Chapter 12 Air quality and greenhouse gas

This chapter provides an overview of the existing environmental conditions and the potential local and a regional air quality and greenhouse gas (GHG) emissions impacts associated with the project. The local air quality assessment has focused on direct emissions near to the source, whereas the regional air quality assessment has also considered secondary pollutants (such as ozone (O_3)), which may form in the atmosphere sometime after the emission of any precursor pollutants such as oxides of nitrogen (NO_X) and Volatile Organic Compounds (VOC).

The prevailing wind flows in the area surrounding the WSI are influenced by the topography of the Sydney Basin region. The ambient air quality levels that are monitored at various locations surrounding WSI indicate that air quality in the area is generally good and is typically below the relevant NSW Environment Protection Authority (EPA) goals except for annual average particulate matter (PM) less than 2.5 micrometres in diameter ($PM_{2.5}$) levels and O_3. Historically, adverse air quality conditions arise from time to time due to extraordinary events such as dust storms and bushfires.

The local air quality assessment indicated the predicted levels associated with the project would be below criteria for all the assessed air pollutants, except for $PM_{2.5}$ and NO_2 in 2055 at a series of receivers located to the immediate north-west of the runway. However, the elevated $PM_{2.5}$ levels are predicted to arise due to existing elevated background levels and the effect of the project is expected to be insignificant. Whilst the project would contribute significantly to 1-hour average NO_2 levels at the nearest receivers to the north-west of the runway, the predicted levels of NO_2 are slightly above the more stringent, recently updated NSW EPA criteria for only a portion of the hours throughout the year that were assessed. The elevated NO_2 levels would only occur at a few locations immediately adjacent to WSI. As the predicted results are likely to be conservative (overestimating of impacts) and as it is likely there will be improvements in fuel efficiency (for aircraft and motor vehicles) and decreases in aircraft emissions in the future, it is reasonable to conclude that no significant impacts would arise.

The regional assessment identified a similar small scale of NO_2 impacts consistent with the local assessment, with predicted levels above the new NSW EPA criteria in close vicinity to the airport in 2055, representing a small localised potential impact. Importantly however, the regional modelling results indicated that the project would not increase maximum O_3 concentrations and would generally result in a net reduction in O_3 concentrations (particularly at night) during periods of high O_3 levels in densely populated areas. This arises as the additional NO_x emitted by the project would react with and thus and diminish existing elevated O_3 concentrations. The results also indicated some increases in maximum O_3, which would occur predominantly over uninhabited forest land and sparsely populated areas. Overall, it can be concluded that the predicted impacts for NO_2 are small, infrequent and highly localised, $PM_{2.5}$ impacts arise due to elevated background pollutant levels, and that the results show an improvement in the predicted maximum O_3 impacts relative to the 2016 EIS.

The project's impact on the concentrations of all other assessed pollutants would be negligible and unlikely to be discernible or measurable within the existing background concentrations.

Monitoring of air quality in the vicinity of WSI commenced as part of the Airport Plan approval, and requires the ongoing monitoring of local air quality once WSI is operational. No further mitigation has been proposed.

With respect to potential GHG emissions, the most carbon-intensive flights are those operating regular public transport (RPT) services to medium and long haul destinations. In 2033 and 2055, these RPT services accounted for only 27 and 23 per cent of projected total air traffic movements but were responsible for more than half of all flight emissions of carbon dioxide equivalents (CO_2e) from WSI to destinations across its anticipated route networks. Emissions of CO_2e from domestic aviation are projected to grow steadily between 2033 and 2055, as activity continues to grow generally in line with population.

Overall, the emissions of CO_2e in the engine exhaust behind aircraft using WSI's flight paths and route network in 2033 and in 2055 are not considered to result in significant impacts or inhibit the achievement of net zero economy targets set by the Australian or NSW Government for 2050.

The total aircraft engine emissions of CO_2e from WSI are expected to be lower than the projections for 2033 and 2055 due to next generation aircraft and propulsion technologies, air navigation and air traffic management infrastructure and operational improvements, and the uptake and use of sustainable aviation fuels (SAF).

Wide-ranging measures will be required to manage and reduce emissions of CO_2e produced in the engine exhaust behind the aircraft operating along WSI's flight paths and route network, many of which are dependent on other aviation stakeholders – such as WSA Co, Airservices Australia, airlines, aerospace manufactures and fuel companies.

An Operational Sustainability Strategy and Operational Sustainability Plan for WSI is also currently under development by WSA Co and will be released prior to the opening of WSI in 2026. A core component of this strategy and plan will be a roadmap to guide WSI along a 'Carbon Neutral Pathway' that will be supported by participation in Airport Council International's (ACI) *Airport Carbon Accreditation* programme, and a strategy to support aviation partners to reduce scope 3 emissions, including those produced by aircraft engine use in the landing take-off (LTO) cycle below 3,000 feet (ft) or 914 metres (m).

WSA Co is also planning to join the ACI's *Airport Carbon Accreditation* programme at one of the 2 highest available levels (being Transformation level (4) or Transition level (4+)). This means that WSA Co will be required to set a policy commitment that will achieve absolute emissions reductions of CO_2e and implement a Carbon Management Plan. This plan will define the emissions reduction trajectory, interim milestones and the measures required to achieve a future science-based target in line with the Intergovernmental Panel on Climate Change's (IPCC) 1.5 degrees Celsius pathway. It will also help WSI operate with the lowest carbon footprint possible as it closely works with all its stakeholders to address third party emissions of CO_2e, particularly for sources that are outside its direct control and ownership (i.e., aircraft engine emissions).

12.1 Introduction and previous assessment

This chapter provides a summary of the potential air quality and GHG emissions impacts associated with the preliminary airspace design. The full assessment of air quality impacts is provided in Technical paper 2: Air quality (Technical paper 2) and a full assessment of the potential GHG emissions impacts is provided in Technical paper 3: Greenhouse gas emissions (Technical paper 3).

The local air quality assessment focussed on direct emissions near WSI, whereas the regional assessment considered a much larger area and also considered potential secondary pollutants, such as ozone, which may form in the atmosphere sometime after the emission of any precursor pollutants such as Nitrogen Oxides (NO_X) and Volatile Organic Compounds (VOC). The assessment of the potential GHG focuses on the contribution of carbon dioxide (CO_2) emissions from aircraft operating to and from WSI. Appropriate mitigation and management measures have been identified to reduce potential impacts. The impact assessment on air quality and aircraft engine GHG have been prepared in consultation with the Australian Government Department of Climate Change, Energy, the Environment and Water and have been carried out in accordance with the EIS guidelines.

12.1.1 The 2016 EIS

It is important to note that both local and regional air quality assessments were prepared as part of the 2016 *Western Sydney Airport Environmental Impact Statement* (Department of Infrastructure and Regional Development, 2016) (2016 EIS) that quantified the potential local air quality impacts due to the operation of Stage 1 Development and long-term airport development. The Stage 1 Development considered a single runway with associated landside and airside facilities (2030). The long-term development (2063) included parallel runways and additional facilities to cater for the additional passenger movements.

The local air quality assessment identified aircraft movements to be largest source of emissions (consisting of particulate matter (PM) (PM_{10} and $PM_{2.5}$), NO_X and sulphur dioxide (SO_2)) followed by the operation of onboard aircraft auxiliary power units and ground support equipment. The biggest contributor of VOC emissions was determined to be from aircraft and fuel storage tanks.

The local assessment concluded that the Stage 1 Development would not result in any exceedances of the applicable air quality criteria at the nearest residential receivers, and that the highest predicted off-site concentrations were found to generally occur to the north and north-east of the Airport Site. This was associated with the location of the runway and the prevalence of south-westerly winds. The long-term operational impacts were only evaluated for key air quality metrics, i.e., NO_2, PM_{10} and $PM_{2.5}$. The results indicated some exceedances of the predicted 1-hour average NO_2 concentrations at 6 residential receivers, intermittently over the modelling period. Two off-site receivers were also predicted to experience an annual average $PM_{2.5}$ level above the relevant criterion.

For the regional assessment, the modelling results were compared against the air quality objectives for maximum 1-hour and 4-hour ozone (O_3) concentrations. For the Stage 1 Development (as described for the 2030 reference year in the 2016 EIS) the peak predicted 1-hour and 4-hour O_3 concentrations were relatively unchanged compared to the base case. For the longer-term development (as described for the 2063 reference year in the 2016 EIS) the maximum predicted 1-hour ozone concentrations remain unchanged, however the maximum 4-hour O_3 concentrations increased on some days.

It is important to note that the assessment presented for this Draft EIS relates only to the flight paths, and no changes to the construction phase of WSI or ground-based operations are proposed. The numbers and types of aircraft have been updated (from those presented in the 2016 EIS) to reflect a more modern aircraft fleet. The relevant air quality criteria have also become more stringent for some key air pollutants. To account for the cumulative impact of the project with operational ground level activities, the predicted impacts from the 2016 EIS air quality assessment have been directly applied.

12.2 Legislative and policy context

This section identifies the applicable air quality and GHG emissions legislation relevant to the project. While the NSW legislative requirements outlined below are not specific to Australian Government airport activities or aircraft operations, the general provisions of both the NSW and Commonwealth legislation has been included for completeness of consideration.

12.2.1 Gaseous pollutants and particulate matter performance criteria

Legislation, guidelines and standards governing ambient air quality and emissions from air pollutants have been established by both the Australian and NSW governments.

Regulated air pollutants are divided into ‘criteria’ pollutants and ‘air toxics’. Criteria pollutants are those emissions that are generally emitted in relatively large quantities and abundant in the atmosphere. Air toxics, such as VOCS, are gaseous or particulate pollutants that are typically present in lower concentrations and can be hazardous to humans, plants or animal life.

Legislation, guidelines and other standards which have been considered for this assessment are summarised in Table 12.1.

Table 12.1 Emissions and air quality legislation

Regulator	Legislation/policy	Summary of legislation requirement(s)
Ambient air quality and odour		
Australian Government	*Airports Act 1996* (Airports Act)	The Airports Act contains an obligation on airport lessee companies to develop a master plan every 5 years including a detailed environmental strategy for the airport. The Airports Act also contains a number of offences that are related to pollution.
	Air Navigation (Aircraft Engine Emissions) Regulations 1995 (Annex 16)	The *Air Navigation (Aircraft Engine Emissions) Regulation 1995* was created under the *Air Navigation Act 1920* and provides the regulatory framework for air pollution generated by aircraft.
	National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM) (NEPC, 2021)	The Ambient Air Quality NEPM specifies national ambient air quality standards for air pollutants. It sets the air quality standards for 6 air pollutants (carbon monoxide, nitrogen dioxide, sulphur dioxide, lead, ozone and PM_{10}) and includes advisory reporting standards for $PM_{2.5}$. It is important to note that NEPM air quality standards are not designed to be applied to the impact assessment of a specific project. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state.
	National Environment Protection (Air Toxics) Measure (Air Toxics NEPM) (NEPC, 2004)	The Air Toxics NEPM specifies investigation levels for ambient air toxics concentrations. Similar to the Ambient Air Quality NEPM, the Air Toxics NEPM aims to facilitate the development of standards that will allow for the equivalent protection of human health and well-being. It sets a nationally consistent approach to monitoring for 5 air toxics: benzene, formaldehyde, toluene, xylenes and benzo(a)pyrene (as a marker for polycyclic aromatic hydrocarbons). The Air Toxics NEPM does not provide 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.
NSW Government	*Protection of the Environment Operations Act 1997* (POEO Act) *Protection of the Environment Operations (General) Regulation 2009*	The POEO Act (and the relevant Regulations made under the Act (i.e., the NSW *Protection of the Environment Operations (Clean Air) Regulation, 2021*) includes a range of controls with regard to air quality. NSW legislation (POEO Act) prohibits emissions that cause offensive odour to occur at any off-site receiver. The NSW legislative requirements are not specific to Commonwealth airport activities or aircraft operations, but the general provisions in this legislation are relevant for consideration. These aspects include appropriately managing and mitigating potential emissions to reduce overall environmental harm or impact in the environment due to operations from the project.

Regulator	Legislation/policy	Summary of legislation requirement(s)
	NSW Odour Policy (NSW DEC, 2006)	The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. The wide-ranging response in how any particular odour is perceived by any individual poses specific challenges in the assessment of odour impacts and the application of specific air quality goals related to odour. The *NSW Odour Policy* sets out a framework specifically to deal with such issues. The NSW criteria for acceptable levels of odour range from 2 to 7 odour units, with the more stringent 2 OU criteria applicable to densely populated urban areas and the 7 OU criteria applicable to sparsely populated rural areas, as outlined below (refer to Section 12.3.2).
Emissions of air quality criteria pollutants		
Australian Government	*Environmental Management of Changes to Aircraft Operations Standard* (NOS) (Airservices Australia, 2022b)	The purpose of the NOS is to prescribe the requirements for environmental impact assessment, social impact analysis and community engagement that must be met, prior to implementing changes to aircraft operations. NOS criteria have been developed by Airservices Australia to provide a quantitative mechanism for determining proposed changes to aircraft operations with the potential to result in 'significant impact' to the environment (as defined under the EPBC Act). Section 2 of Appendix B of the NOS provides criteria to determine whether to seek advice under the EPBC Act regarding potentially significant environmental impacts associated with increases in aircraft fuel burn and emissions (including NO_X, SO_x and PM). It also provides steps in applying fuel burn and emissions criteria: if specific criteria are met, advice must be sought from the Australian Minister for the Environment and Water regarding the potential for the change to cause 'significant impact'. The NOS seeks to endure that that flightpaths be designed to avoid environmental (and social) impacts to the greatest extent practicable, whilst prioritising operational safety. Details of the specific NOS criteria are detailed in Section 2.1.8 of Technical paper 2 and Section 4.3.7 of Technical paper 3.
NSW Government	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 is the key regulatory mechanism in NSW for reducing emissions of harmful pollutants in the air. The regulation prescribes 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) (NSW EPA, 2022)	The NSW Environment Protection Authority (EPA) document *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. This policy document includes criteria for a range of pollutants that may be emitted from a development or facility. It is referred to in Part 5: Air impurities from emitted activities and plant of the Clean Air Regulation.

