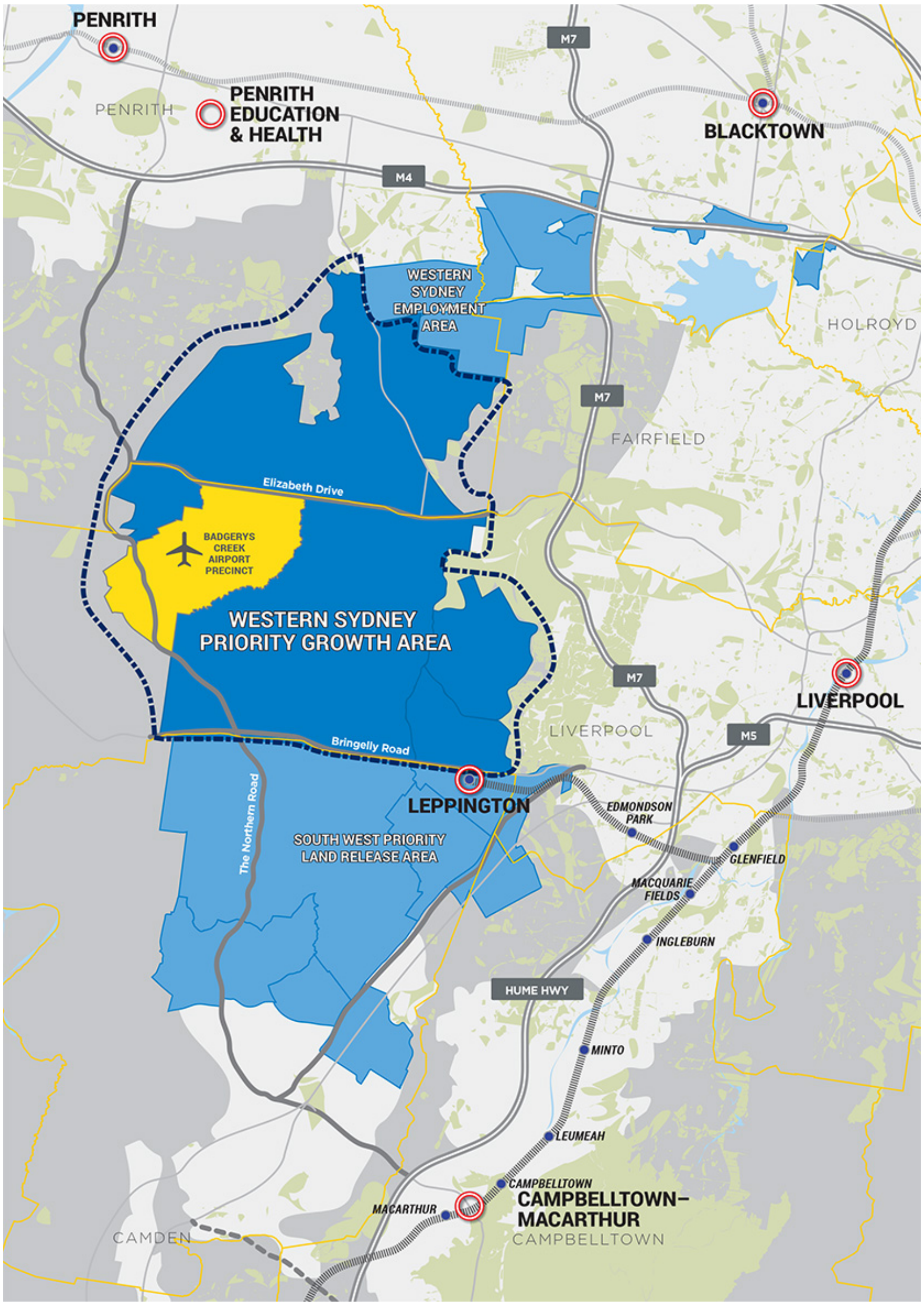


Figure 27–1 Key Western Sydney development areas considered

27.2.3 Western Sydney Employment Area

The Western Sydney Employment Area is a strategic planning initiative that aims to provide businesses in Western Sydney with land for industry and employment including transport, logistics, warehousing and office space. The Western Sydney Employment Area is adjacent to the Western Sydney Priority Growth Area and is shown in Figure 27–1.

