Volume 4

Melbourne Airport
M3R MDP

Chapters B10–B13

MELBOURNE AIRPORT

Chapter B10
Air Quality

Summary of key findings:

- Air quality impacts at Melbourne Airport were assessed for the construction and operational phases of Melbourne Airport's Third Runway (M3R). This chapter also identifies specific measures to avoid, manage, mitigate, and/or monitor air quality impacts.
- Potential impacts due to dust emissions from construction activities will be mitigated to satisfactory levels by applying dust suppression techniques. Project standards for deposited dust (TSP/nuisance dust), PM_{10} and PM2.5 are therefore expected to be met outside the airport.
- The primary contributors to air emissions from airport operations were aircraft movements (Landing and Take-Offs, LTOs), Auxiliary Power Units (APUs) and road vehicle movements.
- Comparisons of model results for the No Build and Build scenarios indicated that overall Build leads to slightly worse air quality impacts. This is to be expected, given aircraft movements and road traffic movements will increase under the Build scenarios. The worst-case scenario was Build 2046 in which aircraft operations increased by 91 per cent and road traffic increased by an average of 95 per cent compared to 2019 (the base scenario).
- Melbourne Airport is considering the most effective mitigation measures and emissions controls for aircraft and road traffic movements that are within its own influence. Melbourne Airport's scope 3 strategy (which will also reduce emissions of other air pollutants) is in development and will be published in 2023. Melbourne Airport will also continue to implement and refine its Air Quality Monitoring Program.
- Proposed mitigation measures include: additional fixed ground electrical power and pre-conditioned air for all international gates; providing additional electric charging points for airside electric vehicles and equipment; and to increase efficiency in using diesel equipment (through reduced taxing times and optimal scheduling) at the airport. Traffic emissions can also be reduced by increasing public transport to the airport (such as through Melbourne Airport Rail) and supporting electric vehicle traffic to replace internal combustion engine vehicles. This includes provision of electric charging points for landside vehicle use. The timely roll out of these measures will minimise air quality impacts as far as practicable.

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B10.1
INTRODUCTION

This chapter describes the existing air quality at Melbourne Airport and compares this to an assessment of potential future scenarios:

- 'No Build' scenario where Melbourne Airport's Third Runway (M3R) is not constructed
- 'Build' scenario where M3R is constructed.

This chapter also identifies specific measures to avoid, manage, mitigate, and/or monitor air quality impacts and is structured as follows:

- Discussion of Statutory and policy requirements in **B10.2**, including a summary of air quality standards
- The significance criteria framework for interpreting assessment results relative to these requirements in **Section B10.3**
- **Section B10.4** describes the technical process followed for air quality modelling
- **Section B10.5** describes existing meteorological and air quality conditions
- **Section B10.6** and **B10.7** present the modelled air quality conditions for the construction and operation impact assessments, relative to the air quality standards
- **Section B10.8** describes impact avoidance, management and mitigation measures
- Final conclusions are presented in **Section B10.9**, including a summary relative to the significance criteria.

B10.2
STATUTORY AND POLICY REQUIREMENTS

Melbourne Airport is located on Commonwealth land. The Airports Act 1996 (Cth) and the Environment Protection and Biodiversity Conservation Act 1999 (Cth) are the key pieces of legislation that set the regulatory framework for M3R and this assessment. However, consideration has also been given to relevant Victorian and local legislation including environmental planning instruments, policies, and guidelines.

B10.2.1
Commonwealth legislative requirements

Applicable Commonwealth legislation and guidelines comprise:

- *Airports (Environment Protection) Regulations 1997 (AEP Regulations)*
- *National Environment Protection (National Pollutant Inventory) Measure 1998 (NPI NEPM)*
- *National Environment Protection (Ambient Air Quality) Measure 2016 (AAQ NEPM)*
- *National Environment Protection (Air Toxics) Measure 2011.*

B10.2.1.1
AEP Regulations 1997

An objective of the AEP Regulations is to promote the improvement of environmental management practices for activities carried out at airports. The AEP Regulations apply to the assessment of air emissions within an airport's boundaries, but do not apply to pollution generated by an aircraft. Hence, because monitoring and modelling measure total air quality effects, the AEP Regulations' requirements have not been applied for this assessment.

The assessment focused on sensitive receptors outside the airport's boundary and, for this reason, used the relevant Victorian regulations. The ambient air quality objectives from the AEP Regulations are provided for comparison in **Table B10.1.**

B10.2.1.2
National Environment Protection Measures

The National Environment Protection Council (NEPC) has set out National Environment Protection Measures (NEPM) which are national objectives designed to assist in protecting and/or managing particular aspects of the environment.

The National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) (NEPC, 2003) was published to assist the protection of ambient air quality. This Measure is used Australia-wide to monitor and assess air quality setting out standards for six criteria (primary) air pollutants; carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2), lead, and particles such as PM_{10}.

NEPC strengthened the AAQ NEPM air quality reporting standards in 2021, adopting more strict criteria for nitrogen dioxide, sulphur dioxide and ozone. The standard also changes the form of the criteria to the maximum value with no allowable exceedances for all pollutants. More strict criteria are also provided for sulphur dioxide and particulate matter $PM_{2.5}$ from 2025. The 2021 standard was applied to this assessment, even though it was not in force at the time of the original air quality assessment .

In addition, the National Environment Protection Measure (Air Toxics) 2011 (NEPC, 2011) was established to facilitate a consistent approach to monitoring and reporting of five key hydrocarbons that impact human health: benzene, toluene, formaldehyde, xylenes and Poly-Aromatic Hydrocarbons (PAHs).

National standards are used to assess air quality concentrations determined by Victoria's air quality monitoring programs. The national air quality (monitoring) standards are relevant to M3R because they are adopted in Victorian Government ambient air quality monitoring standards, described in **Section B10.2.2.**

B10.2.2
Victorian legislation

State legislation and guidelines comprise:

- *Environment Protection Act 1970*
- *Environment Protection Act 2017 (in force from 1 July 2021)*
- *Environmental Protection Amendment Act 2018*
- *EPA Victoria Publication 1961 Guideline for assessing and minimising air pollution in Victoria*
- *State Environment Protection Policy (Ambient Air Quality) 1999 (SEPP (AAQ)) (no longer in force, as of 2021)*
- *State Environment Protection Policy (Air Quality Management) 1999 (SEPP (AQM)) (no longer in force, as of 2021)*
- *Protocol for Environmental Management: Mining and Extractive Industries 2007 (Mining PEM) (no longer in force, as of 2021).*

The air quality assessment was originally prepared under the Environment Protection Act 1970, with reference to the SEPP (AQM) and SEPP (AAQ) criteria and requirements. Criteria from these standards are provided for reference in the modelled results, as these standards were in force for the original air quality assessment.

The current (as of 2022) legislation has also been considered in this assessment under the Environment Protection Act 2017, and EPA Publication 1961 *Guideline for assessing and minimising air pollution.*

B10.2.2.1
Environment Protection Act

The Environment Protection Act is the primary legislative instrument that governs the protection of the environment in Victoria, including protecting beneficial uses of the air quality environment.

The original EP Act (1970) achieved this function by setting objectives for air quality and regulating emissions into the air environment through two State Environment Protection Policies.

Resultant amendments to the EP Act 1970 were made in the Environment Protection Act 2017. The Environment Protection Authority Victoria (EPA Victoria) has enacted new laws aimed at preventing harm to public health and the environment in the 2017 Act from July 2021.

The Environment Protection Act 2017 creates the Environment Reference Standard (ERS), a tool designed to identify important environmental values and assess these values in locations across Victoria. Note the ERS is not a compliance standard and hence does not create any obligations on duty holders nor define any fixed environmental standards for enforcement. For air quality, the ERS replaces the SEPP (Ambient Air Quality), which was in force until mid-2021. As such, impacts from M3R were originally assessed against the SEPM (AAQ) but have since been updated to refer to the ERS. The ERS also provides updated standards for air toxics including VOCs to replace the Air Toxics NEPM.

Victoria passed the Environmental Protection Amendment Act in 2018. The legislation focuses on waste management, industrial waste, and contaminated environments, but also has implications for air quality.

The amendment replaces permissions granted for high-risk activities with a three-tiered permissions framework of registrations, permits and licences. Licences are required to manage complex activities that require the highest level of regulatory control to manage significant environmental risks and will be subject to regular reviews.

B10.2.2.2
EPA Victoria Publication 1961 Guideline for assessing and minimising air pollution in Victoria

EPA Victoria has produced a new air quality guidance called Guideline for assessing and minimising air pollution in Victoria (EPA Publication 1961), which was in draft form at the time of the air quality assessment. The guideline was finalised and published in February 2022. This guideline forms part of Victoria's environmental protection framework that establish the state of knowledge to protect the environmental values of the ambient air environment. Emitters of pollution to air have a responsibility to put in proportionate controls to eliminate or minimise risks to human health or the environment. Being proportionate and preventative requires duty holders to:

- Understand their risks
- Actively seek out ways to eliminate or minimise these risks, so far as reasonably practicable
- Ensure any risks remaining after the implementation of all controls are within acceptable limits

The purpose of the guideline is to provide a framework to assess and control risks associated with air pollution. The guideline outlines a risk management approach that involves a repeating cycle of four steps. The four steps and how they have been addressed in this assessment are detailed below.

1. Identifying hazards

This involves identifying, and if necessary, quantifying emission sources. This also involves characterising the receiving environment including local topography, meteorology, background air quality and nearby sensitive land uses. Sections 10.4 and 10.5 addresses hazard identification.

2. Assessing risks

A three-tiered approach to the assessment of risks from air pollution is outlined, namely:–

- Level 1 assessment: qualitative or semiquantitative assessment, used to assess risks from activities that either have intrinsically low risks, or have common, well-understood risks that can be controlled without extensive assessment.
- Level 2 assessment: involve the use of dispersion modelling or monitoring with predicted concentrations benchmarked against air quality assessment criteria (AQAC).
- Level 3 assessment: detailed risk assessment, usedwhen a simple comparison of a pollutant's concentration to an AQAC cannot adequately assess risks.

An assessment in line with level 2 was undertaken with results presented in Sections 10.6 and 10.7.

3. Implementing controls

Emitters should demonstrate how existing or proposed risk controls minimise risks so far as reasonably practicable. This is addressed in Section 10.8.

4. Checking controls

To evaluate performance, emitters should have clearly documented environmental performance objectives that can be monitored and reported on. This is addressed in Section 10.8.

The air quality impact assessment for M3R aligns to the procedures set out EPA publication 1961, as well as to the former SEPP (AQM) Schedule C. Assessment procedures were consistent with the use of AERMOD and AEDT, the latter being used internationally for air quality impact assessments for airports. EPA Victoria was consulted and agreed with the use of AEDT to model aircraft emissions in conjunction with AERMOD for the assessment for M3R.

B10.2.2.3
State Environment Protection Policies

Victoria's State Environment Protection Policy (Air Quality Management) (SEPP (AQM) and State Environment Protection Policy (Ambient Air Quality) (SEEP (AAQ)) were in force for the original air quality assessment conducted for M3R and as such have been included for reference in modelled results.

The SEPP (AQM) established a framework for managing emissions into the air environment from all sources of air pollutants. The SEPP (AQM) management framework and attainment program for protection of the air environment addresses ambient ('regional') air quality and the management of specific sources such as industry, motor vehicles and open burning, and local air quality impacts including air toxics, odorous pollutants, greenhouse gases and ozone depleting substances.

Schedule A of the SEPP (AQM) prescribes the 'Class 1, 2 and 3 indicators', (i.e. air pollutants), and their 'design criteria'. The design criteria represent an extensive set of ambient air quality standards to be used for air dispersion modelling assessments in Victoria. The design criteria had a separate function from the air quality standards provided in the Ambient Air Quality NEPM and the SEPP (AAQ), which are used for the assessment of ambient air quality using monitoring techniques.

Essentially, the SEPP (AQM) design criteria was a set of air quality standards to be used with air dispersion models with the goal being to prevent exceedances, determined by monitoring, of the air quality standards set out in the SEPP (AAQ) at nearby sensitive receptors. Design criteria have since been replaced by a guiding standard (Publication 1961 and the ERS) seeking to minimise all air pollution rather than allowing pollution up to an accepted level.

B10.2.2.4
Protocol for Environmental Management: Mining

The Mining PEM was an incorporated document to the SEPP (AQM) and provides guidance on how to assess the potential impacts of emissions arising from extractive industries, including construction dust deposition. As with the SEPPs, EPA Victoria Publication 1961 effectively replaces the Mining PEM was therefore also considered relevant to this assessment.

The Mining PEM is the 'relevant industry PEM' referenced in the SEPP (AQM) as the relevant criteria for area-based sources and roads (which includes construction dust sources). The Mining PEM specifies that dust deposition should not exceed 2g/m²/month above background levels, and 4g/m²/month total.

These criteria are considered relevant and for use as a "rule-of-thumb" in EPAV Publication 1961, to identify where further investigation and mitigation is required to address dust issues (rather than a level that industry can pollute up to). 1961 also requires monitoring plus a review of operation controls and management practices as part of meeting the General Environmental Duty (GED).

B10.2.3
Summary of air quality standards

The AAQ NEPM (2021) air quality monitoring standard used in this assessment is provided in **Table B10.1**. The NEPC (2011) monitoring investigation levels for the primary hydrocarbons are set out in **Table B10.2**.

Ambient air quality was assessed beyond the boundary of the airport. Publication 1961 (EPA Victoria, 2022) refers to the Victorian Environment Reference Standard (ERS) for air pollution assessment criteria for criteria air pollutants (nitrogen dioxide, carbon monoxide, particulate matter). The ERS replaces SEPP (AQM) and generally adopts the objectives in the AAQ NEPM (2021). Modifications to the AAQ NEPM are noted in **Table B10.1**. This standard was applied to new and expanded sources of emissions including industrial premises, transport sources including road corridors, and other mobile sources including roads. All ambient air quality criteria are applied at sensitive receptors (refer to **Section B10.4.2.2**).

Note that the Workplace Exposure Standards for Airborne Contaminants (based on the Work Health and Safety (WHS) Act and WHS Regulation) were considered but not directly applied to air pollutants within the boundary of Melbourne Airport. The Exposure Standards provide a set of eight-hour Time Weighted Averages (TWAs) and Short term exposure limits (STEL) applicable to workers exposed to airborne contaminants. The TWA criteria applies to the same air pollutants listed below, and in all cases is higher than the ambient air quality standard. For example, NO_2 has an 8-hour TWA of 5.6 mg/m³ and a STEL of 9.4 mg/m³, compared to a 1-hour average of 169 ug/m³. Carbon monoxide has a TWA of 30 ppm compared with 9 ppm for the ambient air quality objectives. Particulate matter is not listed among pollutants in the WHS Regulations. Since exposure by staff at the airport is expected to be insignificant given staff movements within a typical shift, the ambient air quality standards are used to indicate compliance with the WHS Regulations.

Table B10.1
Ambient air quality objectives and goals – criteria air pollutants

Environmental indicator (air pollutant)	Averaging period	Former SEPP (AAQ) design criteria	Ambient Air Quality NEPM (2021) objectives	NEPM proposed targets (NEPC, '21)	Airport (Environment Protection) Regulations 1997*
CO (max. conc.)	8 hours[b]	9.0 ppm	9.0 ppm (10,300 ug/m^3)	-	9.0 ppm
O_3 (max. conc.)	1-hour	100 ppb			100 ppb
	4 hours[b]	80 ppb			80 ppb
	8 hours	-	65 ppb		-
NO_2	1-hour	120 ppb (226 µg/m^3)	80 ppb (150 µg.m^3 at 25°C) (2021)	-	160 ppb (320 µg/m^3)
	Annual	30 ppb (56 µg/m^3)	15 ppb (28 µg/m^3) (2021)	-	-
SO_2	10 minutes		-	-	250 ppb
	1-hour	200 ppb (523 µg/m^3)	100 ppb (260 µg/m^3 at 25°C)	75 ppb (196 µg/m^3 at 25°C) from '25 with no allowable exceedances	200 ppb
	1 day	80 ppb	20 ppb		20 ppb
	Annual	20 ppb	-		
Particles as PM_{10}	1 day	50 µg/m^3	50 µg/m^3	-	-
	1 year	20 µg/m^3	20 µg/m^3 (based on the ERS, noting the NEPM lists the standard as 25 µg/m^3)		-
Particles as $PM_{2.5}$	1 day	25 µg/m^3	25 µg/m^3	20 µg/m^3 by '25	
	1 year	8 µg/m^3	8 µg/m^3	7 µg/m^3 by '25	-

a Updates to the NEPM in 2021 included changing all criteria to remove any allowance for exceedances. This aligns with the Airport (Environment Protection) Regulations 1997. b Rolling eight-hour average based on one-hour averages. c Rolling four-hour average based on one-hour averages.

Table B10.2
Air toxics NEPM (2011) monitoring investigation levels and goals

Pollutant	Air Toxics NEPM	
	Averaging period	Monitoring investigation level (MIL)
Benzene	Annual average	3 ppb (9.6 µg/m^3)
Benzo(a)pyrene as a marker for polycyclic aromatic hydrocarbons	Annual average	0.3 ng/m^3
Formaldehyde	24-hours	40 ppb (49 µg/m^3)
Toluene	24-hours	1000 ppb (3767 µg/m^3)
	Annual average	100 ppb (377 µg/m^3)
Xylenes (as total of ortho, meta and para isomers)	24-hours	250 ppb (1085 µg/m^3)
	Annual average	200 ppb (868 µg/m^3)

The 8-year goal of the Air Toxics NEPM (2011) was to gather sufficient data nationally to facilitate development of a standard. The annual average concentrations are arithmetic mean concentrations of 24-hour monitoring results. Monitoring over 24-hour periods is conducted from midnight to midnight.
For toluene and xylenes, the annual average and 24-hour MILs were derived independently for different (chronic and acute) health endpoints.
The 24-hour MILs were derived from health-based guidelines of shorter averaging periods: 0.08 parts per million (ppm) for a one-hour averaging period (formaldehyde); 4 ppm for a six-hour averaging period (toluene); and 1 ppm for a 30-minute averaging period (xylene).

B10.2.4
Project (modelling) air quality standards

A summary of the air quality standards (the 'project standards') used for the assessment of modelled Ground Level Concentrations (GLCs), is provided in Table B10.3. Pollutants are assessed against the NEPM (2021) standard, with reference also to the SEPP (AQM) and SEPP (AAQ) standards which were in force at the time of the original air quality assessment. VOCs were modelled as a whole and then assessed for fractions of benzene and formaldehyde to align with the emission rates output from both AEDT and COPERT.

Table B10.3
Project modelling air quality standards

Pollutant	Class, reason for classification	Relevant standard	Avg. period	Standard
Construction phase impacts				
Particles as PM_{10}	Class 1, Toxicity (VG, 2001)	NEPM (AAQ)	24-hours	50 µg/m³
Particles as $PM_{2.5}$	Class 2, Toxicity (VG, 2001)	NEPM (AAQ)	24-hours	25 µg/m³
Deposited dust (TSP)	Amenity / nuisance	EPAV Publication 1961, adapted from Mining PEM	Month	4 g/m² total 2 g/m² above background
Operational phase impacts				
Nitrogen dioxide (NO_2)	Class 1, Toxicity	NEPM (AAQ) / EPA Victoria 1961 and the ERS	1-hour	80 ppb (150 µg/m³) 190 µg/m³ under SEPP (AQM) (no longer in force)
			Annual	15 ppb (28 µg/m³) 56 µg/m³ under SEPP (AQM) (no longer in force)
Particles as PM_{10}	Class 1, Toxicity (VG, 2001)	NEPM (AAQ)	24-hours	50 µg/m³
	Annual		Annual	20 µg/m³
Particles as $PM_{2.5}$	Class 2, Toxicity (VG, 2001)	NEPM (AAQ)	24-hours	25 µg/m³ 20 µg/m³ from 2025
			Annual	8 µg/m³ 7 µg/m³ from 2025
Carbon monoxide CO	Class 1, Toxicity	NEPM (AAQ)	8 hours	9 ppm 29 mg/m³ under SEPP (AQM) (no longer in force)
Sulfur Dioxide SO_2	Class 1, Toxicity	NEPM (AAQ)	1 hour	100 ppb (260 µg/m³) 75 ppb from 2025 450 µg/m³ under SEPP (AQM) (no longer in force)
Formaldehyde	Class 2 (toxicity based), International Agency for Research on Cancer (IARC) Group 2 carcinogen	EPAV 1961 / ERS	30 minutes 3 minutes	80 ppb (100 µg/m³) 40 µg/m³ under SEPP (AQM) (no longer in force)
Benzene	Class 3, IARC Group 1 carcinogen	EPAV 1961 / ERS SEPP (AQM) (no longer in force)	1 hour 3 minutes	180 ppb (580 µg/m³) 53 µg/m³ under SEPP (AQM) (no longer in force)

B10.3 DESCRIPTION OF SIGNIFICANCE CRITERIA

To ensure a consistency of approach across each impact assessment presented in the MDP, Chapter A8: Assessment and Approvals Process describes a framework for assessing the significance of impact assessment results. The significance of air quality impact assessment results is dictated largely by the magnitude of the predicted impacts. Criteria for gauging significance are described in Table B10.4. These criteria have been used for the interpretation of the assessment results presented in Section B10.4.3 and B10.4.4.

Assessment against these criteria has been undertaken for each pollutant using a two-step process to compare

Table B10.4
Significance criteria

Impact significance	Description	Rationale/comments
Major	Major air quality impact on a regional scale determined by assessment parameter 'x' being well in excess of 100% of project standard for discrete (sensitive) receptors.	• Airport activity leads to large modelled predicted exceedances of project standards off-airport. • Risk assessment includes consideration of air quality monitoring results. • Emissions controls expected to be insignificant in reducing these exceedances. • Monitor and report key air pollutant GLCs to assist with air quality management and support air quality research programs. • Annual air quality modelling studies to increase understanding of major adverse air quality effects.
High	Air quality impacts at local scale determined by assessment parameter 'x' approximately greater than or equal to 100 per cent of project standard for discrete (sensitive) receptors.	• Airport activity leads to predicted exceedances of project standards off-airport. • Risk assessment includes consideration of air quality monitoring results. • Emissions controls not expected to have a significant effect reducing these exceedances. • Monitor and report key air pollutant GLCs to assist with air quality management and support air quality research programs. • Occasional air quality modelling studies to increase understanding of high adverse air quality effects.
Moderate	Air quality impacts at local scale determined by assessment parameter 'x' approximately 20 per cent to 99 per cent of project standard for discrete (sensitive) receptors.	• Airport activity has a detrimental effect on air quality, without causing exceedances of project standards at sensitive receptors. • Risk assessment includes consideration of air quality monitoring results. • Emissions controls may assist to reduce exceedances. • Monitor and report key air pollutant GLCs to demonstrate moderate adverse air quality impacts and support air quality research programs. • Occasional air quality modelling studies to increase understanding of high adverse air quality effects.
Minor	Minor air quality impacts at local scale determined by assessment parameter 'x' approximately 1 per cent to 20 per cent of project standard for discrete (sensitive) receptors.	• Airport activity has a slightly detrimental effect on air quality, without causing exceedances of project standards. • Risk assessment includes consideration of air quality monitoring results. • The 20% level is based on the EPA's guidance for using AERMOD. This level recognises increased risk of air quality impact by triggering dispersion modelling with five years of meteorological data. • Emissions controls will assist to improve air quality, especially on-airport. • Monitor and report key air pollutant GLCs to demonstrate minor adverse air quality effects; consider supporting air quality research programs; occasional air quality modelling studies to increase understanding of high adverse air quality effects.
Negligible	Negligible air quality impacts at local scale determined by assessment parameter 'x' approximately less than or equal to 1 per cent of project standard for discrete (sensitive) receptors.	• Changes to baseline air quality only just detected by monitoring or modelling. Emissions controls will still assist to improve air quality on-airport, especially near terminals. • Monitor and report key air pollutant GLCs to demonstrate negligible air quality effects, e.g., it is possible the airport's emissions of • NO_x, HCs, CO and other air pollutants could reduce O_3 levels in the vicinity of the airport to below the O_3 levels observed in other parts of the Melbourne airshed. This may become more important as the airport's emissions increase in future. • Occasional air quality modelling studies to increase understanding of negligible air quality effects and communicate results; consider supporting air quality research programs.
Beneficial	Airport activity causes a decrease in the baseline levels of a pollutant at discrete (sensitive) receptor locations.	• Changes to baseline air quality only just detected by monitoring or modelling. • Emissions controls will still assist to improve air quality on-airport, especially near terminals. • Monitor and report key air pollutant GLCs to demonstrate negligible air quality effects, e.g., it is possible the airport's emissions of • NO_x, HCs, CO and other air pollutants could reduce O_3 levels in the vicinity of the airport to below the O_3 levels observed in other parts of the Melbourne airshed. This may become more important as the airport's emissions increase in future. • Occasional air quality modelling studies to increase understanding of negligible air quality effects and communicate results; consider supporting air quality research programs.

the results for the worst-case emissions scenario (Build 2046) against a baseline scenario (No Build 2046).

The first step focussed on modelled results at discrete receptors. For each pollutant, an assessment parameter (parameter 'x') was defined as the difference between Build and No Build scenarios, divided by the air quality standard for that pollutant (see Table B10.3). In this way, the assessment results were normalised for all pollutants.

The second step was a semi-quantitative analysis of the results for all receptors of the AERMOD modelling grid (to ensure complete coverage), undertaken by inspection of the spatial differences between the contour plots for the Build and No Build cases.

Note that while this chapter measures risk based on air dispersion modelling relative to the air quality standards, mitigation measures to minimise air pollution are also discussed and will be included in Melbourne airport's future strategy.

B10.4 ASSESSMENT METHODOLOGY AND ASSUMPTIONS

B10.4.1 Overview

The air quality impacts of the proposed M3R were assessed for two key stages of the project:

- Construction dust emissions - emissions of airborne particulate matter (PM) as PM_{10} and $PM_{2.5}$ due to activities and equipment associated with construction earthworks
- Operational emissions – particulate and gaseous emissions (e.g. PM_{10}, $PM_{2.5}$, oxides of nitrogen and hydrocarbons) from jet aircraft engine exhausts, airport Ground Support Equipment (GSE) during operations, and aircraft Auxiliary Power Units (APUs), as well as from road vehicles on the airport, surrounding roadways, and car parks.

These air quality impacts were assessed based on a comparison of modelled air quality impacts under the following scenarios:

- Current airport operations – the 'baseline' operating scenario representing the existing runway configuration based on the five most recent and complete years of meteorological data (2015-2019, inclusive) and most recent year of activity data (2019)
- Build – existing runway configuration with the proposed north-south additional runway, along with extensions to the existing road network around the runway:
  - Representing opening year (2026) when new parallel north-south runway operations commence
  - Representing 20 years from opening in 2046
- No Build – existing runway configuration with modelled aircraft movements for reference years 2026 and 2046.