Regulator	Legislation/policy	Summary of legislation requirement(s)
Emissions of greenhouse gases		
Australian Government	*National Greenhouse and Energy Reporting Act (2007)* (NGER Act) and *National Greenhouse and Energy Reporting (Measurement) Determination 2008*	The NGER Act provides for the reporting and dissemination of information related to GHG emissions, GHG projects, energy production and energy consumption. Under the NGER Act, corporations in Australia which exceed thresholds for GHG emissions or energy production, or consumption are required to measure and report data to the Clean Energy Regulator on an annual basis (the NGER Scheme). The *National Greenhouse and Energy Reporting (Measurement) Determination 2008* identifies several methodologies to account for GHGs from specific sources which are relevant to WSI. This includes emissions of GHGs from direct fuel combustion (e.g., fuel for transport energy purposes). Aircraft GHG emissions associated with single runway operations at WSI from its planned opening in 2026 would be included in this ongoing reporting under the NGER Scheme.
	Climate Change Act 2022 and Climate Change (Consequential Amendments) Act 2022	These Acts legislate Australia's emissions reduction targets, including a 43 per cent emissions reduction by 2030 and transition to a net zero economy by 2050.
NSW Government	*Net Zero Plan Stage 1: 2020-2030* (NSW Government, 2020)	The NSW Government has committed to action on climate change and a goal for a net zero carbon economy by 2050. This is set out under the *Net Zero Plan Stage 1: 2020-2030.* The Plan aims to help achieve the State's objective to deliver a 50 per cent cut in emissions by 2030 compared to 2005 levels. It also supports a range of initiatives targeting energy, electric vehicles, hydrogen, primary industries, technology, built environment, carbon financing and organic waste.
Ozone-depleting substances		
Australian Government	*Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* (Ozone Act) and Regulations 1995	This Act and these Regulations impose controls to protect the environment by reducing emissions of ozone depleting substances and synthetic greenhouse gases that deplete ozone in the atmosphere including various Chlorofluorocarbons.
NSW Government	*Ozone Protection Act 1989* (Ozone Protection Act)	The Ozone Protection Act regulates or prohibits the manufacture, sale, distribution, conveyance, storage, possession and use of ozone-depleting substances in NSW.

Further details regarding the legislative and policy context with are provided in Chapter 2 of Technical paper 2 and in Chapter 4 of Technical paper 3.

12.3 Methodology

A summary of the approach to the assessment is provided in this section, including the methodology used to undertake the assessment and the relevant criteria which was applied to the assessment of potential impacts. The air quality and GHG emissions adopted the following 2 assessment years for the project:

- 2033 – selected to represent the early years of operations after the planned 2026 opening of WSI
- 2055 – selected to represent a year when WSI's single runway is expected to operate at near capacity.

For each reference year 7 different flight scenarios were considered to, of which 3 scenarios (No preference, Prefer Runway 05 and Prefer Runway 23) were identified to represent the worst case for potential air quality impacts. These 3 scenarios were selected for detailed assessment to examine the potential maximum air quality impacts associated with the project (refer to Section 12.3.4). A summary of the impact assessment approaches for both the air quality and GHG emissions assessments is outlined in the following sections.

12.3.1 Study area

12.3.1.1 Local air quality study area

The study area for the local air quality assessment generally considered an area within an approximate 10 km radius around the boundary of WSI. The topography of WSI and immediate surroundings are generally gently undulating with decreasing elevation to the east and south-east towards Thompsons Creek. Outside of WSI there are elevated ridges to the south-west and north-west. To the east of the site the terrain remains relatively flatter with some slight undulations. The Blue Mountains are located to the west with the terrain becoming elevated and complex to the west of the north flowing riverine channel. These terrain features influence the local wind distribution patterns and flows which are important for the dispersion and propagation of air emissions.

Figure 12.1 presents a 3-dimensional visualisation of the terrain features surrounding WSI. In terms of air quality, the emissions from aircraft that occur near to WSI and close to the ground are considered to be of primary relevance to the air quality assessment.

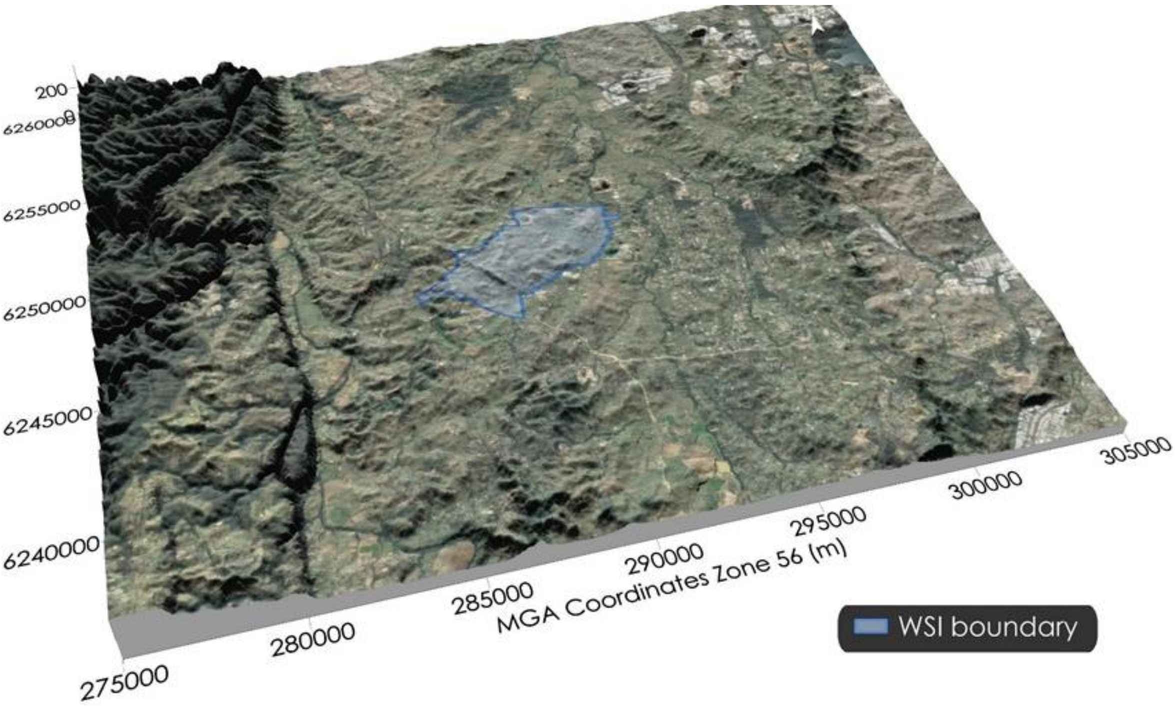

Figure 12.1 Representative visualisation of the local air quality study area topography

Sensitive receivers

Figure 12.2 presents the location of the project and key residential and community receivers considered in this assessment. For the assessment, community receivers included consideration of schools/child care centres, shopping locations, places of worship, parks, nature reserves and recreational/sporting club facilities. According to the Australian Bureau of Statistics 2021 census, there are more than 5.2 million residents in the Sydney Basin however, the selected receivers that were assessed were considered to represent the potentially most affected locations. The sensitive receivers are consistent with the locations assessed in the 2016 EIS. Receivers that represent the key potentially affected community and residential locations are summarised in Table 4.1 of Technical paper 2.

Table 4.1 of Technical paper 2 provides a comprehensive list of the key residential and community receivers considered as part of the assessment.

12.3.1.2 Regional air quality study area

The regional air quality modelling was undertaken at a larger scale than the local air quality assessment. The regional air quality assessment is focused on the effects of the project on ground level air quality spanning over the Sydney Basin. This area generally extends from Newcastle in the north to Shellharbour in the south, and as far west as Medlow Flat (east of Bathurst). An overview of the modelling area for the regional air quality assessment is shown in Figure 12.3.

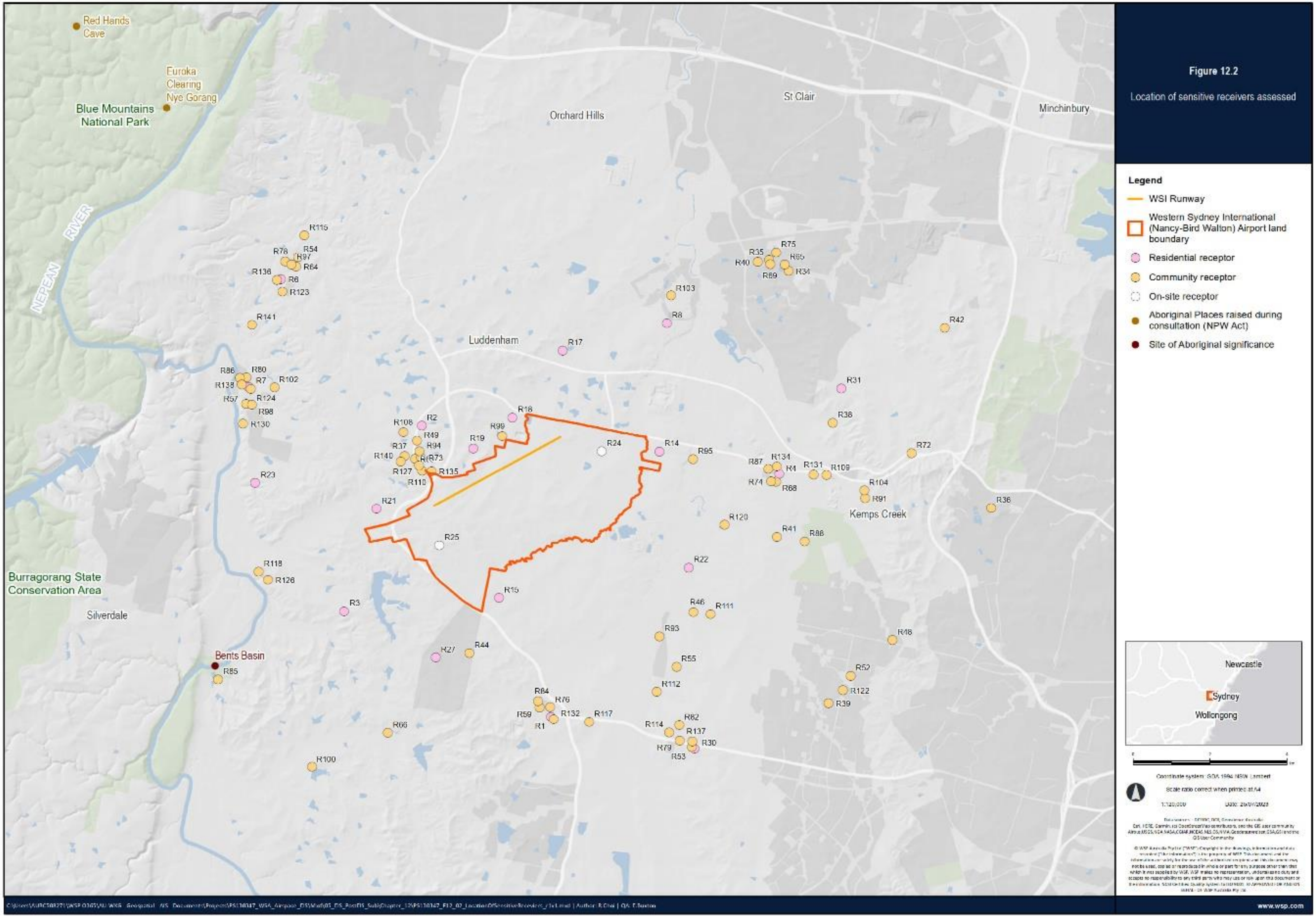

Figure 12.2 Location of sensitive receivers assessed

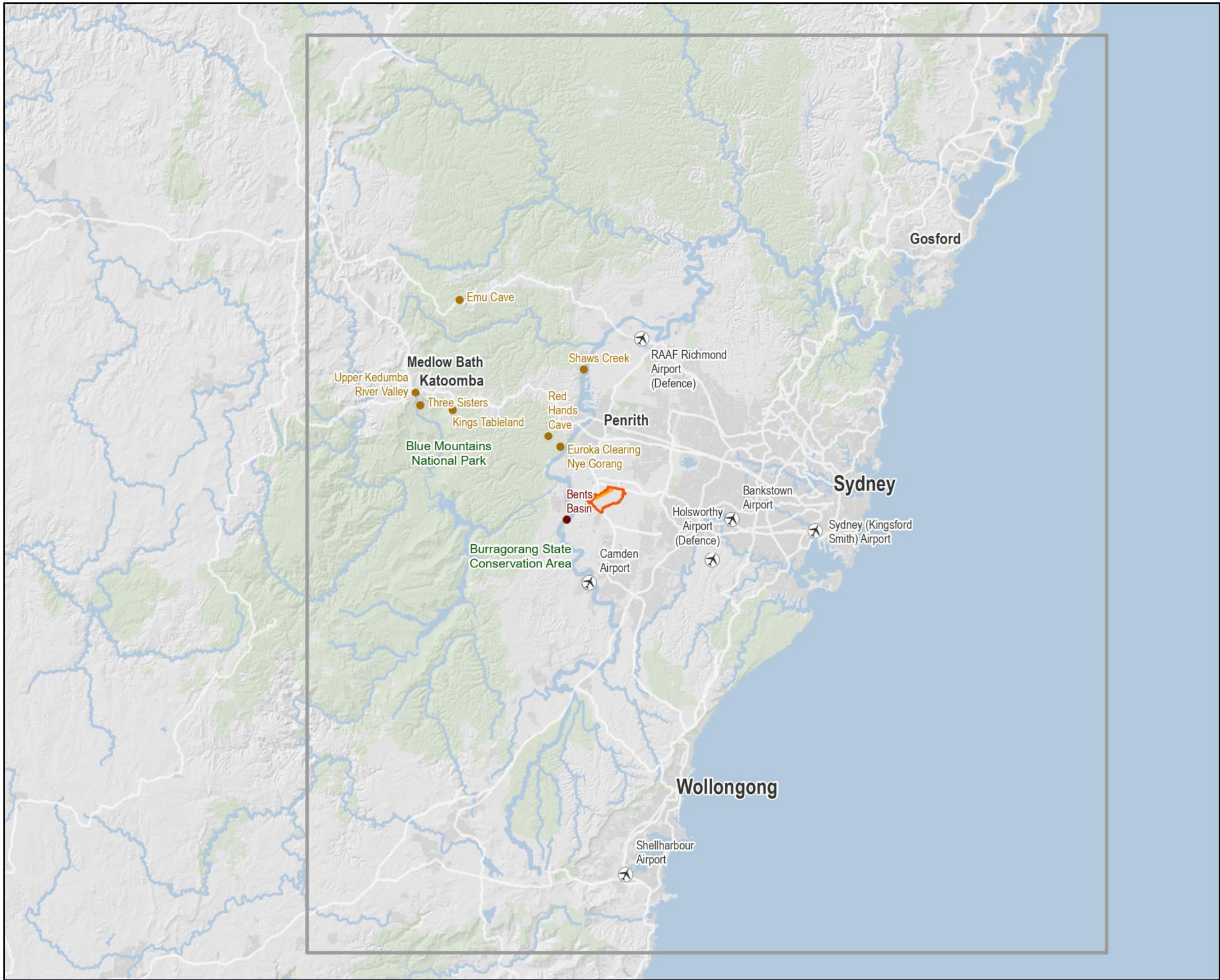

Figure 12.3

Overview of the regional study area

Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Regional study area
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 10 20 km

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:1,000,000 Date: 26/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

12.3.1.3 GHG emissions

For the assessment, the GHG emissions boundary was defined with reference to the methodology described in ISO 14064-1:2018 and the GHG Protocol (a partnership between the World Resources Institute and the World Business Council for Sustainable Development which provides standards, guidance, tools, and training for business and government to measure and manage climate-warming emissions). The calculation methodology adopted for LTO cycle emissions below 3,000 ft (914 m) was based on the International Civil Aviation Organization (ICAO) Document 9889, Air Quality Guidance Manual (latest edition) with the United States Federal Aviation Administration's (US FAA) Aviation Environmental Design Tool (AEDT) (Version 3e) used to model emissions in an extended cruise and descent cycle below 10,000 ft (3,048 m).