The Western Sydney Employment Area is expected to provide more than 57,000 jobs in the next 30 years and more than 212,000 jobs in the longer term. As a result the area would provide opportunities for residents of Western Sydney to work locally.

27.2.4 South West Priority Growth Area

The South West Priority Growth Area is a strategic planning initiative dedicated to provide housing in Western Sydney. It includes lands recently identified by the NSW Government as the South West Priority Land Release Area (see Figure 27–1). The supply of housing generated by the initiative is also expected to place downward pressure on housing costs elsewhere.

The South West Priority Growth Area involves development of communities in precincts including Oran Park, Turner Road, East Leppington, Austral and Leppington North, Edmondson Park and Catherine Fields. Collectively the developments would create around 40,000 residences along with local amenities such as schools, public parks, employment areas and town centres. Planning is ongoing for other precincts such as Lowes Creek and Maryland.

27.2.5 Major projects

In addition to the broad transformational plans identified above, five major projects which are currently undergoing project assessment or have been approved recently were identified as relevant for the assessment of construction and operational phase cumulative effects based on the criteria explained in Section 27.1 of this chapter. The projects are described in Table 27–1 and their locations are shown in Figure 27–2.

Table 27–1 Major projects with potential cumulative effects

Project and location	Description	Status
SIMTA Moorebank Intermodal Facility Stage 1, Moorebank Avenue, Moorebank	Construction and operation of Stage 1 of the facility comprises the following components: • intermodal terminal facility operating 24 hours per day, seven days per week with a capacity to handle up to 250,000 twenty foot equivalent units including: truck processing and loading areas; rail loading and container storage areas; and an administration facility and associated car parking; • a rail link connecting the southern end of the site to the Southern Sydney Freight Line; and • associated works including: rail sidings; vegetation clearing, remediation and levelling works, and drainage and utilities installation.	State Significant Development Concept Plan Approved Assessment by NSW Planning & Environment

Project and location	Description	Status
Bringelly Road Business Hub, Bringelly Road, Leppington	The proposed Bringelly Road Business Hub would accommodate large format retail, bulky goods and light industrial premises and may include the sale of home wares, electrical appliances, home building materials and/or office supplies. The proposal involves: • demolition of existing structures; • subdivision of the site into eight developable lots; • bulk earthworks to regrade the land and provide generally level developable lots; • construction of new internal roads accessed from the realigned Bringelly Road; • construction and delivery of utilities, services and stormwater management infrastructure; and • public domain and landscaping works.	State Significant Development Approved by NSW Planning & Environment
Kemps Creek Resource Recovery Facility, 788 – 804 Mamre Road, Kemps Creek	The facility is intended to process general solid waste associated with the construction and property development industries. In particular, it seeks to screen, crush and sort building and demolition materials, excavated natural materials, and the like. It is expected that the site would process between 200,000 to 250,000 tonnes of such material annually. Recovered materials would be distributed throughout the Sydney metropolitan area, as required.	State Significant Development EIS requirements issued
Transpacific Resource Management Facility, 50 Quarry Road, Erskine Park	Erskine Park Resource Management Facility would include: • Stage 1: Erskine Park Waste Transfer Station with a design capacity of 300,000 tonnes per year of waste (putrescible and non-putrescible) for sorting and transfer; and • Stage 2: Erskine Park Resource Recovery Facility designed to receive up to 150,000 tonnes per annum of selected recyclable material from the transfer station for processing into a number of saleable commodities.	State Significant Development Proponent reviewing submissions
Oakdale South Industrial Estate, Erskine Park	Oakdale South Industrial Estate is a 117 hectare site located within the Western Sydney Employment Area and is the second of four stages of the broader Oakdale Industrial Estate (421 hectares). Land uses permitted at Oakdale South Industrial Estate include those associated with warehouse, distribution and manufacturing. Staged development of the Oakdale South Industrial Estate would comprise: • a master plan for the entire site establishing key development parameters; • subdivision of the entire Oakdale South site into six sub-precincts to allow for the staged development of the site; • bulk earthworks across the entire Oakdale South site, staged to align with infrastructure delivery and market demand; • staged infrastructure/civil works; and • development of selected precincts for warehousing and distribution.	State Significant Development Proponent reviewing submissions

