

Chapter 22 Cumulative impacts

This chapter provides an overview of the potential cumulative impacts within the vicinity of WSI and also at a broader, regional scale. The assessment of cumulative impacts has been undertaken in accordance with the EIS Guidelines and has adopted an approach based on the NSW *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The refinements to the preliminary flight path design since the exhibition of the Draft EIS would not change the conclusions of the overall cumulative impacts assessment as presented in this chapter and supporting technical papers.

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. The assessment provided considers potential impacts associated with the project in conjunction with other known and proposed developments. A single, large study area has been used which allows for a reasonable, qualitative assessment of impacts.

Given the size of the study area and operational timeframes of the project (between 2026 and 2055), other relevant projects or developments considered have been restricted to those of sufficient scale to contribute materially to cumulative impacts at a regional level with similar or overlapping spatial or temporal characteristics.

The assessment of cumulative impacts has considered each of the environmental aspects requiring assessment in the EIS Guidelines. In many cases, the quantitative assessment of issues is difficult, due to the large study area, the indirect nature of potential impacts and the lack of sufficient baseline data relative to some impacts.

A range of cumulative impacts have the potential to occur as a result of the project's location, in proximity to current and future large-scale infrastructure projects, strategic growth areas and economic corridors associated with rapid development in Western Sydney.

There are many factors that make it difficult to quantitatively assess the cumulative impact of aircraft noise from WSI in conjunction with other airspace operations. The cumulative effects of noise impacts would more likely manifest as a greater number of noticeable events over a given period of time. Aircraft operating from WSI concurrently with aircraft from other Sydney Basin airports have the potential to increase overall noise exposure to communities being directly overflown and/or immediately peripheral to other existing flight paths.

The cumulative impact of aircraft noise at locations where there are intersecting or parallel flight paths is widespread, and at these locations, cumulative noise impacts from overflights are likely to be most significant. The application of WSI's flight path design principles along with the necessary separation between flight paths would inherently reduce potential cumulative impacts. Additionally, the proportion of WSI flight paths relative to existing flight paths, and the existing and proposed complex of flight paths within the Sydney Basin, the cumulative impact of introducing WSI flight path noise is not considered high.

The air quality assessment included background air quality levels (i.e., including emissions from other, existing sources in the region) and found all pollutants were below regulatory criteria for 2033 with only minor, short term exceedances for nitrogen dioxide in 2055. On a regional level, contributions of ozone as a result of the project make no significant difference to a 'no project' scenario in both 2033 and 2055. The assessment also found that the cumulative greenhouse gas impacts associated with the project and related projects and developments are not considered to be significant.

Potential cumulative impacts related to wildlife strikes could result from the project operating in conjunction with other existing airports in the study area. A prediction of the cumulative impact of wildlife strikes from undertaking a comparative analysis of strike rates at other airports does not account for the site-specific variables at each airport, including the quality of wildlife management programs applied at each airport.

The assessment of cumulative aircraft related hazards and risks identified that WSI would introduce new elevated crash risks only into areas that are currently subject to entirely negligible risk from existing operations, however it would introduce no more than a trivial additional crash risk into areas that are currently subject to potentially significant risk from existing operations.

Potential cumulative impacts to landscape character and visual impact would include changes to landscape character and views in the vicinity of WSI, as a result of the project in conjunction with future large-scale infrastructure projects. There would also be the potential for cumulative effects on the landscape character zones across the Blue Mountains which are becoming increasingly influenced by air traffic, both from WSI and other airports within the Sydney Basin.

An analysis of the current and proposed network of flight paths in the Sydney Basin (including preliminary WSI flight paths), has identified that the majority of interactions between all flight path corridors that may generate cumulative impacts is at the location where they cross each other.

Despite the low estimates of the proportional contribution of WSI airspace emissions to the totality of air pollution within the Sydney Airshed, there is the potential that increased emission levels could have a negative impact on Aboriginal rock art sites and on some historical buildings over time. However, there is currently no comparative data or research to test this possibility. Despite this, it can be expected that additional emissions add to the general impact on heritage items and there is growing evidence that the deterioration will be accelerated by other anthropogenic factors such as climate change.

Positive and negative changes to composition of the community surrounding WSI may occur once the flight paths are operating in conjunction with other developments. Incremental increases in noise, alterations to air quality and light exposure may result in exacerbated effects to wellbeing, changes to the way people enjoy social infrastructure and their own properties.

The implementation of project specific mitigation measures would avoid, to the greatest extent possible, cumulative impacts with surrounding developments and other airspace users and reduce the potential cumulative impacts to acceptable levels.

22.1 Introduction

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. They can be caused by the compounding effects of a single project or multiple projects in an area, and by the accumulation of effects from past, current and future activities as they arise (NSW DPE, 2022h).

The cumulative assessment provided in this chapter considers all potential impacts associated with the implementation of the preliminary flight paths and a new controlled airspace for single runway operations at WSI, in combination with other major developments within a broad regional location.

22.1.1 EIS Guidelines

The EIS Guidelines as they relate to cumulative impacts requires (7.1 Describe and assess relevant impacts (b)):

The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity). This should include changes to noise levels arising from the proposed action in relation to on-ground sources such as road, rail and industry.

22.2 Methodology

The assessment of potential cumulative impacts has been undertaken in accordance with the EIS Guidelines. There are currently no Australian Government guidelines on carrying out cumulative impact assessments. As such, the methodology for the cumulative impact assessment for this project has adopted an approach based on the NSW *Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The assessment is focussed on the key matters addressed in the EIS that could be materially affected by the cumulative impacts of the project and other relevant future projects and developments within the study area and over similar timeframes. The assessment is predominantly qualitative and proportionate to the study area. The assessment matter draws on the findings of Chapters 11 to 20 as well as the publicly available impact assessments of projects deemed likely to contribute to a cumulative impact.

Cumulative impacts associated with the project and the range of screened projects are outlined in Section 22.4.1. Cumulative impacts are likely to be partially unpredictable due to the complexity and uncertainty of the exact timing associated with these developments. However, the mitigation measures outlined in Chapter 24 (Mitigation and management) have been developed to manage the cumulative impacts of project interfaces and mitigate uncertainty over these impacts.

The adopted approach to cumulative impact assessment is shown in Figure 22.1.

Chapter 8 (Facilitated changes) provides a description of facilitated changes required for other airports prior to the opening of WSI in 2026 to enable the new flight paths and airspace for WSI.

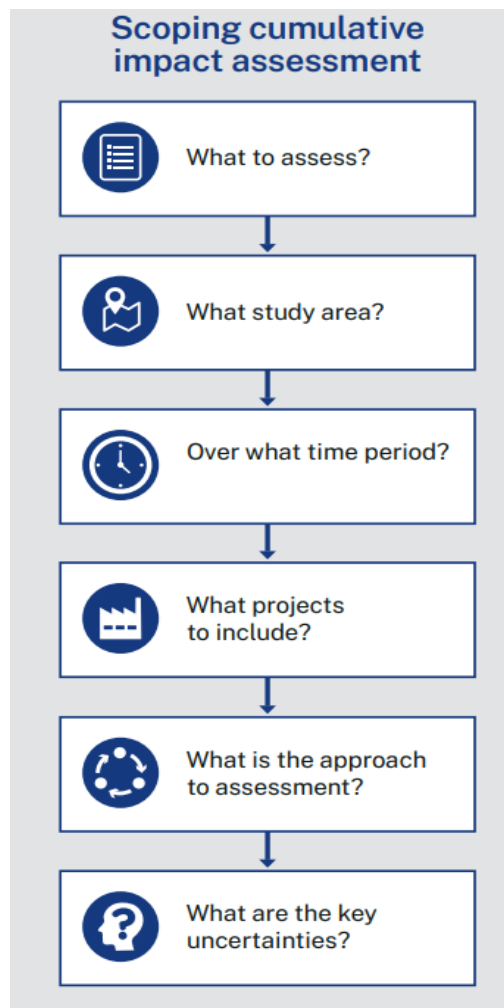


Figure 22.1 Approach to cumulative impact assessment (Source: NSW DPE, 2022h)

22.2.1 Study area

Cumulative impacts for the project have been considered within a single large study area, based on the study area used for assessing aircraft noise which considers potential impacts from aircraft overflights within a nominal 45 nautical mile (nm) (83 kilometres (km)) radius from WSI.