Modelling of air impacts was completed in a three-stage approach:

- Preparation of annual emissions inventories for the construction and airport operations scenarios, which involved:
  - Identifying key sources of air pollutants
  - Applying forecasts of future activity at and around the airport under each scenario listed above
  - Applying relevant emissions factors for each source or source group.
- Dispersion modelling and processing of results incorporating existing conditions (air quality and meteorology) at the airport.
- Presentation of results and reporting.

The air quality models used in this assessment were selected based on the recommendations of the United States of America's Environmental Protection Agency (US EPA) and Federal Aviation Administration. Model selection was also endorsed by the Environment Protection Authority Victoria (EPA Victoria) in February 2020. Note: the methodology used in this assessment has also been peer reviewed by Environmental Consultant GHD.

The air quality impact assessment cumulatively assessed model-predicted ground level concentrations for air pollutants, including background concentrations and the effects from all major sources of air pollutants.

Existing air quality at Melbourne Airport was assessed using monitoring data from two stations maintained by APAM at the airport: a Melbourne Airport south (MAS) and Melbourne Airport east (MAE) station. Monitoring data was compared to data collected by the Victorian Environment Protection Authority (EPA) in Footscray, Campbellfield and Alphington.

The potential air quality impacts from construction of M3R were predicted by estimating the dust emissions from construction activities based on material handling quantities, the construction equipment inventory and the site layout. These activities were input into the Victorian Government regulatory air dispersion model AERMOD (Section B10.4.3).

The potential air quality impacts from the operation of M3R were predicted for existing and future scenarios. A two-step process was adopted. First, the emissions inventory and source characterisation were developed using the internationally recognised Aviation Environmental Design Tool (AEDT) version 3c (build 140.0.11574.1 released March 2020). Second, AERMOD was used to assess emissions dispersion. AERMOD predictions were compared with state and national air quality standards to assess the effects that airport activities may have on the local air quality environment (Section B10.4.4).

The assessment was completed in accordance with the 'Guidance notes for using the regulatory air pollution model AERMOD in Victoria' (EPA Victoria, 2013). The EPA's senior air quality specialists were consulted during the planning phase of this assessment about the proposed models to use, methods to model impacts, and other relevant requirements.

While Melbourne Airport is located on Commonwealth land, the air quality impact assessment supporting M3R was undertaken in accordance with procedures and standards set out in the AAQ NEPM (with reference to the former SEPP (AQM) and SEPP (AAQ)) for the assessment of air quality outside the airport boundaries, which is within the jurisdiction of the Victorian Government (Section B10.2.2).

B10.4.2
Existing knowledge of air quality at Melbourne Airport

B10.4.2.1
Existing Air Quality Monitoring Program

Melbourne Airport has an Air Quality Monitoring Program (AQMP) (July 2019) that defines two air quality monitoring regimes at the airport to assess:

- 'Criteria' air pollutants, considered by regulators to be important for monitoring and reporting, both internationally and Australia-wide (Department of Agriculture, Water and the Environment, 2020). The criteria air pollutants measured at Melbourne Airport are nitrogen oxides (for NO_2), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), and particles as PM_{10} and $PM_{2.5}$.
- 'Air toxics', which in this context are hydrocarbons identified by the Australian Government (2020) as the most important hydrocarbons for monitoring and reporting. The hydrocarbons measured at Melbourne Airport are benzene, toluene, ethylbenzene, xylene and formaldehyde.

Melbourne Airport has two ambient air quality monitoring stations (AQMS) for monitoring criteria pollutants:

- Melbourne Airport south (MAS), which is situated in a cattle grazing paddock at the southern end of the existing north-south runway (16L/34R) within the airport's boundary. It commenced monitoring on 4 December 2013 and continuously monitors all criteria pollutants and meteorological parameters.
- Melbourne Airport east (MAE), located east of the airport boundary in Westmeadows, which commenced monitoring on 1 May 2017. MAE monitors NO_x (including NO_2) and $PM_{2.5}$ for Melbourne Airport.

These two locations are suitable for Melbourne Airport to assess ongoing air quality impacts from airport operations, since prevailing winds are predominantly from the north. As such, the MAS AQMS measures worst case conditions from airport operations and MAE AQMS allows for a comparison of ambient concentrations against concentrations measured at MAS. These monitoring stations are considered suitable for future monitoring of air quality under all scenarios.

Melbourne Airport also specifies a periodic monitoring program in its AQMP (2019) to assess performance (and historical compliance) with air quality standards for Volatile Organic Compounds (VOCs). The most recent round of such monitoring, conducted from December 2014 to July 2017, focused on the key VOCs including benzene, toluene, xylenes, and formaldehyde.

The AQMP has been reviewed periodically by independent experts (Jacobs in 2017 and Point Advisory in 2019). As a result of this process, Melbourne Airport updated its risk register and the AQMP in July 2019.

Melbourne Airport temporarily suspended monitoring at MAE due to the impacts of the COVID-19 pandemic on the aviation industry, which significantly reduced aircraft traffic by more than 95 per cent, and thus the risk of adverse air impacts is low. Monitoring at MAS is ongoing, enabling Melbourne Airport to detect any events resulting from operations at Melbourne Airport. Monitoring at MAE resumed in late 2021.

B10.4.2.2
Sensitive receptors

Figure B10.1 shows the Melbourne Airport boundary and runways, and Figure B10.2 Air quality assessment base map showing M3R Build shows the proposed runway and development footprint. Table B10.5 summarises the sensitive receptors modelled.

Melbourne Airport is predominantly surrounded by non-urban or green wedge land, particularly to the north and west. Urban areas are located to the east and south of the airport comprising a mix of industrial and residential development.

EPA Victoria publication 1961 (as well as the former SEPP (AQM)) discusses the protection of sensitive land uses and provides examples of 'sensitive locations': hospitals, schools and residences. Fourteen discrete receptors representing the closest points to sensitive urban areas surrounding the airport were modelled (Figure B10.1, Figure B10.2). This includes households in the suburbs of Bulla, Greenvale, Attwood, Westmeadows, Tullamarine, Airport West, Keilor Park, and Keilor. All sensitive receptors are ground-based receptors and are impacted by both ground and air-based sources (refer to Sections B10.4.3 and B10.4.4).

In addition, the AQMS at MAS and MAE and the two diffusive sampler monitoring locations (at Living Legends and Keilor Village) were included in the model run as discrete receptors to enable model results to be compared to historical results for model validation.

Table B10.5
Discrete receptors modelled, and associated use

Discrete receptor	Receptor type	Land use type
1. Bulla	Sensitive receptor	Residence
2. Living Legends	Sensitive receptor	Residence
3. Providence Rd	Sensitive receptor	Residence
4. Montrose Ct	Sensitive receptor	Residence
5. Threadneedle St	Sensitive receptor	Residence
6. Westmeadows North	Sensitive receptor	Residence
7. Westmeadows South	Sensitive receptor	Residence
8. Melrose Dve	Sensitive receptor	Residence
9. Janus St	Sensitive receptor	Residence
10. Fisher Gve	Sensitive receptor	Residence
11. Fosters Rd	Sensitive receptor	Residence
12. Arundel Rd	Sensitive receptor	Residence
13. Overnewton Rd	Sensitive receptor	Residence
14. Keilor Village	Sensitive receptor	Retirement Village (residences)
15. Highland Rd	Sensitive receptor	Residence
16. Loemans Rd	Sensitive receptor	Residence
17. MAE	Other receptor: location of AQMS	Public park
18. MAS	Other receptor: location of AQMS	Within airport boundary

Figure B10.1
Map of Melbourne Airport showing sensitive receptors and air quality monitoring stations

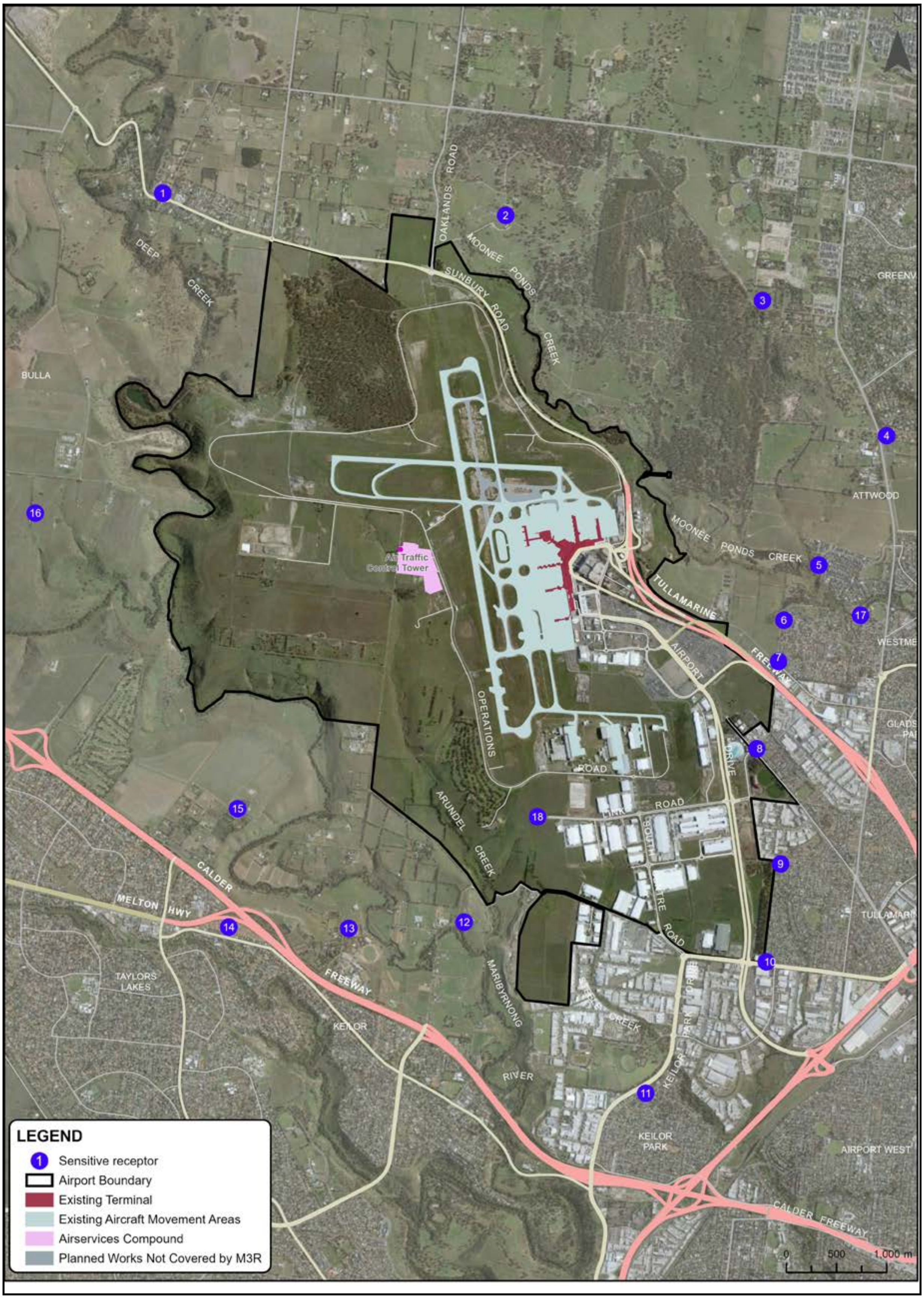
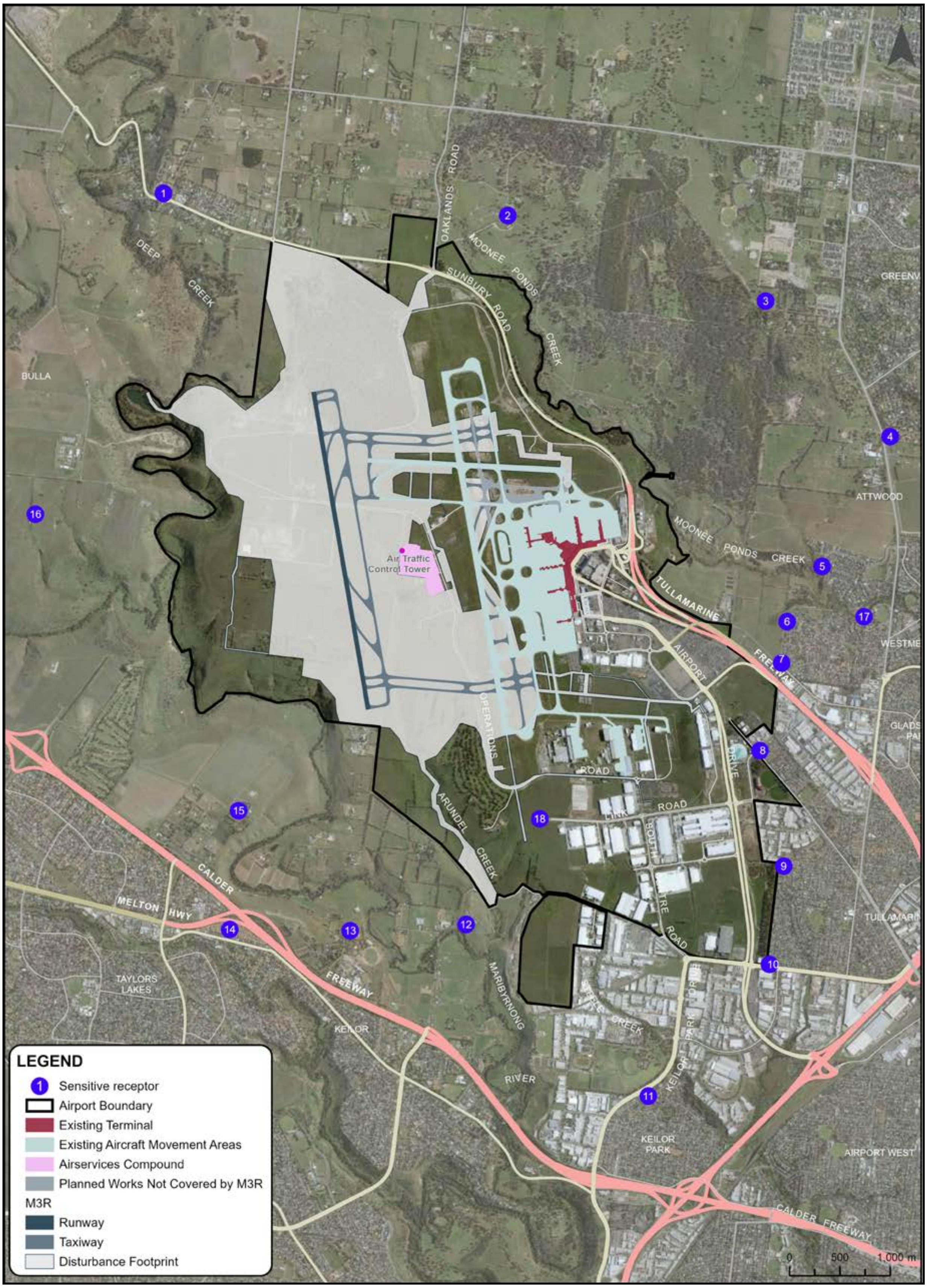


Figure B10.2
Air quality assessment base map showing M3R Build



B10.4.3
Construction dust emissions

The complete construction phase of M3R is expected to occur over a period of four to five years. During this period, dust emissions from bulk earthwork activities are expected to affect ambient air quality. The air quality modelling considered the worst-case scenario regarding dust emissions within a three-year timeframe. The worst-case conditions are based on the following factors:

- Minimum separation distance from key emissions sources to sensitive receptors
- Maximum material handling
- Maximum haul road length
- Maximum area of exposed, non-rehabilitated land.

This confluence of factors is most likely to occur during the earthworks phase of construction, when topsoil stripping and material haulage occur concurrently. Note that annual averages were not assessed because worst-case impacts are likely to occur over only three months during earthworks.

B10.4.3.1
Emissions inventory for construction dust

Construction activities that will contribute to dust emissions include:

- Clearing of land and topsoil scraping
- Excavation of residual soils (subsoil) using conventional earthworks equipment
- Haulage of materials (e.g. imported fill, stone aggregate, sand and cement) to the site, some of the haulage occurring on unpaved roads
- Materials handling by construction equipment such as excavators, bulldozers, and front-end loaders
- Grading and compaction
- Wind erosion from exposed areas and active stockpiles.

Dust emissions from other construction activities can be strictly controlled and are likely to be insignificant in comparison with those listed above. Construction environmental management for M3R will be of a high standard including the provision of dust controls targeting the specific activities listed above. Melbourne Airport has access to sufficient water for dust control by water carts, water sprays and wheel washes. Double handling of material will be minimised where possible, by maximising direct material transportation and minimising stockpiling. These dust controls will be enforced through an approved Construction Environmental Management Plan (CEMP). The CEMP will be developed considering guidance from EPA Victoria Publication 1943 Guidance for assessing nuisance dust, Publication 1834 Civil construction, building and demolition guide, and related documents.

The focus of the air quality assessment of M3R's construction activities has been on small dust particles that may impact human health (PM_{10} and $PM_{2.5}$) and nuisance dust (Total Suspended Particles, TSP) deposited at ground level. These pollutants were estimated using industry accepted techniques, air dispersion modelling using the EPA's regulatory model AERMOD, and comparing model-predicted Ground Level Concentrations (GLCs) to Victorian Government ambient air quality standards for PM_{10}, $PM_{2.5}$ and deposited dust. The air quality standards and relevant policies are detailed in Section B10.2.

Nuisance dust has the potential to contaminate drinking water tanks. However, this is a concern only for heavy metal emissions in dust at contaminated land and mining sites (DEC (WA), 2011) close to sensitive receptors (residences) that are reliant on tank water as their main water supply. Therefore, heavy metal contamination from construction activities is not of concern for residences around Melbourne Airport.

Dust emission quantities from construction activities were estimated from material handling quantities, the construction equipment inventory and the site layout. This information was used to generate model input data including the locations and intensities of the dust generating activities.

The quantitative estimates for construction activities were based on two key standards:

- *NPI Emission Estimation Technique Manual for Mining Version 3.1* (Australian Government, 2012)
- *The AP-42 Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources* (USEPA, 1995 and updates).

Emission factors used to estimate dust emissions for the construction activities are provided in Table B10.6. The $PM_{2.5}$ emissions estimates were calculated using an estimate for the $PM_{2.5}$-to-PM_{10} ratio of 15 per cent based on studies of dust emissions from mining activities by the NSW State Pollution Control Commission (1986) and US EPA (2005).

Estimates of dust deposition are based on emission rates of TSP for an approximated particle size distribution. To give a representative pattern of dust deposition from the site, a particle size distribution for TSP based on US EPA AP-42 Industrial Wind Erosion was applied. TSP was modelled up to a size of 50 μm due to larger particles typically falling out close to the source and therefore unlikely to cause an impact beyond the site boundary.

To quantify emissions for dust dispersion modelling, assumptions were necessary to best represent the expected activities, their locations and timing. The modelled construction scenario and dust emissions estimates were designed to represent the most active construction year: the year of highest anticipated dust emissions over the four-year construction phase.

A summary of TSP, PM_{10} and $PM_{2.5}$ emissions estimates for modelling is provided in Table B10.7. A total imported fill throughput of 2,054,000 cubic metres and excavated fill throughput of 3,946,000 cubic metres (total 6,000,000 cubic metres) was used to estimate the number of vehicle movements divided equally over three years.

Table B10.6
Emissions factors for construction activities

Activity	TSP emission factor	PM_{10} emission factor	Notes
Import fill			
Grader	0.19 kg/VKT	0.085 kg/VKT	Assumes an average speed of 5 km/h per NPI EET Manual for Mining; all worked hours
Tipper truck (8 m^3) – haulage	4.23 kg/VKT	1.25 kg / VKT	Approximately 171,167 vehicle movements will occur over the three-year earthworks program
Tipper truck (8 m^3) – unload fill	0.012 kg/t	0.0043 kg/t	Approximately 2,054,000 m^3 of fill is expected to be imported over three years It was assumed that 50% of the imported material will be stockpiled and the remaining 50% transported to the fill location
Bulldozer (CAT D7)	17 kg/h	4.1 kg / h	Assuming the bulldozers will operate 12 hrs/day
Excavate fill			
Grader	0.19 kg/VKT	0.085 kg/VKT	Assumes an average speed of 5 km/h per NPI EET Manual for Mining for all worked hours
Scraper (CAT 631/651)	0.029 kg/t	0.0073 kg/t	Approximately 27,600 tonnes of soil will be stripped over a 60-day period
Excavator (30 T)	0.025 kg/t	0.012 kg/t	Approximately 3,946,000 m^3 of material is expected to be excavated over three years
Dump truck (Moxy VAT 730) – haulage	4.23 kg/VKT	1.25 kg / VKT	The excavated throughput equates to around 20 vehicle movements per hour, travelling on a haul route approximately 7.5 km long (both ways) It was assumed that 50% of the excavated material will be stockpiled and the remaining 50% will be transported to the fill location
Dump truck (Moxy VAT 730) – unload fill	0.012 kg/t	0.0043 kg/t	It was assumed that 50% of the excavated material will be transported to a stockpile and the remaining 50% will be transported to the fill location
Bulldozer (CAT D7)	17 kg/h	4.1 kg / h	Assuming the bulldozers will operate 12 hrs/day
Transferring stockpiles			
Front End Loader – haulage	0.025 kg/t	0.012 kg/t	Three movements (3 x 28 tonnes) will be transported per hour
Dump truck (Moxy VAT 730) – haulage	4.23 kg/VKT	1.25 kg / VKT	
Unload fill	0.012 kg/t	0.0043 kg/t	
Exposed areas			
Topsoil stockpiles	0.4 kg/ha	0.2 kg/ha	The total topsoil stockpile areas were calculated to be 29.5 ha
Imported material stockpiles	0.4 kg/ha	0.2 kg/ha	The total imported material stockpile areas were calculated to be 20.4 ha
Exposed areas	0.4 kg/ha	0.2 kg/ha	The total exposed area during the worst-case scenarios was calculated to be 94.6 ha

Table B10.7
Emission rates and control methods for construction activities at Melbourne Airport

Activity	Control method	Total TSP emission rate (g/s)	Total PM_{10} emission rate (g/s)	Total $PM_{2.5}$ emission rate (g/s)	Modelled conditions
Import fill					
Grader	-	0.5	0.2	0.04	5 am to 6 pm
Tipper truck (8 m^3) – haulage	Level 2 watering	North route (stockpile): 14.0 North route (fill): 15.8 South route: 4.2	North route (stockpile): 4.1 North route (fill): 4.7 South route: 1.3	North route (stockpile): 0.62 North route (fill): 0.70 South route: 0.19	
Tipper truck (8 m^3) – unload fill	Water sprays (50%)	0.3	0.1	0.01	
Bulldozer (CAT D7)	-	9.4	2.3	0.34	
Excavate fill					
Grader	-	1.1	0.5	0.07	5 am to 6 pm
Scraper (CAT 631/651)	Topsoil naturally/ artificially moist	0.2	0.04	0.01	
Excavator (30 T)	-	4.4	2.1	0.32	
Dump truck (Moxy VAT 730) – haulage	Level 2 watering	24.9	7.4	1.11	
Dump truck (Moxy VAT 730) – unload fill	Water sprays (50%)	0.5	0.2	0.03	
Bulldozer (CAT D7)	-	18.9	4.6	0.68	
Transferring stockpiles					
Front End Loader – haulage	-	0.6	0.3	0.04	5 am to 6 pm
Dump truck (Moxy VAT 730) – haulage	Level 2 watering	3.0	0.9	0.13	
Unload fill	Water sprays (50%)	0.1	0.1	0.01	
Exposed areas					
Topsoil stockpiles	Primary rehabilitation	2.3	1.1	0.17	Only modelled when wind speed greater than 5.2 m/s
Imported material stockpiles	Water sprays (50%)	1.1	0.6	0.08	
Exposed areas	-	10.5	5.3	0.79	

These estimated dust emissions show that haul roads are the most significant source in terms of the mass of emissions (due to wheel-generated dust from tipper trucks/dump trucks). Other key sources include material haulage on unpaved roads, bulldozer activities, and wind erosion from stockpiles and open areas.

The following activities were not included in the modelling for the M3R construction scenario due to their minimal scale:

- Particulates from on-site diesel generators and vehicles are expected to be minor in comparison with those from bulk earthworks activities; and insignificant in comparison with the background PM_{10} and $PM_{2.5}$ levels used in the assessment.
- Gaseous emissions from the combustion of diesel and petrol will result in emissions of NO_2, CO, particulate matter, VOCs and small amounts of SO_2. These emissions during construction were assessed as unlikely to exceed air quality criteria either off-site or at identified receptors. This is because of the comparatively low emission rates (regarding dust impact during construction, and gaseous emissions from aircraft and roadways on and around the airport); the distances between sources; and the short-term nature of their use.

In addition, particulates from asphalt and concrete batch plants in the region were not modelled because emissions from these sources are captured in the background concentrations used in the assessment. Any increase in production due to airport construction activities, and the related increase in emissions, is expected to be insignificant relative to dust emissions from earthworks.

B10.4.3.2
Dispersion model selection for construction dust emissions

The M3R construction phase activities were represented in AERMOD by a series of volume sources representing the location of activities.

Figure B10.3 shows the spatial distribution of modelled sources. Notable emissions sources include the runway footprint; major haul routes extending north and south (I2.1-2.3) centrally located stockpiles (W1-2); and the large, exposed area towards the north of the site (W3). Emissions from the dust-generating activities listed in Table B10.7 were modelled as arising from one or more of these source locations, where appropriate.

Dispersion modelling was carried out using the latest version of AERMOD (v.9.9.0). The assessment was undertaken in accordance with the procedures set out in EPA Victoria Publication 1961, with consideration to the EPA's guidelines for the use of AERMOD (EPA Victoria, 2014).

Site-specific meteorology data was sourced from the Melbourne Airport Automatic Weather Station (AWS) operated by the Bureau of Meteorology (BoM) and converted into surface and profile meteorological files to run in AERMOD using AERMET. Full details on the creation of the meteorological files used in modelling are provided in Section B10.5.1. The years 2015 to 2019 inclusive were selected for modelling.

Site topography and three-dimensional terrain has been used in the model, with 30-metre resolution.

B10.4.4
Operational emissions

The operational emissions assessment focused on air pollutants released from:

- Airport operations - including aircraft movements (landing, take-off cycle) and related equipment
- Transportation attributed to the airport - private transport and freight to and from the airport, as well as car parking at the airport.

Pollutants released from these two source groups are predominantly released from the combustion of fossil fuels (avgas, diesel and petrol) in private, freight or aviation vehicles. This combustion process emits nitrogen oxides, carbon monoxide, ozone, dust particles (PM_{10} and $PM_{2.5}$) and Volatile Organic Compounds (VOCs) to air.