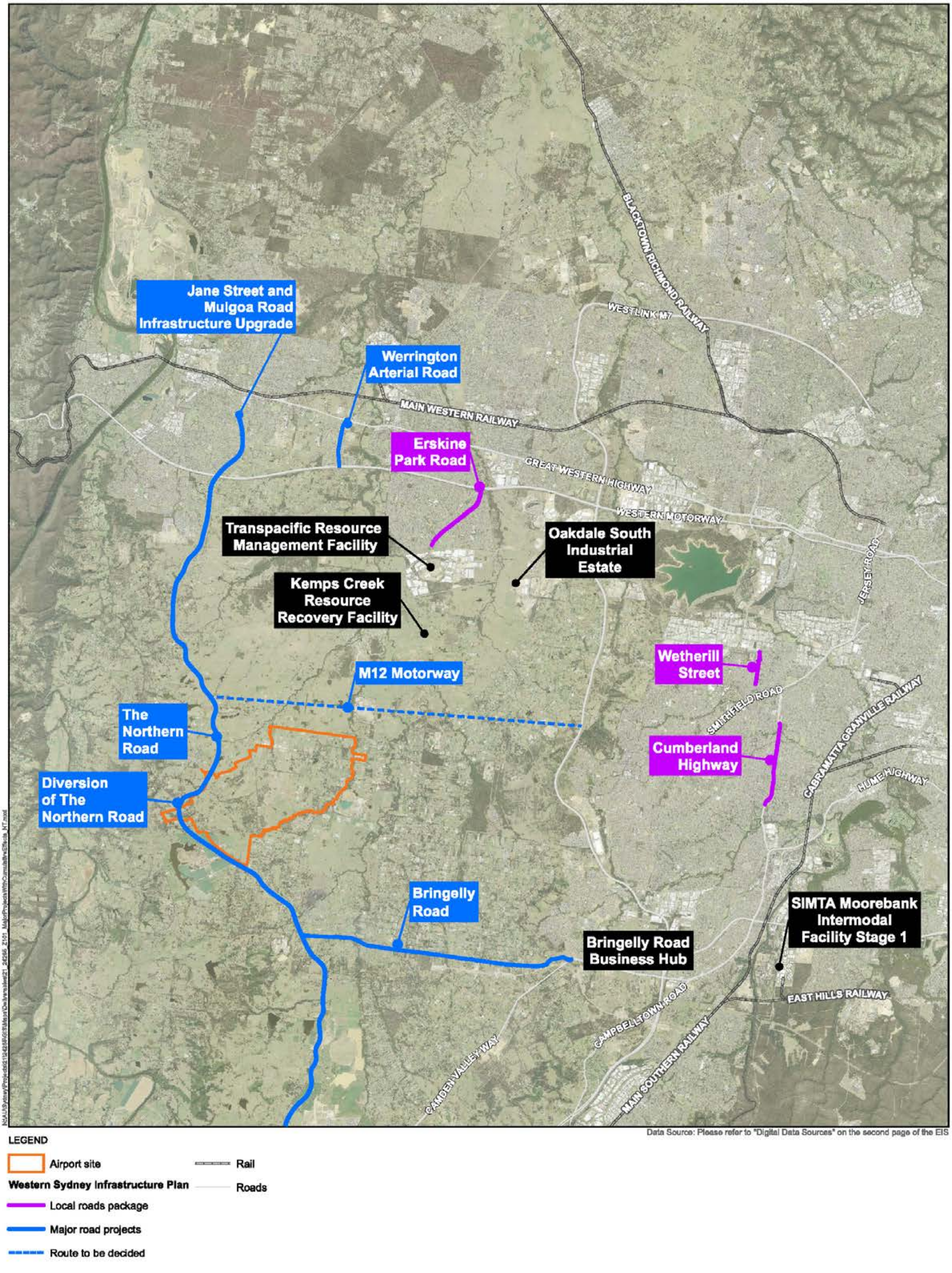


Figure 27-2 - Location of major projects with potential cumulative effects

27.3 Cumulative impacts

The cumulative impacts that may arise during construction and operation of the proposed Stage 1 development are outlined below.

27.3.1 Noise

Noise at the proposed airport would be generated from Stage 1 construction activities, aircraft overflights, including noise from take-offs and landings, and ground-based noise sources such as aircraft engine ground running and passenger and road freight traffic.

There is considered to be limited potential for cumulative noise impacts as a result of Stage 1 construction activities at the airport site. Noise and vibration emissions arising from construction activities would be predominantly limited to the airport site and immediate surrounds. The geographic separation from other major developments in Western Sydney would limit the potential for cumulative effects of noise upon any individual sensitive receivers.

The relocation of The Northern Road and other site infrastructure is proposed to be undertaken concurrently with site preparation activities at the airport site. Site preparation activities are expected to generally proceed from east to west within the airport site to facilitate relocation of the existing infrastructure. These works may also coincide with construction of the M12 Motorway. The distance between concurrent construction activities would limit the potential for cumulative impacts to receivers in proximity to the airport site.

Cumulative noise impacts may be experienced along haulage routes associated with construction vehicles accessing the airport site and surrounding developments. The majority of the roads on the anticipated haulage routes carry relatively high volumes of existing traffic and the increase in noise from construction traffic is predicted to be less than 2 dBA, which is unlikely to be perceptible.

During Stage 1 operations, aircraft operating concurrently with those from other Sydney region airports have the potential to increase aircraft noise exposure to the surrounding community. While the proposed airport would result in additional aircraft movements, the indicative flight paths are designed to facilitate safe, efficient and independent airspace operations