The use of engines to propel the aircraft forward during the take-off roll, in the airspace below 10,000 ft (3,048 m), and to guide an aircraft into land at WSI are the sources of GHG emissions that have been assessed for the project. Aircraft engines are classified as either gas turbine turbofans or turbo-prop engines fuelled with aviation kerosene (commonly referred to as Jet A-1 fuel).

The methodology from ACI's *Airport Carbon Accreditation* Application Manual (Issue 13, March 2023) and the ICAO Carbon Emissions Calculator (Version 11.1, June 2018) were also used to calculate full flight emissions from WSI to all destinations across its anticipated route network. Each departing flight in the projected demand schedules provided by WSA Co, including the individual aircraft types and flight distances to each destination across WSI's anticipated 2033 and 2055 route networks were modelled. Calculations were made of individual aircraft fuel consumption according to the destination airport they were flying to using the adjusted Greater Circle Distance[1] with emission factors from ICAO and the National Greenhouse Gas Accounts 2022 applied to calculate emissions of CO_2e in tonnes (tCO_2e).

The results of the aircraft engine GHG emissions modelling have been presented as total aggregated emissions in both assessment years (2033 and 2055), representing the anticipated tailpipe CO_2e emissions produced in the engine exhaust behind the aircraft using WSI's flight paths to destination airports across its anticipated route networks.

12.3.2 Assessment criteria

This section identifies the applicable national air quality standards and state impact assessment criteria in order to assess acceptable impacts or compliance by the project. It should be noted that for some air pollutants, the standard or criteria may already be exceeded in the existing environment, and this does not indicate that the project would have an unacceptable effect. The sections below also identify both Australian Government and NSW air quality criteria, noting that the NSW criteria do not formally apply to the project.

12.3.2.1 Gaseous pollutants and particulate matter performance criteria

The air quality criteria adopted for use in the air quality assessment are principally those defined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* EPA Approved Methods (NSW EPA, 2022). The NSW EPA Approved Methods account for various pollutant criteria and averaging periods from multiple sources, including the Ambient Air Quality NEPM.

A summary of the adopted air quality goals/criteria and their source is provided in Table 12.2 (including individual odorous air pollutants – toluene and xylene). In each case, where several performance criteria are available, the more stringent criterion has been identified.

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1 Greater Circle Distance is the distance between origin and destination airports is derived from latitude and longitude coordinates originally obtained from the ICAO Location Indicators database.

Table 12.2 NSW EPA air quality impact assessment criteria

Pollutant	Averaging period	Percentile	Criterion	Criterion	Location
Total suspended particulates (TSP)	Annual	100	90 µg/m^3	–	Receiver
Particulate matter ≤10µm (PM_{10})	Annual	100	25 µg/m^3	–	Receiver
	24-hours	100	50 µg/m^3	–	Receiver
$PM_{2.5}$	Annual	100	8 µg/m^3	–	Receiver
	24-hours	100	25 µg/m^3	–	Receiver
Deposited dust	Annual	100	2 g/m^2/month [a]	–	Receiver
	Annual	100	4 g/m^2/month [b]	–	Receiver
CO	15-minutes	100	100 mg/m^3	87 ppm	Receiver
	1-hour	100	30 mg/m^3	25 ppm	Receiver
	8-hours	100	10 mg/m^3	9 ppm	Receiver
SO_2	1-hour	100	286 µg/m^3	0.1 ppm	Receiver
	24-hours	100	57 µg/m^3	0.02 ppm	Receiver
NO_2	1-hour	100	164 µg/m^3	0.08 ppm	Receiver
	Annual	100	31 µg/m^3	0.015 ppm	Receiver
O_3	8-hours	100	139 µg/m^3	0.065 ppm	Receiver
Benzene	1-hour	99.9	0.029 mg/m^3	0.009 ppm	Boundary
Benzo[a]pyrene	1-hour	99.9	0.0004 mg/m^3	–	Boundary
Formaldehyde	1-hour	99.9	0.02 mg/m^3	0.018ppm	Boundary
Toluene	1-hour	99.9	0.36 mg/m^3	0.09ppm	Receiver
Xylene	1-hour	99.9	0.19 mg/m^3	0.19ppm	Receiver

Notes: µm = micrometre, g/m^2/month = grams per square metre per month, µg/m^3 = micrograms per cubic metre, mg/m^3 = milligrams per cubic metre, ppm = parts per million

Deposited dust pollutant:
[a] maximum increase in deposited dust level.
[b] maximum total deposited dust level.

The Ambient Air Quality NEPM also includes standards appliable from 2025 onwards for SO_2 of 0.075 ppm (current standard as shown in Table 12.2 is 0.1 ppm) and also 2025 goals for $PM_{2.5}$ of 20 µg/m^3 for a one day averaging period and 7 µg/m^3 for one year averaging period (currently 25 µg/m^3 and 8 µg/m^3 respectively). It is important to note that NEPM air quality standards are not designed to be applied to specific projects. The NEPM standards apply to the average exposure to air pollutants of the general population, in each state.

Additionally, in order to include consideration of the potential health issues that may arise from exposure to air toxics, 'investigation levels' have been identified for 5 pollutants in ambient air under the Air Toxics NEPM. These investigation levels are listed in Table 12.3.

Table 12.3 Advisory standard air toxic investigation levels applicable to the project

Pollutant	Averaging period	Investigation level
Benzene	1 year	0.003 ppm
Benzo[a]pyrene	1 year	0.3 ng/m³
Formaldehyde	24-hours	0.04 ppm
Toluene	24-hours	1 ppm
	1 year	0.1 ppm
Xylene	24-hours	0.25 ppm
	1 year	0.2 ppm

Source: Schedule 3 (Table 2), NEPC, 2004

12.3.2.2 Odour performance criteria

For activities with potential to release significant odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point to where odour reaches surrounding receivers. This approach allows the air dispersion model to produce results in terms of odour units (OUs). The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose.

The NSW EPA Approved Methods (NSW EPA, 2022) provides ground-level concentration criteria for complex mixtures of odorous air pollutants, taking account of population density in a given area. Table 12.4 lists the odour assessment criteria across different population densities. This criterion has been refined to consider population densities of specific areas and is based on a 99th percentile of dispersion model predictions calculated as 1-second averages (nose-response time).

Table 12.4 Impact assessment criteria for complex mixtures of odorous air pollutants (nose-response-time average, 99th percentile)

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Source: NSW EPA, 2022

12.3.2.3 GHG emissions – scopes and sources

In the GHG Protocol (WRI, 2004), emissions are categorised into 3 scopes, and each are reported on separately. These scopes are defined in Table 12.5 and provide a means for identifying the ownership and control of emissions sources and thus responsibility for managing the emissions.

Table 12.5 GHG emission scope and sources

Scope	Description
1	Direct GHG emissions that occur from sources owned and/or controlled by the reporting company (i.e., airline or airport operator), including emissions such as from the combustion of fuels in owned/controlled generators including back-up (emergency) systems, fire extinguishers and fleet vehicles and for airlines and freight companies, the aircraft they operate both in the air and on the ground (in the case of an airline company or air freight operator).
2	Indirect emissions from the offsite generation of purchased electricity consumed by the reporting company (i.e., airline or airport operator).
3	All other indirect emissions, which are the consequence of the reporting company's (i.e., airline or airport operator) activities, but occur from sources not owned and/or controlled by the reporting company, including ground transport, third party energy use, third party fleet vehicles, staff commute and business travel, offsite waste/water treatment, and aircraft engine use on the ground (onboard aircraft auxiliary power unit, ground running, taxiing) and in the air (take-off roll, initial climb, final approach and landing roll) within the ICAO defined LTO cycle below 3,000 ft (915 m), etc.

To ensure a consistent approach across each impact assessment presented in this EIS, project-specific criteria have been developed for the assessment of GHG emissions produced in the engine exhaust behind aircraft using WSI's flight paths and route network as described in Table 12.6.

Table 12.6 Aircraft GHG emissions significance criteria

Impact severity	Description	Other comments
Major	A significant increase in annual GHG emissions representing >1% of Australia's total annual GHG emissions, or >1% of NSW's total annual GHG emissions, excluding the Land Use, Land-Use Change and Forestry (LULUCF) sector[1].	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention globally, affecting the Australian Government's ability to comply with the Paris Agreement.
High	An increase in annual GHG emissions representing >0.5% but <1% of Australia's total annual GHG emissions, or >0.5% but <1% of NSW's total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention nationally, affecting the Australian Government's ability to comply with the Paris Agreement.
Moderate	An increase in annual GHG emissions representing >0.1% but <0.5% of Australia's total annual GHG emissions, or >0.1% but <0.5% of NSW's total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention state-wide, affecting the NSW Government's delivery of a net zero economy by 2050.

Impact severity	Description	Other comments
Minor	An increase in annual GHG emissions representing <0.1% of Australia's total annual GHG emissions, or <0.1% of NSW's total annual GHG emissions, excluding LULUCF.	Comparison with latest publicly available GHG emissions inventories. Exceedance of these levels assumes negative reputation and media attention state-wide and locally, affecting local efforts to delivery of a net zero economy by 2050 for Western Sydney.
Negligible	No net annual increase in Australian aviation's share of total annual GHG emissions, or NSW's aviation share of total GHG emissions when measured against 2019 levels (carbon neutral growth).	

1. Accounts for emissions from and removals by human-induced activities in forest lands, croplands, grasslands, wetlands and settlements, including land clearing, timber harvesting, wildfires and prescribed fires (NSW Department of Planning and Environment).

12.3.3 Impact assessment approach

12.3.3.1 Air quality

Separate technical air modelling assessment approaches were undertaken for the local and regional air quality impact assessments. The local air quality impact assessment focused on the potential for air quality impacts to arise in the immediate vicinity of WSI and assess a range of potential air pollutants that would be directly emitted into the air and primarily affect ground-based sensitive receivers. The regional air quality impact assessment focuses on the potential for air pollutants to affect the regional air quality environment in the Sydney Basin, and specifically considers the potential formation of secondary pollutants, in particular ground level O_3. The regional assessment has focussed on any additional formation of O_3 that may arise from the direct emissions of aircraft take-offs and landings.

Local air quality

The local air assessment utilised well established, commonly used modelling methods to calculate the dispersal of air pollutants associated with the project. The assessment follow the NSW EPA guidelines set out in *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2022), and the NSW EPA document *Generic Guidance and Optimum Model Setting for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'* (TRC Environmental Corporation, 2011).

In summary, the local air quality assessment adopted the following approach:

- generation of meteorological files
- identification and collection of modelling inputs including:
  - aircraft emissions data from the US FAA's AEDT (Version 3e) software to develop emissions profiles of the proposed aircraft operations. AEDT is a software system that models aircraft performance in space and time to estimate fuel consumption, emissions, noise, and air quality effects.
  - background ambient air monitoring data and weather conditions
  - nearest sensitive receivers

- a quantitative assessment of the potential impacts associated with the project using CALPUFF air dispersion modelling in accordance with the NSW EPA Approved Methods with estimated emission rates for aircraft including:
  - Carbon Monoxide
  - Volatile Organic Compounds
  - Total Organic Gases
  - Oxides of Nitrogen
  - Sulphur Oxides
  - Particulate Matter
- a quantitative assessment of emission estimates generated by the project that arise below 1,000 ft (305 m)
- identifying mitigation measures.

Further details regarding the local air quality modelling methodology is provided in Section 3.1, Chapter 5 and Appendix A of Technical paper 2.

Regional air quality

This assessment has considered NO_2, SO_2, CO, $PM_{2.5}$, PM_{10} and O_3 at ground level within the regional study area.

For the assessment of ozone, the modelling for the regional assessment followed the current NSW EPA guidelines, specifically the *Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources* (NSW EPA, 2011). It is noted that this guideline is not strictly applicable to the project as it applies to stationary sources, however it is the only generally suitable O_3 guideline available that is specifically designed for use in NSW.

As noted in Table 12.2, the current impact assessment criteria for O_3 is based on an 8-hour average (which was adopted by the NSW EPA in late 2022 and is based on the NEPM reporting standard that came into force in May 2021) which is considered to be more stringent than the previous one hour and 4-hour average criteria. For completeness, all 3 averaging periods were considered as part of the regional air quality methodology.