Ultrafine particles (UFP) were also considered in the assessment. UFPs are a class of particulate matter smaller than 0.1 µm ($PM_{0.1}$). EPA Victoria Publication 1961 notes that the smaller the size of the particles, the more hazardous the particles can be to health, however no regulatory requirements or criteria have been set.

As per EPA Victoria Guideline 1961, criteria pollutants were assessed based on multiple lines of evidence:

- Comparison of predicted (modelled) concentrations to background pollution
- Assessing incremental contribution to ground level concentrations
- Validating data using observational data from the MAS and MAE stations, and
- Assessing model variability (sensitivity) by using multiple years of meteorological data in air dispersion modelling.

Emissions from the two key source groups identified above were assessed differently:

- Aircraft operational emissions were modelled using the Aviation Environmental Design Tool (AEDT) (Version 3c). AEDT utilises the USEPA dispersion model AERMOD to model the dispersion of such emissions in the atmosphere
- Emissions from road vehicle traffic and car parks in the vicinity of Melbourne Airport were modelled separately, also in AERMOD.

The results of these two approaches were then combined in post-processing using AERMOD.

The following subsections describe the characterisation of emissions from airport operations and surrounding roadways and car parks, followed by a more detailed discussion on dispersion model selection and configuration.

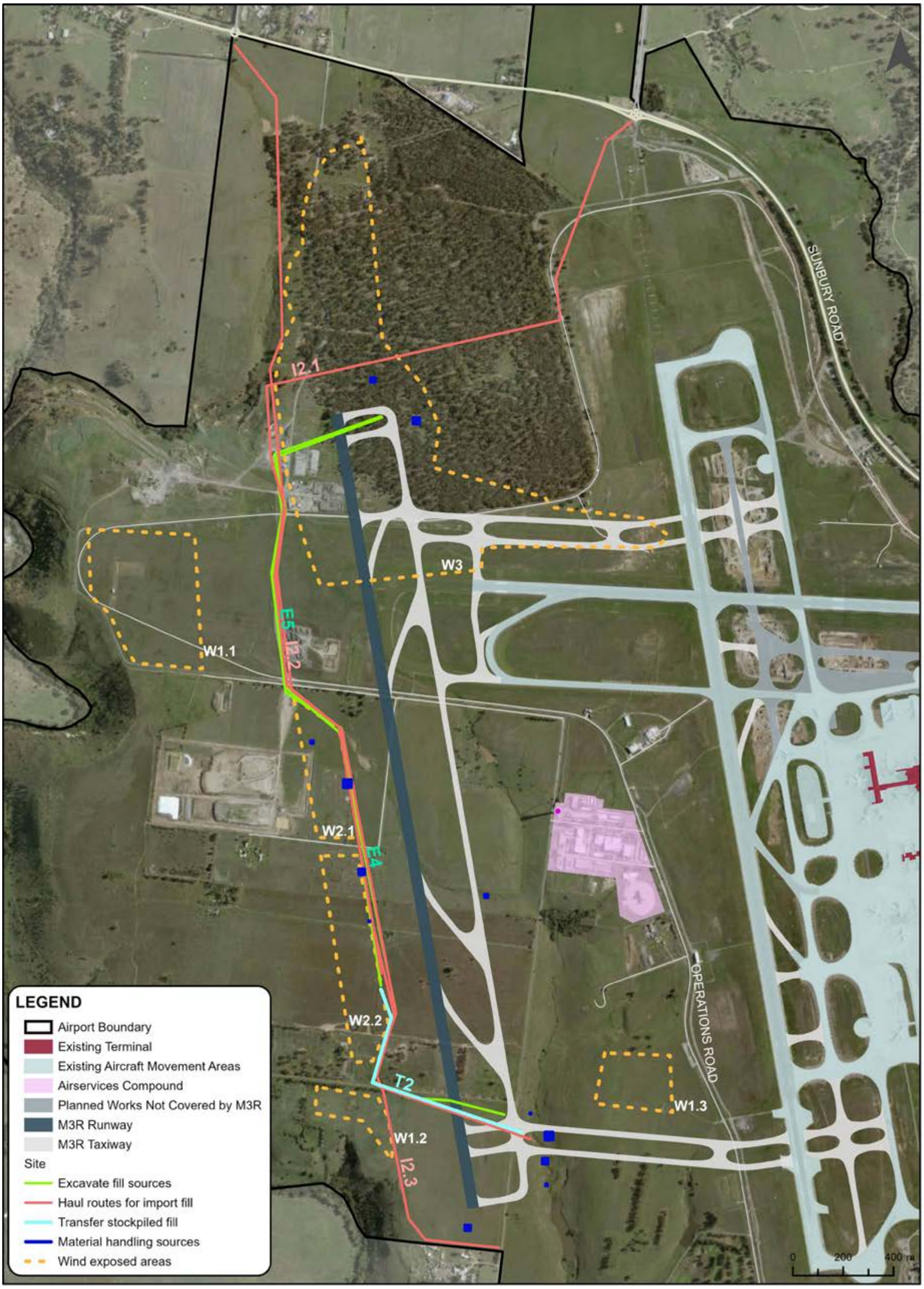
B10.4.4.1
Emissions from Airport Operations

Airport operations include:

- Aircraft operations on-airport during the Landing and Take-Off (LTO) cycle
- Ground Support Equipment (GSE) and Auxiliary Power Units (APUs)
- All other equipment that consumes fuel at the airport (such as back-up generators, fuel storage tanks) and other industry on site.

Emissions to air from these operations have been characterised based on two key datasets: aircraft schedules and emission factors. The treatment and use of each are discussed below.

Figure B10.3
Location of modelled sources for construction dust assessment (I = haul routes for import fill; E = excavate fill sources; W = wind-exposed areas, T = transfer stockpiled fill)



B10.4.4.2
Melbourne Airport aircraft schedules

Aircraft schedule data representing aircraft operational movements undertaken at the airport in 2019 were used as input for modelling the 2019 airport operations. The 2019 database comprised 254,280 records representing the same number of aircraft movements (i.e. a landing or a take-off).

A schedule for aircraft operational movement was developed for the No Build and Build operating scenarios. The movements are modelled using the output of 'Concept of Operations' data developed by Melbourne Airport, and reviewed by Airservices, for M3R. The schedule was used to develop predictions for annual Air Traffic Movements (ATM) and aircraft types for a standard operating week, taking into consideration:

- Changes in the time distribution of aircraft movements, to account for diurnal and daily changes in aircraft movements
- The destination airport for departure flights, to account for different fuel loads (and hence fuel burn rates) based on the stage length of the flight
- The likely gate of arrivals/departures, to account for the spatial distribution of aircraft and taxi movements around the airport.

Operating conditions assumed that 100 per cent of flights arrived from the south and departed to the north (runway 34) to represent worst-case operating conditions for all scenarios, and hence is considered conservative. Normal airport operations typically comprise a mixture of departures and arrivals from both ends of the 16/34 runway. This modelling assumption therefore increases total emissions to the southern runway end, resulting in higher modelled GLCs (while GLCs to the north would remain low).

The numbers of ATM for each operating scenario are listed in Table B10.8. The 2019 base case was input to AEDT based on the ATMs. For all other years, emissions were scaled directly based on the percentage increase in ATM. For example, the emissions inventory and thus emission rate of aircraft in 2026 was increased by 18 per cent. For the 'Build' scenarios, all additional aircraft movements beyond 2019 were assumed to occur on the M3R runway. For example, 18 per cent of the existing runway movements were assumed to occur on the new runway in 2026, resulting in an increase of 18 per cent of aircraft movements in total. Note that 50 per cent of aircraft movements were taken to be arrivals, and 50 per cent departures.

B10.4.4.3
Emissions factors: airport operations

The air emissions inventory for current and possible future operations at the airport was developed by AEDT (this has replaced the Emissions and Dispersion Modelling System (EDMS) model as the industry best practice air quality modelling tool for airports).

AEDT is a combined emissions and dispersion model developed in the US for assessing air quality at airports (FAA 2015). It is linked to data from the aircraft performance model BADA which is owned and managed by EUROCONTROL. AEDT models aircraft performance in space and time to estimate noise, fuel consumption, emissions, and air quality consequences. Aircraft types are represented in detail (including a comprehensive list of emission factors for specific aircraft engines). Aircraft engine data is sourced from the BADA model, which contains a database with emission factors for over 300 aircraft types and specifications for supporting equipment.

AEDT and BADA were used to compile emissions inventories for criteria pollutants NO_x, PM_{10} and $PM_{2.5}$, VOCs, CO and SO_2 based on the aircraft movements specified above. AEDT alone was used to generate an emissions file compatible with AERMOD to enable dispersion modelling using that software.

Note that airborne lead was not assessed in modelling. It is not an issue for Melbourne Airport because the use of Avgas in piston engines by small aircraft is insignificant, and lead in Jet A1 fuel is also insignificant (Jet A1 is the jet fuel used for most aircraft types including jet engine and turbo-propeller powered aircraft).

The detailed aircraft schedule databases from BADA,

Table B10.8
Numbers of ATM for each operating scenario

Year	Actual data (APAM)	Forecast ATM No Build	Forecast ATM Build	Ratio (Build/No Build)
Existing (2019)	254,280	n/a	n/a	n/a
2026 (opening year)	n/a	299,832	299,832	1.00
2046 (+20 years)	n/a	329,732	483,340	1.47

constructed for input to AEDT, comprised several hundreds of thousands of records representing each aircraft movement in a scenario year and included the following main fields:

- Aircraft code specifying the aircraft type (e.g. B737-8W)
- Aircraft engine code specific to the aircraft type (e.g. 4CM040)
- A date and time string
- An indicator for the type of movement (arrival or departure)
- The terminal used by the aircraft (T1 to T4 for Melbourne Airport)
- A runway indicator (e.g. 09L for Runway 09-Left, 09R for Runway 09-Right).

The hourly emissions estimates calculated in AEDT depend on many factors including the aircraft engine type, its varying location and mode (e.g. taxiing), and period of operation. Aircraft emissions vary depending on the operating modes for each scenario (taxiing versus take-off), and the GSE and APU emissions data were dependent on default settings for each aircraft type. Detailed emissions datasets were created by AEDT for use with AERMOD. Annual summaries for each of the modelled operational scenarios, divided by source type, are provided in the following tables for operations up to 3,000 feet (~914 metres). Note that emissions in 2026 and 2046 were scaled from the 2019 inventory based on aircraft movements in those years. The assessment does not include the effect of increasing energy efficiency of aircraft, as the actual mix of next-generation aircraft in future years is uncertain. The AEDT model sensitivity to aircraft efficiency was assessed in a separate sensitivity test, and it was found that next generation aircraft have the potential to decrease aircraft emissions by around 10%.

It is noted that the No Build cases will likely result in increased aircraft congestion at ground level in comparison with the Build cases (e.g. aircraft delayed on the taxiways), which can cause increases in emissions. Melbourne Airport expects these differences in the delay times to be substantial, as described in **Chapter A2: Need for the Project**. These differences were not factored into modelling. This adds a degree of conservatism to this comparative assessment (i.e. potential under-estimation of the No Build impacts).

Table B10.9
AEDT estimates of NO_x emissions, by source type and scenario (kg/year)

Source type	2019 (% total)	No Build 2026	Build 2026	No Build 2046	Build 2046
Aircraft	1,421,062 (78%)	1,676,853	1,676,853	1,847,380	2,714,227
Taxi in/out	95,956 (5%)	113,228	113,228	124,742	183,275
GSE	37,158 (2%)	43,846	43,846	48,305	70,971
APUs	55,430 (3%)	65,408	65,408	72,059	105,872
Parking facilities	2,986 (0.2%)	3,622	4,245	5,179	8,213
Roadways	215,545 (12%)	244,175	252,329	264,798	317,297
Total	1,828,136	2,147,130	2,155,908	2,362,464	3,399,855

Table B10.10
AEDT estimates of PM_{10} emissions, by source type and scenario (kg/year)

Source type	2019 (% total)	No Build 2026	Build 2026	No Build 2046	Build 2046
Aircraft	8,965 (35%)	10,579	10,579	11,655	17,123
Taxi in/out	1,798 (7%)	2,121	2,121	2,337	3,434
GSE	1,987 (8%)	2,344	2,344	2,583	3,795
APUs	6,118 (24%)	7,219	7,219	7,953	11,685
Parking facilities	627 (2%)	760	891	1,087	1,724
Roadways	5,949 (23%)	6,737	6,966	5,949	8,762
Total	25,443	29,761	30,120	31,564	46,523

Table B10.11
AEDT estimates of $PM_{2.5}$ emissions, by source type and scenario (kg/year)

Source type	2019 (% total)	No Build 2026	Build 2026	No Build 2046	Build 2046
Aircraft	8,965 (39%)	10,579	10,579	11,655	17,123
Taxi in/out	1,798 (8%)	2,121	2,121	2,337	3,434
GSE	1,878 (8%)	2,216	2,216	2,442	3,588
APUs	6,118 (26%)	7,219	7,219	7,953	11,685
Parking facilities	426 (2%)	517	606	739	1,172
Roadways	4,045 (17%)	4,581	4,737	4,045	5,958
Total	23,230	27,234	27,478	29,171	42,960

Table B10.12
AEDT estimates of VOCs emissions, by source type and scenario (kg/year)

Source type	2019 (% total)	No Build 2026	Build 2026	No Build 2046	Build 2046
Aircraft	50,527 (26%)	59,622	59,622	65,686	96,508
Taxi in/out	66,068 (35%)	77,960	77,960	85,888	126,190
GSE	11,864 (6%)	14,000	14,000	15,424	22,661
APUs	3,107 (2%)	3,667	3,667	4,040	5,935
Parking facilities	5,017 (3%)	6,084	7,132	8,701	13,796
Roadways	54,783 (29%)	62,003	64,217	67,316	80,979
Total	191,367	223,337	226,598	247,054	346,069

B10.4.4.4
Emissions from road traffic

Two source groups were included in the inventory for transportation emissions caused by induced demand from airport operations:

- Road vehicles on all major roadways leading to the airport, and all major roadways immediately surrounding the airport
- The largest car parks at the airport.

Emissions to air from these sources have been characterised based on two key datasets: road traffic modelling and emission factors. The treatment and use of each are discussed below.

B10.4.4.5
Melbourne Airport roadways traffic modelling

This assessment included the busiest roadways surrounding, and within, the airport. These are shown in Table B10.13 for current airport operations and No Build scenarios, and in Table B10.14 for current airport operations and Build scenarios (as defined in Chapter B8: Surface Transport). The roadways and traffic modelled in this assessment are considered to represent the majority of vehicle movements in the vicinity of the airport (the remainder are considered to contribute to background air pollutant levels).

Annual road vehicle movements for 2019 were taken from measured data. Traffic modelling was conducted using the Victorian Integrated Transport Model. VITM provided traffic data for the years 2019, 2026 and 2046, for Build and No Build scenarios, with and without an airport rail link.

B10.4.4.6
Melbourne Airport car parks

Thousands of cars are parked at Melbourne Airport each day, and its large car parks are a significant source of air pollutants. Car parks were modelled in AERMOD based on their annual capacities.

Estimates for the annual throughputs of car parks were provided by Melbourne Airport and are listed in Table B10.15 (currently, and for No Build scenarios) and Table B10.16 (currently, and for Build scenarios). The estimates for forecast future operating scenarios were scaled using increases in the roadway traffic data for the same years i.e. 2026 and 2046.

B10.4.4.7
Emission factors: road vehicles

Emissions factors for road vehicles were derived from COPERT Australia based on a review of studies of emissions from Australian road vehicles (Smit R. , Australian

Table B10.13
Main roadways and annual road vehicle movements - current airport and M3R No Build scenario

Roadway traffic (both directions) – no M3R	Current airport (2019) vehicles p.a.	M3R No Build 2026 vehicles p.a.	M3R No Build 2046 vehicles p.a.
Airport Drive north of Sharps Road	3,896,830	4,494,017	6,598,673
Calder Freeway west of Keilor Park Drive	24,610,099	24,992,195	31,602,969
Keilor Park Drive south of Tullamarine Park Road	6,225,150	6,741,317	8,972,253
Melrose Drive north of Mickleham Road (on-airport)	2,004,364	2,311,617	3,657,662
Melrose Drive south of Mickleham Road	3,155,015	3,169,013	4,003,517
Mickleham Road north of Broadmeadows Road	7,147,955	7,252,582	8,421,470
Mickleham Road 'south' (assumed equal to Mickleham Road plus Broadmeadows Road)	5,504,243	5,569,142	8,059,873
Sharps Road west of Melrose Drive	4,281,605	4,618,014	5,775,526
Sunbury Road north of Airport (2025 data & estimates)	8,838,073	9,405,154	22,620,107
Tullamarine Freeway north of Mickleham Road	27,079,885	32,285,226	51,007,570
T4 Express Link	10,323,885	12,722,182	17,695,428

Table B10.14
Main roadways and annual road vehicle movements - current airport and M3R Build scenarios

Roadway traffic (both directions) – with M3R	Current airport (2019) vehicles p.a.	M3R Build 2026 vehicles p.a.	M3R Build 2046 vehicles p.a.
Airport Drive north of Sharps Road	3,896,830	5,856,009	11,993,459
Calder Freeway west of Keilor Park Drive	24,610,099	25,427,788	33,199,029
Keilor Park Drive south of Tullamarine Park Road	6,225,150	7,183,860	10,274,506
Melrose Drive north of Mickleham Road (on-airport)	2,004,364	3,101,376	5,514,679
Melrose Drive south of Mickleham Road	3,155,015	3,208,663	4,261,286
Mickleham Road north of Broadmeadows Road	7,147,955	7,315,044	8,623,333
Mickleham Road 'south' (assumed equal to Mickleham Road plus Broadmeadows Road)	5,504,243	5,633,126	8,771,274
Sharps Road west of Melrose Drive	4,281,605	4,996,840	6,526,220
Sunbury Road north of Airport (2025 data & estimates)	8,838,073	9,463,055	24,122,055
Tullamarine Freeway north of Mickleham Road	27,079,885	33,462,773	61,508,728
T4 Express link	10,323,885	13,614,242	22,610,599

Table B10.15
Estimates for car park annual throughput – current airport and No build scenarios

Car park [No. levels]	Current airport (2019) vehicles p.a.	M3R No Build 2026 vehicles p.a.	M3R No Build 2046 vehicles p.a.
Short-term: T1, T2, T3 [6]	7,429,159	9,009,897	12,885,146
Long-term, west [1]	1,616,719	1,960,716	2,804,040
Long-term, east [1]	570	691	988
VLS [1]	86,355	104,729	149,774
Staff Car Park [1]	2,194,063	2,660,904	3,805,387
NBCP [1]	37,979	46,060	65,871
T4 [7]	1,301,258	1,578,133	2,256,904

Table B10.16
Estimates for car park annual throughput – current airport and M3R build scenarios

Car park [No. levels]	Current airport (2019) vehicles p.a.	M3R Build 2026 vehicles p.a.	M3R Build 2046 vehicles p.a.
Short-term: T1, T2, T3 [6]	7,429,159	10,561,636	20,431,063
Long-term, west [1]	1,616,719	2,298,403	4,446,168
Long-term, east [1]	570	810	1,566
VLS [1]	86,355	122,766	237,486
Staff Car Park [1]	2,194,063	3,119,181	6,033,932
NBCP [1]	37,979	53,993	104,447
T4 [7]	1,301,258	1,849,929	3,578,613

Motor Vehicle Emission Inventory for the National Pollutant Inventory (NPI), 2014) (Smit, et al., 2015).

Their current validity was confirmed with EPA Victoria in April 2020, noting that these factors are conservative given the 2010 base year. They can be updated for recent years given the changing nature of vehicle sales, vehicle growth and scrappage rates, and age-mileage relationships.

COPERT Australia includes emissions factors for 226 different classes of petrol and diesel vehicles, for NO_X, PM, CO and VOCs. They were extracted for each vehicle class at operating speeds of 60kph, 80kph and 100kph; emissions factors for 50kph, 70kph and 90kph operating speeds were then derived by interpolation and extrapolation. All roads were assumed to be at-grade with zero gradient. This information was combined with estimated mean traffic velocities, and the traffic modelling described in Section B10.4.4.5, to create hourly incremented diurnal emission rate information for each road link. The resulting data was input to AERMOD.

B10.4.4.8
Determination of NO_2 from modelled NO_X

The combustion of fossil fuels leads to the emission to air of oxides of nitrogen (NO_X), which are comprised of nitric oxide (NO) and nitrogen dioxide (NO_2). The ratio of NO_2 to NO_X can differ depending on the emissions source (and atmospheric residence time). NO_2 is of interest to this assessment.

For jet engines, Sheffield University (for the UK Government for the Project for Sustainable Development of Heathrow) developed mode-specific primary NO_2 fractions for aircraft, which ranged from 25 per cent to 50 per cent for idling engines, and from one per cent to 20 per cent for take-off, climb out and approach (Garcia-Naranjo & Wilson, 2005). For road vehicles, a conversion ratio from NO_X to NO_2 of 10 per cent is often used (PIARC (2012). This conversion ratio is highly dependent on fleet fuel mix and current and future vehicle technology.

Given this variability, a percentage of 15% of NO_X was used for all NO_2. This was validated by comparing modelled results for current airport operation to background monitored levels of NO_2 at Melbourne Airport. In this manner, monitored data was used to introduce a degree of calibration of NO_2 emission rates into the assessment.

B10.4.4.9
Determination of $PM_{2.5}$ and PM_{10} from modelled PM

The combustion of fossil fuels also leads to the emission to air of particulate matter (PM_{10} and $PM_{2.5}$). It was assumed that 100% of PM from road traffic was PM_{10} from COPERT. A ratio of 68% $PM_{2.5}$ to PM_{10} was applied to estimate the fraction of $PM_{2.5}$, based on the 2010 Australian Motor Vehicle Emissions Inventory analysis (Smit R. , 2014).

For aircraft emissions, it was assumed that 100% of PM_{10} was also $PM_{2.5}$, based on the fuel combustion fuel output from the AEDT model.

In the absence of specific standards or criteria, UFPs were assessed based on a literature review of airport studies of particulate matter and UFPs.

B10.4.4.10
Assessment of volatile organic compounds

Melbourne Airport maintains a risk register of environmental impacts that includes air quality. It investigated concentrations of volatile organic compounds (VOCs) at the airport from 2014 to 2017 and did qualitative investigations of VOCs in 2018-19. As a result of this, Melbourne Airport focuses on benzene and formaldehyde as the VOCs representing the highest risk from sources at the airport (specifically from jet engine emissions). Previous assessments found the other VOCs to present a lower risk at the airport. Given this, an assessment can focus on a small number of higher risk air pollutants rather than producing an assessment of many tens – or even hundreds – of compounds.

The AEDT-AERMOD results were output as VOC ground level concentrations. These were then factored by the weighted averages of the benzene and formaldehyde emissions factors that had been derived from the aircraft and road vehicle emissions.

B10.4.4.11
Dispersion model selection for airport operations and road traffic

Consideration was given to the EPA guidelines for air dispersion modelling using AERMOD (EPA Victoria, 2013). The EPA's senior air quality specialists were consulted from the start of the impact assessment regarding the methodology used to conduct the air quality assessment with regards to model selection, use of background pollutant concentrations, and air quality criteria.

As discussed in Section B10.4.4.1, the AEDT model was used to model emissions from airport operations. And, as discussed in Section B10.4.4.7, COPERT characterised emissions from road traffic. Output from these was input to AERMOD (the regulatory dispersion model used by Victoria) to model atmospheric dispersion.

The latest version of AERMOD (Version 9.9.0) was used for predictions of air pollutant concentrations. These were compared with the Victorian and national air quality standards to assess the effects that these activities may have on the local air quality environment. The input data required by AERMOD comprised emission source locations and characteristics; emission rates of pollutants; locations of receptors (point locations for the model-predicted GLCs); and hourly meteorological data. Annual meteorological datasets were synthesised from data recorded by the Bureau of Meteorology (Section B10.5.1).

In AERMOD, mobile sources (i.e. vehicle traffic on roads) are represented by a series of volume sources. These factor in location, base elevation, release height, and initial lateral and vertical dimensions. The pollutant emission rate is calculated from the vehicle volumes along each road section. Modelling using AERMOD assumed an initial lateral dimension (plume width) equal to the road width plus three metres either side. Note that AERMOD does not calculate concentrations within this area.

Emissions modelling used hourly varying background concentrations based on measurements at MAS and MAE in accordance with guidance from EPA Victoria. Qualitative judgment was required to determine the number of off-site emissions sources (e.g. roads) to include in the modelling to limit double-counting of emissions sources if those sources were also modelled as additional sources to background. Background concentrations of pollutants are assessed further in **Section B10.5**.

B10.5 EXISTING CONDITIONS

B10.5.1 Local meteorology

Meteorological conditions are important in determining the direction and rate at which emissions from a source will disperse. The key factors in air dispersion models are wind speed, wind direction, temperature, atmospheric stability class, and mixing layer height.

EPA Victoria requires five years of meteorological data for modelling. This increases the likelihood that worst-case meteorological conditions are captured, and that inter-annual variability is considered in the assessment.

The data used for this assessment were collected by the Bureau of Meteorology (BoM) from Melbourne Airport monitoring station number 086282 (located on the airport).

The years 2015 to 2019 inclusive were selected for modelling. One-minute surface data and 30-minute cloud data were obtained from Bureau of Meteorology. These datasets were averaged to create hourly data for the following parameters:

- Wind speed (metres per second, scalar averaged)
- Wind direction (degrees true north, vector averaged)
- Temperature (degrees Celsius)
- Relative humidity (per cent)
- Station level pressure (millibar, hectopascal)
- Cloud amount (tenths).

Surface roughness values were input for the modelling grid (covering emissions sources and sensitive receptors) within a one-kilometre radius of Melbourne Airport. Three sectors were defined in AERMET as having different surface roughness values (commercial/industrial/transport land use selected). Albedo and the Bowen Ratio were determined for the area within a five-kilometre radius of the site (10 km by 10 km domain). Note that albedo and the Bowen Ratio have seasonal dependencies where average moisture conditions were used.

The AERMOD meteorological processor AERMET was used to construct the AERMOD meteorological input files based on the input data described above accounting for the proposed Project, in accordance with EPA Victoria publication guideline Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD) (Publication 1550) (EPA Victoria, 2014).

Profile data up to 5,000 feet was considered to align with the USA Federal Aviation Administration's guidance to assess emissions in the take off and approach phases of the Land Take-off Operations cycle, up to 3,000 feet (FAA, 2000). As such, upper air radiosondes from the BoM monitoring station were included in the upper air file and input to AERMET.

B10.5.2 Air quality at Melbourne Airport

EPA Victoria Publication 1961 (as well as the former SEPP (AQM)) requires that air quality impact assessments are cumulative (i.e. the predicted air quality impacts due to a certain facility are added to existing background air pollutant levels).