The study area has been identified for the purposes of defining the bounds of the cumulative impact assessment, such as screening of other projects and developments which could contribute to cumulative impacts and to allow for a reasonable, qualitative assessment of impacts.

The assessment of impacts within the study area, however, varies spatially for each environmental issue and takes into consideration the nature and scale of the impact, the environmental values which could be impacted, physical and geographical features, and community and social values.

22.2.2 Assessment time period

The project does not include any physical infrastructure or construction work. For the purposes of this assessment, cumulative impacts resulting from the interaction of the project with other projects have been considered between 2026 (when WSI would be ready for scheduled flight operations) and 2055 (which represents the year when the single runway is operating close to its movement handling capacity).

Like the study area, the time period selected for the cumulative impact assessment is broad and each matter will vary depending on the characteristics of the matter and the scale and nature of the potential impacts on the matter.

22.2.3 Project screening

Given the size of the study area and operational timeframes of the project, other relevant projects or developments considered have been restricted to those of sufficient scale to contribute materially to cumulative impacts at a regional level with similar or overlapping spatial or temporal characteristics. The process adopted for screening of projects included:

- a. proposed or recently approved projects and developments within the study area
- b. projects and developments which meet (a), and have the potential to contribute materially to cumulative impacts
- c. projects that meet (a) and (b) and are likely to be constructed between 2026 and 2055.

A search of the following strategic development and policy documents and project registers was conducted to identify projects which meet the screening criteria:

- NSW State Infrastructure Strategy 2022–2042 (Infrastructure NSW, 2022)
- Greater Sydney Region Plan – A Metropolis of Three Cities (Greater Sydney Commission, 2018b)
- major infrastructure projects listed on the NSW Department of Planning and Environment's (DPE) Major Projects register
- the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) Public Portal
- relevant airport master plans within the Sydney Basin.

Strategic infrastructure projects have been included for consideration but have not been assessed in detail given the uncertainty of the status, timing and impacts of these projects. Major developments within economic corridors and growth areas have not been considered on an individual basis on the grounds that these are captured through the consideration of broader strategic land use changes.

22.3 Relevant projects and developments

Projects and proposed developments which met the screening criteria outlined in Section 22.2.3 and are considered to have the potential for cumulative impacts with the project are listed in Table 22.1 and shown in Figure 22.2.

Table 22.1 Screened projects with potential for cumulative impacts with the project

Ref #	Project/development	Description and proposed timing	Potential interaction with the project
Approved and committed projects			
1	Western Sydney Airport Stage 1	<p>The Stage 1 Development of WSI has been approved and is limited to single runway operations. It will handle up to 10 million annual passengers and around 81,000 air traffic movements per year by 2033 including freight operations.</p> <p>The approval provides for the construction of the aerodrome (including the single runway), terminal and landside layout and facilities, and ground infrastructure such as the instrument landing systems (ILS) and high intensity approach lighting (HIAL) arrays. Construction of the Stage 1 Development commenced in 2018.</p> <p>The Australian Government has committed to developing and delivering WSI by the end of 2026.</p>	Stage 1 of WSI.
2	Sydney Metro – Western Sydney Airport	<p>Sydney Metro – Western Sydney Airport is a new 23 km metro rail link from St Marys through to WSI and the Western Sydney Aerotropolis.</p> <p>Construction has commenced and the line is expected to be completed in 2026 in time for the opening of WSI.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
3	Great Western Highway Upgrade Program	<p>Upgrade of the Great Western Highway between Katoomba and Lithgow is being delivered across 4 packages:</p> <ul style="list-style-type: none"> • Central Package – Blackheath to Little Hartley (also subject to the EPBC Act) • East Package – Katoomba to Blackheath • Medlow Bath upgrade • West Package – Little Hartley to Lithgow. <p>Construction of Medlow Bath upgrade commenced in 2023 and is expected to be completed by 2025. Transport for NSW has since announced that the remaining packages have been paused.</p>	Within the study area and adjacent to the Greater Blue Mountains Area (GBMA), with the potential to contribute to regional cumulative impacts.
4	M12 Motorway	<p>The M12 Motorway is a 16 km, 4-lane motorway between the M7 at Cecil Hills and The Northern Road at Luddenham.</p> <p>Construction began in 2022 and the Motorway is scheduled to open prior to WSI opening in 2026.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
5	Warragamba Dam Raising	<p>Warragamba Dam Raising is a project to provide temporary storage capacity for large inflow events into Lake Burragarang to facilitate downstream flood mitigation and includes infrastructure to enable environmental flows.</p> <p>WaterNSW (2023) has stated that dam raising for the purposes of flood mitigation is no longer proceeding and any required future work (and therefore impacts) are undefined.</p>	Adjacent to WSI with potential to contribute to regional cumulative impacts.

Ref #	Project/development	Description and proposed timing	Potential interaction with the project
Strategic infrastructure priorities (with potential to be constructed prior to 2055)			
6	Western Sydney Freight Line and Intermodal Terminal	<p>The Western Sydney Freight Line is a proposed, dedicated freight rail line connection between the Western Parkland City and Port Botany. The need for a dedicated freight rail line between Western Sydney and Port Botany was identified as part of the NSW Freight and Port Plan (2018–2023) (NSW Government, 2018).</p> <p>In 2020 the NSW Government announced and protected the final corridor for the western end of the freight line. Work on finalising and protecting the eastern end of the corridor is underway.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
7	Outer Sydney Orbital	<p>The Outer Sydney Orbital is a proposed corridor for a motorway and freight rail line in Western Sydney.</p> <p>Transport for NSW has consulted on a recommended corridor of land for the Outer Sydney Orbital for a possible future motorway and freight rail line.</p>	Adjacent to WSI with potential to contribute to regional cumulative impacts.
8	Sydney Metro expansions	<p>Future Sydney Metro extensions been identified (although remain uncommitted). The timing of these projects is unknown and subject to business cases. These could include:</p> <ul style="list-style-type: none"> the north-west line extending from St Marys to Schofields, connecting to the WSI line a south-west line extending from the Aerotropolis to Macarthur. <p>Prior to the Sydney Metro expansion announcement corridors for a north-west and south-west rail links had been identified by Transport for NSW in 2020.</p>	Within the study area with the potential to contribute to regional cumulative impacts.
9	Western Sydney fuel pipeline	<p>The NSW Government is undertaking preliminary work to identify route options for a fuel pipeline corridor to WSI and surrounds.</p> <p>Construction and operation unlikely until the 2030s.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
Proposed aviation developments			
10	Sydney (Kingsford Smith) Airport	<p>A number of potential, future key developments have been identified in the Sydney Airport Master Plan (2039) (SACL, 2019). Proposed developments are within the 20-year planning horizons for aviation and non-aviation development and infrastructure. The Master Plan outlines potential and proposed developments via specific development plans, to support the forecast increase in passenger numbers and aircraft movements to 2039 including:</p> <ul style="list-style-type: none"> Terminal Development Plan Airfield Development Plan Commercial Development Plan Ground Transport Development Plan Utilities Development Plan. 	Within the study area with the potential to contribute to regional cumulative impacts.