for each airport. Air traffic arrangements will be confirmed through the detailed airspace and flight path design process, which will consider any interactions between aircraft operating at the proposed airport and other aerodromes in the Sydney basin. As a result, there are not expected to be any significant cumulative noise impacts upon any individual receivers.

The primary sources of ground-based noise during operations would be aircraft engine maintenance testing and taxiing. Road traffic generated by the airport would also increase local noise levels during operation. Apart from a section of the proposed M12 Motorway and Elizabeth Drive, noise level increases attributable to airport traffic would be less than 2 dBA. These increases are unlikely to be discernible.

It is important to note that a general increase in background noise levels associated with the ongoing urbanisation and development of Western Sydney is anticipated within the timeframes for airport construction and Stage 1 operations. For example, certain proposed road projects, such as the proposed relocation and upgrade of The Northern Road, would contribute to changed background noise levels in the vicinity of the airport site. An increase in background noise would effectively limit the incremental increase associated with noise generated by airport operations.

27.3.2 Air quality and greenhouse gas emissions

Emissions from existing local sources were reflected in the ambient air quality data obtained from monitoring stations in the vicinity of the airport site. The inclusion of this background data in the impact assessment of the proposed airport, coupled with a generally conservative approach to impact assessment, means that the potential impacts identified would account for any potential cumulative air quality impacts associated with existing sources. To address the potential cumulative impacts of the airport, emissions from airport operations sources have been characterised within the modelling. The potential for increases in ozone in Sydney's regional airshed was also considered as part of the assessment process.

Consideration of cumulative impacts is, therefore, inherently captured in the overall modelling approach for the assessment of air quality impacts associated with the proposed airport.