Unlike the local air quality assessment, only selected periods of high O_3 impact potential were analysed. This is in accordance with the NSW EPA guidelines. The periods of high O_3 impact potential arise in the warmer seasons, when the conditions are most conducive to the chemical reactions in the atmosphere that form O_3.

The *NSW EPA Air Emissions Inventory* (NSW EPA, 2019) was used to characterise existing sources of air emissions in the Sydney Basin air shed, including biogenic emissions (from plants). The model was run without including the potential new emissions from WSI and compared with the measured data as part of the due diligence or verification of model performance. The verified regional model was then re-run with the WSI emissions included, and the results compared with the base case to determine the effects on air quality that may arise due to the project.

Further details regarding the local air quality modelling methodology is provided in Section 6.1.2 and Appendix B of Technical paper 2.

Modelling limitations

The AEDT model only utilises verified emission performance for existing aircraft. It is likely that more efficient and less polluting aircraft will be developed and become operational in the timeframes considered in this assessment. The model as a result may overestimate likely emissions from aircraft in the future scenarios.

The projections in the *NSW EPA Air Emissions Inventory* do not extend to 2055, and there is a high degree of uncertainty regarding emissions from transport and other sources at that time. For example, it is reasonable to assume a larger proportion of electric vehicles in the NSW fleet by 2055 and that NO_2 contributions from vehicle emissions would reduce. These changes have not been accounted for in this assessment.

Increases in global temperatures may increase ozone reactions in the future, provided there is sufficient NO_x present to sustain these reactions noting that the de-carbonisation of energy and transport sectors will likely limit future fuel combustion. The CSIRO projections (Cope et al., 2008) for 2020–30 do indicate more widespread but not more frequent O_3 impacts, which aligns with O_3 levels measured in 2021. While it is likely that more widespread O_3 impacts may arise in the future, this cannot be known with a high degree of certainty.

12.3.3.2 GHG emissions

Sources of GHG emissions from aircraft occur during all phases of flight. The assessment projected the aircraft engine GHG emissions for:

- the LTO cycle below 3,000 ft (914 m) above ground level (in accordance with the definition in Document 9889, Air Quality Guidance Manual (2020 edition)
- an extended climb and descent cycle below 10,000 ft (3,048 m) above ground level to capture GHG emissions from additional phases of flight as aircraft climb to 10,000 ft or descend from this altitude to their landing threshold
- all one-way flights (departures only) to each destination across WSI's anticipated route network in 2033 and 2055.

Absolute and intensity based GHG emissions from aircraft engine operations for regional, domestic and international RPT and freight services were estimated in each assessment year (2033 and 2055).

The purpose of the assessment was to calculate GHG emissions produced in the engine exhausts behind the aircraft using WSI's flight paths and route network in the early years of operation after opening (in 2033) and when single runway operations approach capacity (in 2055). This assessment focused on the potential impacts of the project itself (flight path impacts from take-off to landing below 10,000 ft (3,048 m) and all flights departing from WSI to each destination airport across its anticipated route network), excluding GHG emissions associated with one-way flights from each origin airport to WSI, aircraft engine use on the ground (taxiing operations or use of the onboard aircraft auxiliary power unit), other airfield operations (engine ground running), and airside ground support equipment and other vehicles required to handle/service an aircraft turnaround. The assessment also excluded the GHG emissions associated with all other landside or terminal activities.

The calculation of aircraft engine GHG emissions primarily comprised 3 main parameters:

1. **Time in mode.** Being the time, usually measured in seconds, that the aircraft engines operate at an identified engine power (thrust) setting in one of flight phases identified in the assessment.
2. **Main engine fuel flow.** The unit mass of fuel burned, kilograms of fuel, for a specific engine in each phase of flight identified in the assessment.
3. **Main engine emission index.** Represents the units of CO_2-equivalent (CO_2e) emitted per kilogram of fuel burned. Multiplying the mode-specific emission index by the time in mode-specific fuel flow yields a mode-specific CO_2e rate in units of kilograms or tonnes per second.

CO_2e is the term used for describing different GHGs in a common unit. For any quantity and type of GHG, CO_2e signifies the amount of CO_2 which would have the equivalent global warming potential.

The aggregation of GHG emissions was then calculated based on the projected fleet mix and number of flight operations at WSI. Figure 12.4 illustrates the approach to calculate the aircraft engine GHG emissions.

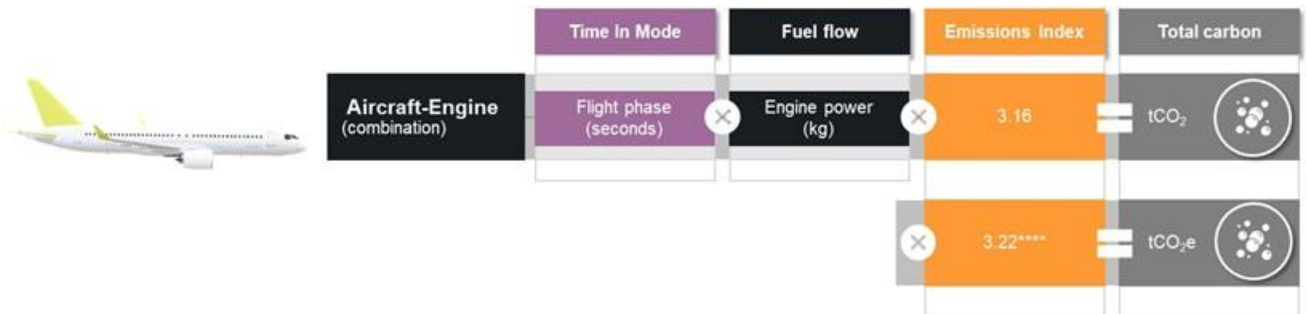


Figure 12.4 Calculation approach for GHG emissions from aircraft main engine use

The following CO_2e emissions scenarios were considered as part of the assessment:

- total GHG emissions for all phases of flight (both arriving and departing) below 3,000 ft (914 m)
- total GHG emissions for all phases of flight (both arriving and departing) below 10,000 ft (3,048 m)
- total GHG emissions (expressed in tonne CO_2e): all projected one-way flights to each destination airport across WSI's anticipated route network (departures only).

Further details regarding the methodology and assumptions associated with the GHG assessment are provided in Chapter 6 of Technical paper 3.

12.3.4 Aircraft emissions and assessment scenarios

The different aircraft expected to be in operation at WSI would generate varying levels of emissions depending on the aircraft manufacturer, the size of the aircraft and the number of available engines, destination to be served, payload and weight, individual pilot techniques and meteorological conditions at the time of flight. Aircraft emissions arise from the operation of the aircraft engines and the rate of emissions are governed by the engine power (thrust) settings during the different phases of flight in the LTO cycle below an altitude of 3,000 ft (914 m). These phase of flight include:

- Taxi/idle mode – the taxiing and idling operations of arriving and departing aircraft on the ground
- Take-off mode – the period between commencement of acceleration on the runway and the aircraft reaching a height of 656 ft (200 m)
- Climb-out mode – period between 656 ft (200 m) and 3,000 ft (914 m) above ground level, and
- Approach mode – period between 3,000 ft (914 m) to ground level for arrivals.

12.3.4.1 Assessment scenarios

The assessment scenarios used for the assessment of emissions impacts (for air quality) were the same as those utilised for the noise impact assessment, comprising a total of 7 overall modes of operation (refer to Section 11.5.6.1 and Table 11.4). Similar to the noise assessment, the air quality modelling focused on 3 modes of operation comprising:

- **No preference** – No preference to Runway 05 or Runway 23. Aircraft emissions from flight path use in this scenario were considered only for 2033. This scenario was considered to be comparable with the previous 2016 EIS and was used to assess relative differences arising from the application of current aircraft fleet emissions to 50/50 runway split scenario of the 2016 EIS.
- **Prefer Runway 05** – Preference to the operation of Runway 05 (day) and preference to RRO (night). Aircraft emissions from flight path use under this scenario was considered for both 2033 and 2055 in the assessment.
- **Prefer Runway 23** – Preference to the operation of Runway 23 (day) and preference to RRO (night). Aircraft emissions from flight path use under this scenario was considered for both 2033 and 2055 in the assessment.

Their reasons for selection of these 3 scenarios were similar to those for the noise assessment being:

- where no preference was given to a runway mode, runway use is balanced in terms of runway use and runway-end exposure. This indicated that both runway ends are exposed to a similar proportion of arrivals and departures on an annualised basis
- the outer bounds of runway usage (and by implication the extents of the emissions exposure) is defined by Prefer Runway 23 (82 per cent on Runway 23) and Prefer Runway 05 (74 per cent on Runway 05). However, both runway ends would experience a balanced exposure based on total movements. This indicated that these scenarios would primarily vary in terms of the type of operation (arrival or departure), not in terms of total movements
- Prefer Runway 05 and Prefer Runway 23 introduce the RRO mode of operation during the night time (11 pm to 5:30 am) – arrivals on Runway 05 and departures on Runway 23.
- all possible scenarios fell somewhere between the outer bounds in terms of runway use.

Only the more impacting scenarios from 2033 were selected for assessment in 2055 (i.e., the no preference scenario was not assessed in 2055).

12.4 Existing environment

12.4.1 Climatic and meteorological conditions

Long term climatic data collected at the Bureau of Meteorology weather station at Badgerys Creek Automatic Weather Station (Station Number 067108) were analysed to characterise the local climate in the proximity of the project. In summary, the weather data indicated that:

- January is the hottest month with a mean maximum temperature of 30.2 degrees Celsius and July is the coldest month with a mean minimum temperature of 4.1 degrees Celsius
- rainfall is higher during the first half of the year, with an annual average rainfall of 675 mm over 69.2 days, with March being the wettest month and July the driest
- for the period reviewed, winds are varied and predominantly occur from the southwest and the west-southwest and are typically influenced by the topography of the Sydney Basin.

Further detail regarding the existing climatic conditions is presented in Section 4.2 and 4.3 of Technical paper 2.

12.4.2 Ambient air quality

Background air quality levels from local DPE monitoring stations at Bringelly, St Marys and Camden were used to represent the background levels surrounding WSI (providing monitoring data between 2014 and 2021). The main sources of air pollutants in the wider area surrounding WSI include industrial and commercial operations and local anthropogenic activities such as wood heaters and motor vehicle exhaust. Historically, adverse air quality conditions arise from time to time due to extraordinary events such as dust storms and bushfires.

In general, the background levels indicate:

- the annual average PM_{10} concentrations for all monitoring stations reviewed across the monitoring period were below the relevant NSW EPA criterion of 25 µg/m³. Identified periods of elevated PM_{10} levels typically corresponded with regional dust events and bushfires, particularly evident in 2019/ 2020
- annual average $PM_{2.5}$ concentrations for all monitoring stations across the monitoring period reviewed were below the relevant NSW EPA criterion of 8 µg/m³ except for all monitors in 2019 and the Bringelly monitor in 2020. The likely cause of the elevated annual levels at the monitors are attributed to bushfire events, wood smoke from domestic wood heaters and automobile exhaust
- the annual average NO_2 concentrations for all monitoring stations across the monitoring period reviewed were below the relevant NSW EPA criterion of 62 µg/m³
- the annual average SO_2 concentrations for the Bringelly monitoring station was below the NSW EPA criterion of 60 µg/m³
- the maximum 1-hour average CO concentrations for all monitors during the review period are well below the NSW EPA criterion
- there were 5 days in 2021 with O_3 levels recorded over the 8-hour O_3 standard at one or more stations within NSW.

Background air quality levels from the nearby DPE monitoring stations were used to represent the background levels surrounding WSI. Table 12.7 presents a summary of the applied background levels.

Table 12.7 Summary of background air quality levels

Pollutant	Averaging period	Background level	Source
$PM_{2.5}$	24-hours	21 µg/m³	Maximum value below the criterion of 25 µg/m³ recorded at the Bringelly monitor for 2020, excluding exceptional event days (NSW DPIE, 2021).
	Annual	7.6 µg/m³	Average level recorded at Bringelly monitor for 2017, 2018 and 2021. These years are not affected by significant bushfire events.
PM_{10}	24-hours	43.5 µg/m³	Maximum value below the criterion of 50 µg/m³ recorded at the Bringelly monitor for 2020, excluding exceptional event days (NSW DPIE, 2021).
	Annual	18.8 µg/m³	Annual average Bringelly monitor for 2020.
NO_2	1-hour	OLM Method [1]	NO_2 and O_3 data from Bringelly monitor for 2020 applied.
	Annual	OLM Method	NO_2 and O_3 data from Bringelly monitor for 2020 applied.
SO_2	1-hour	80 µg/m³	Maximum value recorded at the Bringelly monitor for 2020.
	24-hours	10.3 µg/m³	Maximum value recorded at the Bringelly monitor for 2020.
CO	1-hour	6,125 µg/m³	Maximum value recorded at the Camden monitor for 2020.

1. The USEPA's Ozone Limiting Method (OLM) may be used to predict ground-level concentrations of NO_2. This method assumes that all the available O_3 in the atmosphere will react with NO in the plume until either all the O_3 or all the NO is used up. This approach assumes that the atmospheric reaction is instant. In reality, the reaction takes place over a number of hours. (NSW EPA, 2022)

12.4.3 GHG emissions

GHGs are gases that trap heat in the atmosphere, with key contributors including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Water vapor is also a product of jet fuel consumption, making up about 30 per cent of the exhaust. The presence of water vapour in the exhaust plume from an aircraft has an indirect impact by contributing to the formation of contrails.

For a single, comparable value of GHG emissions, the total emissions of all emitted gases are converted to CO_2e. The combustion or burning of jet fuel (kerosene) emits various gases and particles referred to as GHGs. CO_2 is the largest component of aircraft engine GHG emissions, accounting for approximately 70 per cent of the engine exhaust. The amount of GHG emitted from aircraft engine use is directly related to the amount of fuel consumed.

12.5 Assessment of impacts

12.5.1 Air quality

12.5.1.1 Local air quality

The dispersion modelling predictions for each assessed scenario (refer to Section 12.3.4.1) in the local air quality assessment are summarised in this section. The results presented include those for:

- the project in isolation (incremental impact)
- the project with other approved sources (i.e., the ground-based operations approved in 2016) and background levels (cumulative impact).