Hourly varying background concentrations of key air quality pollutants were used in the modelling to give a cumulative impact assessment (as recommended by EPA Victoria in the initial consultation on air quality methodology).

Air quality monitoring data acquired from the airport's MAS AQMS in 2019 was used as the time-varying background concentration. Measured concentrations in 2019 were compared to the previous year (2018) and cross-checked with EPA air quality monitoring data and reports from 2019 to confirm that the background estimates used in the modelling were sound.

The background concentration analysis for all criteria pollutants identified two key pollutants as having an elevated risk of GLCs above the standards as a result of the expansion of activities at and around Melbourne Airport: PM_{10} and NO_2.

Although downward trends in the Melbourne airshed have been observed for some air pollutants (**Section B10.5.3**), for the purpose of this assessment it was assumed the background air quality situation would be unchanged for future scenarios. As such the same hourly-varying background values were used for each scenario. This was the case for all substances except NO_2, for which the background values were inherent in the empirical equation used to determine the NO_2 GLCs from the predicted NO_X GLCs (**Section B10.4.4.8**).

Estimates for background benzene and formaldehyde were determined by inspection of Melbourne Airport's VOCs monitoring results and making some allowance for the short (three-minute) averaging period of the design criteria of the SEPP (AQM) in force at the time of monitoring.

The following sections provide the airport's results from the MAS monitoring station in 2019. Results were compared to the AAQ NEPM and (former) SEPP (AAQ) criteria, as discussed in **Section B10.2**.

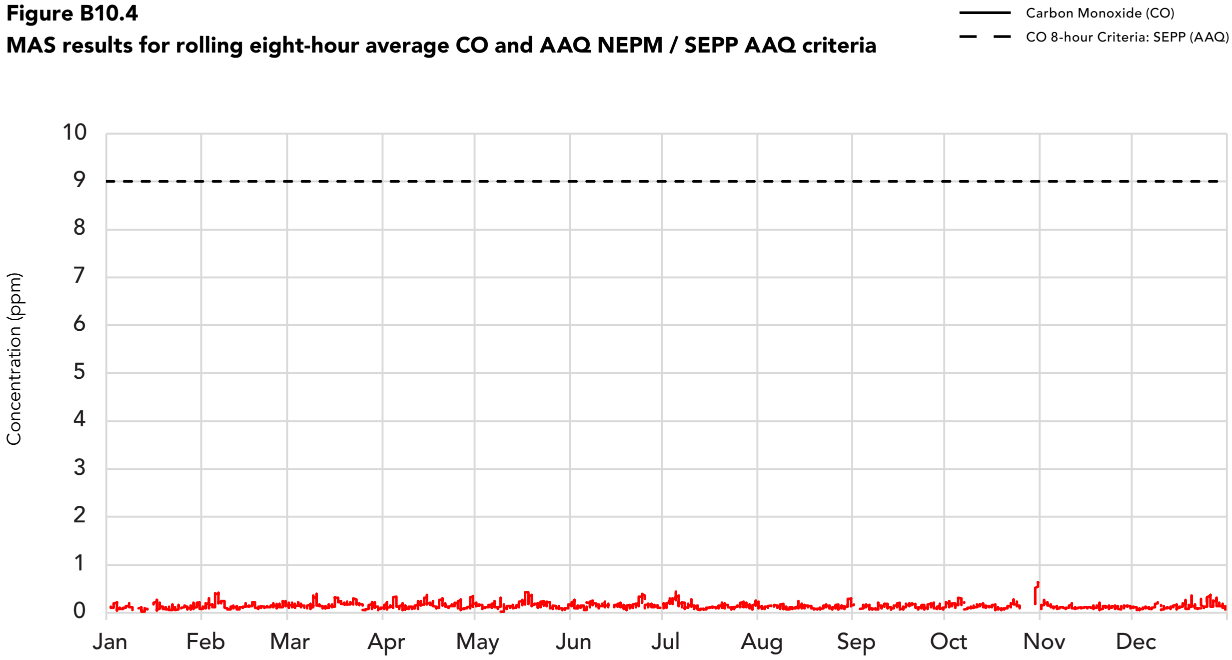
B10.5.2.1
Melbourne Airport South 2019 monitoring results: CO

The MAS results for eight-hour rolling average CO concentration (ppm) for 2019 is shown in **Figure B10.4**. The maximum CO eight-hour concentration in 2019 was 0.63 ppm, which is seven per cent of the criterion (nine ppm). CO concentrations remained consistently low, with no recorded exceedances of the AAQ NEPM objective (equal to the former SEPP AAQ criterion). These results are comparable to typical concentrations observed for the Melbourne region as a whole (**Table B10.17**).

B10.5.2.2
Melbourne Airport South and East 2018 and 2019 results: NO_2

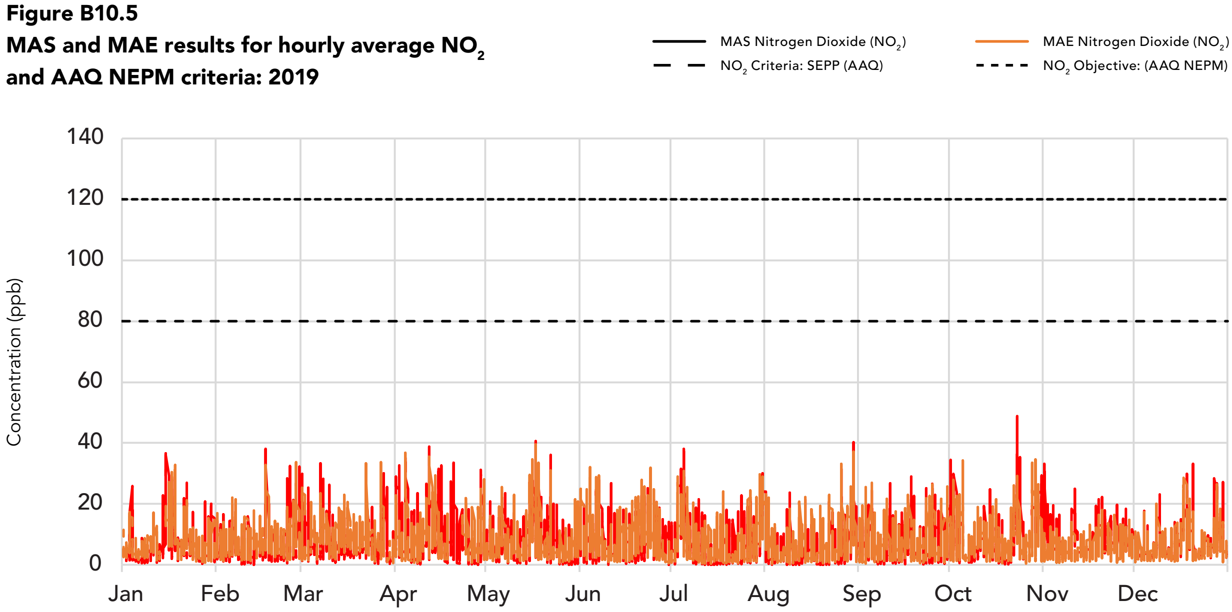
The 2019 results for hourly average NO_2 concentrations (ppb) for MAS and MAE monitoring stations are shown in **Figure B10.5**. NO_2 concentrations were consistently low at both stations, with no recorded exceedances of the AAQ NEPM ambient air quality objectives. The average NO_2 concentration was 7.0 ppb at MAS and 6.9 ppb at MAE in 2019. The results for 2018 are also shown for comparison in **Figure B10.6**. These results

Figure B10.4
MAS results for rolling eight-hour average CO and AAQ NEPM / SEPP AAQ criteria



Source: APAM

Figure B10.5
MAS and MAE results for hourly average NO_2 and AAQ NEPM criteria: 2019



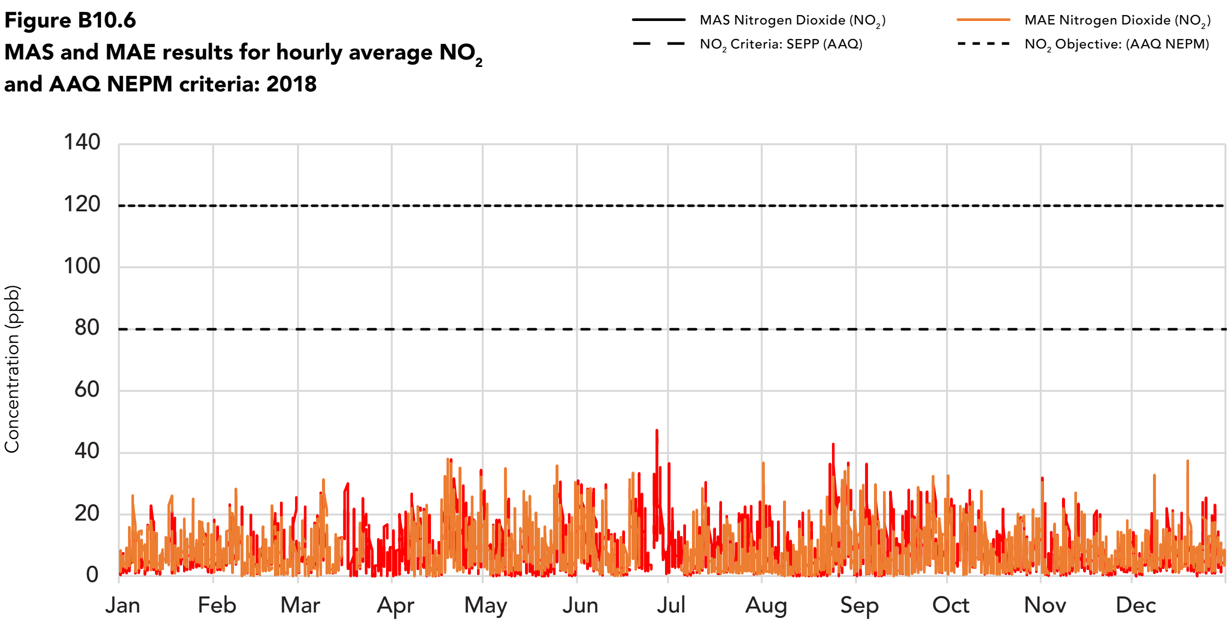
Source: APAM

are comparable to typical concentrations observed for the Melbourne region as a whole (**Table B10.17**) and also demonstrate that year to year variability in NO_2 background concentrations is low.

B10.5.2.3 Melbourne Airport MAS 2019 results: O_3

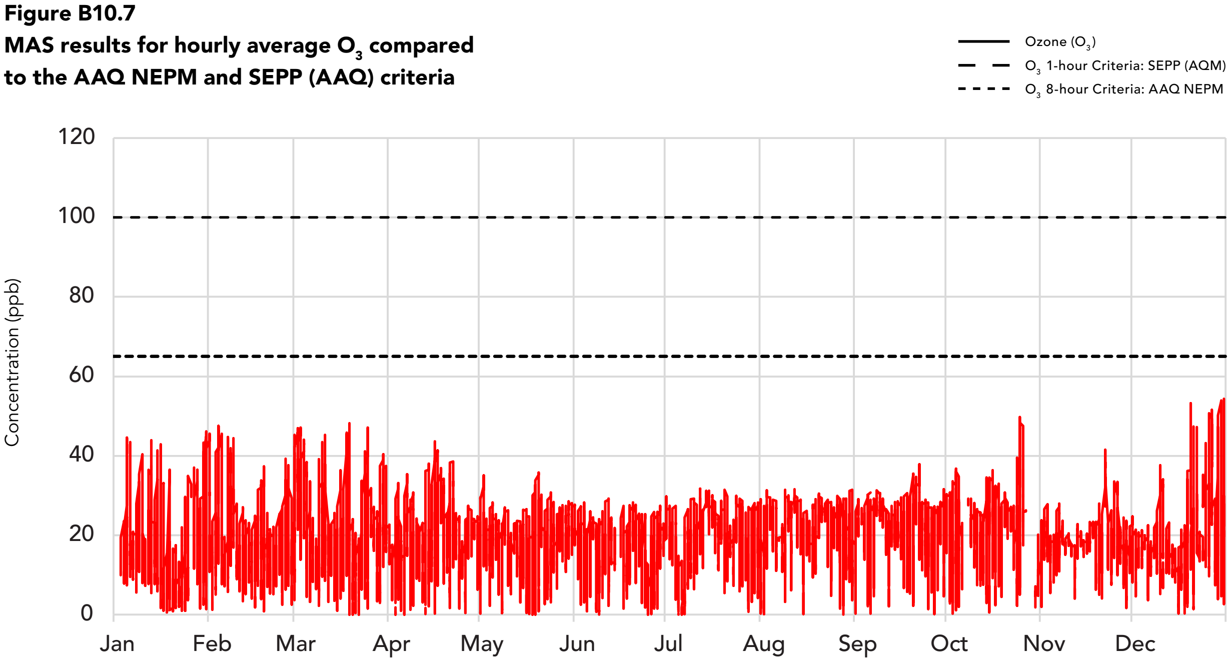
The MAS results for hourly average O_3 concentrations is shown in **Figure B10.7**. O_3 concentrations remained consistently low, with no recorded exceedances of the AAQ NEPM criteria nor the SEPP (AQM) criteria (no longer in force). An increase in O_3 concentrations is observed from October to March, peaking around 45 ppb, while concentrations from May to September are typically around 30 ppb. These results are comparable to typical concentrations observed for the Melbourne region as a whole (**Table B10.17**).

Figure B10.6
MAS and MAE results for hourly average NO_2 and AAQ NEPM criteria: 2018



Source: APAM

Figure B10.7
MAS results for hourly average O_3 compared to the AAQ NEPM and SEPP (AAQ) criteria



Source: APAM

B10.5.2.4
Melbourne Airport MAS 2019 results: SO_2

The MAS results for hourly average SO_2 concentrations for 2019 are shown in Figure B10.8. SO_2 concentrations remained consistently low, with no recorded exceedances of the AAQ NEPM or SEPP (AAQ) criteria (no longer in force). The average hourly SO_2 concentration for 2019 was 1.2 ppb, and the maximum recorded value was 20.2 ppb. These results are comparable to typical concentrations observed for the Melbourne region as a whole (Table B10.17).

B10.5.2.5
Melbourne Airport MAS 2019 results: PM_{10}

Daily average PM_{10} concentrations for MAS and two EPA monitoring stations at Alphington and Footscray for 2019 are shown in Figure B10.9. PM_{10} concentrations at MAS followed similar intra-annual patterns to those at Alphington and Footscray, indicating that major sources of PM_{10} were not localised to the vicinity of Melbourne Airport.

Thirteen exceedances of the AAQ NEPM 24-hour ambient air quality objective were recorded at MAS. Of these exceedances, twelve were also above the objective at Alphington and/or Footscray and were attributable to airshed-wide pollutant events of natural or external origin (e.g. bushfire, windblown dust). Hence, these results have been excluded from the analysis, resulting in one exceedance at MAS that may be due to local sources such as the airport. No exceedances were observed from May to September.

B10.5.2.6
Melbourne Airport South and East 2019 results: $PM_{2.5}$

Daily average $PM_{2.5}$ concentrations for MAS, MAE and EPA monitoring stations at Alphington and Footscray for 2019 are shown in Figure B10.10. $PM_{2.5}$ concentrations at MAS and MAE followed similar intra-annual patterns to those at Alphington and Footscray, indicating that major sources of $PM_{2.5}$ were not localised to the vicinity of Melbourne Airport.

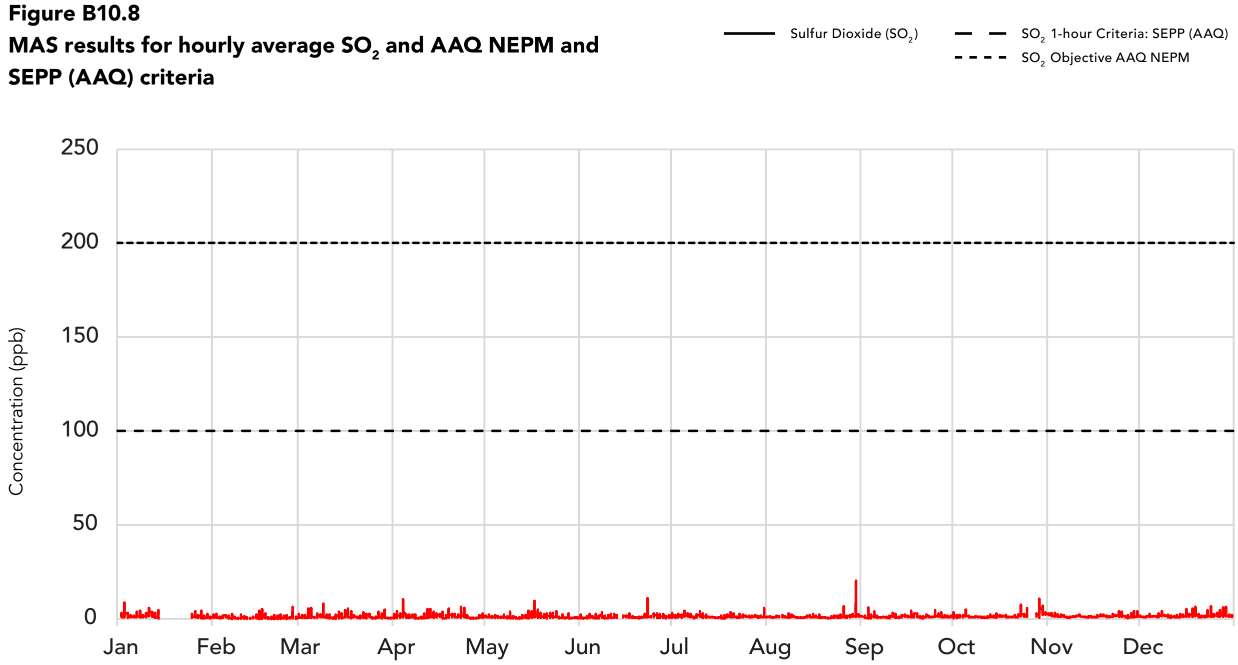
Five exceedances of the AAQ NEPM 24-hour ambient air quality objective were recorded at MAS. Of these exceedances, three were attributable to airshed-wide pollutant events of natural or external origin (e.g. bushfire, windblown dust). Hence, these results have been excluded from the analysis, resulting in two exceedances at MAS.

B10.5.2.7
Melbourne Airport MAS 2019 results: VOCs

This section draws upon diffusive sampler (VOCs) monitoring results for Melbourne Airport for the monitoring period December 2014 to July 2017 inclusive, for the two higher risk VOCs selected for assessment: benzene and formaldehyde. The results were compared with air toxics NEPM Monitoring Investigation Levels (MILs).

All the measured benzene concentrations were low, with all results less than two µg/m³ (24-hour averages and longer-term averages). There were no exceedances of the air toxics NEPM MIL for benzene (annual average three ppb: or 9.6 µg/m³ at 25°C).

Figure B10.8
MAS results for hourly average SO_2 and AAQ NEPM and SEPP (AAQ) criteria



Source: APAM

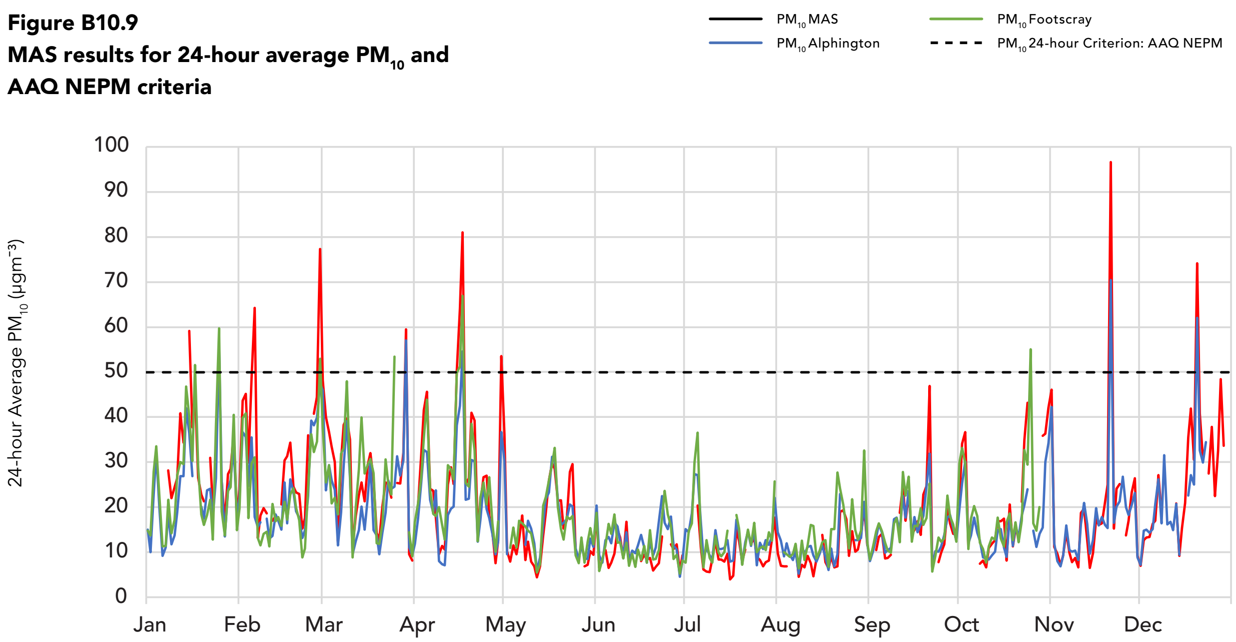
A conservative method was used to estimate the absolute maximum 24-hour average formaldehyde concentrations that could be obtained from weekly and two-week samples. The resulting formaldehyde concentrations were low, with results typically around 20 per cent of the air toxics NEPM MIL (49 μg/m³: 24-hour average). The highest measurement was approximately 50 per cent of the NEPM MIL.

B10.5.3
Air quality in the Melbourne airshed

The EPA's air quality monitoring data acquired across the entire Melbourne airshed were reviewed for comparison against the existing levels of air pollutant concentrations used in this assessment.

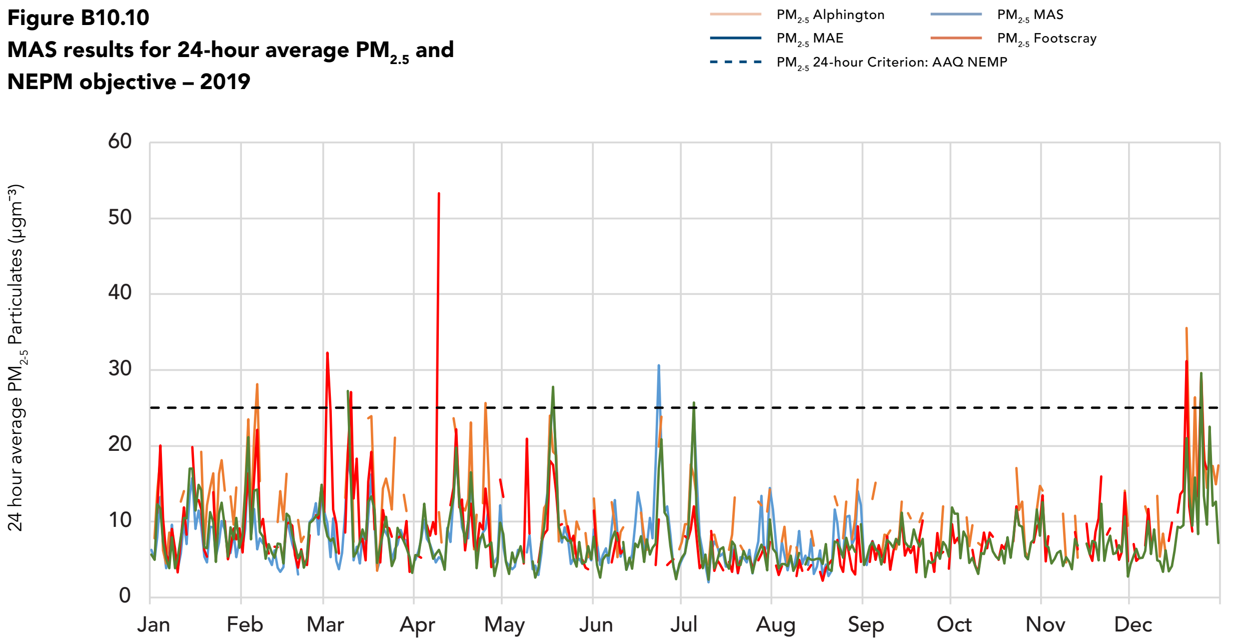
The EPA operates several air quality monitoring stations in the Melbourne airshed and provides annual reports including summaries for each pollutant (e.g., EPA (2016)). Estimates for typical air pollutant concentrations in the Melbourne airshed from 2002-2015 were determined by

Figure B10.9
MAS results for 24-hour average PM_{10} and AAQ NEPM criteria



Source: APAM

Figure B10.10
MAS results for 24-hour average $PM_{2.5}$ and NEPM objective – 2019



Source: APAM

inspection of the trends graphed in EPA (2016) and are summarised in Table B10.17, e.g. 'trending downwards' means that typically the concentrations in previous years are higher than more recent data.

B10.6 ASSESSMENT OF CONSTRUCTION PHASE IMPACTS

This section presents the results of atmospheric dispersion modelling for comparison against project air quality standards (**sections B10.2.3** and **B10.2.4**) for the construction phase for PM_{10} and $PM_{2.5}$ emissions and deposited dust generated, corresponding to the construction scenario described in **section B10.4.3**. Throughout this section, the contour plots show lines of equal predicted Ground Level Concentrations (GLCs) predicted by the model in accordance with the rules set out in the AAQ NEPM and SEPP (AQM) (no longer in force).

B10.6.1 Construction phase impacts: $PM_{2.5}$

B10.6.1.1 Predicted peak impact – project construction

The predicted $PM_{2.5}$ ground level concentrations arising from M3R construction operations (i.e. excluding background) are shown in **Figure B10.11** M3R construction: maximum 24h $PM_{2.5}$ GLC excluding background (µg/m³). The contour presented displays the maximum 24-hour average assessment criteria (25 µg/m³) for $PM_{2.5}$. Model results show that maximum daily concentrations in excess of this criterion were restricted to the immediate vicinity of major haulage routes and heavily trafficked areas and were not found to extend beyond the airport boundary.

It was predicted that the $PM_{2.5}$ impact from M3R construction for all modelled years was below the GLC standard at each identified sensitive receptor. The highest predicted GLC at any sensitive receptor was five µg/m³ over five years of model runs (approximately 20 per cent of the 25 µg/m³ assessment criteria) at R13 (**Figure B10.1**).