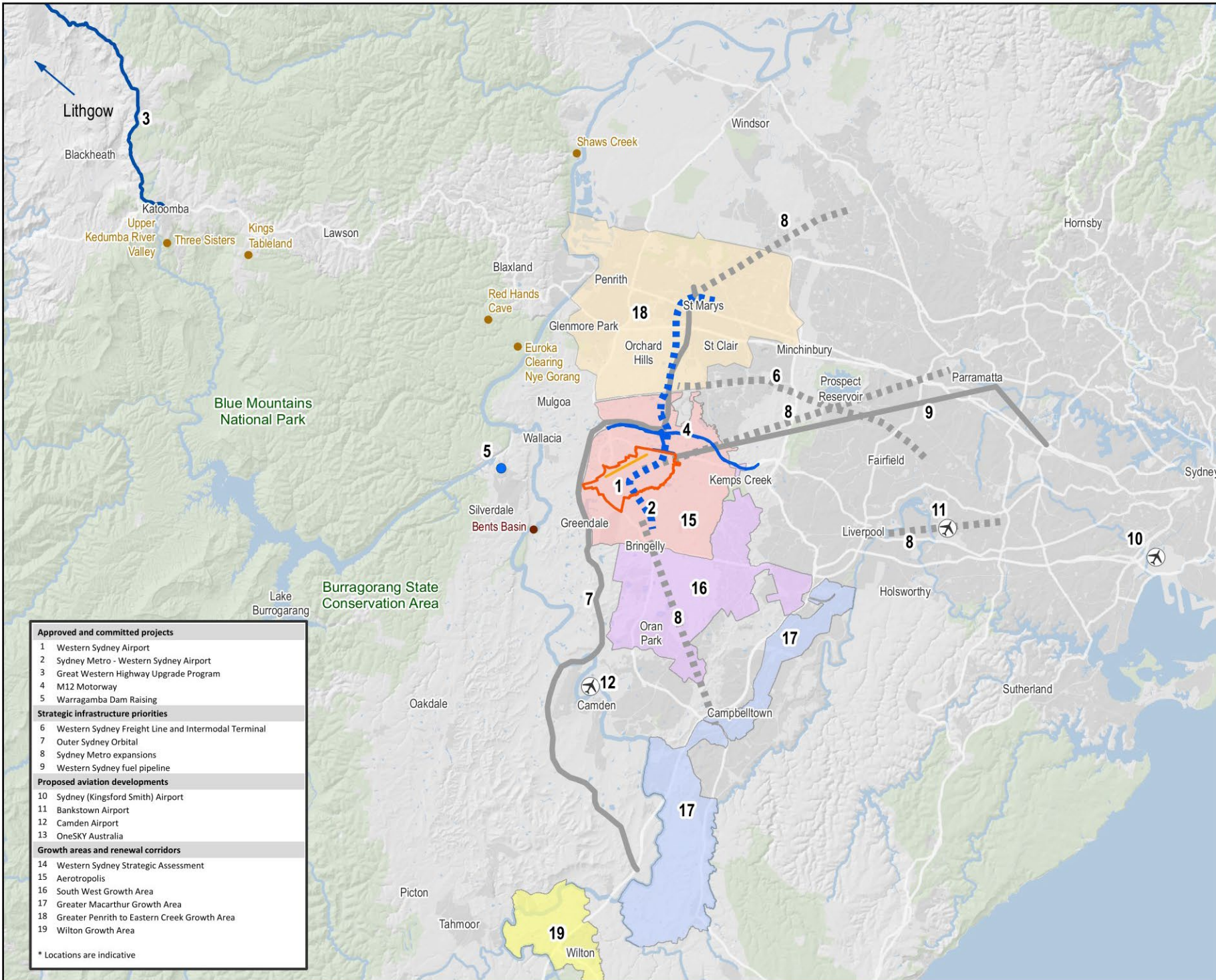
Ref #	Project/development	Description and proposed timing	Potential interaction with the project
11	Bankstown Airport	<p>A number of potential future key developments have been identified in the Bankstown Airport Master Plan (2019) (Bankstown Airport Limited, 2019). These are within the 5 and 20-year planning horizons for aviation and non-aviation development and infrastructure. Key, proposed developments which could contribute to cumulative impacts include:</p> <ul style="list-style-type: none"> • staged developments within Bankstown Airport’s commercial zone including community based retail, commercial and industrial developments • future extension of Centre Runway (11C/29C) to the south-east • intersection upgrades, widening of roads and major road improvements surrounding Bankstown Airport • Metro South-West Rail Extension - extended passenger rail between Bankstown and Liverpool CBDs • formalisation of the ring road surrounding Bankstown Airport. 	Within the study area with the potential to contribute to regional cumulative impacts.
12	Camden Airport	<p>A number of potential future key developments have been identified in the Camden Airport Master Plan (2020) (Camden Airport Limited, 2021). These are planned to be within the 8-year planning horizon. Key, proposed developments which could contribute to cumulative impacts include:</p> <ul style="list-style-type: none"> • transition from a Registered to a Certified Aerodrome (Responding to CASA MOS 139) • taxiway and apron expansion (to service new hangars). 	Within the study area with the potential to contribute to regional cumulative impacts.
13	OneSKY Australia	<p>The OneSKY Program includes investment in critical air traffic infrastructure, facilities and services to enhance the safety, efficiency and capacity of the Australian air traffic network. It is a partnership between Airservices Australia and the Department of Defence and will replace the current independent civil and Defence air traffic management systems with an advanced integrated system known as the Civil Military Air Traffic Management System (CMATS).</p>	Within the study area with the potential to contribute to regional cumulative impacts.

Ref #	Project/ development	Description and proposed timing	Potential interaction with the project
Strategic plans and policies, growth areas and urban renewal corridors in proximity to WSI			
14	Western Sydney Strategic Assessment	<p>The NSW Government has identified 4 areas for urban growth and other development ('nominated areas') and a series of major transport corridors within and outside the nominated areas to support the future growth of Western Sydney until 2056. The nominated areas comprise:</p> <ul style="list-style-type: none"> • Western Sydney Aerotropolis (excluding where there is overlap with the existing South West Growth Area) • Greater Macarthur Growth Area (GMAC) • Greater Penrith to Eastern Creek Investigation Area (GPEC) • Wilton Growth Area (Wilton). <p>The major transport corridors comprise major road or rail projects within identified corridors and are identified in this table.</p> <p>Further discussion on the Western Sydney Strategic Assessment is provided in Section 22.4.7.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
15	Aerotropolis	<p>The Western Sydney Aerotropolis is a 11,200-hectare area surrounding WSI. The Aerotropolis will become a hub of industry and innovation, attracting local and global companies drawn to the Western Parkland City and WSI.</p> <p>The Aerotropolis Precinct Plan (NSW DPE, 2023a) was finalised and announced as part of the Aerotropolis Planning Framework in March 2022. Following release of the Phase 2 Development Control Plan (DCP) (NSW DPE, 2022g), proponents can now prepare detailed development applications on land within the initial precincts of the Aerotropolis.</p> <p>Ongoing construction within the Aerotropolis is expected to continue beyond 2026.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.
16	South West Growth Area	<p>The South West Growth Area (SWGA) is around 10,000-hectares adjoining the Western Sydney Aerotropolis where new greenfield communities are being established.</p> <p>To date, 9 precincts have been rezoned with a focus on providing new residential areas to support Western Sydney's growth. The NSW Government updated the Structure Plan for the SWGA in December 2022. In conjunction with the new Structure Plan, a new Ministerial Direction under section 9.1 of the <i>Environmental Planning and Assessment Act 1979</i> (NSW) has been issued. Ongoing development of the SWGA is expected to continue beyond 2026.</p>	Adjacent to WSI with potential to contribute to local and regional cumulative impacts.