The results of the air dispersion modelling indicate that predicted emissions would typically be below the respective air quality assessment criteria during construction and operation for both incremental impacts of the airport alone and when considered cumulatively with other surrounding land use and development. Predicted exceedances were generally associated with external sources such as regional dust storms and emissions generated by traffic on the surrounding road network. The assessment of regional air quality impacts has found that operation of the proposed airport would have only a marginal impact on regional ozone levels.

The contribution of the Stage 1 development to global greenhouse gas emissions would not be material. The airport would contribute less than 0.09 per cent of NSW's total anthropogenic emissions for 2011-2012, and would account for approximately 0.11 per cent of the total forecast 'Transport' greenhouse gas emissions for Australia in 2029-2030. However, given that Australia faces significant environmental and economic impacts from climate change across a number of sectors, including water security, agriculture, coastal communities, and infrastructure, the cumulative impact of greenhouse gas emissions is an important issue requiring an effective international response. The EIS identifies a number of mitigation measures to minimise the proposed airport's greenhouse gas emissions.

27.3.3 Human health

A health risk assessment was undertaken for the chronic health risks which might result from the most likely pathways of exposure from the Stage 1 development. These were pollutant emissions to the atmosphere, noise exposure and surface and groundwater quality impacts during construction and Stage 1 operations. With regards to the health risks from air emissions, the modelling approach considers the cumulative impacts of the proposed airport development in combination with increased non-airport related traffic on major roadways near the airport site related to the urbanisation and development of Western Sydney.

While in general, the health risks of the Stage 1 development were low, some air pollutants emitted during operation were determined to be at the upper bound or marginally above levels considered to be acceptable by national and international regulatory agencies. Further analyses indicated that the primary causes of the elevated levels of risk were emissions from motor vehicles operating on roads outside the airport site that were non-airport related i.e. background traffic related to increased urbanisation and development. The contributions of these non-airport related motor vehicle emissions varies according to the estimate year and by pollutant but in 2030 includes: 88 per cent for carbon monoxide, 70 per cent for volatile organic compounds, 68 per cent for nitrogen dioxide and between 90-92 per cent for particulate matter.

The health risks identified for the Stage 1 development are all additional to the existing baseline level. In 2006, a Parliamentary Inquiry into the health impacts of air pollution in the Sydney basin found that despite evidence that air pollution had improved over the last 30 years, these improvements were offset by Sydney's growing population, particularly in the south-west and western areas of Sydney. Evidence provided by NSW Health at that time estimated that in Sydney, there was between 600 and 1,400 deaths per year due to air pollution in the Sydney basin. Additionally, a recent review of the *Fuel Quality Act 2000* estimated that in Sydney, NO_2 was responsible for 330 additional deaths per year and an additional 336 and 371 hospital admissions in 2015.

The health risk assessment finds that the risks posed by noise to the health of exposed communities is generally low and within acceptable limits. In addition, the assessment finds that potential health impacts to Sydney's drinking water supplies are unlikely. Due to this, it is not expected that there would be cumulative impacts associated with these pathways of exposure.

Managing the cumulative health impacts of proposed urbanisation and development in Western Sydney over the next several decades will be a challenging issue that will need to be addressed by the relevant government agencies.

27.3.4 Traffic and transport

The traffic impact assessment was undertaken using the Strategic Travel Model provided by the Transport for NSW Bureau of Transport Statistics to project travel patterns in the Sydney Greater Metropolitan Area. The model uses land use forecasts in the form of population and employment projections by travel zone combined with a detailed representation of the road and public transport networks to assess the impact of growth and trip making behaviour on transport infrastructure. Cumulative impacts associated with the proposed airport in conjunction with other major developments in Western Sydney are therefore inherently captured in the modelling approach.

Additional vehicle movements associated with the construction and operation of the proposed airport are not likely to affect the operation of the surrounding road network significantly. A plan would be developed in consultation with relevant stakeholders to control and manage traffic during the construction phase of the proposed airport development. Development of the plan would seek to ensure coordination of measures with any concurrent road works projects.