Table B10.17
Typical air pollutant concentrations for Melbourne airshed 2002-2015

Air pollutant	EPA monitoring stations	Air toxics NEPM standard/ MIL	Typical value (50th percentile)	Typical high value (99th percentile)
CO	Alphington, Geelong South & Richmond	Max. 8-hour average, 9.0 ppm (10 mg/m^3 @ 25^{o}C)	2002-2015: < 0.5 ppm (< 0.6 mg/m^3 @ 25^{o}C)	Trending downwards; 2015: < 1.5 ppm (1.7-2.3 mg/m^3 @ 25^{o}C)
NO_2	Alphington, Brighton, Footscray, Geelong South & Point Cook	Max. 1-hour average, 120 ppb (226 µg/m^3 @ 25^{o}C)	2002-2015: 15-20 ppb (28-38 µg/m^3 @ 25^{o}C)	Trending downwards; 2010-2015: 35-40 ppb (66-75 µg/m^3 @ 25^{o}C)
O_3	Alphington, Brighton, Dandenong, Footscray, Geelong South, Melton, Mooroolbark & Point Cook	Max. 1-hour average, 100 ppb (196 µg/m3 @ 25oC)	2002-2015: 25-30 ppb (49-59 µg/m^3 @ 25^{o}C)	No trend; 2002-2015: 60-70 ppb (118-137 µg/m3 @ 25oC)
SO_2	Altona North only (worst case)	Max. 1-hour average, 200 ppb (524 µg/m3 @ 25oC)	2002-2015: 5 ppb (13 µg/m^3 @ 25^{o}C)	No trend; 2002-2015: 20-40 ppb (52-105 µg/m3 @ 25oC)
PM_{10}	Alphington, Brighton, Dandenong, Footscray, Geelong South, Mooroolbark & Richmond	Max. 24-hour average, 50 µg/m3	2010-2015: 15 µg/m^3	Trending downwards, but affected by bushfire smoke: 2010-2015: 40-50 µg/m3
$PM_{2.5}$	Alphington and Footscray	Max. 24-hour average, 25 µg/m3	2010-2015: 6 µg/m^3	Trending downwards, but affected by bushfire smoke: 2010-2015: 17-30 µg/m3
Benzene	Tullamarine landfill (EPA, 2012)	MIL annual average, 3 ppb (9.6 µg/m^3)	< 10 µg/m^3	Highest 24-hour average 2280 µg/m^3 (road traffic)
Formaldehyde	Tullamarine landfill (EPA, 2012)	MIL 24-hour average, 40 ppb (49 µg/m^3)	< 5 µg/m^3	Highest 24-hour average 10 µg/m^3

B10.6.1.2
Predicted peak impact – including background concentrations

The $PM_{2.5}$ 24-hour average varying background file was added to the maximum 24-hour predicted GLC at each of the 16 identified receptors to determine the cumulative impact of M3R construction works and the existing background air quality for each modelled day. It is found that where an exceedance of the 25 µg/m³ criterion has occurred, in all cases it is because of an elevated background level occurring on that day.

Based on this analysis, it was determined that no exceedances of the $PM_{2.5}$ criteria would occur due to M3R construction activities, when background is included. The risk of the cumulative GLCs (from M3R construction activities plus background) exceeding the assessment criteria is therefore considered low.

B10.6.2
Construction phase impacts: PM_{10}

B10.6.2.1
Predicted peak impact: Project construction

The predicted PM_{10} ground level concentrations arising from M3R construction operations (i.e., excluding background) are shown in Figure B10.12. The contour presented displays the maximum 24-hour average assessment criteria (50 µg/m³) for PM_{10}. Model results show that maximum daily concentrations were contained mostly within the airport boundary around stockpiles and major haul routes. Concentrations above the 24-hour average assessment criteria were predicted for properties (other sensitive receptors, however these were not modelled as nominated sensitive receptors) near the north and south site boundaries. However, this is considered to be a low probability occurrence as the results reflect worst-case conditions modelled over a period of five years, whereas the earthworks phase of construction shall only be a portion of the overall project development duration.

For the identified sensitive receptors (Figure B10.1), it was predicted that the PM_{10} impact from M3R construction phase for all modelled years was below the standard. The highest predicted GLC of 33 µg/m³ over five years of model runs (approximately 66% of the 50 µg/m³ assessment criterion) occurred at R13.

B10.6.2.2
Predicted peak impact including background concentrations

The PM_{10} 24-hour average varying background file was added to the maximum 24-hour predicted GLC at each of the 16 identified receptors to determine the cumulative impact of the project construction operations and the existing background air quality for each modelled day.

It is found that where an exceedance of the 50 µg/m³ criterion is predicted, in almost all cases it is as a result of an elevated background level occurring on that day. Where there is a cumulative exceedance, it was found that that the background concentration contributed greater than 50 per cent of the criterion for all exceedances with the exception of receptor 13 (R13).

Based on this analysis, only one exceedance of the 50 µg/m³ criterion is predicted to occur at the identified sensitive receptors as a result of M3R construction activities, when background is included. The risk of the cumulative GLCs (from M3R construction activities plus background) exceeding the assessment criteria is therefore considered low.

B10.6.3
Construction phase impacts: deposited dust (TSP)

B10.6.3.1
Predicted peak impact: project construction

The predicted ground level dust deposition values arising from M3R construction (i.e. excluding background) are shown in Figure B10.13 M3R construction: maximum predicted deposited dust excluding background. 2 g/m²/month contour indicated. The contour presented displays the monthly threshold level (two g/m²/month) for deposited dust. Dust deposition above this threshold level is generally restricted to the vicinity of the constriction area, with a southward bias due to prevailing northerly winds. No existing airport infrastructure to the east of runway 16L/34R was found to be impacted.

It was found that the deposited dust predicted impact from M3R constriction activities for all modelled years met the required ground level threshold at each nominated sensitive receptor. The highest predicted ground level deposition of over two g/m²/month occurred at residences to the north of the airport, near receptor R1 (Bulla), and to the south of the airport. The highest predicted ground level deposition at the nominated receptors was 1.8 g/m²/month over five years of model runs (approximately 90 per cent of the threshold level), occurring at R13.

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Figure B10.11
M3R construction: maximum 24h $PM_{2.5}$ GLC excluding background (µg/m³)

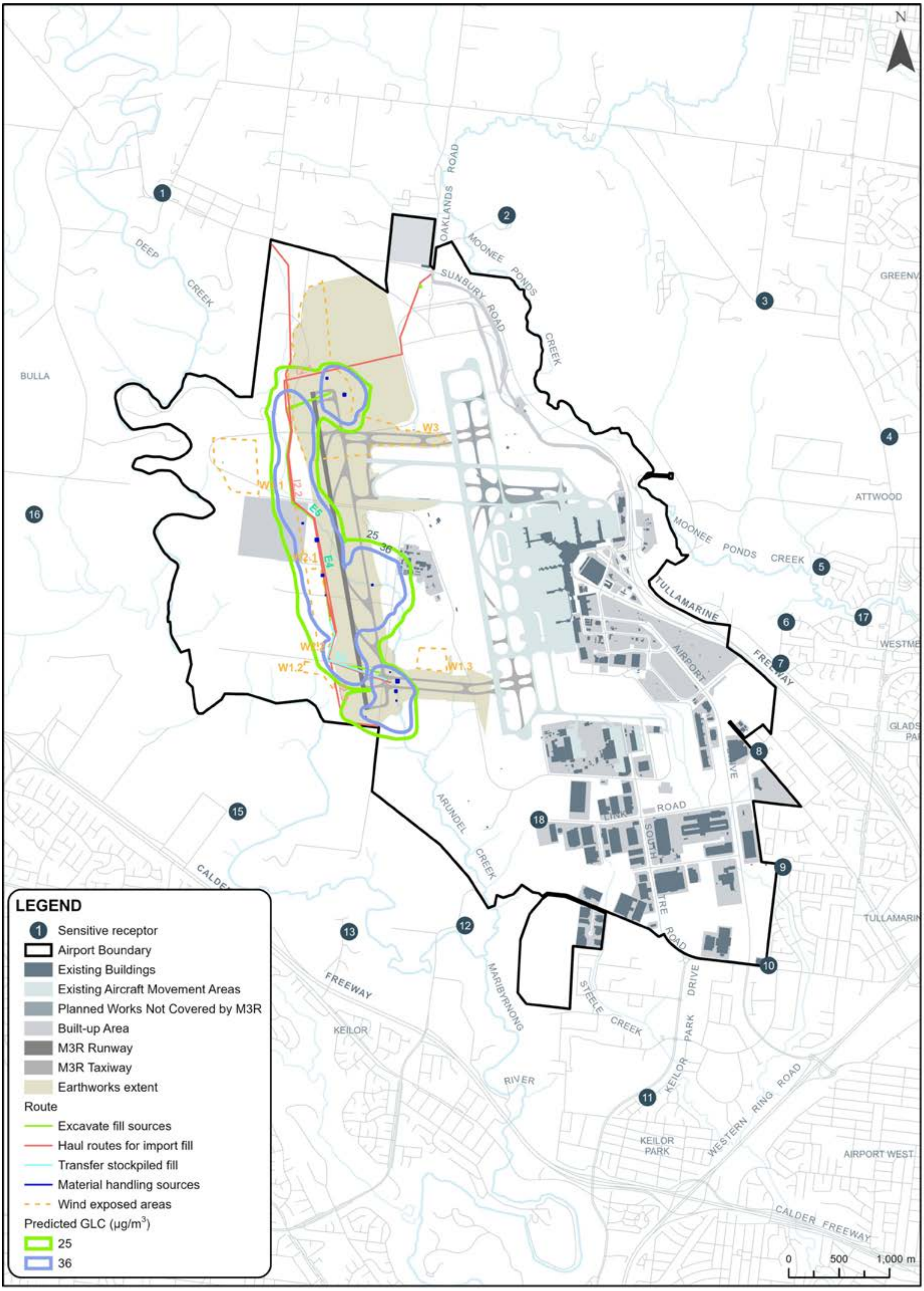


Figure B10.12
M3R construction: maximum 24h PM_{10} GLC excluding background (µg/m³)

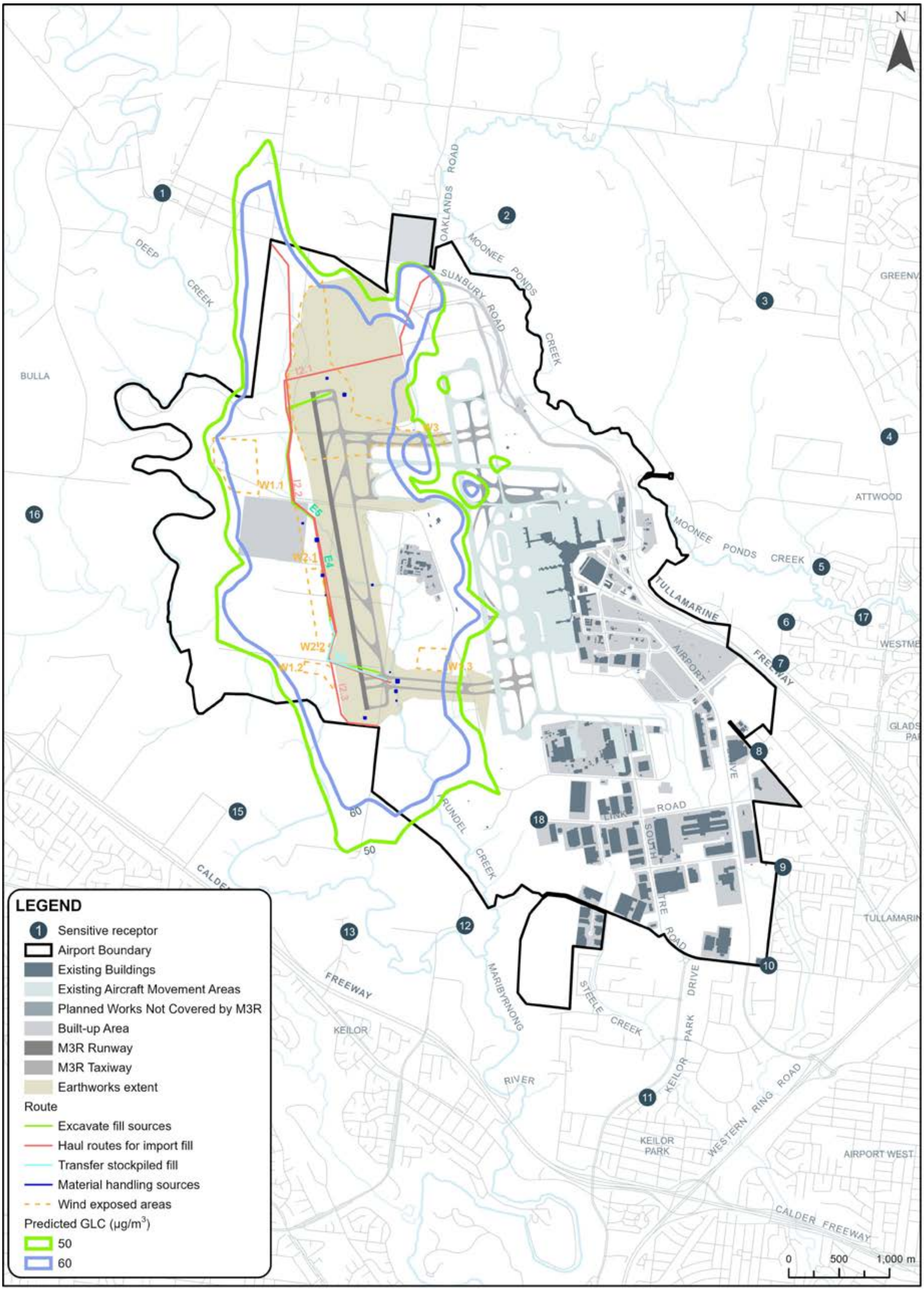
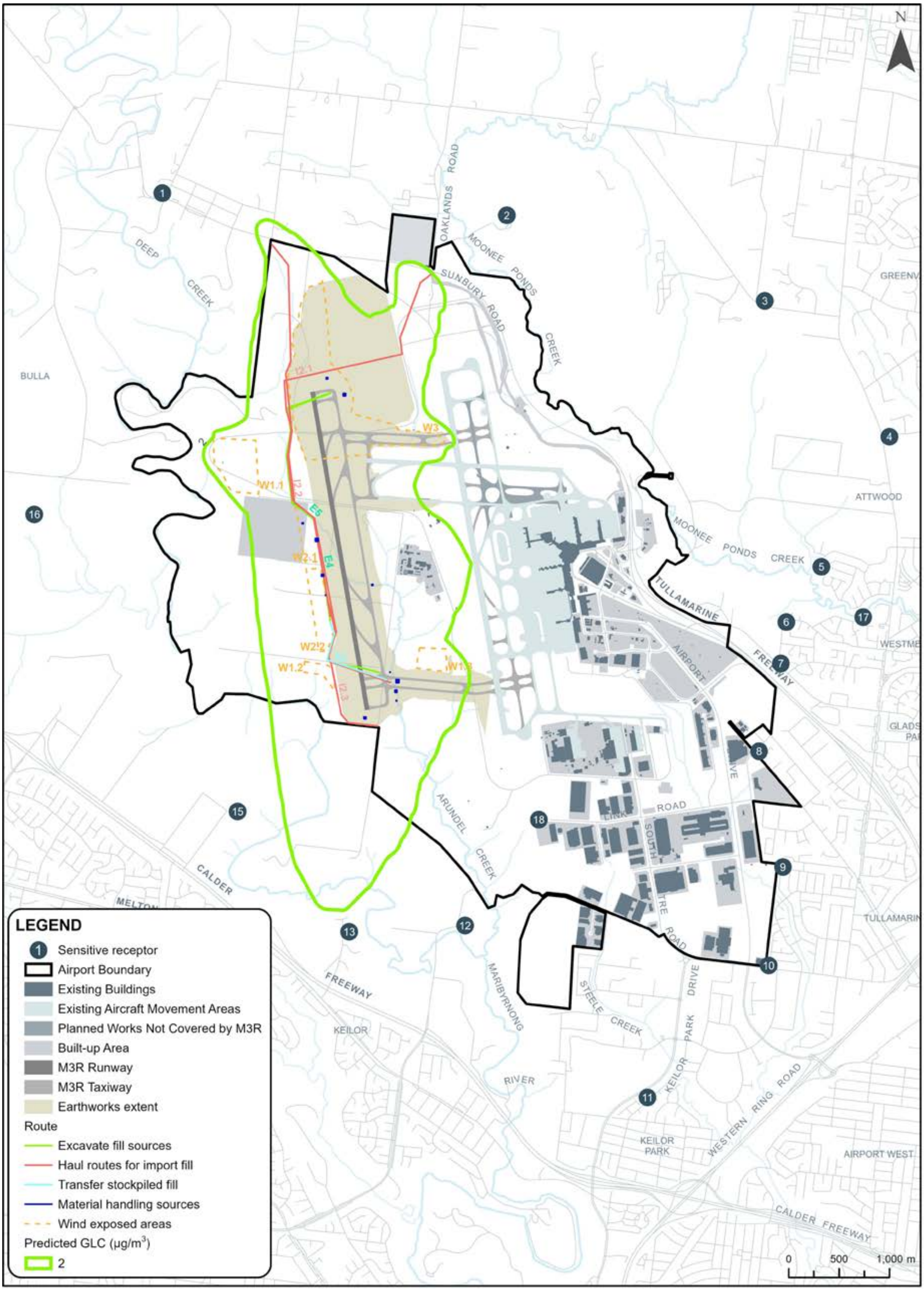


Figure B10.13
M3R construction: maximum predicted deposited dust excluding background. 2 g/m²/month contour indicated



B10.6.3.2
Predicted peak impact: including background concentrations

As dust deposition is not currently measured at the project site, a measured background value is unable to be added to the deposited dust predicted model result. However, it is noted that the Mining PEM states the following with regards to deposited dust:

> *"Results of monitoring should not exceed 4 g/m²/month (no more than 2 g/m²/month above background) as a monthly average".*

Therefore, if background levels are well below two g/m²/month, then residences in the area with concentrations above two g/m²/month would fall within the threshold levels (four g/m²/month) adapted from the Mining PEM guidance.

B10.6.4
Ground level concentration contour plots

The AERMOD results for $PM_{2.5}$ and PM_{10} GLCs and dust deposition rate are provided as the following contour plots in accordance with the procedures set out in EPAV Publication 1961 (and the former SEPP (AQM)):

- Maximum 24h $PM_{2.5}$ GLC excluding background (μg/m³)
- Maximum 24h PM_{10} GLC excluding background (μg/m³)
- Maximum predicted deposited dust excluding background (g/m²/month).

The assessment methodology is detailed in **section B10.4**. The AERMOD results for GLCs are provided as contour plots in units of μg/m³, with the adapted thresholds from the Mining PEM (used in EPAV Publication 1961) colour-coded in each case.

B10.7
OPERATIONAL PHASE IMPACTS

This section presents the results of atmospheric dispersion modelling for comparison against project air quality standards (**sections B10.2.3** and **B10.2.4**) for the operational phase for NO_2 and PM_{10}. The method used to assess operational emissions is described in **section B10.4.4**.

Throughout this section, contour plots show lines of GLCs predicted by the model in accordance with the rules set out in EPA Victoria Publication 1961 (as well as the SEPP (AQM), in force at the time of the original assessment). The contours are overlaid on a base map to illustrate the locations of impacts to air quality. Results at nominated sensitive receptors are presented in **section B10.7.6**.

Background concentrations of NO_2 and PM_{10} are not included in the figures in this section. As such, figures show the maximum impacts of airport operations rather than the maximum cumulative impact on sensitive receptors when background concentrations are added to airport operations.

Other criteria air pollutants were assessed for worst case scenario only. Results are shown in **B10.7.6**. Model inputs and results were peer reviewed by Environmental Consultant GHD.

B10.7.1
Current impacts (2019)

The following subsection presents the baseline modelling results for aircraft operations and road traffic for 2019, corresponding to the operations scenario described in **section B10.4.4**.

B10.7.1.1
Current impacts: NO_2

The AERMOD results for NO_2 are shown in **Figure B10.14** for the one-hour average. The AAQ NEPM standard for NO_2 (150 μg/m³) was used for the assessment. The criterion from the SEPP (AAQ) criterion for NO_2 (226 μg/m³) and SEPP (AQM) criterion (190 μg/m³) are also provided for reference.

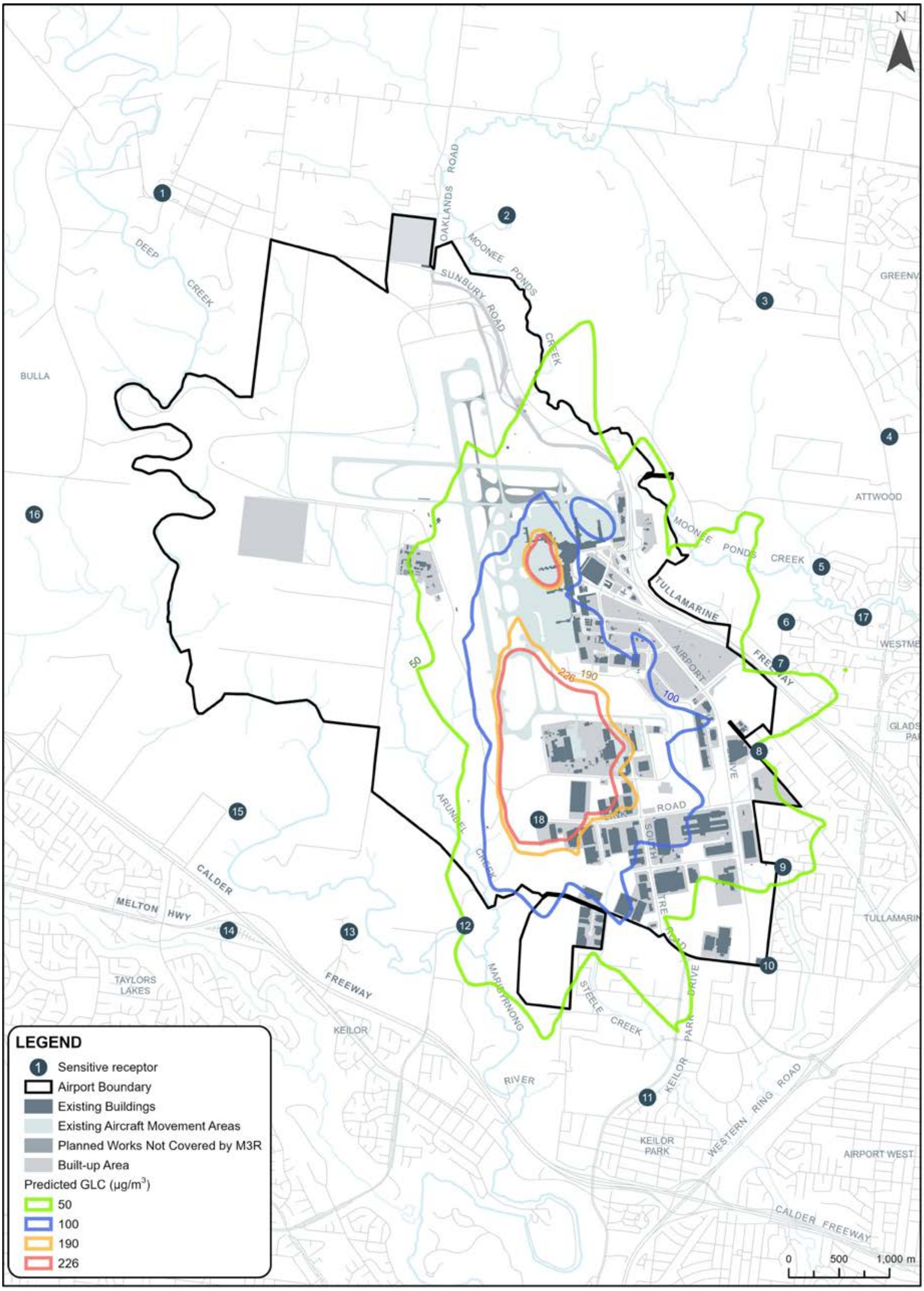
As evident from **Figure B10.14**, the highest GLCs of NO_2 are observed to the south end of the runway, predominantly from emissions from aircraft movements. Gates and taxiways are observed to have a lower impact but still contribute to GLCs.

No exceedances of the AAQ NEPM criteria are observed outside of the airport boundary. The highest concentrations are observed to the south of the 16L/34R runway. The MAS monitoring station is situated in this area, indicating that the monitoring station is measuring impacts from the both the operation of the airport and the ambient background pollutant levels. As such, model results that use data from MAS as representing background concentrations (presented in **section B10.7.6**) are likely to have some double counting of aircraft emissions (as recorded in the MAS data, plus the modelled impact).

Note that the model run represents worst case conditions, and a comparison of modelled results against data recorded at MAS demonstrates that actual emissions are lower and unlikely to result in any exceedances of air quality criteria. The ninth highest concentration (i.e. the 99.9th percentile) of NO_2 measured at MAS in 2019 was 71.7 μg/m³ (38.15 ppb), which is 20 per cent of the ninth highest concentration for 2019 at MAS. By comparison, the highest 99.9th percentile prediction for a sensitive receptor was observed at receptor R9 (Janus St) at 54.6 μg/m³ (36 per cent of the AAQ NEPM criteria).