Ref #	Project/development	Description and proposed timing	Potential interaction with the project
17	Greater Macarthur Growth Area	<p>Greater Macarthur Growth Area (GMGA) is a Growth Area incorporating Glenfield to Macarthur urban renewal precincts and the land release precincts to the south of Campbelltown, including Gilead, North Appin and Appin. In the Greater Macarthur 2040 plan, there are not only plans for substantial land release areas south of Campbelltown, but also details on an urban renewal corridor along the railway line from Glenfield to Macarthur. The plans for several precincts have been finalised and planning proposals are currently being assessed for Gilead and Appin.</p> <p>Ongoing development of the SWGA is expected to continue beyond 2026.</p>	Within the study area with the potential to contribute to regional cumulative impacts.
18	Greater Penrith to Eastern Creek Growth Area	<p>Greater Penrith to Eastern Creek Investigation Area (GPEC) spans around 19,000-hectares from the Nepean River in the west to the M7 Motorway in the east.</p> <p>The GPEC Strategic Framework was finalised on 28 June 2023 and has been prepared to support strategic planning for the Western Parkland City. The framework identifies St Marys Town Centre and Orchard Hills (south of the M4) as priority areas. This means that these areas will be planned for in the short-term to leverage the potential for growth and investment arising from the Sydney Metro – Western Sydney Airport line.</p>	Within the study area with the potential to contribute to regional cumulative impacts.
19	Wilton Growth Area	<p>The Wilton Growth Area is positioned at the junction of the Hume Motorway and Picton Road in the Wollondilly Shire Local Government Area. There are 7 precincts within the Wilton Growth Area.</p> <p>Ongoing development of the SWGA is expected to continue beyond 2026.</p>	Within the study area with the potential to contribute to regional cumulative impacts.

Figure 22.2

Study areas for cumulative impacts



Legend

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

Approved and committed projects

- Great Western Highway/ M12
- Sydney Metro - Western Sydney Airport
- Warragamba Dam Raising

Strategic infrastructure priorities

- Outer Sydney Orbital/ Western Sydney fuel pipeline
- Western Sydney freight line/ Sydney Metro expansions

Growth areas and renewal corridors

- Aerotropolis
- South West Growth Area
- Greater Macarthur Growth Area
- Greater Penrith to Eastern Creek Growth Area
- Wilton Growth Area

Approved and committed projects
1 Western Sydney Airport
2 Sydney Metro - Western Sydney Airport
3 Great Western Highway Upgrade Program
4 M12 Motorway
5 Warragamba Dam Raising
Strategic infrastructure priorities
6 Western Sydney Freight Line and Intermodal Terminal
7 Outer Sydney Orbital
8 Sydney Metro expansions
9 Western Sydney fuel pipeline
Proposed aviation developments
10 Sydney (Kingsford Smith) Airport
11 Bankstown Airport
12 Camden Airport
13 OneSKY Australia
Growth areas and renewal corridors
14 Western Sydney Strategic Assessment
15 Aerotropolis
16 South West Growth Area
17 Greater Macarthur Growth Area
18 Greater Penrith to Eastern Creek Growth Area
19 Wilton Growth Area

* Locations are indicative



0 5 10 km

Coordinate system: GDA 1994 NSW Lambert
Scale ratio correct when printed at A4
1:400,000 Date: 6/06/2023

Data sources: DTDRDC, DCS, Geoscience Australia
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22.4 Assessment of cumulative impacts

The cumulative impacts identified as having the potential to arise during operation of the project are outlined below.

22.4.1 Summary of potential cumulative impacts

Table 22.2 provides a brief summary of the potential cumulative impacts associated with the project and other major developments in the study area. Where a potential cumulative impact has been identified further discussion and assessment is presented in Section 22.4.2 to Section 22.4.10.

Table 22.2 Summary of potential cumulative impacts

Impact	Summary
Aircraft noise	<ul style="list-style-type: none"> potential for a greater number of noticeable events over a given period of time in proximity to the intersection between existing and the preliminary flight paths potential to increase overall noise exposure to communities being directly overflowed and/or immediately peripheral to other existing flight paths.
Air quality and greenhouse gas	<ul style="list-style-type: none"> potential increases in emissions from aircraft operations a small increase in the total economy wide greenhouse gas emissions for NSW and Australia.
Aircraft hazard and risk	<ul style="list-style-type: none"> increase in third party and infrastructure risks from aircraft crashes increased risk of wildlife strike.
Land use	<ul style="list-style-type: none"> additional land being subject to planning restrictions or controls from: <ul style="list-style-type: none"> aircraft noise contours (Australian Noise Exposure Concept (ANEC)/ Australian Noise Exposure Forecast (ANEF)) protected airspace (Obstacle Limitation Surfaces (OLS) and Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)) implementation of wildlife buffers.
Landscape character and visual impact	<ul style="list-style-type: none"> changes to landscape character in the vicinity of WSI effects to views seen in proximity to current and future large-scale infrastructure projects, when seen together with changes to the character of the sky due to increasing airspace activity potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.
Biodiversity	<ul style="list-style-type: none"> increased risk of wildlife strike alterations to air quality and contributions to greenhouse gas emissions which could impact ecosystems affected by seasonal climatic fluctuations, such as wetlands and temperate forests which occur throughout the Sydney Basin and GBMA.
Heritage	<ul style="list-style-type: none"> increased impact to Aboriginal and non-Aboriginal cultural places and values impacts of new emissions and climate change on heritage gardens impacts to cultural values due to additional noise and visual intrusion further disruption to land-sky connection.
Social and economic	<ul style="list-style-type: none"> incremental changes to community composition effects to wellbeing from changes in noise, air quality and light exposure constrained housing availability in the local area increased business and employment opportunities and job generation.

22.4.2 Aircraft noise

Noise from aircraft using WSI's flight paths is of concern to those people most likely to experience its direct impact. This could relate to night noise and in proximity to WSI when aircraft are departing or arriving. Other noise concerns relate to the cumulative impact of aircraft overflight noise. There are many factors that make it difficult to quantitatively assess the cumulative impact of aircraft noise from WSI flight operations including the following:

- whether the effects from the different sources (other Sydney Basin airports and ongoing development and urbanisation of Western Sydney) would be likely to occur at the same time, or the same time of day
- the duration of any combined effects
- whether one effect dominates or whether effects might be additive
- whether the effects on individual noise sensitive receivers are likely to be on the same façade (if a residential dwelling or building) or location of the property.

The potential for WSI's flight paths and the facilitated changes to generate cumulative impacts has been assessed qualitatively in regard to aircraft noise.

For cumulative noise impact assessment, it is essential to understand the logarithmic nature of sound level. This means that adding a 60 dB(A) event to an area already experiencing 70 dB(A) does not result in an arithmetic addition of exposure ($60 + 70 \neq 130$ dB(A)). The resulting addition of sound waves reaching the human ear will be less than 71⁵ dB(A) and the difference not discernible to the human ear.

The cumulative effects of noise impacts will more likely manifest as a greater number of noticeable events over a given period of time (days, weeks or months) or different times of the day. Areas considered most sensitive and where people are most likely to experience direct and disruptive impacts from noise from aircraft using WSI's flight paths are subject to many interdependencies, variables and uncertainties, including:

- Sydney (Kingsford Smith), Bankstown and Camden Airports are all approaching their Master Plan update cycles which will likely contain a response to single runway operations at WSI from 2026 as well as post-COVID-19 activity forecasts
- flying training areas - the final proposed detail and ultimate procedures will not be confirmed until completion of a separate airspace change proposal, depending on the extent of the change
- the application of radar vectoring on some WSI flights and other Sydney Basin airport procedures may result in a noise sharing outcome that cannot be quantifiably presented
- varying meteorological influences across the Sydney Basin would result in different combinations of runway direction usage for the 5 major airport operations. Conditions in Western Sydney may be distinctly different to coastal conditions which would define Sydney (Kingsford Smith) Airport preferred runway nomination.