Significant road improvement works are part of the Western Sydney Infrastructure Plan and other planned developments in Western Sydney. These works may be concurrent with construction and operation of the proposed airport and may result in noticeable congestion at peak times and in certain locations on the surrounding road network. The existing road network and Western Sydney Infrastructure Plan works are, however, expected to provide sufficient capacity to cater for the traffic demand associated with the Stage 1 development and beyond.

The Australian and NSW governments are undertaking a joint scoping study into Western Sydney's rail needs, which will help to determine the need, cost, timing and route of a future rail connection to the airport site. A final alignment would be determined in consultation with the NSW Government.

27.3.5 Biodiversity

The progressive development and urbanisation of Western Sydney has placed increased pressure on the biodiversity values of the region including the endangered Cumberland Plain Woodland and a range of threatened flora and fauna. The cumulative impacts of the proposed airport and other developments would include further loss and fragmentation of habitat and creation of edge effects in retained remnant native vegetation.

The biodiversity offset package detailed in Chapter 16 and Appendix K2 (Volume 4) would help address unavoidable impacts of the proposed airport on Cumberland Plain Woodland and other threatened species, including the likely cumulative impacts outlined above. The quantum of biodiversity offsets required has been calculated in accordance with the *Environmental Offsets Policy* (DSEWPaC 2012) and NSW Government *Biodiversity Banking and Offsets Scheme* (BioBanking).

At this stage, most of the offsets package is planned to be delivered through the conservation of offset sites in perpetuity under the BioBanking scheme. Suitable offset sites have been identified for Cumberland Plain Woodland and other impacted biodiversity values at the airport site. Alternative mechanisms to offset impacts would be considered such as conservation projects, especially where they would be more readily implemented or achieve better conservation outcomes.

Long term development at the airport site would require separate calculation of any additional biodiversity offsets with reference to the prevailing airport master plan and the prevailing environmental offsets regulations. Due to the many employment, residential and transport infrastructure projects taking place in Sydney, including the North West Priority Growth Area and the Western Sydney Priority Growth Area, there is high demand for suitable biodiversity offsets. To address these cumulative impacts, strategic offsetting opportunities will need to be considered.

27.3.6 Surface water and groundwater

Site preparation and construction of the Stage 1 development would transform the site to a predominantly built environment, altering the nature of surface water flow in catchment areas within the airport site. The design of the Stage 1 development includes a water management system to control the flow of surface water and improve the quality of water prior to its release back into the environment. Modelling of the airport site indicates that the proposed water management system would be generally effective at mitigating impacts on water quality and flooding.

Planned future development in the vicinity of the proposed airport, including development associated with the Western Sydney Employment Area, Western Sydney Priority Growth Area and the South West Priority Growth Area has the potential to impact flooding and watercourse geomorphology. Any new development would be subject to requirements to review and mitigate impacts downstream through measures such as on-site detention.

Existing water quality at the airport site and surrounding areas is in a degraded condition due to land clearing and other historical land uses. With the mitigation proposed as part of the Stage 1 development, including the proposed bio-retention basins and other treatment measures, water quality is expected to improve relative to existing conditions. Using interim site-specific water quality trigger levels established for the site, water pollutant concentrations for Stage 1 operations are predicted to satisfy the water quality criteria at all the modelled locations.

27.3.7 Aboriginal, European and other heritage

The progressive development and urbanisation of Western Sydney has placed pressure on the Aboriginal and European heritage values of the locality.

Further development such as the proposed airport and other major projects and growth initiatives would result in an increasing pressure on Aboriginal, European and other heritage values to be retained in their original location and landscape setting.

The Department of Infrastructure and Regional Development will seek to establish, with the support and collaborative action of governments and other stakeholders, an Aboriginal cultural heritage ‘keeping place’ for archival storage of some artefacts salvaged from the airport site. Any such facility may also be used as a repository for Aboriginal cultural artefacts salvaged from other development sites in Western Sydney. The EIS mitigation measures also provide for reburial of other salvaged materials at a designated area on the airport site’s Environmental Conservation Zone as a means of addressing cumulative impact on Aboriginal cultural heritage values. These measures are described in Chapter 19 and Appendix M1 (Volume 4).