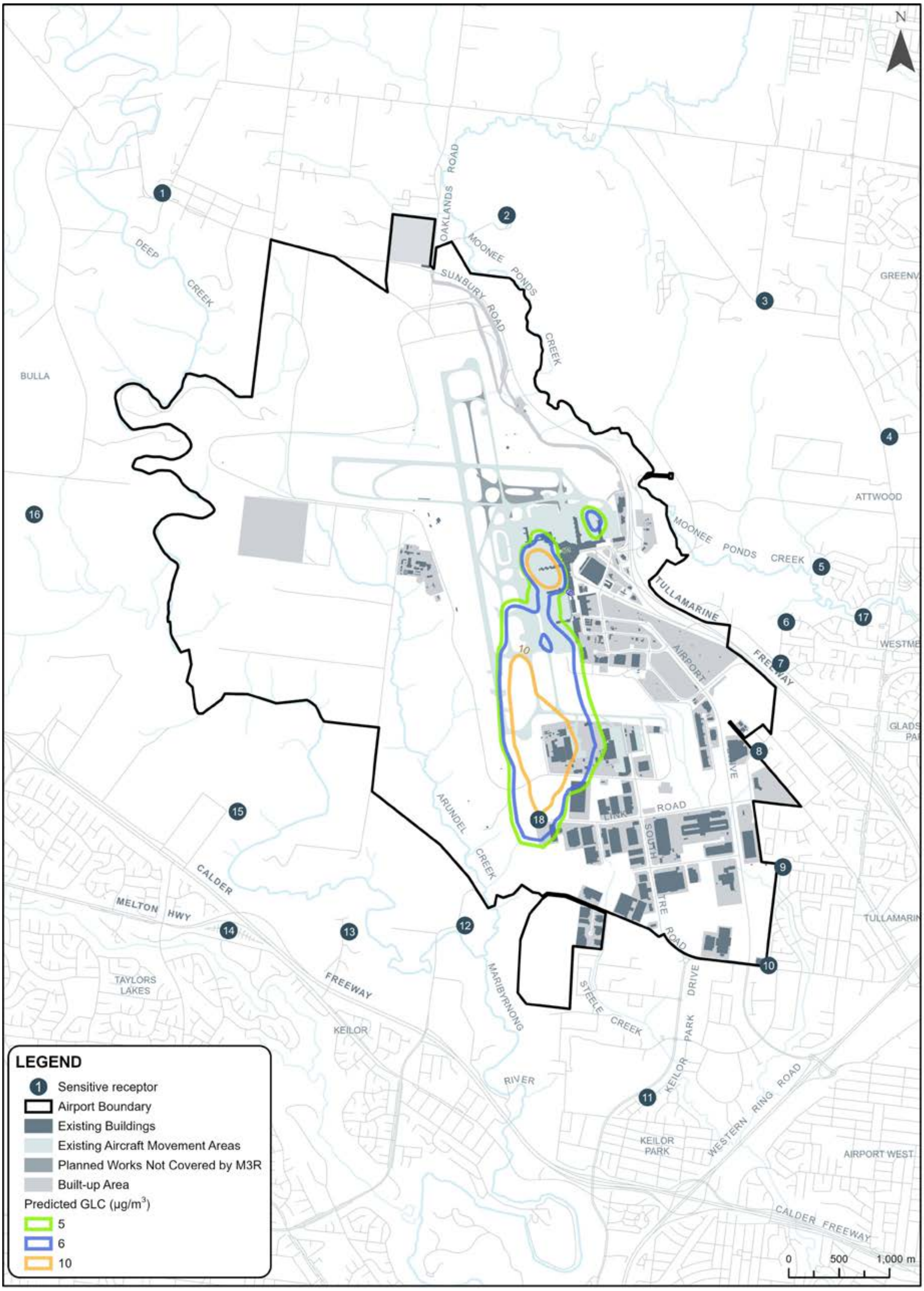
Figure B10.15 shows AERMOD results for the NO_2 annual average. Predicted maximum concentrations, occurring to the south of the existing 16/34 runway, are less than 40 per cent of the AAQ NEPM standard for NO_2 (28 μg/m³).

Figure B10.14
AERMOD results for current (2019) airport operations: µg/m³ NO_2 (99.9th percentile, one-hour average, no background)



Note: The AAQ NEPM standard (150 µg/m³) is not shown in the figure, however is observed to fall within the airport boundary. The SEPP (AAQ) criterion for NO_2 (226 µg/m³) is represented by the red contour, and the SEPP (AQM) criterion (190 µg/m³) is represented by the orange contour. These criteria are no longer in force but are shown for reference.

Figure B10.15
AERMOD results for current (2019) airport operations: NO_2 (annual average, no background)



Note: AAQ NEPM criterion for NO_2 (28 µg/m³) is not shown, as modelled results are below this concentration.

Model results demonstrated that all impacts at receptors were below AAQ NEPM standard. Note that this standard applies to the maximum concentration, however EPA Victoria recommend using the 99.9th percentile concentration in modelling for averaging times one hour or less, which is adopted in the figures below. Note this standard is not compliance related.

B10.7.1.2
Current impacts: PM_{10}

The AERMOD results for PM_{10} are shown in **Figure B10.16** (24-hour impacts) and **Figure B10.17** (annual impacts). The AAQ NEPM 24-hour criterion for PM_{10} (50 µg/m³) was the standard used for the assessment. Note the figure does not include background concentrations. The results are presented as such because the impact of emissions from the airport is minimal compared to background concentrations and would otherwise be indistinguishable in this figure.

As evident from **Figure B10.16**, the highest GLCs of PM_{10} are observed around the gate sources, extending towards the car parks at Melbourne Airport. Taxiways and aircraft are shown to have a minimal impact on PM_{10} concentrations. No exceedances of the criteria are observed outside the airport boundary. Similarly, annual PM_{10} concentrations are shown to be well below the annual criterion in all locations (20 µg/m³).

B10.7.1.3
Variability of model results

Five years of meteorological data was used to determine a worst-case meteorological dataset based on AERMOD model results for predicted NO_2 GLCs (one-hour average, 99.9th percentile).

Concentrations at the sensitive receptors are shown in **Table B10.18**. As evident from the table, concentrations at each receptor varied, but were of a similar order of magnitude. At all sensitive receptors, GLCs were well below the AAQ NEPM criteria, with receptor R12 (Arundel Road) predicted to have the highest concentration NO_2 of 94.5 µg/m³ (63 per cent of the criteria). Comparisons with the measurements at MAS in 2019 confirmed these AERMOD results were conservative (high).

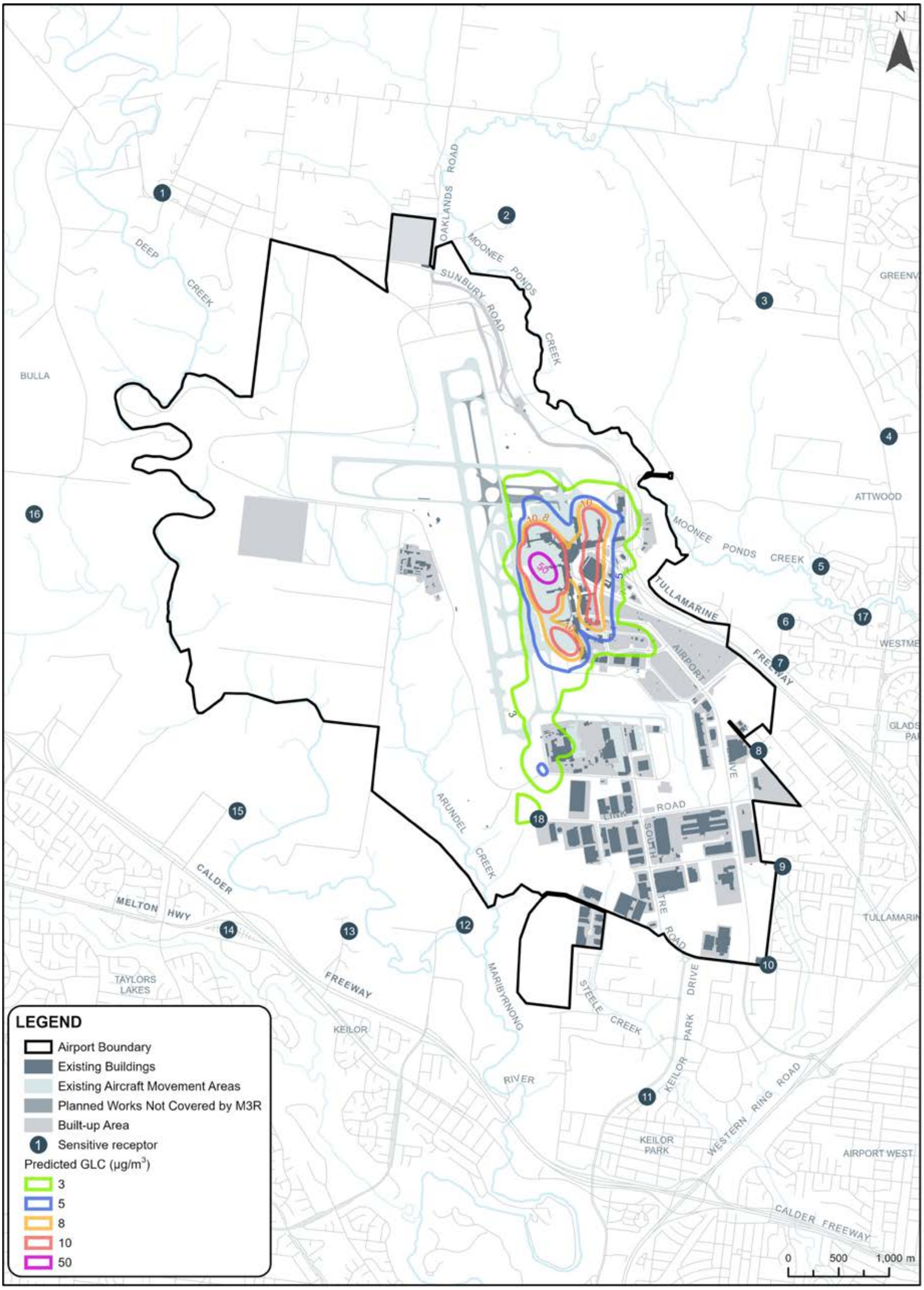
The meteorological data from 2017 typically produced worst-case results with the AEDT-AERMOD modelling combination. Modelling results from the 2019 dataset however produced results that were closest to the measured concentrations at the MAS monitoring station, and hence this dataset was selected for use for the assessment.

The AERMOD results for NO_2 GLCs (one-hour average, 99.9th percentile) are shown in **Figure B10.18**. Predicted GLCs above the AAQ NEPM criteria of 150 µg/m³ for all years centred around the south end of the existing 16/34 runway and cover a similar area. GLCs were predicted to be above the criteria outside of the airport boundary for one year (2015), although no sensitive receptors are located in the impact area.

Table B10.18
Current airport: AERMOD results for 99.9 percentile one-hour average NO_2 GLCs (µg/m³) (no background)

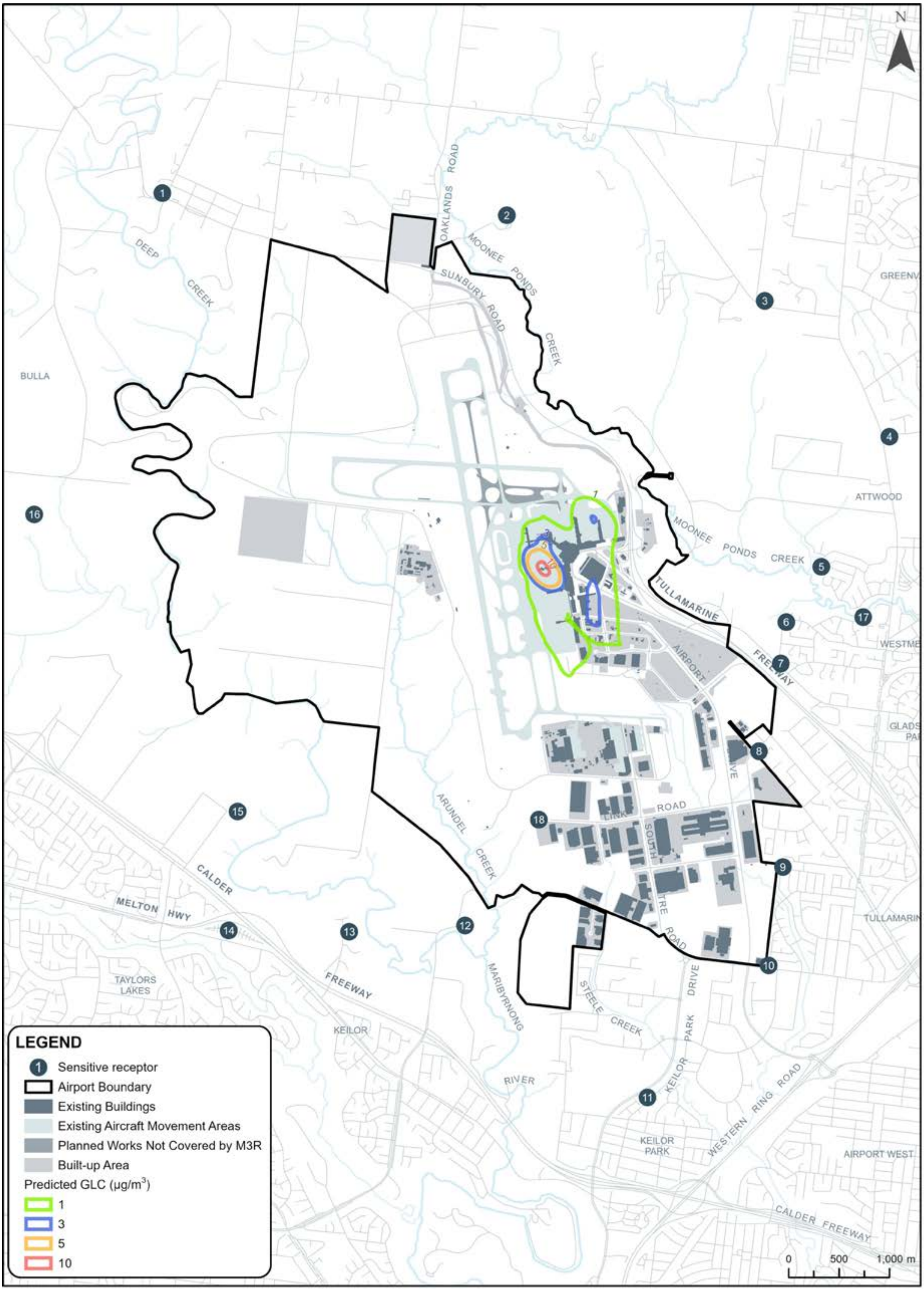
Discrete receptor	2015	2016	2017	2018	2019
1. Bulla	8.4	8.9	5.3	8.4	8.7
2. Living Legends	24.7	30.0	30.4	26.2	22.6
3. Providence Rd	16.5	13.4	14.9	19.1	19.8
4. Montrose Ct	19.1	19.7	18.6	20.9	20.3
5. Threadneedle St	43.2	29.4	28.5	33.8	33.9
6. Westmeadows North	48.9	46.3	43.5	48.4	42.4
7. Westmeadows South	53.0	43.0	58.2	49.0	42.1
8. Melrose Dve	66.4	77.0	74.5	51.3	48.7
9. Janus St	40.3	28.9	50.1	40.3	54.6
10. Fisher Gve	34.9	31.9	35.7	49.7	30.8
11. Fosters Rd	66.8	35.4	81.2	34.9	24.2
12. Arundel Rd	91.1	46.2	94.5	58.3	48.1
13. Overnewton Rd	22.5	25.3	46.8	30.6	19.7
14. Keilor Village	15.0	17.2	26.5	20.2	11.8
15. Highland Rd	14.2	25.1	21.4	14.8	7.8
16. Loemans Rd	4.9	4.0	4.3	3.5	4.5
17. MAE	35.5	24.5	36.2	28.7	25.0
18. MAS	842.6	403.7	649.8	430.5	365.8

Figure B10.16
AERMOD results for current (2019) airport operations: PM_{10} maximum 24-hour average (no background)



AAQ NEPM criterion for PM_{10} 24-hour average (50 µg/m³) is shown by the purple contour.

Figure B10.17
AERMOD results for current (2019) airport operations: PM_{10} yearly average (no background)



Note: EPAV Publication 1961 criterion for PM_{10} yearly average (20 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.18

Results comparing 1-hour NO_2 average concentration of 226 µg/m³ (99.9 percentile) GLC variability among five years of meteorological files in model runs (no background) (noting 226 µg/m³ was the SEPP (AQM) criteria in force at the time of assessment)

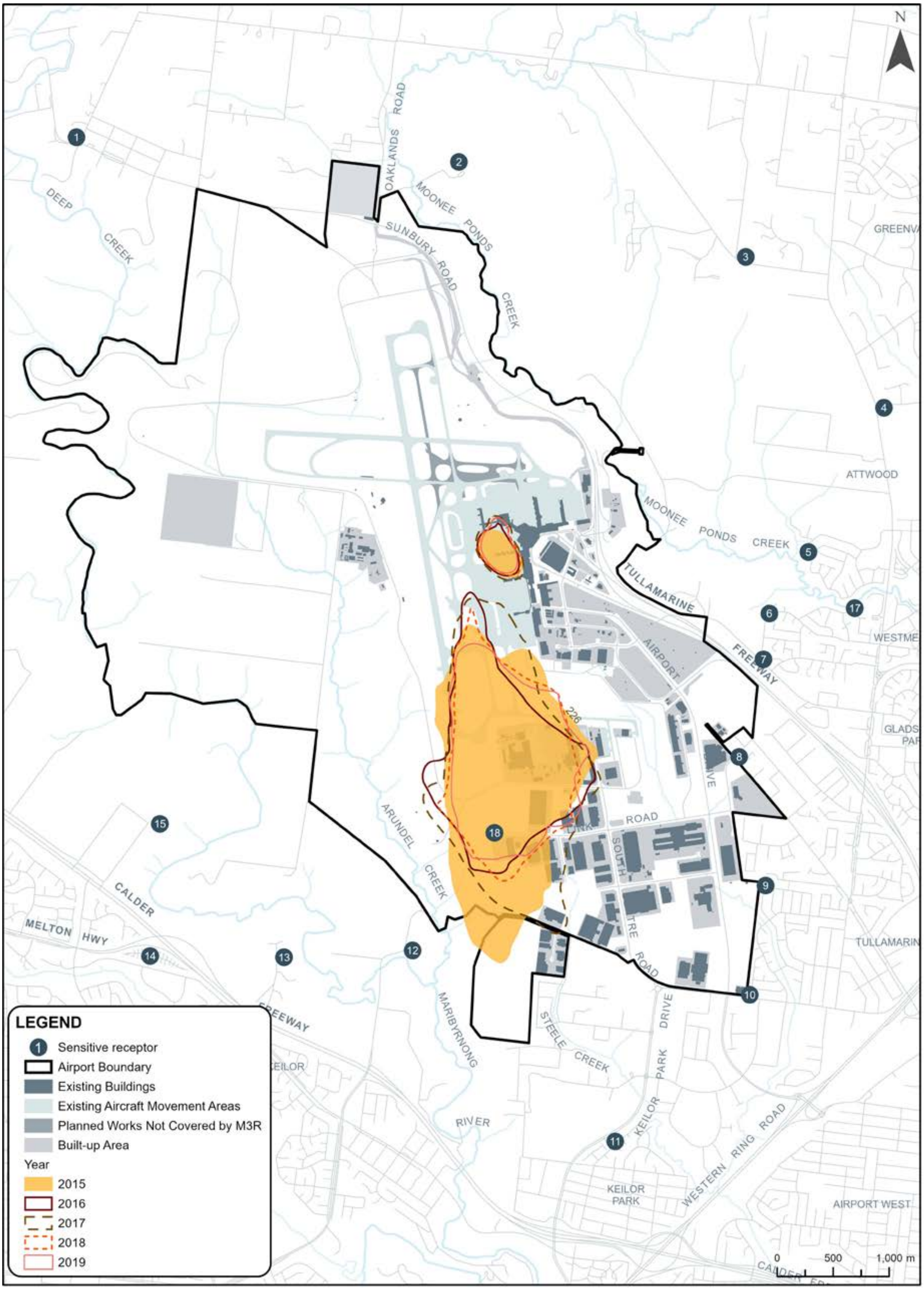
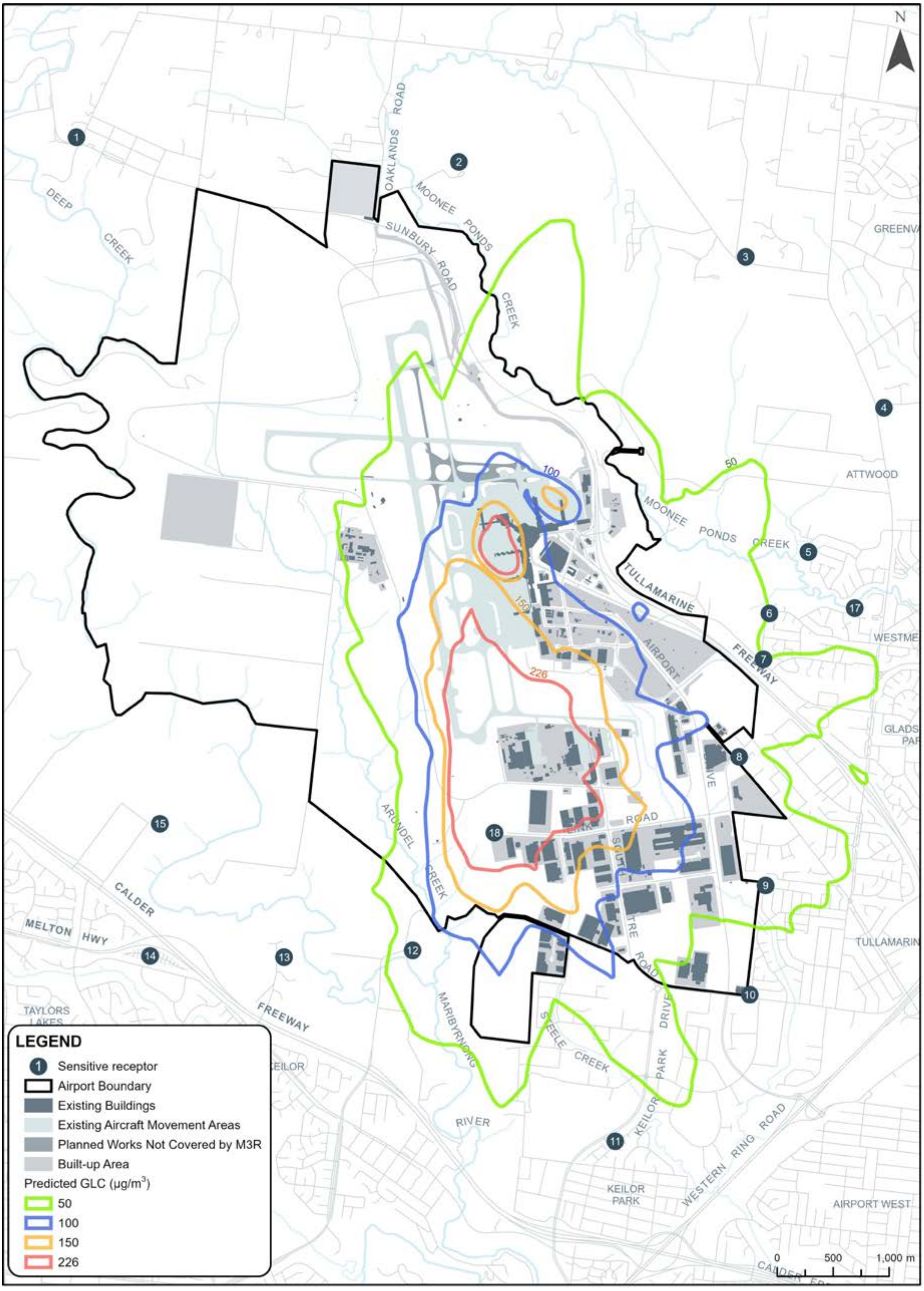


Figure B10.19
M3R No Build 2026: AERMOD results for 99.9 percentile hourly NO_2 GLC (μg/m³) (no background)



Note: The SEPP (AAQ) criterion (no longer in force) for NO_2 (226 μg/m³) is represented by the red contour, and the AAQ NEPM Standard (150 ug/m³) is represented by the orange contour).

B10.7.2
Predicted impacts (No Build 2026)

This section presents the results of atmospheric dispersion modelling for the airport operations in 2026 for NO_2 and PM_{10} if M3R is not built. All concentrations exclude background levels to show maximum impacts from airport operations. Concentrations at sensitive receptors are provided in **section B10.7.6.**

B10.7.2.1
No Build 2026: NO_2

The AERMOD results for NO_2 are shown in **Figure B10.19** for the one-hour average. The AAQ NEPM standard for NO_2 (150 µg/m³) was used for the assessment. The criterion from the SEPP (AAQ) criterion for NO_2 (226 µg/m³) and SEPP (AQM) criterion (190 µg/m³) are also provided for reference.

As evident from **Figure B10.19**, no exceedances of the AAQ NEPM criteria are observed outside of the airport boundary. GLCs above the AAQ NEPM standard cover an area slightly larger than in 2019, due to increased aircraft movements, extending a further 40-100 metres than in 2019.

Figure B10.20 shows AERMOD results for the NO_2 annual average. As with the 2019 modelling, there are no exceedances of the AAQ NEPM annual NO_2 standard (28 ug/m³), and impacts are similar to those predicted in 2019.

B10.7.2.2
No Build 2026: PM_{10}

The AERMOD results for PM_{10} are shown in **Figure B10.21** for the 24-hour average, with reference to the AAQ NEPM standard for PM_{10} (50 µg/m³).

As evident from **Figure B10.21**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary. GLCs above the standard cover an area slightly larger than the 2026 no build scenario, with a further increase in aircraft movements.

Figure B10.22 shows AERMOD results for the PM_{10} annual average. As with the 2019 modelling, there are no exceedances of the EPAV 1961 criterion, and impacts are similar to those predicted in 2019.

B10.7.3
Predicted impacts (Build 2026)

This section presents the results of atmospheric dispersion modelling for the airport operations in 2026 if M3R is built for NO_2, PM_{10}, and $PM_{2.5}$. All concentrations exclude background levels, to show maximum impacts from airport operations. Concentrations at sensitive receptors are provided in **section B10.7.6**.

As evident from the results below, predicted concentrations are very similar to the 'No Build' scenario since operations include the same number of aircraft movements (an 18 per cent increase in movements from 2019). As such, the major difference in this scenario is some additional spatial dispersion of pollutants due to a larger area in which sources operate as a result of the new runway.

B10.7.3.1
Build 2026: NO_2

The AERMOD results for NO_2 are shown in **Figure B10.23** for the one-hour average. The AAQ NEPM standard for NO_2 (150 µg/m³) was used for the assessment. The criterion from the SEPP (AAQ) criterion for NO_2 (226 µg/m³) and SEPP (AQM) criterion (190 µg/m³) are also provided for reference.

As evident from **Figure B10.23**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary. GLCs above the standard cover an area slightly larger than in 2019, due to increased aircraft movements, extending a further 40-100 metres than in 2019.

Figure B10.24 shows AERMOD results for the NO_2 annual average. As with the 2019 modelling, there are no exceedances of the AAQ NEPM annual NO_2 standard (28 ug/m³), and impacts are similar to those predicted in 2019.