Aircraft using flight paths to arrive and depart from WSI may be noticeable (audible and/or visible) up to 45 nm (around 83 km) from WSI and beyond. These aircraft are expected to operate up to 20,000 feet and higher depending on the flight path in use, type of aircraft and its origin-destination, weather, pilot technique and other factors. While the measured volume of an aircraft noise event may be relatively low, there are many factors which will influence the degree of noticeability and possible annoyance to any individual. It is known that the reaction of any specific individual to a defined noise event can be very different and not necessarily dependent on the actual volume as measured on a sound level meter.

Aircraft operating from WSI concurrently with aircraft from other Sydney Basin airports have the potential to increase overall noise exposure of communities being directly overflowed by WSI flight paths, immediately peripheral to and further surrounding WSI, and underneath or along the other flight paths in use. Overall noise exposure in a geographic area as large as the Sydney Basin does not necessarily translate into a quantifiable cumulative increase in impact. WSI will introduce additional aircraft into an already complex and heavily trafficked Sydney Basin airspace environment. In 2033, this additional traffic is projected to represent around 9 per cent of total projected Sydney Basin air traffic movements

⁵ <https://au.noisemeters.com/apps/db-calculator/>

(estimated to be over 890,000 movements inclusive of the expected 81,000 movements projected at WSI in 2033). The flight paths and airspace structure for WSI have been designed to facilitate safe, efficient and independent airspace operations at each Sydney Basin airport.

Some adjustments are required to Sydney Basin operations prior to the opening of WSI in 2026 to facilitate WSI flight paths and airspace structure. Several of these adjustments are required to Sydney (Kingsford Smith) Airport departures for a range of destinations. WSI's flight paths will cross and interact with these departures, resulting in minor adjustments and changes to the lateral and vertical profiles of these flight paths to maintain safety assurance levels.

An analysis of existing flight paths in the Sydney Basin and the preliminary flight paths for WSI has identified that cumulative noise impacts are likely to be most significant where different flight paths cross each other.

Within 10 nm (around 19 km) from WSI there is some intersecting (with altitude separation) of WSI departures and arrival flight paths. Within the Sydney Basin airspace, WSI and Sydney (Kingsford Smith) Airport departure and arrival flight paths will typically have WSI procedures lower in the vicinity of WSI and higher in the vicinity of Sydney (Kingsford Smith) Airport.

The cumulative impact of aircraft noise at locations where there are intersecting or parallel flight paths is widespread, and at these locations, cumulative noise impacts from overflights are likely to be most significant. The application of WSI's flight path design principles along with the necessary separation between flight paths would inherently reduce potential cumulative impacts. Additionally, the proportion of WSI flight paths relative to existing flight paths, and the existing and proposed complex of flight paths within the Sydney Basin, the cumulative impact of introducing WSI flight path noise is not considered high.

A cumulative increase in background noise from the ongoing urbanisation and development of Western Sydney is anticipated to reduce the relative noise impacts associated with aircraft using WSI's flight paths in locations subject to urbanisation and development. Future infrastructure projects in Western Sydney, such as future rail or road projects, would be subject to separate environmental impact assessments and sector-specific requirements to mitigate noise contributions.

The assessment of vibration generated by aircraft is based on an assessment of the 90 dB(A) threshold. The occurrences of 90 dB(A) events are generally contained within Airport Site and as such any potential for cumulative vibration impacts is unlikely.

22.4.3 Air quality and greenhouse gas

The screened projects and developments in Table 22.1 would have emissions of similar air pollutants (combustion emissions, particulates, volatile organic compounds) and greenhouse gases to those produced by the project. Improvements in combustion technology and fuel efficiency in aircraft and on-ground vehicle fleets will continue to improve air emissions over time. The assessment of project related air quality and greenhouse gas impact is provided in Chapter 12 (Air quality and greenhouse gas).

22.4.3.1 Air quality

The air quality impact assessment assessed project emissions including background air quality levels (i.e., including emissions from other, existing sources in the region) and found all pollutants were below regulatory criteria for 2033. In 2055, there are few exceedances of the short term (1-hour) criterion for nitrogen dioxide (a combustion pollutant and ozone precursor) however, the annual average levels are below the relevant criterion. On a regional level, contributions of ozone as a result of the project make no significant difference to a 'no project' scenario in both 2033 and 2055.

The potential cumulative impacts associated with other projects are likely to occur as a result of emissions from aircraft, vehicles and other ground-based sources during construction and operation. The potential environmental impacts of adverse air quality include the release of air pollutants, greenhouse gas emissions and ozone depleting substances.

Construction emissions are generally transient in nature, particularly when following an alignment such as a road or pipeline, and would be subject to approval conditions to avoid, minimise and manage impacts. Combustion emissions and particulates from vehicles on roads, freight rail and aircraft are the key pollutants associated with operation, and would be subject to operational environmental management plans. It is expected that the construction and operational air quality impacts of all projects and developments would be minimised to the extent practicable. Any contributions from future infrastructure projects would be expected to be localised and associated with on-ground sources.

As the assessment has concluded that 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 concentration, the cumulative air quality impacts associated with the project and related projects and developments are not considered to be significant. Further, contributions from motor vehicles and aircraft are expected to reduce over time, given the improvements in combustion technology and fuel efficiency.

As existing aircraft operations and infrastructure developments occur throughout most of the Sydney Basin, including areas above the GBMA, the cumulative contributions of impacts from the project in addition to the impacts that are expected from other projects in areas adjacent to the GBMA are considered to be minimal to negligible.

22.4.3.2 Greenhouse gas

Growth and development associated with the screened projects (see Table 22.1) would produce greenhouse gas emissions, specifically in proximity to WSI, where development, infrastructure, land use, transportation and associated activity will intensify over time as the Aerotropolis transitions into a city.

All anthropogenic (human-induced) activity and development (existing and new) produce greenhouse gas emissions. Greenhouse gas emissions are expressed as carbon dioxide equivalent (CO_{2e}) emissions to enable comparisons on the basis of global warming potential. Greenhouse gas emissions associated with the project have been set in the context of projected CO_{2e} emissions from domestic commercial aviation activity in Australia. This is aligned to the commitments made by the Australian Government as a party to the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement, which include Australia's 2030 emissions reduction targets and an economy-wide 2050 trajectory to net zero emissions. Projections of CO_{2e} emissions were obtained from the Australian National Greenhouse Accounts (DCCEEW, 2022c); Australia's national inventory reports (NIR) and the Australian Government's growth rates for commercial aviation activities. This data formed the basis for longer-term greenhouse gas emissions extrapolated to 2055.

Direct impacts associated with the project have been accounted for in the total economy-wide greenhouse gas emissions for NSW and Australia. Greenhouse gas emissions associated with WSI flight paths would commence in the Sydney Basin airspace and continue enroute to all destinations across the WSI network. On an economy wide basis, the greenhouse gas emissions from WSI are small. In the years to 2040, these greenhouse gas emissions are unlikely to make material difference in the physical risk of future climate change projections, as historic greenhouse gas emissions have already been locked in global warming over this timeframe.

Beyond this date to 2055, WSI's greenhouse gas emissions would marginally contribute to potential climate change but not at a level expected to inhibit the Australian Government's commitment made under the Paris Agreement (including the NSW Government) to emissions reduction targets or a net zero emissions transition by 2050.

The project has been designed to reduce fuel burn through the provision of an efficient airspace system with supporting air traffic management procedures such as Continuous Climb Operations (CCO) and Continuous Descent Operations (CDO).

The cumulative greenhouse gas impacts associated with the project and related projects and developments are not considered to be significant.

22.4.4 Aircraft hazard and risk

There are potential impacts and risks associated with the operation of the existing aerodromes and airspace in the Sydney Basin, including risks to third parties. The assessment of project related hazards and risk is provided in Chapter 13 (Aircraft hazard and risk).

Potential cumulative impacts associated with aircraft hazards and risks would include:

- increase in third party and infrastructure risks from aircraft crashes
- increased risk of wildlife strike.