No exceedances were identified for the 2033 scenario, with only minor exceedances identified for the 2055 scenario. The results indicate the project would not result in any tangible or significant impacts above the applicable criteria, noting that the recent, more stringent NSW EPA air quality criteria were applied to the assessment.

A summary of the results and discussion of the significance of the potential impacts is described in the following sections. This presents the maximum contribution from the project at an assessed residential receiver location (that is, the most impacted receiver). Further detailed assessment and modelling predictions, including the maximum contribution at other assessed receiver locations, are presented in Section 6.1 of Technical paper 2.

Particulate matter concentrations

Table 12.8 presents a summary of the predicted cumulative $PM_{2.5}$ concentrations for the project for 2033 and 2055. It is assumed that 100 per cent of the PM_{10} is assumed to be in the $PM_{2.5}$ size fraction, hence the PM_{10} and $PM_{2.5}$ incremental values are the same.

Predicted cumulative $PM_{2.5}$ concentrations for 2033 at the most impacted assessed receiver location indicates the predicted cumulative 24-hour average and annual average levels would be below all relevant criteria and the project would only make a small air quality contribution to the assessed receiver locations.

The predicted cumulative $PM_{2.5}$ annual average concentrations for 2055 at the most impacted receiver have been identified to be above the relevant criteria (refer to shaded boxes). This is primarily due to the assumed future background levels which are set at the current background levels and are already near to the criterion. The maximum annual average contribution of 0.32 µg/m^3 represents the effect of all flight activity associated with project).

The results indicate the effect of the project on annual average $PM_{2.5}$ is very small and would not result in any tangible effect on air quality.

Table 12.8 Summary of cumulative $PM_{2.5}$ concentrations (µg/m³)

	24-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Background level	21	21	21	21	21	7.6	7.6	7.6	7.6	7.6
Maximum value[1]	0.45	0.52	0.61	1.28	1.42	0.09	0.11	0.13	0.29	0.32
Estimated contribution from ground-based WSI operations	0.44	1.06	1.06	2.22	2.22	0.11	0.11	0.11	0.33	0.33
Cumulative level	21.9	22.6	22.7	24.5	24.6	7.8	7.8	7.8	**8.2**	**8.3**
Criterion	*25*	*25*	*25*	*25*	*25*	*8*	*8*	*8*	*8*	*8*

1. The maximum contribution from the project at the most impacted residential receiver

Table 12.9 presents a summary of the predicted cumulative PM_{10} concentrations for both 2033 and 2055. The results indicate the predicted cumulative 24-hour average and annual average levels would be below all relevant criteria for both average periods during both reference years.

Table 12.9 Summary of cumulative PM_{10} concentrations (µg/m³)

	24-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Background level	43.5	43.5	43.5	43.5	43.5	18.8	18.8	18.8	18.8	18.8
Maximum value[1]	0.45	0.52	0.61	1.28	1.42	0.09	0.11	0.13	0.29	0.32
Estimated contribution from ground-based WSI operations	0.51	1.13	1.13	4.18	4.18	0.11	0.11	0.11	0.63	0.63
Cumulative level	44.5	45.2	45.2	49.0	49.1	19.0	19.0	19.0	19.7	19.8
Criterion	*50*	*50*	*50*	*50*	*50*	*25*	*25*	*25*	*25*	*25*

1. The maximum contribution from the project at the most impacted residential receiver

NO_2 concentrations

Table 12.10 presents a summary of the predicted cumulative NO_2 concentrations for the project for both 2033 and 2055. The results indicate predicted cumulative 1-hour average and annual average levels would be below the relevant criterion in 2033. For 2055, the results indicate predicted cumulative 1-hour average levels would be above the relevant criterion of 164 µg/m³ at some receiver locations near the northern boundary and north-west of the WSI (refer to shaded boxes) and the annual average levels would be below the relevant criterion.

Table 12.10 Summary of cumulative NO_2 concentrations (µg/m³)

	1-hour average					Annual average				
	2033 Scenarios			2055 Scenarios		2033 Scenarios			2055 Scenarios	
	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23	Prefer Runway 05	Prefer Runway 23
Maximum value[1]	113.8	112.1	112.9	185.3	238.1	10.9	12.1	12.8	19.8	21.0
Estimated contribution from ground-based WSI operations	8.2	8.2	8.2	16.1	16.1	1.5	1.5	1.5	3.6	2.9
Cumulative level	121.9	120.3	121.0	**201.5**	**254.2**	12.3	13.5	14.3	23.4	23.9
Criterion	*164.0*	*164.0*	*164.0*	*164.0*	*164.0*	*31.0*	*31.0*	*31.0*	*31.0*	*31.0*

1. The maximum contribution from the project at the most impacted residential receiver

The elevated NO_2 levels are predicted to occur in the 2055 year as the single runway approaches capacity for the Prefer Runway 05 and Prefer Runway 23 scenarios. A key contributor to the elevated NO_2 levels in 2055 would be to the higher NO_X emissions associated with the aircraft operating at WSI during this year. The predicted levels of NO_2 are likely to be conservative (i.e., an overestimate of the like potential impacts) due to the following factors:

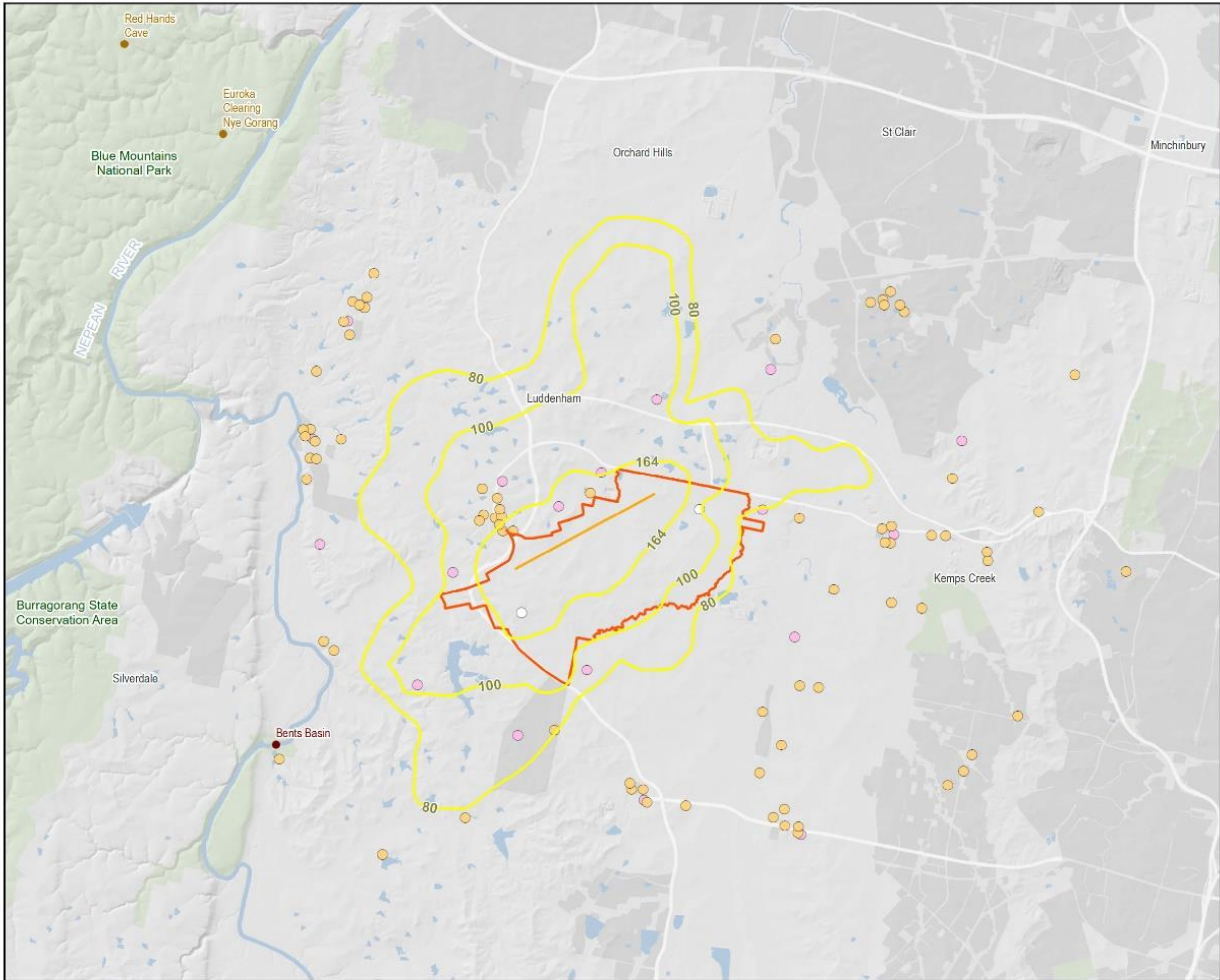
- the modelling used the more conservative Ozone Limiting Method approach for chemical transformations to predict the NO_2 levels
- the modelling assumed the worst case scenario for every hour of the year (which in reality may not occur in the predicted hour of maximum impact)
- the predicted impacts are infrequent, arising for only a few hours out of 8,760 hours in a year
- the modelling did not account for any improvement in fuel or engine emission control which may occur in the future.

The combination of the above factors means these predicted impacts are unlikely to actually occur. As the predicted results are likely to be conservative and it is likely there would be improvements in fuel efficiency (for aircraft and motor vehicles) and decreases in aircraft emissions in the future, it is reasonable to conclude that no significant impacts would arise.

Isopleth diagrams of the modelling predictions showing the predicted maximum 1-hour average NO_2 concentrations for Prefer Runway 05 and Prefer Runway 23 scenario in 2055 are shown as Figure 12.5 and Figure 12.6. The modelling predictions indicate elevated levels would primarily occur to the north-west of the Airport Site aligning with the length of the runway. The intensification of residential receivers in this location would be limited as the land has been zoned for Agribusiness and the area largely corresponds to land within the ANEC 20 contour and above. As outlined in Chapter 14 (Land use), new residential development and other noise sensitive developments are prohibited on land within the ANEC 20 contour, except in limited circumstances.

Figure 12.5

Predicted maximum 1-hour average NO2 concentrations (µg/m³) for 2055 – Prefer Runway 05



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted maximum 1-hour average NO2 concentrations (µg/m³) for 2055 – Prefer Runway 05
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

Data sources: DITRDC, DCS, Geoscience Australia

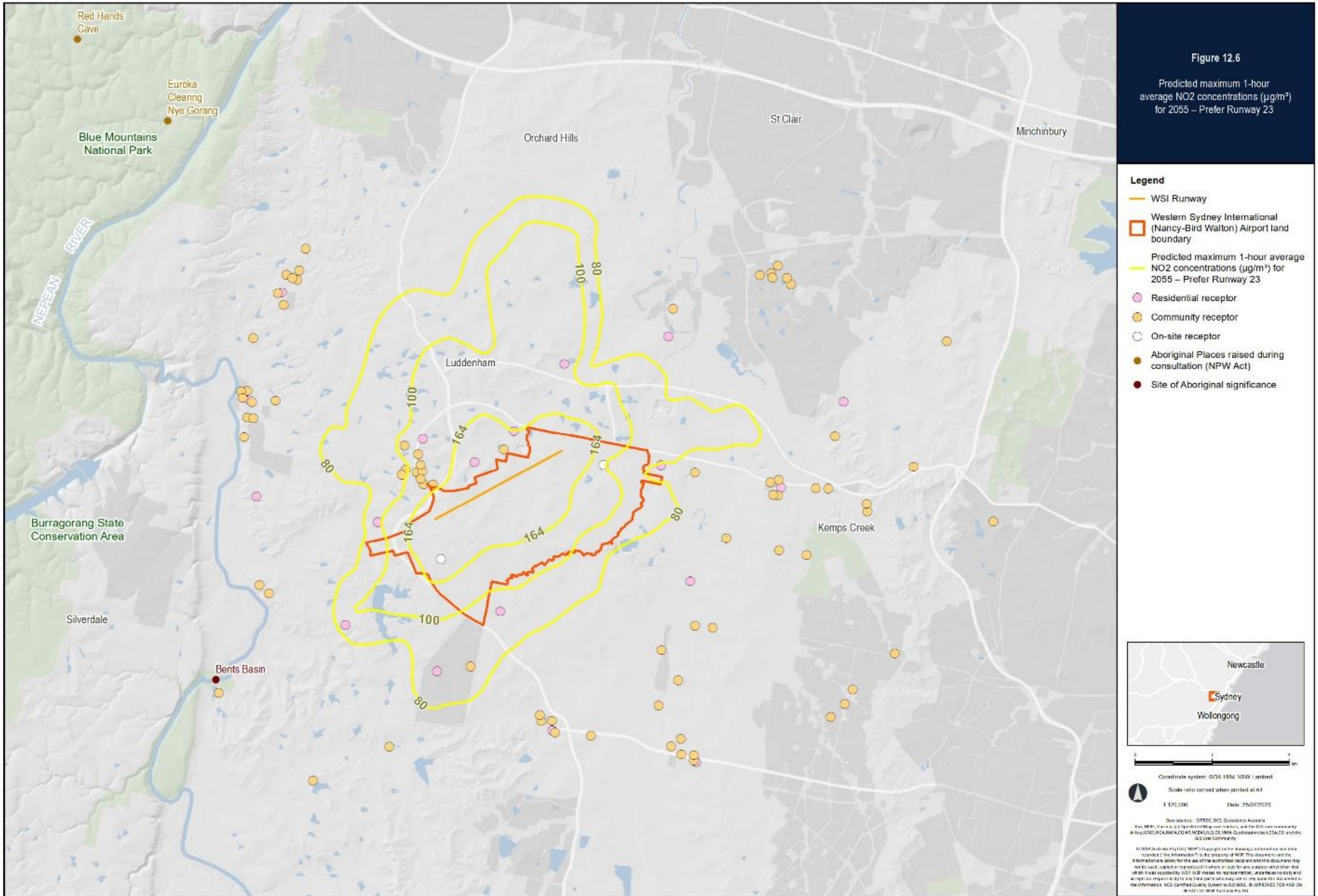


Figure 12.6

Predicted maximum 1-hour average NO_2 concentrations (µg/m³) for 2055 – Prefer Runway 23

SO_2 concentrations

Table 12.11 presents a summary of the predicted cumulative SO_2 concentrations for 2033 and 2055 in brackets. The results indicate predicted cumulative 1-hour average and 24-hour average levels are below the relevant criterion in 2033.