Impacts to European and other cultural heritage values at the airport site would be mitigated and managed by a range of measures including further investigation and archival recording. These measures are described in Chapter 20 and Appendix M2 (Volume 4).

27.3.8 Planning and land use

The cumulative effects of the development of the Western Sydney Priority Growth Area, Western Sydney Employment Area and the South West Priority Land Release Area are expected to transform existing rural-residential land uses to urban land uses, particularly over the long term. In developing the Western Sydney Priority Growth Area (previously part of the South West Priority Growth Area and the Broader Western Sydney Employment Area) around the proposed airport site, the NSW Government and local councils have taken into consideration the potential cumulative opportunities and impacts from the proposed airport.

Planning for the proposed airport and surrounding land uses has been ongoing for a number of decades, across all levels of government. Land use planning controls have largely protected the airport site from incompatible development and reduce land use conflict between the airport and surrounding land uses. For example, lands adjoining the north-west and south-east sides of the airport site have been earmarked for commercial and industrial purposes. A formal Australian Noise Exposure Forecast (ANEF) chart will be prepared during the detailed airspace and flight path design process — based on projected long term airport operations — to ensure that local land use planning complements the future operation of the proposed airport.

27.3.9 Landscape and visual amenity

The implementation of the Western Sydney Priority Growth Area, South West Priority Land Release Area and Western Sydney Employment Area will contribute to changing the rural-residential character of Western Sydney. The proposed airport is expected to accelerate this process of urbanisation.

These projects will lead to increased urbanisation of the area over time and corresponding visual effects. The increased urbanisation of the area will generally reduce the impact of the airport development, including night sky glow, as it becomes a part of the developing urban visual character of the area.

27.3.10 Social

Western Sydney is undergoing a major transition to a more highly urbanised region. This transition will be accelerated by the various major employment, residential and transport infrastructure projects identified for Western Sydney, including the proposed airport development. The cumulative impacts of these projects will have both positive and negative aspects and are likely to be widespread.

Due to the Stage 1 development and other residential and transport initiatives, there will be more people forecast to live and work in Western Sydney, where business profits and household incomes will increase. This economic development will stimulate further development in regional and local centres and contribute to the provision of better quality social infrastructure, including shops, health services and recreation services. At the same time, there will likely be changes to social amenity and lifestyle, as urban development brings greater demand on social infrastructure, an increased number of cars on roads, more sources of noise, and further potential health risks.

27.3.11 Economic

The proposed Stage 1 development is predicted to generate a range of economic and employment impacts directly through investment and employment, and indirectly through demand generated by the proposed airport and the workforce at the airport site.

Western Sydney is undergoing a major transition to a more highly urbanised region, evidenced by numerous major residential and transport infrastructure initiatives such as the Australian Government's Western Sydney Infrastructure Plan, NSW Government's priority growth areas, multiple road and rail projects and the proposed airport. The cumulative impacts of these projects will result in economic benefits for Western Sydney and the wider region, and will lead to a greater proportion of Sydney's jobs and residents being located in Western Sydney. The proposed airport development will facilitate this development, through its predicted positive economic contribution to indicators such as value-add, business profits and household incomes.

27.3.12 Resources and waste

The generation of waste during construction and operation of the proposed airport would be reduced through the implementation of a waste management plan. Waste requiring disposal would be sent to an appropriately licensed facility. The waste management market in Western Sydney is mature and handles significant volumes of waste from various domestic, commercial and industrial sources across Sydney. Waste facilities in Western Sydney have sufficient capacity to handle wastes of the type and volume expected to be generated at the airport site in conjunction with the broader development of Western Sydney.

27.3.13 Greater Blue Mountains World Heritage Area

The proposed airport would have no direct impact on the Greater Blue Mountains. The contributory factors influencing potential cumulative impacts on the Greater Blue Mountains World Heritage Area (GBMWHA) are potential direct impacts from increased urban development in the Blue Mountains and indirect impacts from overflight noise, air quality emissions and visual amenity. Indirect impacts associated with the operation of the airport are unlikely to have a significant impact on World Heritage values or the integrity of the listed property.