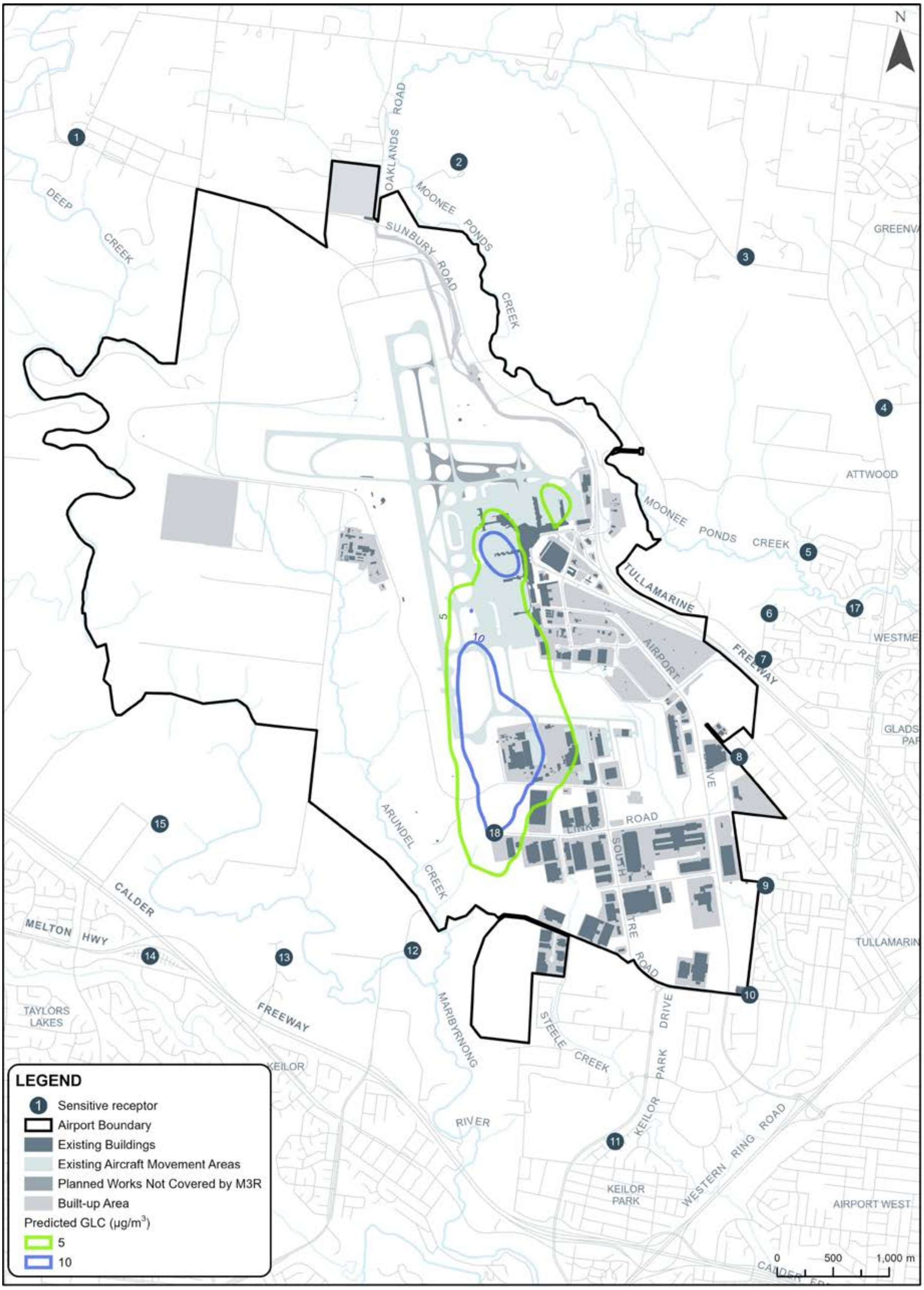
B10.7.3.2
Build 2026: PM_{10}

The AERMOD results for PM_{10} are shown in **Figure B10.23** for the 24-hour average, with reference to the AAQ NEPM standard for PM_{10} (50 µg/m³).

As evident from **Figure B10.23**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary.

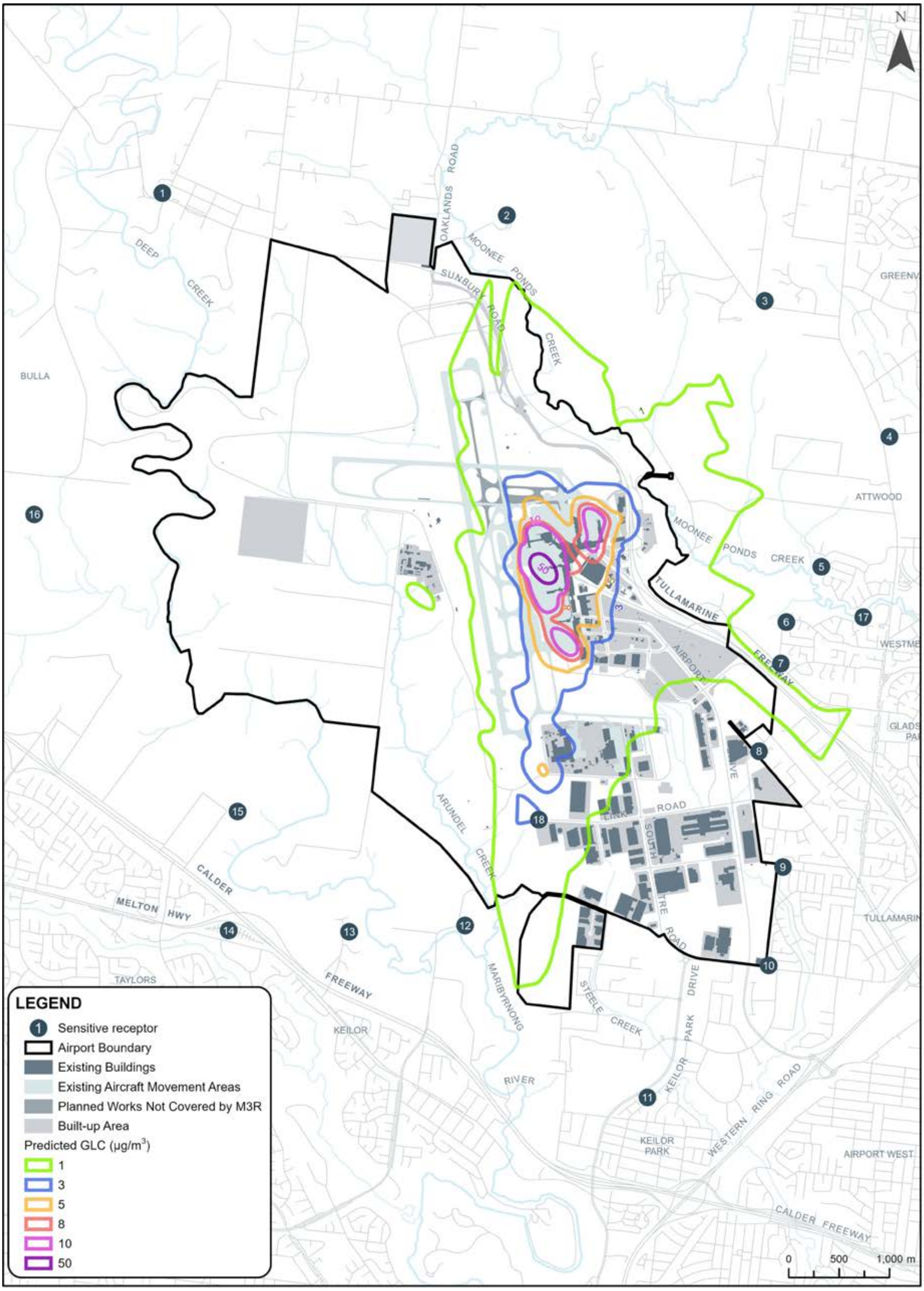
Figure B10.24 shows AERMOD results for the PM_{10} annual average. As with the 2019 modelling, there are no exceedances of the EPAV 1961 criterion, and impacts are similar to those predicted in 2019.

Figure B10.20
M3R No Build (2026): AERMOD results for annual NO_2 GLC (ug/m³) – no background



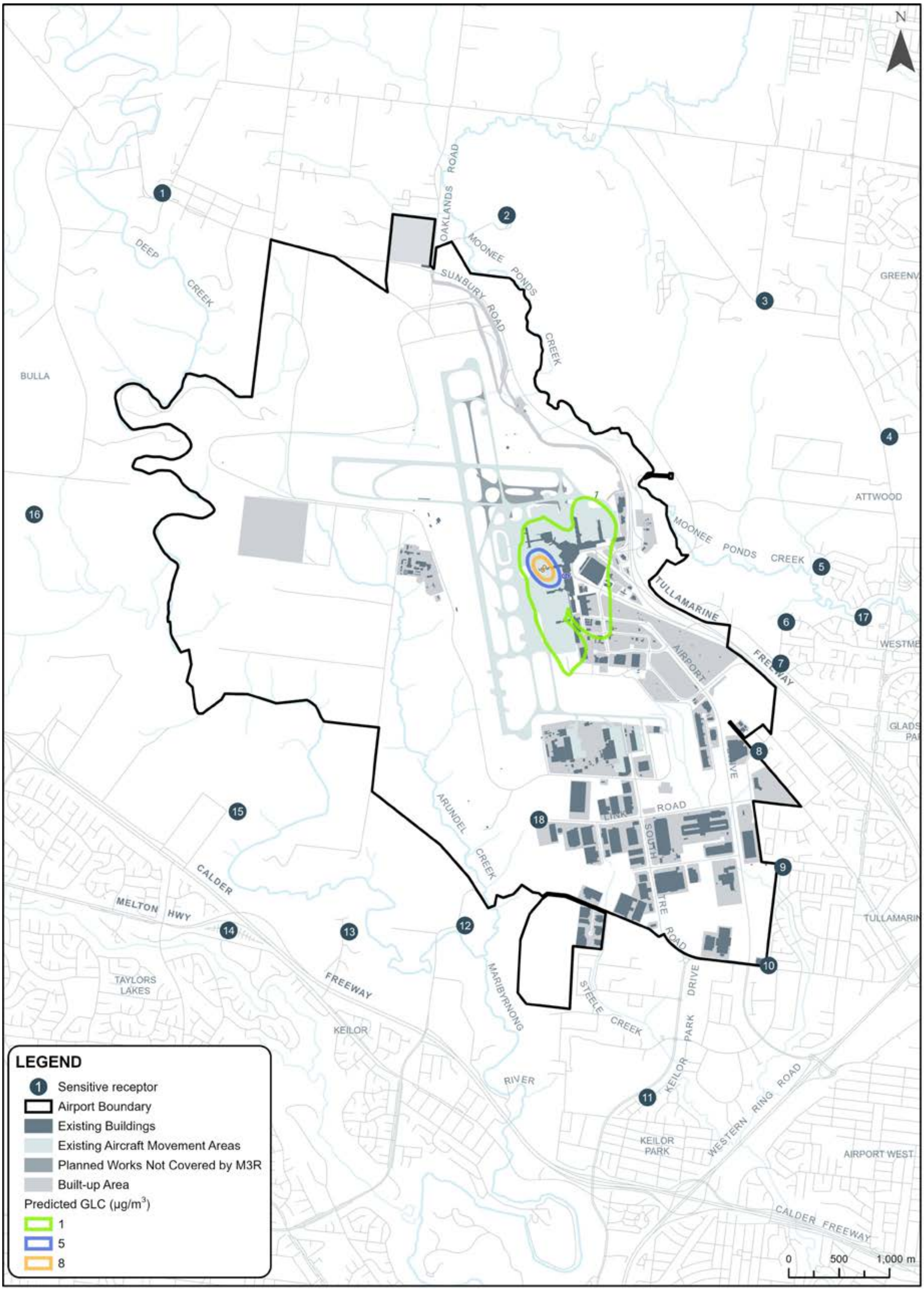
Note: The AAQ NEPM standard for NO_2 (28 μg/m³) is not shown, as modelled results are below this concentration.

Figure B10.21
M3R No Build 2026: AERMOD results for maximum 24-hour PM_{10} GLC (µg/m³)



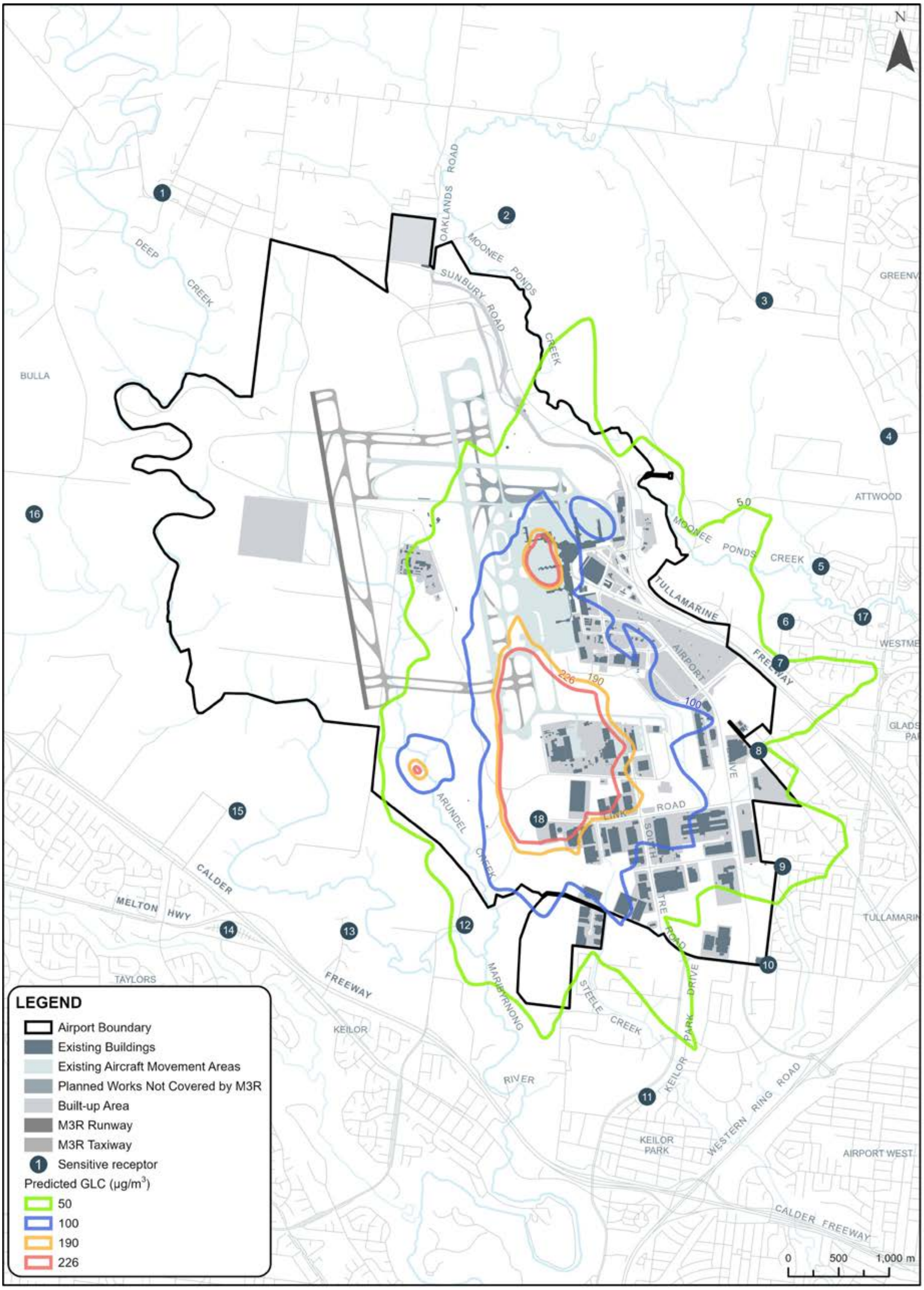
The AAQ NEPM standard for PM_{10} (50 µg/m³) is represented by the purple contour.

Figure B10.22
M3R No Build 2026: AERMOD results for annual average PM_{10} GLC (µg/m³)



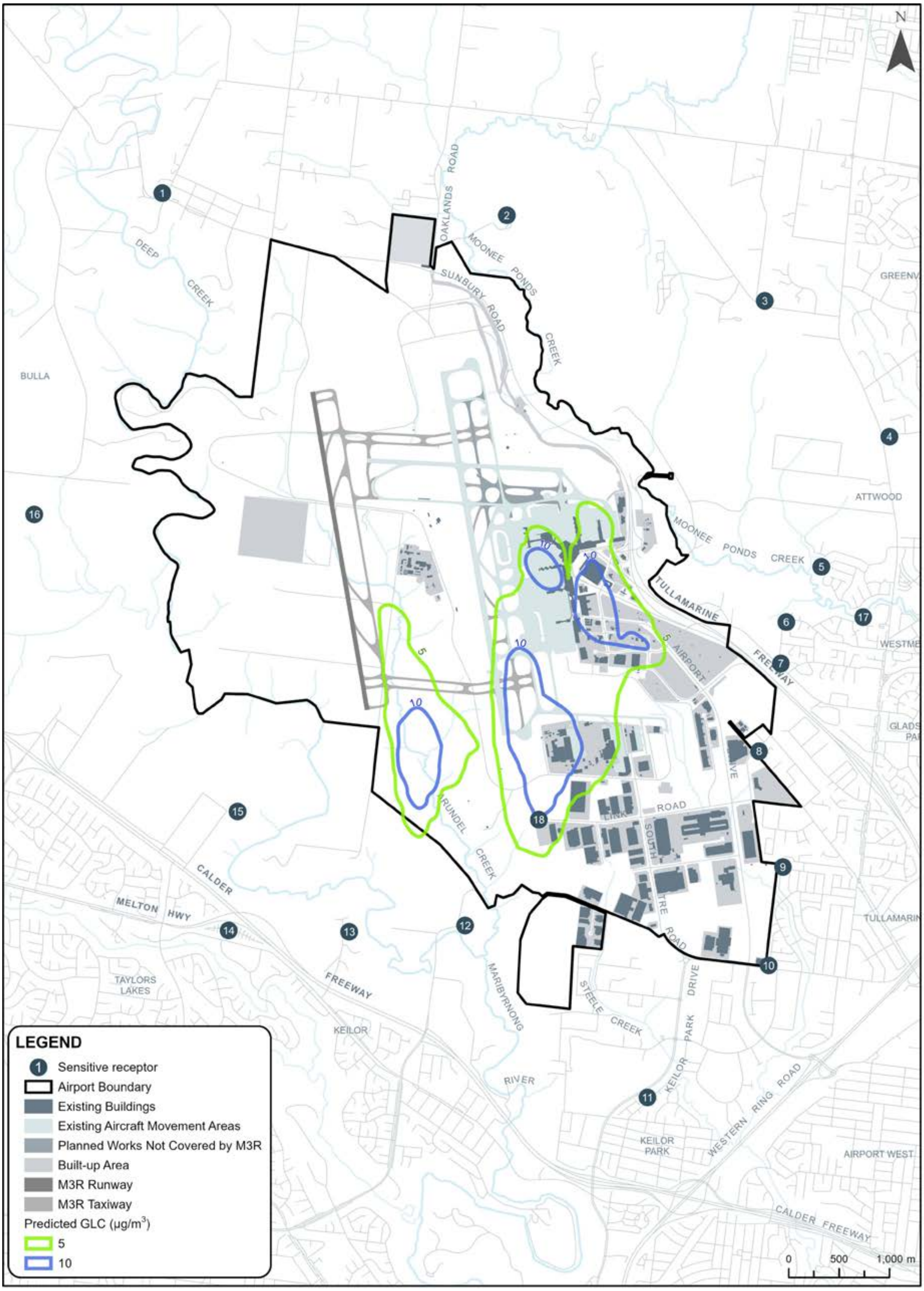
Note: The EPAV 1961 criterion for PM_{10} yearly average (20 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.23
M3R Build 2026: AERMOD results for 99.9 percentile hourly NO_2 GLC (µg/m³) – no background



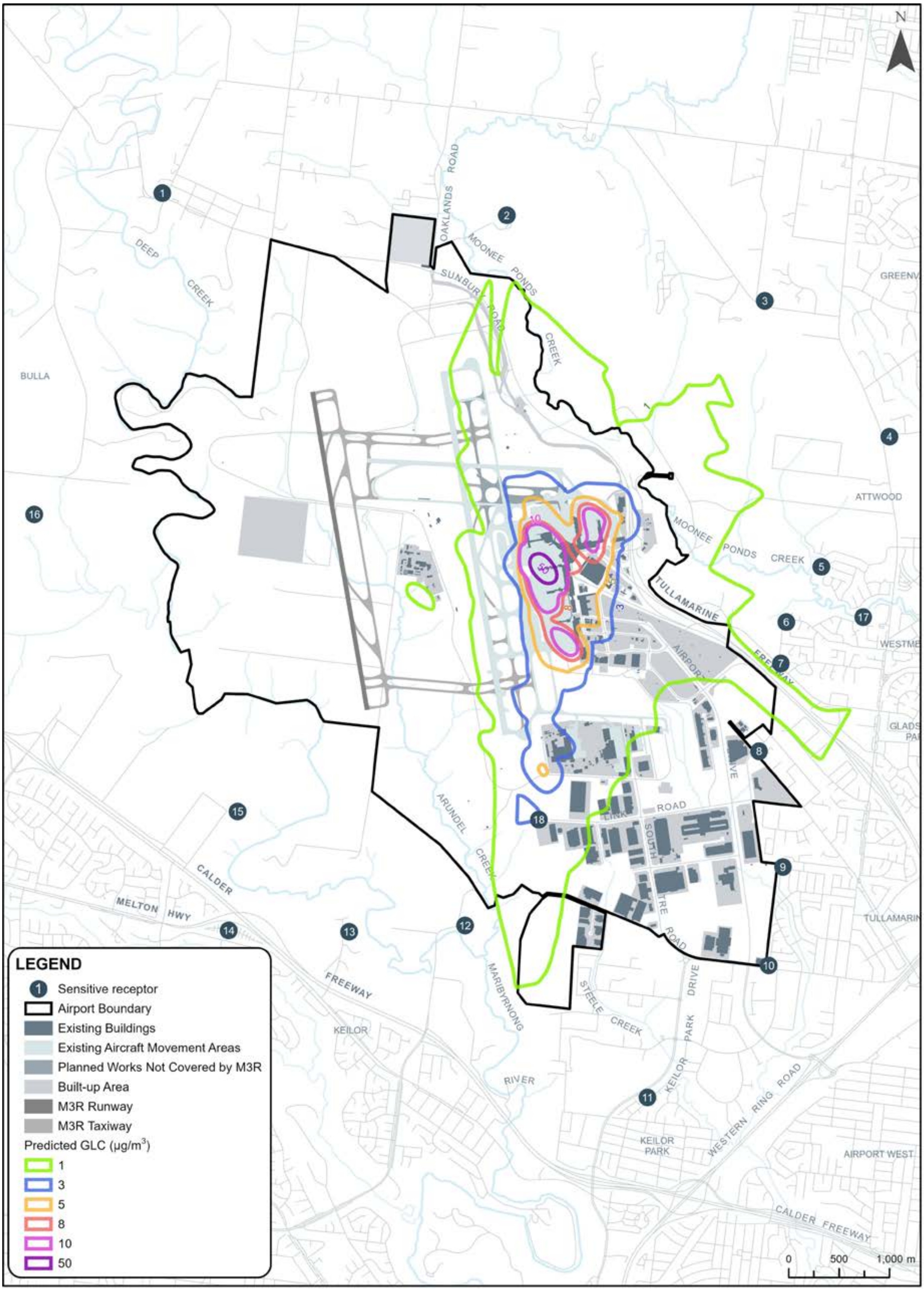
The SEPP (AAQ) criterion for NO_2 (226 µg/m³) is represented by the red contour, and the SEPP (AQM) criterion (190 µg/m³) is represented by the orange contour. The AAQ NEPM standard contour sits between the orange and blue contours (noted since modelling was originally conducted against SEPP (AQM) criteria).

Figure B10.24
M3R Build 2026: AERMOD results for annual NO_2 GLC (µg/m³) – no background



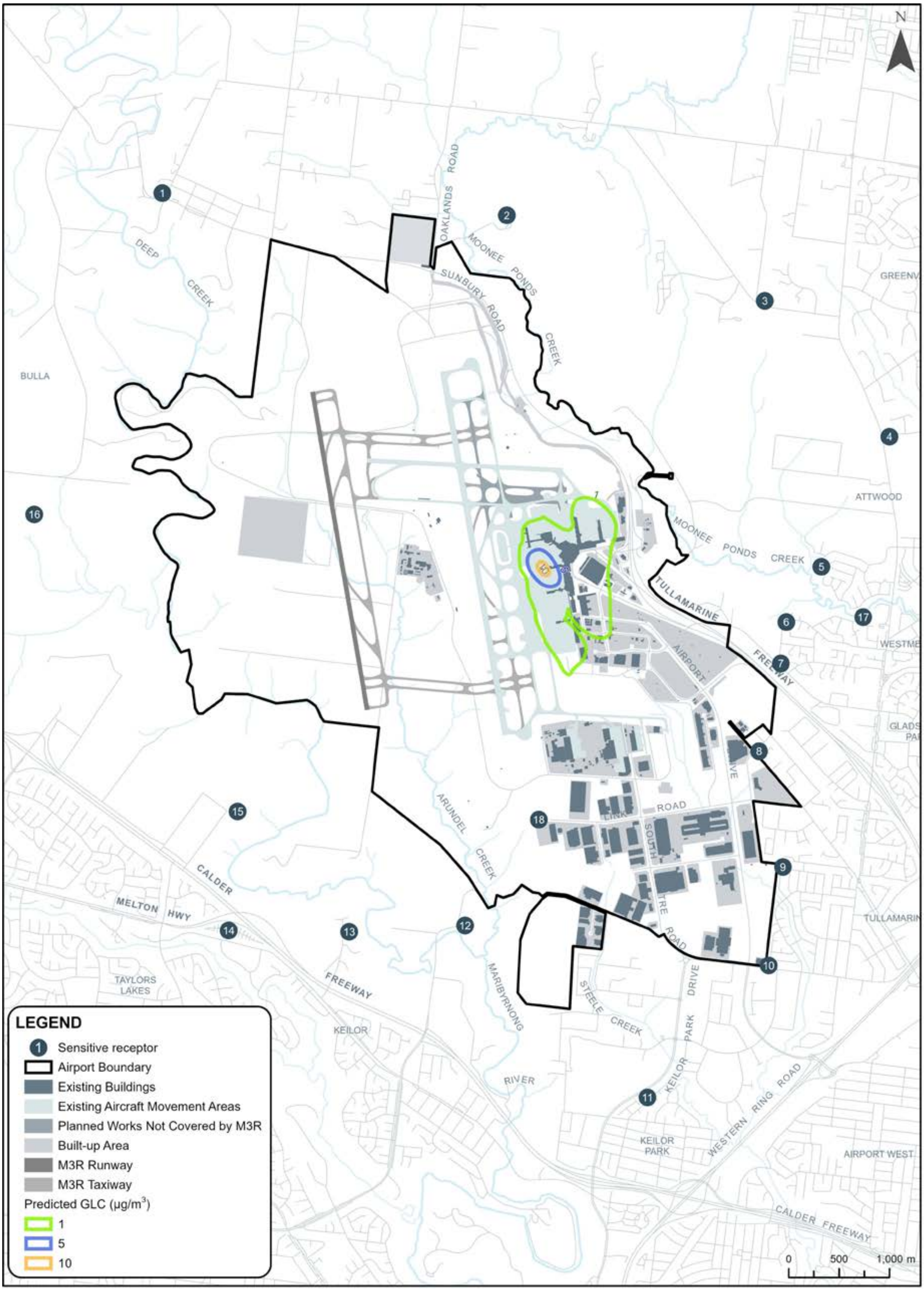
Note: AAQ NEPM standard for NO_2 (28 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.25
M3R Build 2026: AERMOD results for maximum 24-hour PM_{10} GLC (µg/m³)



Note: The ***AAQ NEPM standard*** *for PM_{10} (50 µg/m³) is represented by the red contour.*

Figure B10.26
M3R Build 2026: AERMOD results for annual average PM_{10} GLC (µg/m³)



Note: The EPVA 1961 criteria for annual average PM_{10} (20 µg/m³) is not shown, as modelled results are below this concentration.