Table 12.11 Summary of cumulative SO_2 concentrations (µg/m³) – 2033 and (2055)

	1-hour average			24-hour average		
	No preference	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23
Background level	80.0	80.0	80.0	10.3	10.3	10.3
Maximum value[1]	41.4	33.5 (101.3)	43.4 (116)	5.2	5.5 (15.9)	6.0 (18)
Estimated contribution from ground-based WSI operations	5.8	5.8	5.8	0.4	0.4	0.4
Cumulative level	127.2	119.4	129.2	15.9	16.1	16.7
Criterion	*286.0*	*286.0*	*286.0*	*57.0*	*57.0*	*57.0*

1. The maximum contribution from the project at the most impacted residential receiver

CO concentrations

Table 12.12 presents a summary of the predicted cumulative CO concentrations for 2033 and 2055 in brackets. The results indicate predicted cumulative 15-minute average and 1-hour average levels are below the relevant criterion in 2033.

Table 12.12 Summary of cumulative CO concentrations (µg/m³) – 2033 and (2055)

	15-minute average			1-hour average		
	No preference	Prefer Runway 05	Prefer Runway 23	No preference	Prefer Runway 05	Prefer Runway 23
Background level	–	–	–	6,125	6,125	6,125
Maximum value[1]	512.7	512.7 (1,343)	539.3 (1,360)	388.6	388.6 (1,018)	408.7 (1,031)
Estimated contribution from ground-based WSI operations	839.5	839.5	839.5	620.5	620.5	620.5
Cumulative level	1,352	1,352	1,379	7,134	7,134	7,154
Criterion	*100,000*	*100,000*	*100,000*	*30,000*	*30,000*	*30,000*

1. The maximum contribution from the project at the most impacted residential receiver

VOC and odour concentrations

The predicted VOC concentrations for the project, including concentrations of benzene, formaldehyde, toluene and xylene were all predicted to be below the acceptable criteria for all considered receivers. The results indicate predicted 1-hour average levels are below the relevant criterion in both 2033 and 2055. The odorous air pollutants are below the relevant criterion which indicates the odour would be acceptable.

Assessment of deposited matter

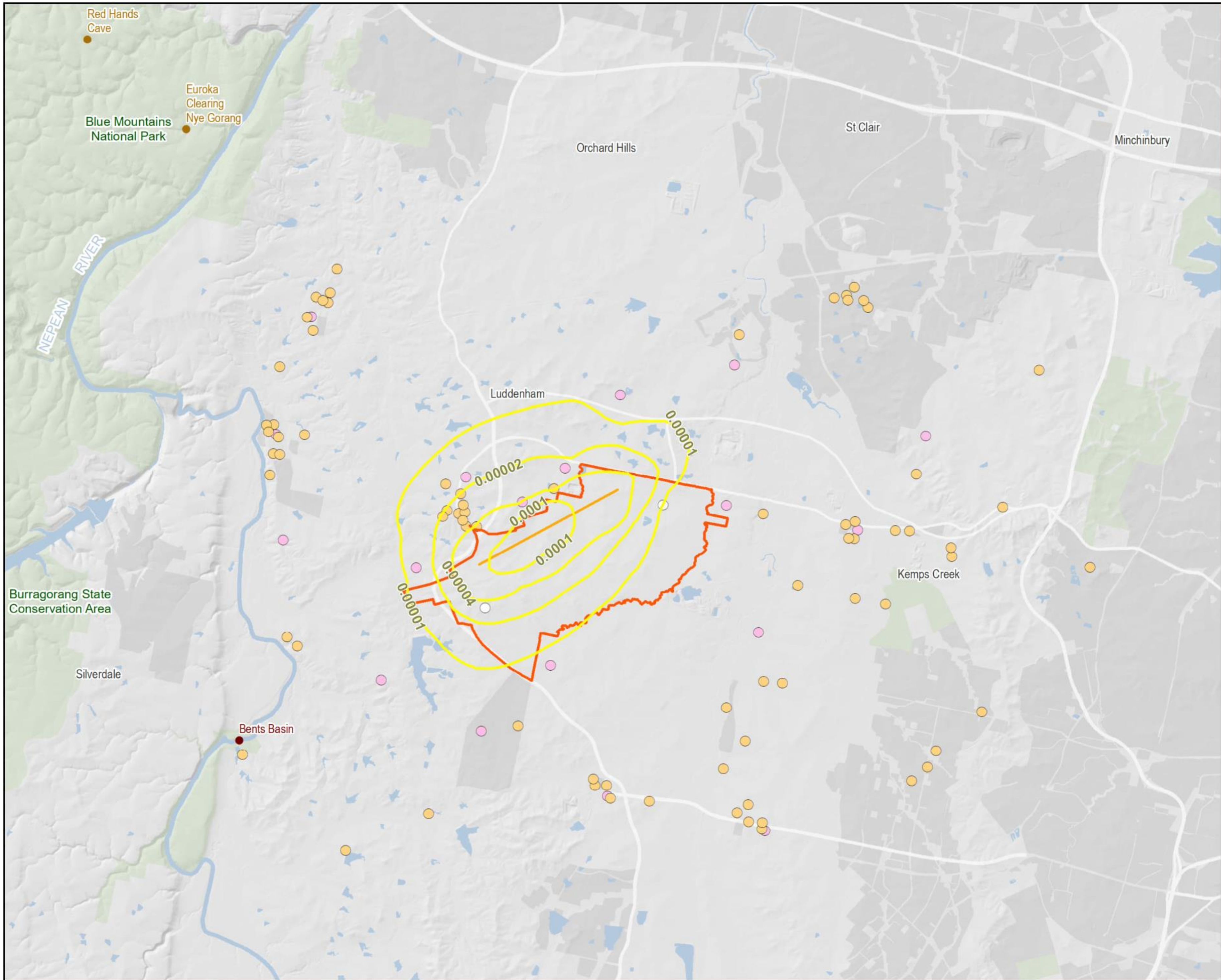
The predicted incremental deposited matter concentrations for the project in Prefer Runway 05 and Prefer Runway 23 scenarios during 2055 are presented as isopleths in Figure 12.7 and Figure 12.8, respectively. The levels due to the project range from 0.0001 to 0.00001 g/m²/month and are considered to be too low to be measurable or detectable.

Based on the total particulate matter emissions predicted for 2055, a dilution ratio was estimated and applied to other modelled pollutants (noting that the other modelled pollutants are gaseous, and no tangible deposition is likely, thereby representing a very large overestimate of potential surface deposition of these other pollutants). Despite this overestimation, the predicted likely maximum rates of deposition are very small and insignificant, with:

- 0.006 g/m²/month for CO
- 0.02 g/m²/month for NO_X
- 0.001 g/m²/month for SO_X.

Figure 12.7

Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 05



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 05
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

0 2 4 km

Coordinate system: GDA 1994 NSW Lambert

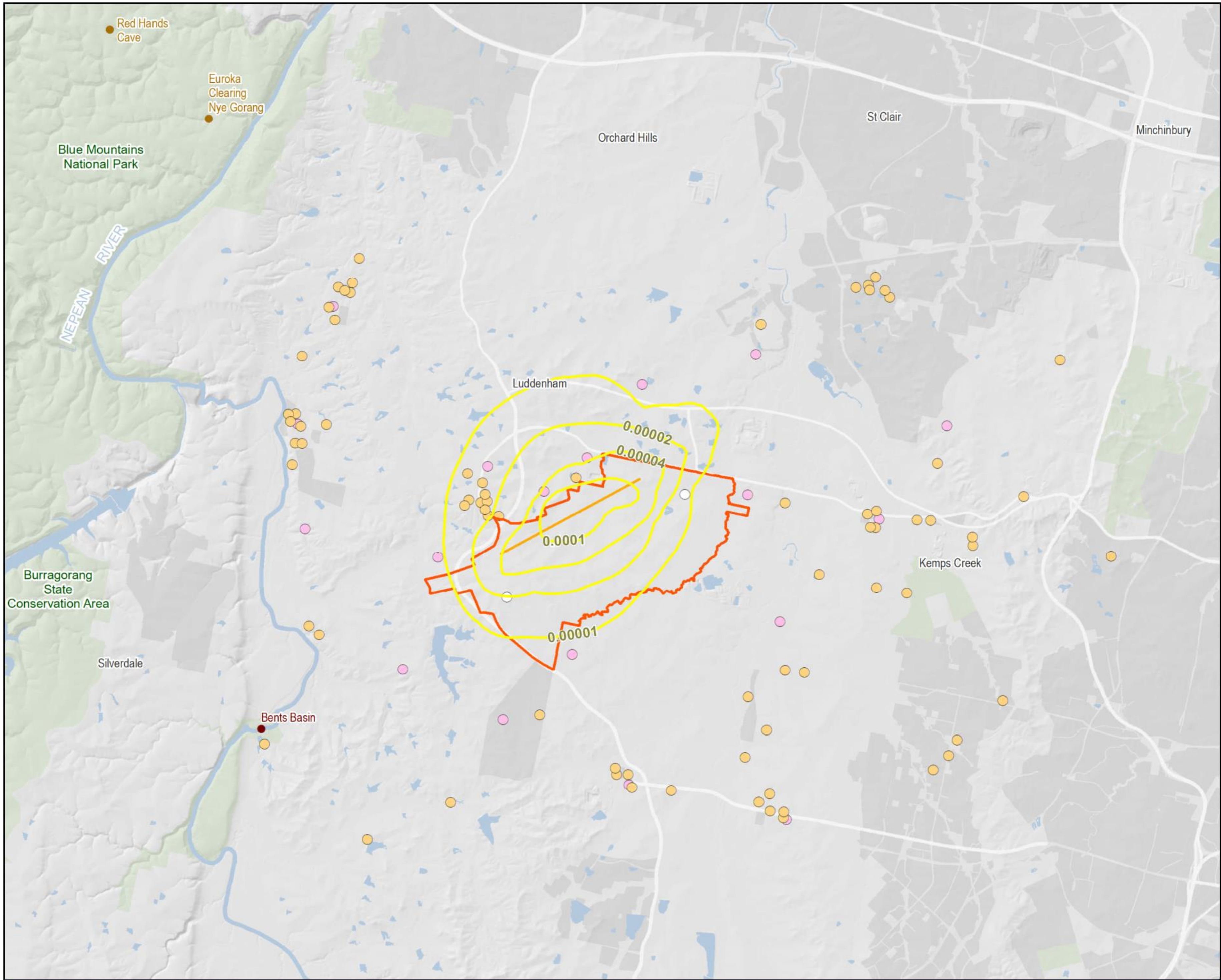
Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community
Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

Figure 12.8

Predicted incremental annual average deposited particulate matterconcentrations from the project (g/m²/month) for 2055 – Prefer Runway 23



Legend

- WSI Runway
- Western Sydney International (Nancy-Bird Walton) Airport land boundary
- Predicted incremental annual average deposited particulate matter concentrations from the project (g/m²/month) for 2055 – Prefer Runway 23
- Residential receptor
- Community receptor
- On-site receptor
- Aboriginal Places raised during consultation (NPW Act)
- Site of Aboriginal significance

Coordinate system: GDA 1994 NSW Lambert

Scale ratio correct when printed at A4

1:120,000 Date: 25/07/2023

Data sources: - DITRDC, DCS, Geoscience Australia
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Airbus,USGS,NGA,NASA,CGIAR,NCEAS,NLS,OS,NMA,Geodatastyrelsen,GSA,GSI and the GIS User Community

12.5.1.2 Regional air quality

The regional air quality assessment considered the results for the following modelled emission scenarios which were compared to an identified baseline level (i.e., existing emissions from all pollution sources across the Sydney Basin without the project) (refer to Section 6.2 of Technical paper 2) in order to determine the potential impacts of the project:

- 2033 – No Preference and Prefer Runway 05
- 2055 – Prefer Runway 05.

Maximum pollutant contours for O_3 (1-hour, 4-hour and 8-hour average), NO_2, SO_2, CO, $PM_{2.5}$ and PM_{10} for all assessed scenarios compared with the baseline are presented in Appendix D of Technical paper 2.

NO_2 concentrations

Figure 12.9 and Figure 12.10 presents the maximum 1-hour average NO_2 concentrations for the assessed 2033 and 2055 scenarios compared to the baseline scenario.

In 2033, the predicted emissions originating from the project would result in an increase in NO_2 concentrations in the vicinity of WSI. In 2033, the results of the No preference and Prefer Runway 05 scenarios are very similar which indicate that the runway mode of operation does not have any significant effect on the ground level concentrations. However, the choice of runway would ultimately concentrate emissions at one end of the runway or the other, and in certain prevailing wind conditions this could lead to slightly higher concentrations of pollutants in one area compared to another scenario. This effect however is highly localised and would not have significant bearing on the regional air quality.

Increases in NO_2 would generally be limited to a radius of around 5 to 6 km from WSI. This indicates that the contribution to ground level concentrations from the project is primarily due to aircraft near or at ground level during take-off and landing. Emissions released higher than a few hundred metres above ground level do not appear to have any significant influence on ground level concentrations.

In 2055, the assessment indicates emissions originating from the project would result in an increase in NO_2 concentrations in the vicinity of WSI. The assessment indicates that NO_2 concentrations are predicted to be above the criterion (0.08 ppm) adjacent to the runway, just outside the north-western section of WSI. This aligns with the local air quality modelling results (refer to Section 12.5.1.1) which show a similar scale of impact for NO_2.