While the proposed airport would provide progressively increasing aviation capacity in the Sydney region, which could also parallel a growth in tourism and visitation for the GBMWHA, it is very unlikely that an airport would directly contribute to inappropriate development or uncontrolled visitor access, particularly within the context of management plans which are already in place for the GBMWHA. Other factors such as Sydney's expanding population are considered more likely to influence the need for any new management responses to threats posed by increased visitations.

The predicted increase in aircraft overflights over the GBMWHA and their cumulative effect with existing overflights from other airports is considered in Chapter 26. Large areas of the World Heritage area would not experience aircraft overflights, or would do so infrequently. In those areas directly under or near flight paths, potential indirect impacts on amenity are not considered to be significant due primarily to the high altitude of operating aircraft.

27.3.14 Other developments on the airport site

The Airport Plan, when determined, will provide authorisation for additional non-aviation and commercial uses at the airport site within the Stage 1 construction impact zone and identifies permissible onsite uses outside the zone. The EIS identifies the biodiversity and heritage values of the airport site, including in those areas outside the Stage 1 construction impact zone. It also documents potential impacts on these values and the predicted economic benefits of commercial uses at the airport site. Issues such as increases in traffic generation, potential impacts on surface and groundwater quality and social equity considerations associated with additional non-aviation and commercial uses are not addressed. The potential cumulative impacts of these additional activities are acknowledged. Any future development of these or other types of non-aviation uses at the airport site outside the Stage 1 construction impact zone would be subject to separate environmental assessment and approvals processes under the Airports Act 1996.

27.3.15 Airport development beyond the proposed Stage 1 development

It is expected that the proposed airport would be progressively developed as demand increases beyond 10 million annual passengers. Additional aviation infrastructure and support services such as taxiways, aprons, terminals and support facilities would be required to service the growing demand.

The need for a second runway would be triggered when operational demand approaches 37 million annual passengers, which is forecast to occur around 2050. Conceptual layouts have been developed for an airport with the capacity to service approximately 82 million annual passengers. This level of patronage is forecast to occur by around 2063.

A strategic level environmental assessment of this possible long term development is provided in Volume 3 to provide an indication of the impacts associated with the progressive expansion of operations beyond the scope of the proposed Stage 1 development. Volume 3 also includes a strategic level assessment of predicted aircraft overflight noise for a scenario where the proposed first runway is operating at or near its design capacity. Any further developments by the Airport Lessee Company (ALC) on the airport site that are not covered by the Airport Plan determined by the Infrastructure Minister will be subject to the existing regulatory regime contained in Part 5 of the Airports Act 1996 after the airport lease has been granted. This includes the requirement for public consultation on and approval of a major development plan for major airport developments.

27.4 Conclusion

This assessment considers the potential cumulative impacts that may arise as a result of the construction and operation of the proposed airport and other major projects that are planned to occur in the vicinity of the airport site. The chapter identifies key major projects to consider in project planning and key cumulative risks.

As part of its Stakeholder and Community Engagement Plan, the Department of Infrastructure and Regional Development will liaise with the proponents for the major projects identified and key stakeholders (such as Roads and Maritime Services (RMS), Transport for NSW, the Department of Planning and Environment, and the Greater Sydney Commission) to reduce the potential for cumulative impact to arise during construction.

The highest risk for cumulative impact is the concurrent upgrade and relocation of The Northern Road and the construction of the M12 Motorway between the M7 and The Northern Road which could contribute to construction fatigue for surrounding communities. To manage this risk a high level of coordination will occur between the Department of Infrastructure and Regional Development, RMS and relevant construction contractors.

Prior to and during operations, the ALC and the Department of Infrastructure and Regional Development will liaise with Airservices Australia, the Civil Aviation Safety Authority, other Sydney basin airport operators, NSW Government agencies and other key stakeholders to identify measures to reduce the cumulative impacts of airport operations.

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