In accordance with the historical accident record and the third party risk model used to assess the third party risks associated with WSI operations, third party risks associated with other potential developments were concentrated along flight paths closer to each runway end. In these areas, individual risks may reach levels that would be considered potentially significant when assessed against recognised quantitative criteria for the evaluation of risk impact significance. Outside these areas, risks would be at levels that can be regarded as negligible.

Further from each runway end the risks associated with existing operations more generally in the Sydney Basin airspace can be expected to be considerably lower than the 1 in a million per annum individual risk level below which risks are considered to be acceptable and of no regulatory concern.

The risks that were determined for WSI and that are shown in the risk contour plots (refer to Chapter 13 (Aircraft hazard and risk)) would be introduced into an area that is a substantial distance from the existing aerodromes and where the existing background risk would be very low in comparison with the WSI-related risks. Closer to WSI, the cumulative risk associated with the new and existing operations would therefore be dominated entirely by the risks associated with WSI operations. That is to say, the background risk in the vicinity of WSI associated with existing operations would be so small (much lower than 1 in a million per annum) that it would not add significantly to the WSI-related risks which are adequately represented by the estimates made for WSI operations alone.

The areas that are currently subject to elevated risk levels associated with existing operations may be subject to an additional risk from WSI operations. Given the substantial distance from WSI and its associated flight paths to these areas of existing elevated crash risk, the additional risk can be expected to be very small and the cumulative impact only marginally above the existing risk level.

Potential cumulative impacts related to wildlife strikes could result from the project operating in conjunction with other existing airports in the study area. Major Australian airports between 2008 and 2017 averaged 4.8 strikes per 10,000 aircraft movements (ATSB, 2019). If WSI aligned with this rate, the addition of the project may result in increases in potential wildlife injury or mortality due to wildlife strike. This is estimated to be around 39 strikes per year by 2033 and 108 strikes per year by 2055.

However, it is important to note that a comparative analysis of strike rates at other airports does not account for the site-specific variables and nuances at each airport that contribute to the strike risk and the quality of wildlife hazard management programs applied on and off the Airport Site.

The species surveyed on and off the Airport Site to date may be indicative of the suite of species likely to occur at WSI and surrounds once WSI is operational. It is likely that known urban adaptors, particularly those known to occupy areas on and around other Australian airports (e.g., Australian White Ibis *Threskiornis moluccus*, Australian Magpie *Gymnorhina tibicen*, Masked Lapwing *Vanellus miles*, and Pacific Black Duck *Anas superciliosa*), will also occur at WSI. However, the upcoming changes to the Western Sydney landscape means that it is difficult to qualify, with accuracy, how wildlife populations would respond, and how this would impact the strike risk. As such, ongoing monitoring would be critical to identify trends and ensure the early detection of wildlife issues.

Overall, the project would introduce new potentially significantly elevated crash risks only into areas that are currently subject to entirely negligible risk from existing operations. It would introduce no more than a trivial additional crash risk into areas that are currently subject to potentially significant risk from existing operations.

22.4.5 Land use

Cumulative land use impacts are likely to occur as a result of the project's location, in proximity to a range of current and future large-scale infrastructure projects and ongoing strategic growth centre development areas in Western Sydney. The combined effect of the projects outlined in Table 22.1 are resulting in extensive land use changes in the vicinity of WSI.

The Western City District Plan (Greater Sydney Commission, 2018a) is a 20-year plan to manage growth in the context of economic, social and environmental matters to achieve the 40-year vision for Western Sydney. This growth will result in competing land use demands, with existing industrial, commercial and recreational land requiring safeguarding from competing pressures, especially residential and mixed-use zones.

Strategic land use planning in the vicinity of WSI has considered and incorporated the operational needs of WSI into land use planning. This has been ongoing for over a decade in conjunction with planning for WSI and is well established in existing planning instruments, and this has been an effective means of providing appropriate controls over land use planning and development. In developing the growth areas in proximity to WSI, the NSW Government and local councils have considered the potential cumulative opportunities and impacts of WSI. The assessment of project related land use impacts is provided in Chapter 14 (Land use).

Potential cumulative impacts associated with land use planning would include additional land being subject to planning restrictions or controls from:

- aircraft noise contours (ANEC/ANEF)
- protected airspace (OLS and PANS-OPS)
- implementation of wildlife buffers.

Planning controls for land surrounding WSI including the Aerotropolis and surrounding growth areas have adopted a precautionary approach to aircraft noise controls, particularly noise sensitive development within the ANEC 20. The adoption of the ANEC 20 contour around WSI has increased the area of land subject to planning restrictions based on aircraft noise. This includes more land on which noise sensitive developments are not permitted or where existing developments may be required to improve noise insulation.

WSI's OLS was prescribed by declaration on 19 October 2017 and since then building height restrictions on all land use types have applied within the OLS. OLS are also in place at all other airports in the Sydney Basin. The adoption of the OLS for WSI has increased the area of land in which specific height controls are in place to define the limits to which structures or objects may project into the airspace.

A PANS-OPS for WSI will be prepared once flight paths have been finalised. Once this occurs, consent authorities are required under the *Airports Act 1996 (Cth)* and *Airports (Protection of Airspace) Regulations 1996 (Cth)* to review all building and development applications they receive for any infringements into the PANS-OPS. This would increase the area of land in which long-term controlled activities (longer than 3 months) penetrating the PANS-OPS airspace are not permitted.

Any new development classed as 'relevant development' under the *State Environmental Planning Policy (Precincts – Western Parkland City) 2021 (NSW)* (Western Parkland City SEPP) and within the 13 km wildlife buffer of WSI will be subject to the wildlife management controls contained within the Western Parkland City SEPP. Wildlife buffers resulting in land use restrictions and other wildlife controls are also in place at all other airports in the Sydney Basin and the addition of further wildlife buffers has increased the area of land in which wildlife controls are in place.

To date, the range of existing planning controls in the vicinity of WSI have been an effective means of providing appropriate land use controls and cumulative impacts related to land use and planning are not considered significant.

22.4.6 Landscape and visual amenity

Generally, planned land use changes around WSI have anticipated the potential for increased activity associated with WSI (including increased airspace activity). Consequently, the landscape character is considered lower in some areas in close proximity to WSI. The assessment of cumulative impacts has anticipated these land use changes as the baseline for landscape character and views, and sensitivity of future potential receivers over the time horizons assessed. The assessment of landscape character and visual impacts is provided in Chapter 15 (Landscape and visual amenity).

Potential cumulative impacts to landscape character and visual impact would include:

- changes to landscape character in the vicinity of WSI
- effects to views seen in proximity to current and future large-scale infrastructure projects, when seen together with changes to the character of the sky due to increasing airspace activity
- potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.

There would be cumulative effects on several landscape character zones near WSI, where there would be a greater concentration of flights and flights at lower altitudes. This includes the Penrith south-east rural transition landscape character zone (LCZ2), Greendale and Silverdale rural and residential landscape character zone (LCZ3), and Luddenham village and agricultural precinct landscape character zone (LCZ4), where the land use change together with increased airspace activity would transform the character of the landscape.

Cumulative visual impacts are likely to occur where views are seen in proximity to current and future large-scale infrastructure projects and ongoing strategic growth centre development areas in Western Sydney. This changing visual setting has been considered in the visual impact assessment as a changing baseline condition. There would be a cumulative effect on views from Luddenham village, Silverdale and Orangeville to the west of WSI, and Orchard Hills to the north, where the transformation of the landscape character of the land would be seen together with changes to the character of the sky due to increasing airspace activity.

There would also be a cumulative effect on views from recreational areas to the east of WSI, including George Maunder Lookout at Prospect Reservoir, where there would potentially be views to the development in areas surrounding the reservoir and increasing flights in the airspace across this elevated view.