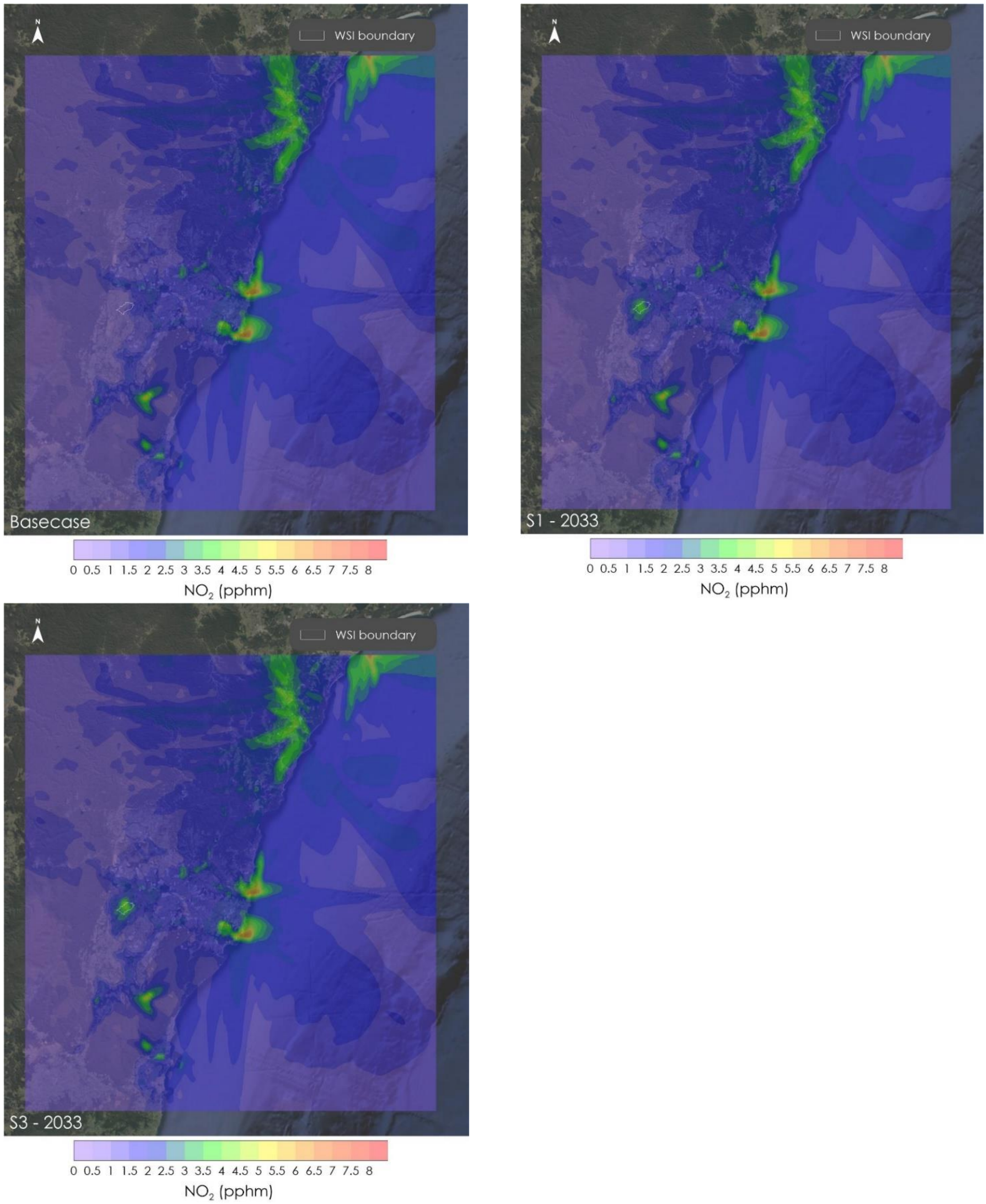

Figure 12.9 Maximum predicted 1-hour NO_2 concentrations for base case (without project) (top left), No preference (top right) and Prefer Runway 05 scenarios (bottom left) – 2033

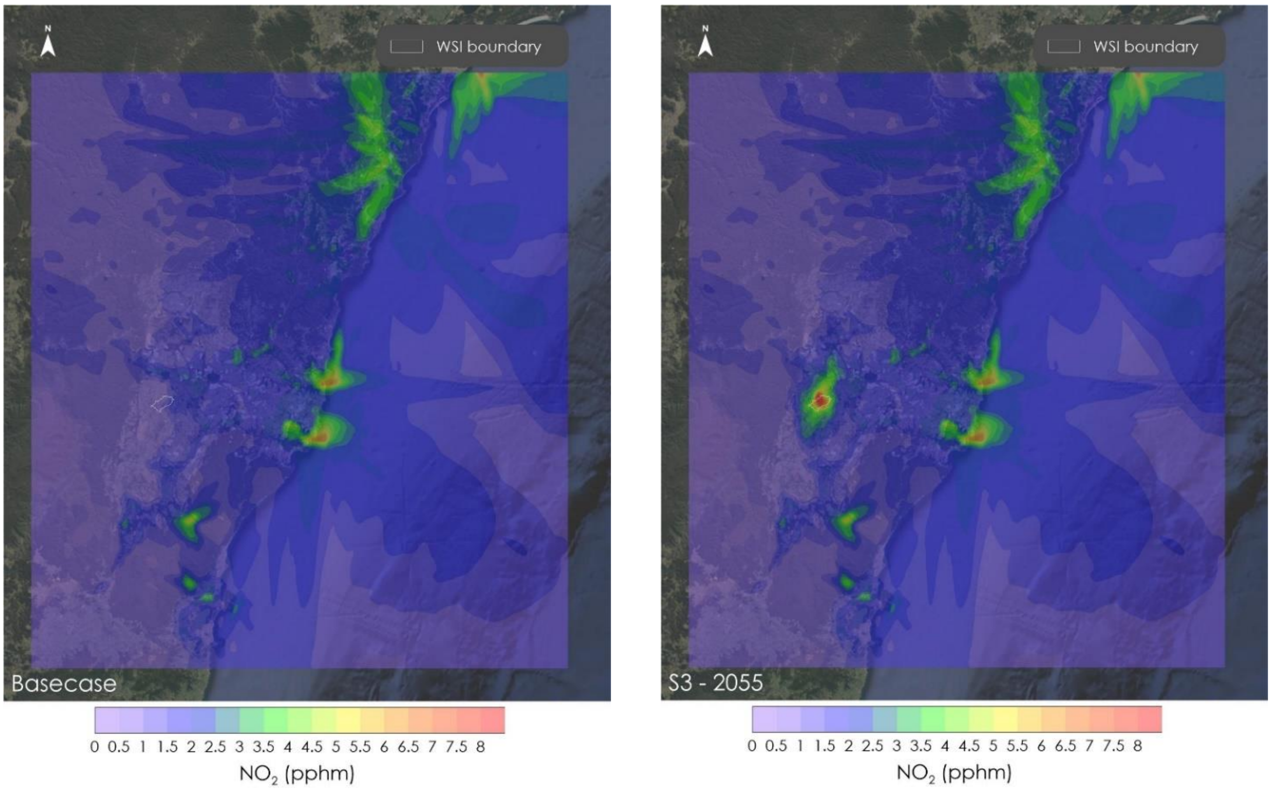

Figure 12.10 Maximum predicted 1-hour NO_2 concentrations for base case (without project) (left) and Prefer Runway 05 scenario (right) – 2055

O_3 concentrations

The assessment has considered the maximum O_3 concentration and change in O_3 concentrations due to the project for the modelled high O_3 period.

The results show that:

- in the locations where the maximum total O_3 concentration occurs, the project makes no significant difference to O_3 concentrations. The maximum change predicted with the project at these locations are:
  - in 2033, 0.1 parts per hundred million (pphm) for the maximum 4-hour and 8-hour averaging periods and 0.0 pphm for the maximum 1-hour average period in 2033
  - in 2055, up to 0.2 pphm for the 4-hour and 8-hour averaging periods, and 0.0 pphm for the maximum 1-hour average period
- on days where the maximum 8-hour average criterion is exceeded (6.5 pphm), the maximum change predicted with the project is 0.00 pphm in 2033 and 0.01 pphm in 2055
- in the locations where the maximum change occurs with the project (i.e., locations away from where the maximum total O_3 concentrations occur), the project would not result in the exceedance of the maximum 8-hour average criterion. The maximum change predicted with the project at these locations are:
  - in 2033, 0.4, 0.2 and 0.2 pphm for the 1-hour, 4-hour and 8-hour averaging periods, respectively
  - in 2055, 0.8, 0.6 and 0.6 pphm for the 1-hour, 4-hour and 8-hour averaging periods, respectively.

Other pollutants

For all other pollutants in 2033 and 2055, the impact of emissions from the project on the existing pollutant concentrations would be negligible and would be unlikely to be discernible above background concentrations.

12.5.2 GHG emissions

Aircraft engines produce GHG emissions with a significant proportion emitted at higher altitudes in the cruise phase of flight. They occur during all phases of flight and can alter the atmospheric concentration of GHGs, creating condensation trails (or contrails – temporary white, cloud-like plumes composed of ice crystals formed in aircraft engine exhaust) and cause cirrus clouds to form (on occasions) all of which contribute to climate change.

The following sections provide a summary of the assessment of potential aircraft engine GHG emissions from the project. All projections of aircraft engine CO_2e emissions do not account for future aircraft fuel and operational efficiency improvements, new aircraft and propulsion technologies or use of SAF.

12.5.2.1 LTO cycle emissions below 3,000 ft (914 m)

Table 12.13 presents the estimated GHG emissions footprint in the LTO cycle (phases of flight below 3,000 ft (around 914 m) exclusive of taxi operations on the ground) from aircraft movements projected in 2033 and 2055.

The projected total LTO cycle emissions of CO_2e from the approximate 81,190 aircraft movements forecast in 2033 is around 63,813 tonnes of CO_2e at an estimated intensity of 0.79 tCO_2e per air traffic movement). This correlates approximately to the LTO cycle emissions reported at Adelaide Airport in 2019. The passenger throughput, operations and aircraft movements at Adelaide Airport are within a similar range with future operations at WSI in 2033.

In 2055, total LTO cycle emissions of CO_2e are projected to increase to 220,331 tonnes CO_2e at an estimated intensity of 0.97 tCO_2e per air traffic movement). Air traffic movements are projected to increase by 146,309 aircraft movements (from 81,990 in 2033 to 227,499 in 2055) as WSI's single runway approaches capacity. Over 47 per cent of these flights are expected to operate services on international routes mostly by higher fuel consuming wide-body jets.

The initial climb-out phase of flight is responsible for more than 40 per cent of LTO cycle emissions in 2033 and 2055. This is because aircraft are at their heaviest at this point in the take-off cycle and need to be configured under a high level of engine power (thrust) to create the lift required to get airborne.

Table 12.13 LTO cycle emissions of CO_2e below 3,000 ft (914 m) – all WSI projected aircraft movements in 2033 and 2055

Flight phase	2033 (tCO_2e)	Percentage	2055 (tCO_2e)	Percentage
Take-off roll	18,200	28%	64,974	29%
Initial climb-out	27,989	44%	98,172	45%
Approach	15,115	24%	49,859	23%
Landing roll	2,508	4%	7,326	3%
Total	**63,813**	**100%**	**220,331**	**100%**

The results of the LTO cycle emissions calculations for the project indicate the following:

- emissions of CO_2e in 2055 are projected to grow significantly by 156,518 tonnes when compared to 2033. This is primarily driven by the growth in international flights at WSI
- emissions of CO_2e from domestic flights are projected to more than double by 2055, emitting around 66,834 tonnes of additional CO_2e compared to 2033 levels of 32,581 tonnes
- growth in international flights by 2055 was projected to increase by around 81,000 movements from 2033 (around 26,000 movements), accounting for around 47 per cent of all flight movements and almost 70 per cent of total emissions of CO_2e at 153,497 tonnes.

In 2019, the LTO cycle emissions reported at Sydney (Kingsford Smith) Airport were 431,445 tonnes of CO_2e, from 333,862 flights (or 1.29 tCO_2e per air traffic movement) carrying more than 44 million passengers (SAAH, 2022). By comparison, the estimated LTO cycle emissions from aircraft departing or arriving at WSI are anticipated to be significantly lower in absolute and intensity based CO_2e emissions for both 2033 and 2055.

12.5.2.2 Extended climb and descent cycle emissions below 10,000 ft (3,048 m)

Table 12.14 presents the estimated GHG emissions footprint in the extended climb and descent cycle below 10,000 ft (around 3,048 m) exclusive of taxi operations on the ground) from aircraft movements projected in 2033 and 2055.

Table 12.14 Extended climb and descent cycle emissions of CO_2e below 10,000 ft (3,048 m) – all WSI projected aircraft movements in 2033 and 2055

Flight phase	2033 (tCO_2e)	Percentage	2055 (tCO_2e)	Percentage
Take-off roll	18,200	14%	64,974	15%
Initial climb-out	27,989	22%	98,172	22%
Extended climb	54,079	42%	190,012	43%
Descent from 10,000 feet	26,002	20%	81,451	18%
Landing roll	2,508	2%	7,326	2%
Total	**128,778**	**100%**	**441,935**	**100%**

The projected total emissions of CO_2e from all phases of flight in the extended climb and descent cycle below 10,000 ft (3,048 m) in 2033 are estimated to be around 128,778 tonnes of CO_2e from 81,190 flights. In 2055, these emissions of CO_2e are estimated to increase to approximately 441,935 tonnes CO_2e from more than 227,000 flights. On a flight intensity basis, this equates to an increase of around 0.3 tCO_2e per air traffic movement or 19 per cent above when comparing 2033 levels of around 1.6 tCO_2e per air traffic movement to 2055 levels of around 1.9 tCO_2e per air traffic movement.

12.5.2.3 Full flight emissions

In 2033, one-way flights (departures) to all 48 destination airports across WSI's anticipated route network are predicted to emit around 1.8 million tonnes of CO_2e (in total) from the point of departure to arrival. Almost half of WSI's air traffic movements are expected to be short haul flights operating on routes of less than around 500 nm (926 km). These flights were however only predicted to account for around 13 per cent of total emissions of CO_2e (approximately 0.42 million tonnes of CO_2e). Conversely, long haul flights operating to destinations over 4,000 nm (around 7,400 km), are predicted to represent around 10 per cent of total flights but account for 39 per cent of total emissions of CO_2e (approximately 0.70 million tonnes of CO_2e).