There are no land use changes or major projects identified within the Blue Mountains that would influence the landscape character or views. However, in relation to landscape character, there is the potential for increased air traffic across the Blue Mountains as a consequence of upgrades to airports and changes to the management of airspace above the Sydney Basin and Blue Mountains.

There would be cumulative effects on the landscape character zones across the Blue Mountains which are increasingly influenced by air traffic, both from WSI and other airports within the Sydney Basin. These cumulative effects may occur where there are increased flights at other airports within the Sydney Basin flying over the Blue Mountains Landscape character zones (Blue Mountains iconic features landscape character zone (LCZ13), Blue Mountains forested hills and valleys landscape character zone (LCZ14) and Blue Mountains township spine landscape character zone (LCZ15)).

There is the potential for a cumulative effect on views from lookouts (including Echo Point and Walls Lookout), campgrounds and scenic routes throughout the Blue Mountains as flight frequency increases and flights related to other airports in the region have the potential to be seen in these views.

22.4.7 Biodiversity

Significant urbanisation and development in Western Sydney is placing increasing pressure on the biodiversity values of the Sydney Basin Bioregion, including threatened flora and fauna. The assessment of project related biodiversity impacts is provided in Chapter 16 (Biodiversity).

Potential cumulative impacts on biodiversity associated with the project and the screened projects (see Table 22.1) would include:

- incremental increases of noise and light exposure that may disrupt species within the vicinity of WSI and flight paths which may lead to species relocating or alter species behaviour and communication
- increases in potential wildlife strike (also refer Section 22.4.4)
- alterations to air quality and contributions to greenhouse gas emissions which could impact ecosystems affected by seasonal climatic fluctuations, such as wetlands and temperate forests which occur throughout the Sydney Basin and GBMA.

The Stage 1 Development of WSI has been approved and is limited to single runway operations. It will handle up to 10 million annual passengers and around 81,000 air traffic movements per year by 2033 including freight operations. The approval provides for the construction of the aerodrome (including the single runway), terminal and landside layout and facilities, and ground infrastructure such as the instrument landing systems (ILS) and high intensity approach lighting (HIAL) arrays. Construction of the Stage 1 Development commenced in 2018. These impacts are primarily limited to direct impacts on the ground. In terms of cumulative impacts, the indirect impacts overlapping with the airspace impacts (such as noise, air and light impacts) are negligible in the local and regional context.

The Western Sydney strategic assessment is a collaboration between the Australian and NSW Governments with the aim of safeguarding protected matters from the impacts of development within Western Sydney. Under the Western Sydney strategic assessment, the NSW Government is seeking approval for development in nominated growth areas and transport corridors. Development as a result of the implementation of the strategic assessment will likely increase the pressures on the same cumulative (indirect) impacts such as air quality, noise and light.

Ongoing development of the region will lead to additional cumulative impacts that are as yet unplanned and undefined and are therefore not quantifiable but will nonetheless increase pressures on biodiversity in the region. In a cumulative sense it is considered that a higher level of planning of development in Western Sydney will lead to better conservation outcomes and less 'ad-hoc' and unregulated cumulative impacts.

Although there are several recent and proposed projects in the locality that will incrementally exacerbate impacts on biodiversity, there are existing flight paths over the study area that generate similar impacts. Biodiversity values within the study area have been historically overflown to varying degrees by aircraft associated with Sydney (Kingsford Smith), Bankstown and Camden Airports as well as military flights from RAAF Base Richmond and Holsworthy Airfield. The study area is also likely to be intermittently overflown by recreational and light aircraft in transit from private airstrips. As such, biodiversity within the region is already subject to varying degrees of impacts relevant to WSI.

Furthermore, impacts on biodiversity generated by most planned and proposed projects in the vicinity of WSI would be limited to on-ground impacts. These impacts include (but are not limited to) the direct removal of vegetation and the habitat it provides, introduction and spread of invasive species, barriers and habitat fragmentation, erosion and sedimentation, which are largely not consistent with the impacts associated with the project.

Despite this, the project is likely to incrementally increase wildlife strike, noise, light and alter air quality within the region which has the potential for impacts to biodiversity values. As existing aircraft operations and infrastructure developments occur throughout most of the Sydney Basin, including areas around the Airport Site, the project is likely to contribute to cumulative impacts on biodiversity within the locality.

The EPBC Act lists the 'loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' as a Key Threatening Process (KTP). This KTP includes 'reductions in the bioclimatic range within which a given species or ecological community exists due to emissions induced by human activities of greenhouse gases' (Threatened Species Scientific Committee, 2001). The project has potential to contribute to long term climate change impacts via the production of greenhouse gases.

Chapter 12 (Air quality and greenhouse gas) identifies that the emissions from aircraft engines during all phases of flight alter the atmospheric concentration of greenhouse gases. The KTP lists several ecosystem types which are affected by anthropogenic greenhouse gases including wetlands and temperate forests which occur within the study area. These ecosystems would not be directly impacted by the project and are tolerant of seasonal climatic fluctuations. Although species within these ecosystems show resilience to harsh and variable environmental conditions such as bushfire and drought, this resilience is being tested by the extension and severity of these environmental conditions in response to climate change (Nolan et al. 2021).

22.4.8 Heritage

Despite a number of significant heritage sites existing for many years under the Sydney Basin flight paths there has been no specific consideration of the physical impacts of emissions on heritage items. Undertaking a study to consider this issue would be complex given the other contributors to airborne pollution nearby and the lack of a pre-flight path baseline. The assessment of project related heritage impacts is provided in Chapter 17 (Heritage).

Potential cumulative impacts related to Aboriginal and historic heritage places and values would result from the project operating in conjunction with other major developments and existing airports in the study area. Potential cumulative impacts include:

- increased impact to Aboriginal and non-Aboriginal cultural places and values
- impacts of new emissions and climate change on heritage gardens
- impacts to cultural values due to additional noise and visual intrusion
- further disruption to land-sky connection.

Given the range of current and proposed developments in Western Sydney it is difficult to calculate cumulative impacts with any degree of accuracy. This is exacerbated in the case of Aboriginal sites because for some decades Heritage NSW has not maintained an accurate record of destroyed sites as area wide Aboriginal Heritage Impact Permits are granted for development that cover the destruction of known and unknown sites within the area. It may be assumed that despite the large number of sites within the study area, that many of these have been destroyed since they were recorded.

This means that it is important to take a precautionary approach to approving impacts to Aboriginal heritage rather than basing assessment on the perceived commonness of site type.

The cumulative impacts of WSI related air pollution across WSI airspace are best understood as a contributing factor to the totality of air pollution present across the Sydney airshed. The air emissions inventory for the Greater Metropolitan Region in NSW (NSW EPA, 2012) showed that emissions from existing airport operations in Sydney in 2008 were less than 3 per cent of total emissions for the region. Despite the low estimates of the proportional contribution of WSI airspace emissions to the totality of air pollution within the Sydney Airshed, there remains the possibility that the cumulative impact of locally increased emission levels (such as for particulate matter, or the precursors of acid rain) in the proximity of flight paths with lower altitude aircraft, would have an impact on nearby rock art sites over time.

There is currently no comparative data or research to test this possibility. It is not known, for example, if air-borne pollutants from lower-altitude aircraft could raise rock-surface acidity levels at near-by or over-flown rock art sites beyond the natural acidity expected from the surrounding groundwater, soil and bedrock chemistry. Distinguishing local-area aircraft from other more generalised airshed sources of pollutants is also an issue in this context. Similarly, natural processes of surface mineralisation and case-hardening across natural rock surfaces may also offer some protection against raised acidity. The deposition of airborne particulate matter onto rock art panels appears a more clearly defined contender for a significant cumulative impact over time. Any increase in airborne dust content, whether above or below acceptable thresholds determined by human health risks, provides an opportunity for increased deposition of dust onto rock art panels. This would gradually impact their visibility and long-term conservation. It can be expected that all rock shelter sites within and around the Greater Sydney Metropolitan Region would be impacted by accumulated deposits of dust from the aerosol particulate matter of the Sydney airshed. It would be expected that within this general fall-out, and subject to local climatic conditions, heavier particulate matter may settle closer to its source than lighter fractions. A consequence of this expectation is that rock shelters under or close to flight paths used by low-altitude aircraft (such as during descent/arrival and ascent/departure) may experience greater dust fall-out, and therefore cumulative impacts.

While it is known that air pollution has a negative impact on some historical building fabric such as sandstone there has been little research into understanding the sources and contributory impact of emissions from industrial generators. It can be expected that additional emissions will add to the general impact on stone buildings and there is growing evidence that the deterioration will be accelerated by other anthropogenic factors such as climate change (Basu et al. 2020). Contemporary weathering is dependent on the constituents of the building materials and the past weathering history of the material, as well as on current pollution (Inkpen, 2004).

It is not possible to provide any quantifiable assessment of the likely cumulative impact of any emissions related to the project in addition to the existing and emerging climate change impacts on heritage gardens because no baseline data exists regarding the current climate change impacts (NSW DPE, 2023d). Little research has been undertaken regarding climate change impacts on the heritage gardens of the Blue Mountains area despite the focus on gardens as part of Blue Mountains tourism. Several of the State Heritage Register listed sites include significant gardens e.g., Everglades and Lilianfels. Heritage gardens in the Blue Mountains are particularly vulnerable to the impacts of climate change such as a warming environment (Bramwell, 2007).

The Blue Mountains region is predicted to experience fewer cold nights and frosty mornings and increased Autumn rainfall. Daytime temperatures in the region will become increasingly warmer. Wet and dry spells are likely to be longer and more severe (NSW Office of Environment and Heritage, 2014). These changes will not only increase risks associated with bushfires but are likely to also lead to plant disease and mildew and rust on leaves of exotic species like the rhododendrons, for which the gardens of the area are famous. The introduction of new or increased airborne pollutants will have an unknown impact on the ability of these gardens to cope and adapt to environmental changes.

During consultation with First Nations Knowledge holders it was clear that community accessibility of sites and places played a large part in the selection of the cultural places people were most concerned about. First Nations people carry out contemporary gatherings, ceremonies and transgenerational training at places that are historically important to them, provide the suitable mental and physical landscape conditions (i.e., connection to nature, sense of remoteness from urban life and tranquillity) and which are accessible to them. For this reason, should the visual, noise and frequency of aircraft render treasured places unsuitable for cultural practice then this would further restrict First Nations people from accessing country and revitalising their heritage. As accessible places become rarer the cumulative impact caused by the loss of such places becomes severe.

This is a concern in the case of Shaws Creek Aboriginal Place in Yellomundee Regional Park and Bents Basin where predicted impacts, particularly from noise and frequency of flights, poses a real risk that these places will no longer be suitable for the cultural practices for which they are currently used.

The preliminary flight paths would be visible from several spiritual sites. For example, while flights at high altitude can already been seen crossing the vista of the Three Sisters in their dramatic cultural landscape, adding more visual intrusions would over time continue to erode this iconic scene and produce a disconnect between the spiritual values and the landscape (refer Technical Paper 9: Heritage).

22.4.9 Social and economic

Recent and proposed changes in planning, such as that occurring within the broader Aerotropolis precinct, will result in changes to community composition, way of life and livelihoods over time as development surrounding WSI (such as the Aerotropolis) transforms the region. However, it is noted there are no other planned or potential airspace projects that have been identified that may introduce cumulative airspace direct or indirect impacts. The assessment of project related social impacts is provided in Chapter 18 (Social).

Potential cumulative social impacts resulting from the project and the screened projects and developments in Table 22.1 include:

- incremental changes to community composition. It is anticipated there would be in-and-out migration resulting from the interaction of the projects, as people would experience changes to their way of life and others would be interested in moving into the area due to increased employment opportunities. These changes to the community composition will affect both positively and negatively the existing social fabric and cohesion of the communities in the local study area
- incremental increases in noise, alterations to air quality and light exposure during construction of on-the-ground projects may result in changes to wellbeing and the way people enjoy social infrastructure and their own properties
- incremental acquisition of land and properties to construct the on-the-ground projects, paired with land use restrictions, may contribute to constrained housing availability within the local study area. However, it is acknowledged that within the regional study area there are a number of residential developments that would increase housing availability, such as Bradfield City Centre
- the sustainability of Luddenham may be enhanced due to the increased influx of people and business and employment opportunities within the local study area.

The assessment of project related economic impacts is provided in Chapter 19 (Economic). Potential economic cumulative impacts resulting from the project and the screened projects and developments in Table 22.1 include:

- the generation of jobs in Western Sydney and contribution to gross regional product. The conclusions from the 2016 EIS was that airport operations would directly generate 8,730 jobs in 2031 increasing to 61,500 jobs by 2063 (Ernst and Young, 2016). Additional jobs on the Airport Site could be accommodated in retail, hospitalities, business park and airport related industries. The 2016 EIS estimated an additional 4,439 jobs in 2031 increasing to 27,148 jobs by 2063 (Ernst and Young, 2016). Additional employment from the Aerotropolis will provide as many as 100,000 jobs by 2060 spread over 11,200 hectares of land surrounding the Airport Site. Flight paths are an integral element of WSI itself and do not directly generate jobs or create economic value
- potential for loss in the value of residential property in proximity to on-the-ground projects and WSI flight paths
- no loss in tourism spend in the regional area and hence no impacts on the local economy is expected. On the contrary, WSI itself provides some potential for positive impact on tourism in the Blue Mountains due to its proximity.

22.4.10 Human health

Impacts from the operation of the flight paths would occur following construction of WSI, where impacts associated with construction would no longer be relevant. Impacts related to ground operations of WSI were considered in the 2016 EIS. The 2016 EIS identified a number of localised impacts associated with surrounding roadways, particularly in relation to air quality. The assessment of project related human health impacts associated with the project is provided in Chapter 20 (Human health).

Cumulative impacts on community health cannot be assessed as insufficient information is available. It would be expected that future developments in the area would need to consider impacts derived from the operation of WSI.

The screened projects (identified in Table 22.1) would require the assessment of cumulative impacts and the implementation of associated mitigation measures. Impacts relating to the operation of new road and rail infrastructure would generally result in localised impacts close to on-ground construction and operational areas, and are considered unlikely to contribute to significant cumulative health impacts associated with WSI flight paths.

22.5 Conclusion

This chapter provides an overview of the potential cumulative impacts within the vicinity of WSI and also at a broader, regional scale. The assessment of cumulative impacts has been undertaken in accordance with the EIS Guidelines and has adopted an approach based on the *NSW Cumulative Impact Assessment Guidelines for State Significant Projects* (NSW DPE, 2022h).

The assessment of cumulative impacts has considered each of the environmental aspects requiring assessment in the EIS Guidelines. In many cases, the quantitative assessment of issues is difficult, due to the large study area, the indirect nature of potential impacts and the lack of sufficient baseline data relative to some impacts.

A range of cumulative impacts have the potential to occur as a result of the project's location, in proximity to current and future large-scale infrastructure projects, strategic growth areas and economic corridors associated with rapid development in Western Sydney.

During operation of the project, WSA Co will liaise with Airservices Australia, the Civil Aviation Safety Authority (CASA), other Sydney Basin airport operators, NSW Government agencies and other key development stakeholders to identify measures to reduce the cumulative impacts of WSI operations, including airspace operation.

The implementation of project specific mitigation measures would avoid, to the greatest extent possible, cumulative impacts with surrounding developments and other airspace users and reduce the potential cumulative impacts to acceptable levels.