Figure 12.11 shows the full flight emissions of CO_2e estimated for all 40,595 flights departing from WSI to the 48 destination airports across the anticipated 2033 route network. The top 5 carbon emitting routes comprised operations by one domestic and 4 international RPT services (representing around 30 per cent of total departure movements in 2033) and accounted for 0.56 million tonnes of CO_2e. This represents around 31 per cent of total flight departure emissions (inclusive of domestic and international) in 2033 at an average flight intensity of 46.4 tCO_2e per air traffic movement.

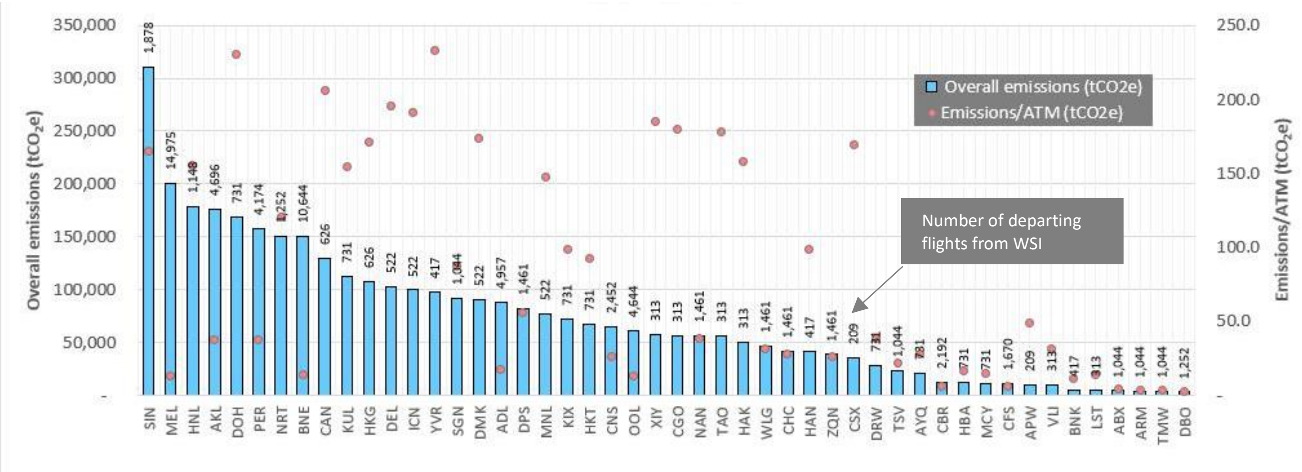

Figure 12.11 2033 full flight departure emissions – total tCO_2e and tCO_2e per air traffic movement

In 2055, all flights departing from WSI to all 86 destination airports across its anticipated route network are projected to emit around 8.65 million tonnes of CO_2e – an increase of around 6.85 million tonnes of CO_2e when compared to 2033 levels. Short haul flights on routes of less than 500 nm (around 915 km) only account for around 38 per cent of total flight activity (an 11 per cent drop from 2033 levels) and 6 per cent of total emissions of CO_2e (down 7 per cent). Long haul flights would comprise a slightly higher share of total movements at 23 per cent and accounted for 63 per cent of the total CO_2e emissions in 2055. Compared to 2033, total emissions of CO_2e from long haul flights are predicted to increase by around 4.8 million tonnes to 5.5 million tonnes. Steady growth emerged in the share of flights operating routes of between 500 nm (926 km) to 4,000 nm (around 7,400 km) in length accounting for 41 per cent of all traffic movements and around 30 per cent of total emissions of CO_2e, at 2.6 million tonnes.

Figure 12.12 shows the full flight emissions of CO_2e estimated for all flights serving the 86 destination airports from WSI in 2055. The top 5 carbon emitting routes are all international RPT services to long haul destinations over 4,000 nm (around 7,400 km) and account for around 2.0 million tonnes of CO_2e. This represents around 24 per cent of total flight departure emissions in 2055 at a flight intensity of around 209 tCO_2e per air traffic movement based on 9,757 departures. This increase is attributed to a combination of the projected route density and service frequency on these routes, of which most are too long haul destinations that tend to be operated by large, wide-body aircraft that use considerably more fuel and emit greater amounts of $C0_2e$ compared to other aircraft and destinations.

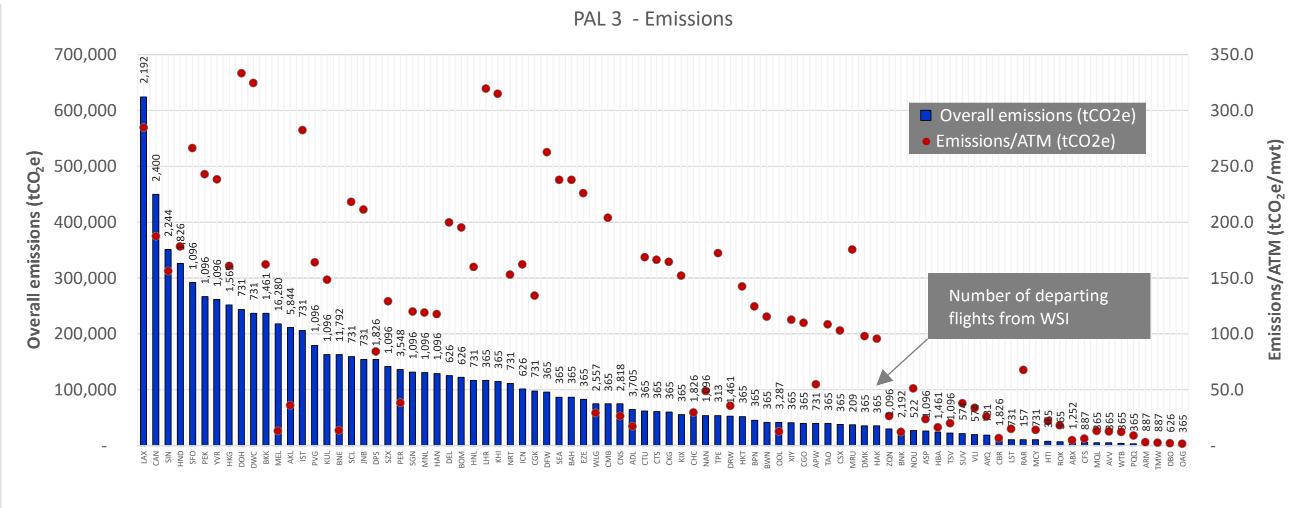

Figure 12.12 2055 full flight departure emissions – total tCO_2e and tCO_2e per air traffic movement

12.5.2.4 WSI contributions to broader emissions

Under the United Nations Framework Convention on Climate Change, domestic and international aviation are treated separately. Domestic aviation emissions are calculated as part of Australia's Paris Agreement target while international aviation emissions are dealt with separately as part of Australia's involvement in ICAO. To avoid the risk of double counting, only the flights departing from WSI have been modelled in the full flight assessment to calculate estimated emissions of CO_2e as all origin airports across the WSI route network would account for their flight departure emissions. These CO_2e emissions have been projected in 2033 and in 2055 and then compared to economy wide emissions projections by the Australian and NSW Governments in these years. The economy wide emissions account for emissions from several sectors including agriculture, energy, industrial processes, resources, transport (inclusive of commercial aviation) and waste.

These comparisons have been used to determine the potential significant impact of WSI's domestic flight departure emissions on the Australian and NSW Government's ability to comply with the Paris Agreement and transition to net zero economies by 2050. International flight departure emissions from WSI are excluded from these comparisons but are presented to provide a total full flight emissions footprint for all flight departures to all destinations across WSI's anticipated route networks in 2033 and 2055.

To that end, the following observations are noted for each assessed year:

- 2033: the project's domestic flight departure emissions of CO_2e would represent around 0.4 per cent for Australia's total projected economy wide emissions which is low whereas the project's intrastate flight departure emissions of CO2e would represent 0.04 per cent of NSW's total economy wide emissions, which is extremely low resulting in very minor adverse impacts to the Australian and NSW Governments decarbonisation plans and transition to net zero carbon economies by 2050.
- 2055: the project's domestic flight departure emissions of CO_2e are projected to increase to 0.95 million tonnes of CO_2e and would represent around 0.5 per cent of Australia's total projected emissions which is moderately low whereas the project's intrastate flight departure emissions of CO_2e would represent 0.2 per cent of NSW's total projected economy-wide emissions, remaining low despite the significant increase in air traffic growth and increase in the number of domestic flight destinations beings served.

The emissions of CO_2e attributed to aircraft departing from WSI to domestic destinations in either 2033 or in 2055 would be unlikely to result in significant impacts or inhibit the achievement of net zero economy targets set by the Australian or NSW Government for 2050. It is expected that these emissions of CO_2e would reduce over these time horizons as more fuel efficient, next-generation aircraft enter service and operate within the airline fleets serving WSI, improvements are made to air navigation and air traffic management infrastructure and operations and the anticipated availability and use of SAF progressively increases.

Table 12.15 presents the aircraft engine CO_2e emission projections for WSI's domestic flight departures in 2033 and in 2055. The CO_2e emissions are presented alongside projected economy wide emissions for Australia and NSW which includes their respective commercial aviation sectors.

Table 12.15 Comparison of WSI's domestic flight departure emissions footprint to Australia and NSW Government economy wide emissions (reported and projected)

Parameter	**2019** (Mt CO_2e)	**2033** (Mt CO_2e)	**2055** (Mt CO_2e)
Australia total economy wide emissions			
All sectors	505.8	340.1	175.8
Transport	100.3	101.3	81
% contribution of transport	20	30	46
% contribution of aviation	5	9	31

Parameter	**2019** (Mt CO_2e)	**2033** (Mt CO_2e)	**2055** (Mt CO_2e)
Australia commercial aviation emissions			
Domestic	8.3	11.2	18.6
International	15.4	18.8	36.1
Total	23.7	30	54.7
NSW total economy wide emissions			
Total	136.6	55.9	25.6
Transport	27.6	19.9	5.7
Aviation	2.4	1.8	2.8
% contribution of aviation	1.7	3.2	11
WSI			
Full flight emissions (all domestic flight departures)	–	0.45	0.95
% contribution of Australia total (economy wide) (domestic full flight emissions)	–	**0.13**	**0.5**
Full flight emissions (all NSW flight departures)	–	0.02	0.05
% contribution of NSW total (economy wide) (NSW full flight emissions only)	–	**0.04**	**0.2**
Full flight emissions (all domestic and international flight departures)	–	**1.75**	**8.65**

12.6 Mitigation and management

12.6.1 Existing management

12.6.1.1 Air quality

Emissions from aircraft movements are predominantly due to the engine emissions, which are required to meet Australian (and international) performance specifications. As discussed in Section 12.6.1.2, fleet renewal, improved technologies, operational procedures and alternative fuels can reduce air emissions.

Measures to help reduce emissions from aircraft operations generally involve procedures and techniques to optimise the vertical profiles of aircraft climbing or descending to an airport engine power (thrust) settings (such as CCO and CDO) and the configuration of flight paths relative to terrain. The measures tend to result in lower air emissions from the aircraft. These are discussed in Chapter 11 (Aircraft noise).

WSA Co is responsible for ground level activities, which are not the subject of this Draft EIS. Mitigation measures were provided in the 2016 EIS to address emissions generated by ground-based activities. Air quality monitoring, initially established at WSI to establish baseline air quality conditions, will continue during future operations at WSI as per the 2016 EIS. Existing air quality monitoring in the vicinity of WSI is undertaken by WSA Co as part of the 2016 EIS approval.

Once operational, emissions from aircraft will be captured by these monitors in addition to existing ground level sources. As this study did not identify any significant change in the approved ground level impacts per the 2016 EIS, no additional monitoring for aircraft engine emissions is required.

12.6.1.2 GHG emissions

There are many available options to minimise the emissions of CO_2e from aircraft engine use, however, many of these are outside of the control of this project.

Significant opportunity lies in the optimisation of aircraft operations, including the LTO and extended climb and descent cycles. Generally, aircraft CO_2e emissions can be reduced through activities such as:

- minimising taxiing time
- flying at optimal cruise altitudes
- optimising climb gradients and continuous climb profiles
- flying minimum-Greater Circle Distance routes, considering prevailing winds
- minimising or eliminating holding and stacking around airports.

In general aircraft emissions can be reduced in one of 4 ways:

- fleet renewal with cleaner, more fuel-efficient next-generation aircraft (i.e., Airbus A32N and Boeing B73M)
- retrofit aircraft for improved efficiency
- operational streamlining to reduce fuel consumption (such as use of CDO, CCO and RNP procedures)
- fuel substitution with less carbon intensive alternatives.

Wide-ranging measures will be required to manage and reduce emissions of CO_2e from engine use by aircraft operating along WSI's flight paths and route network, many of which are dependent on other stakeholders. A collaborative approach is required amongst aviation stakeholders including WSA Co, Airservices Australia, airlines, aerospace manufactures and fuel companies to help WSI operate with the lowest carbon footprint possible.

An Operational Sustainability Strategy and Operational Sustainability Plan for WSI is currently under development by WSA Co, which will be released prior to the commencement of operations at WSI. A core component of this strategy and plan will be a roadmap to progress WSI along a 'Carbon Neutral Pathway' that will be supported by participation in ACI's *Airport Carbon Accreditation* programme, and a strategy to support aviation partners to reduce scope 3 emissions, including those produced by aircraft engine use in the LTO cycle.

WSA Co is planning to join ACI's *Airport Carbon Accreditation* programme at one of the 2 highest available levels (being Transformation level (4) or Transition level (4+)). This means that WSA Co is required to set a policy commitment that will achieve absolute emissions reductions of CO_2e and implement a Carbon Management Plan. This plan will define the emissions reduction trajectory, interim milestones and the measures required to achieve a future science-based target in line with the IPCC's 1.5 degrees Celsius pathway. It will also help WSI operate with the lowest carbon footprint possible as it closely works with all its stakeholders to address third party emissions of CO_2e, particularly for sources that are outside its direct control and ownership (i.e., aircraft engine emissions).

No project specific greenhouse gas emissions mitigations or monitoring is proposed.