B10.7.4
Predicted impacts (No Build 2046)

This section presents the NO_2 and PM_{10} atmospheric dispersion modelling results for airport operations in 2046 if M3R is not built . All concentrations exclude background levels. Concentrations at sensitive receptors are provided in **Section B10.7.6**.

As evident from the results below, predicted concentrations are slightly higher than in 2026 (for the No Build scenario), due to an increase in aircraft operations to 30 per cent higher than 2019 (compared with 18 per cent in 2026). This is deemed the maximum number of aircraft movements at Melbourne Airport under a No Build scenario.

B10.7.4.1
No Build 2046: NO_2

The AERMOD results for NO_2 are shown in **Figure B10.27** for the one-hour average. The AAQ NEPM standard for NO_2 (150 µg/m³) was used for the assessment. The criterion from the SEPP (AAQ) criterion for NO_2 (226 µg/m³) and SEPP (AQM) criterion (190 µg/m³) are also provided for reference.

As evident from **Figure B10.27**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary. GLCs above the standard cover an area slightly larger than the 2026 no build scenario, with a further increase in aircraft movements.

Figure B10.28 shows AERMOD results for the NO_2 annual average. As with the 2019 modelling, there are no exceedances of the AAQ NEPM annual NO_2 standard (28 ug/m³), and impacts are similar to those predicted in 2019.

B10.7.4.2
No Build 2046: PM_{10}

The AERMOD results for PM_{10} are shown in **Figure B10.29** for the 24-hour average, with reference to the SEPP (AQM) design criterion for PM_{10} (50 µg/m³).

As evident from **Figure B10.29**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary. GLCs above the AAQ NEPM standard cover an area slightly larger than the 2026 no build scenario, with a further increase in aircraft movements.

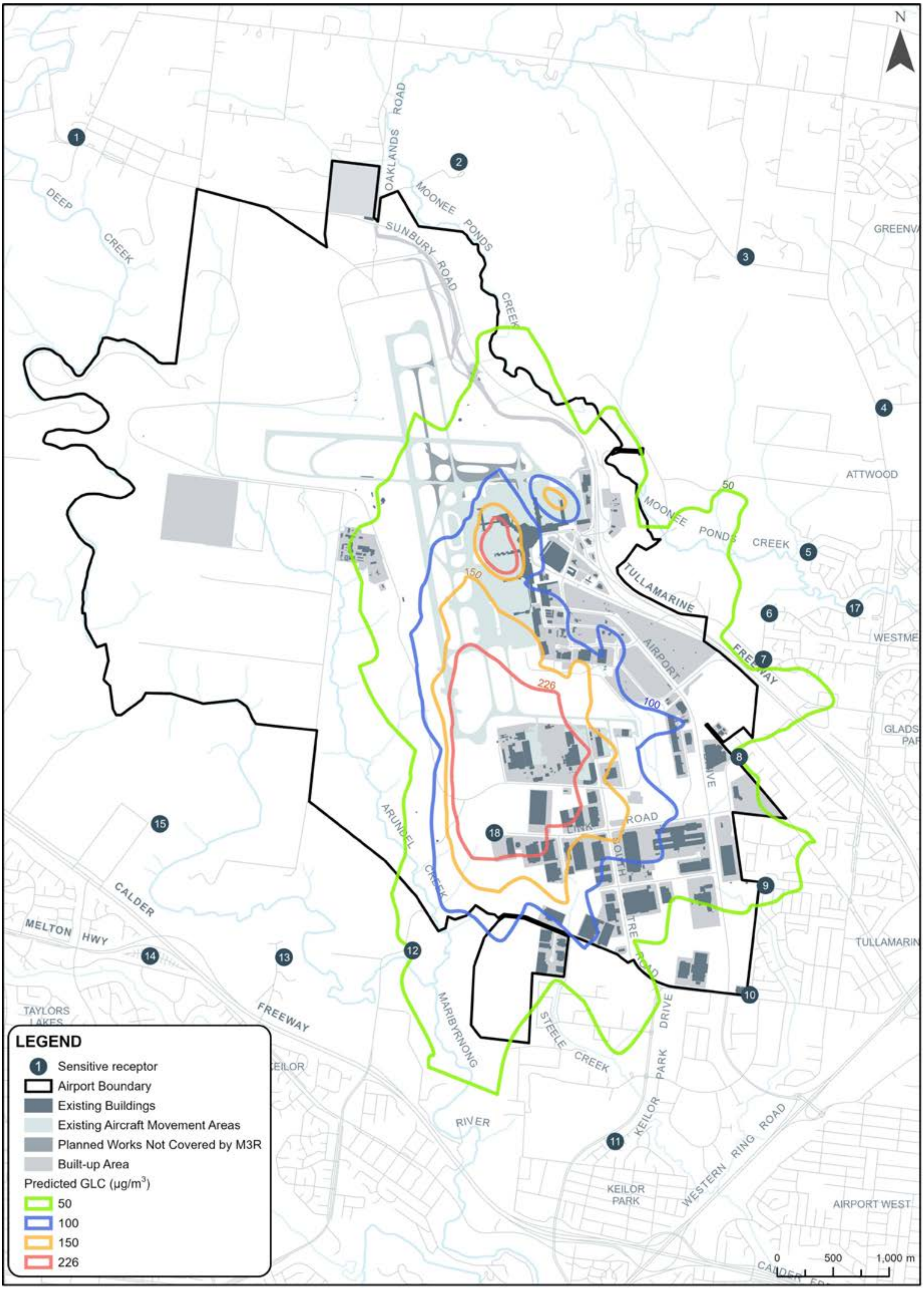
Figure B10.30 shows AERMOD results for the PM_{10} annual average. As with the 2019 modelling, there are no exceedances of the AAQ NEPM annual NO_2 standard (28 ug/m³), and impacts are similar to those predicted in 2019.

B10.7.5
Predicted impacts (Build 2046)

This section presents the results of atmospheric dispersion modelling for the airport operations in 2046 if M3R is built for NO_2, and PM_{10}. All concentrations exclude background levels to show maximum impacts from airport operations. Concentrations at sensitive receptors are provided in **section B10.7.6**.

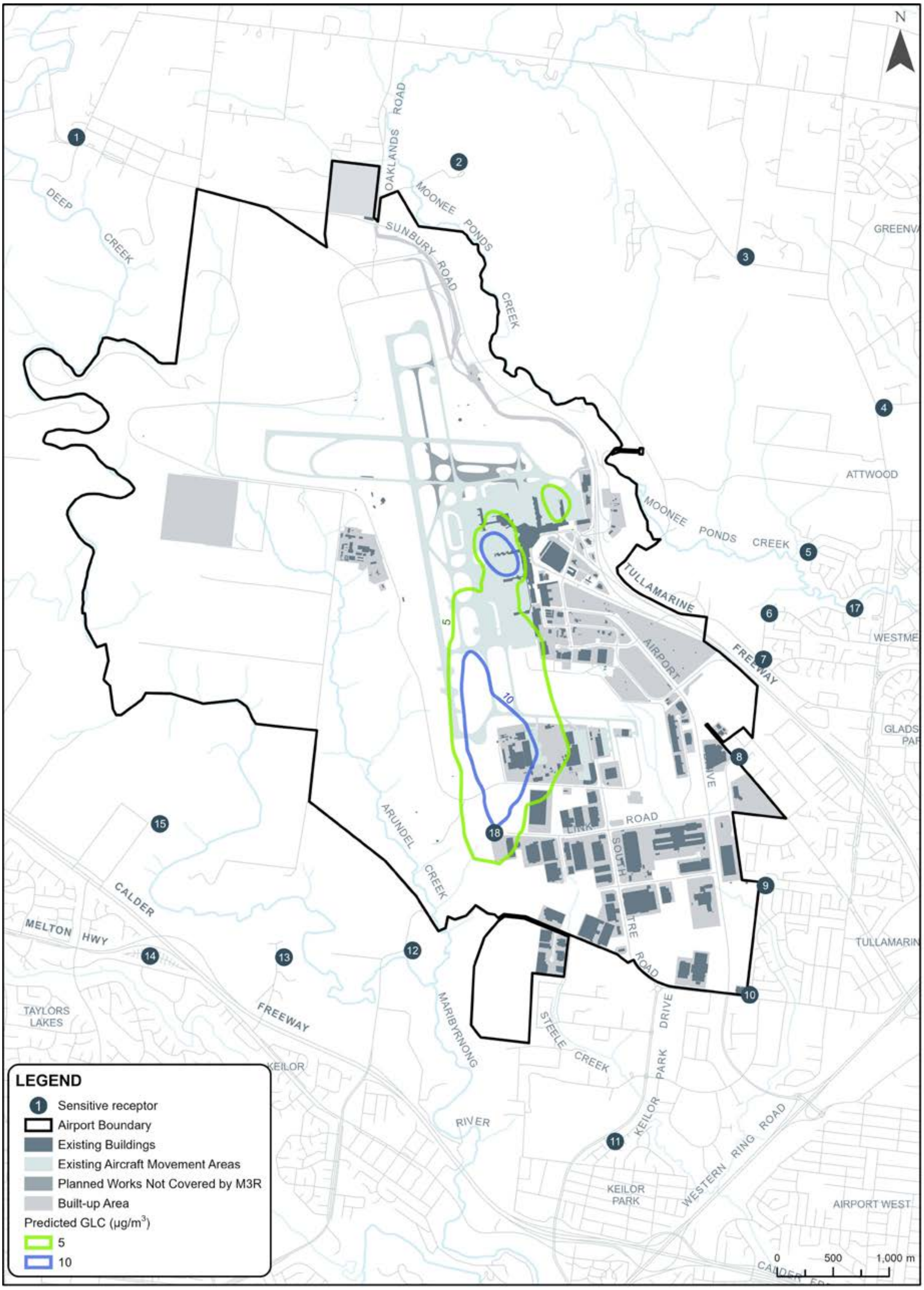
As evident from the results below, predicted concentrations are higher than the 'No Build' 2046 scenario since operations include 91 per cent more aircraft movements than in 2019, compared with 30 per cent more aircraft movements under a 'No Build' scenario. As such, two impact zones are evident at the southern ends of both runways. While an increase in aircraft movements shifts concentrations above the criteria for NO_2 outside of the airport boundary, GLCs at all sensitive receptors still comply with the criterion.

Figure B10.27
M3R No Build 2046: AERMOD results for 99.9 percentile hourly NO_2 GLC (μg/m³) (no background)



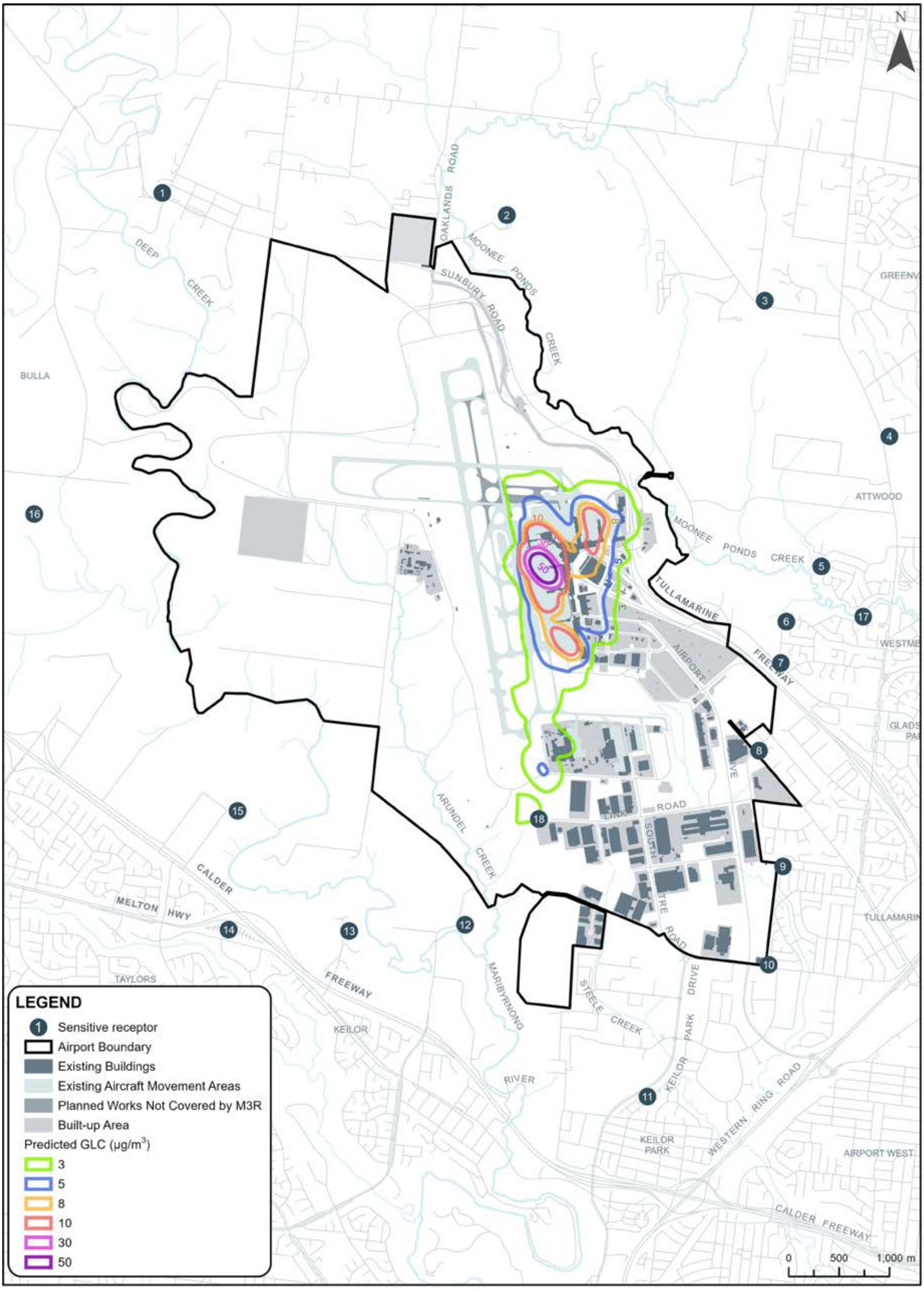
Note: The AAQ NEPM standard for NO_2 (150 μg/m³) is represented by the orange contour; the SEPP (AQM) criterion is represented by the red contour.

Figure B10.28
M3R No Build 2046: AERMOD results for annual NO_2 GLC (µg/m³) (no background)



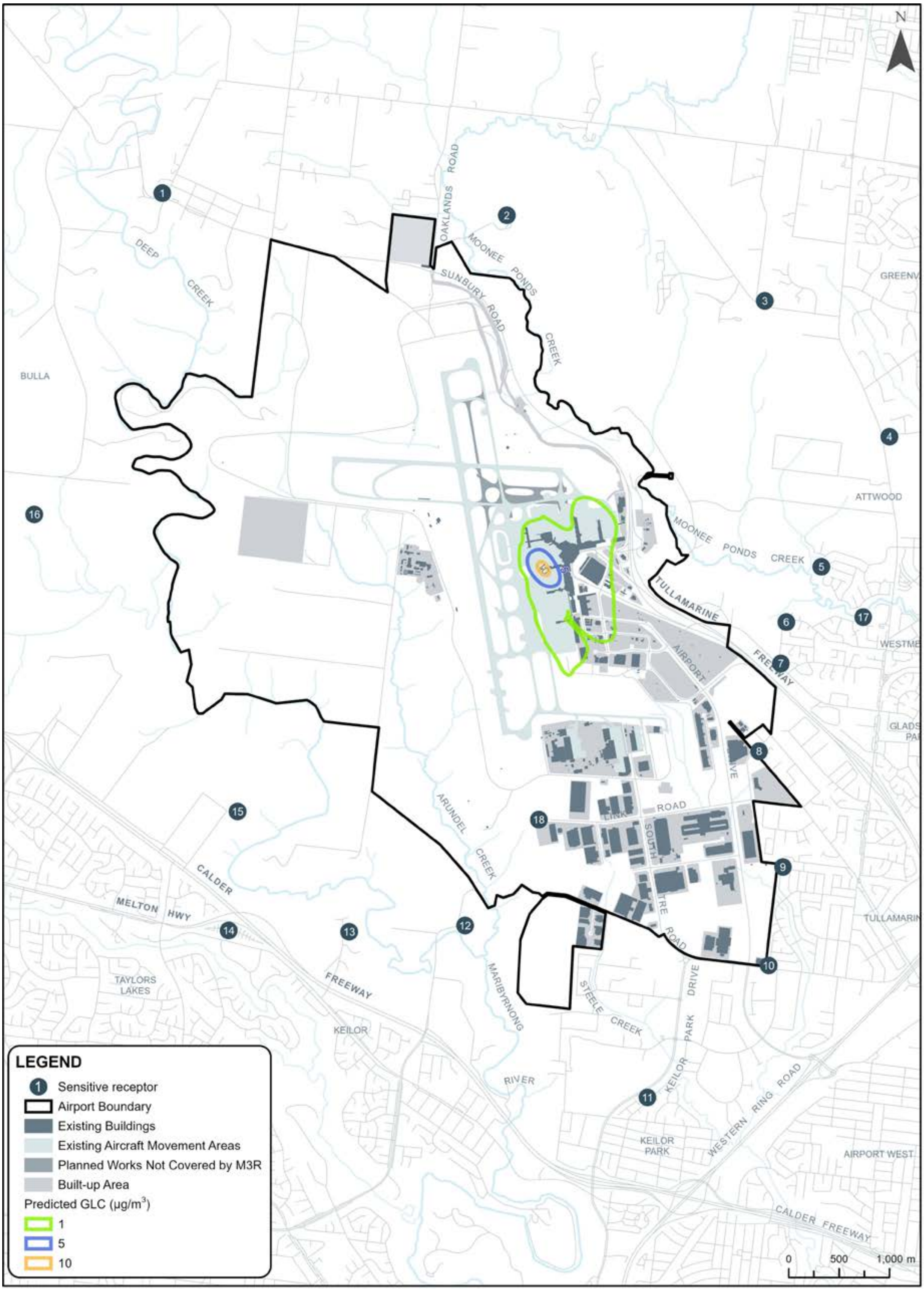
Note: The AAQ NEPM standard for NO_2 (28 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.29
M3R No Build 2046: AERMOD results for 24-hour average PM_{10} GLC (µg/m³)



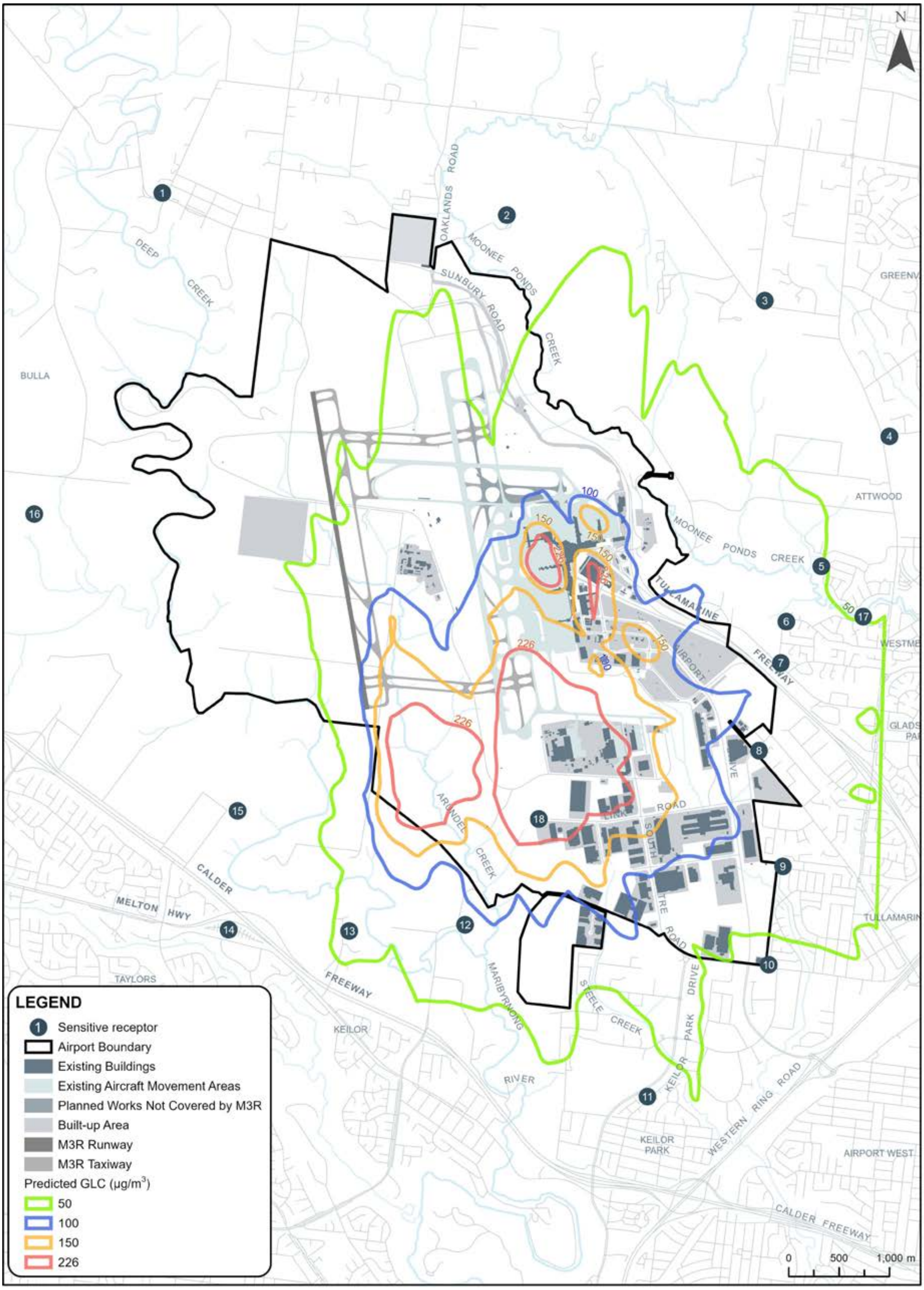
Note: The AAQ NEPM standard for PM_{10} (50 µg/m³) is represented by the purple contour.

Figure B10.30
M3R No Build 2046: AERMOD results for annual PM_{10} GLC (µg/m³)



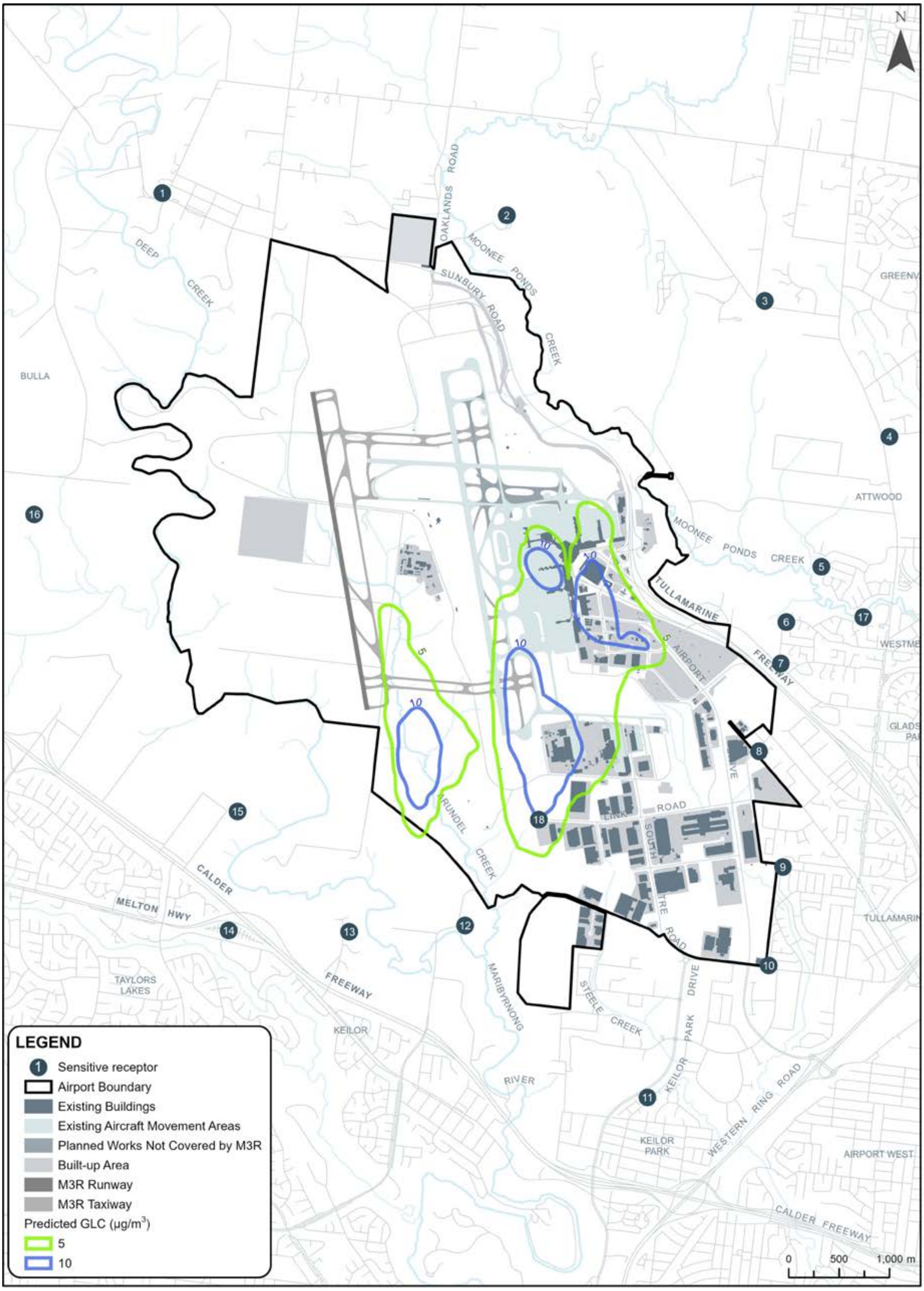
Note: *The EPAV 1961 criterion* for PM_{10} (20 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.31
M3R Build 2046: AERMOD results for 99.9 percentile hourly NO_2 GLC (ug/m³) (no background)



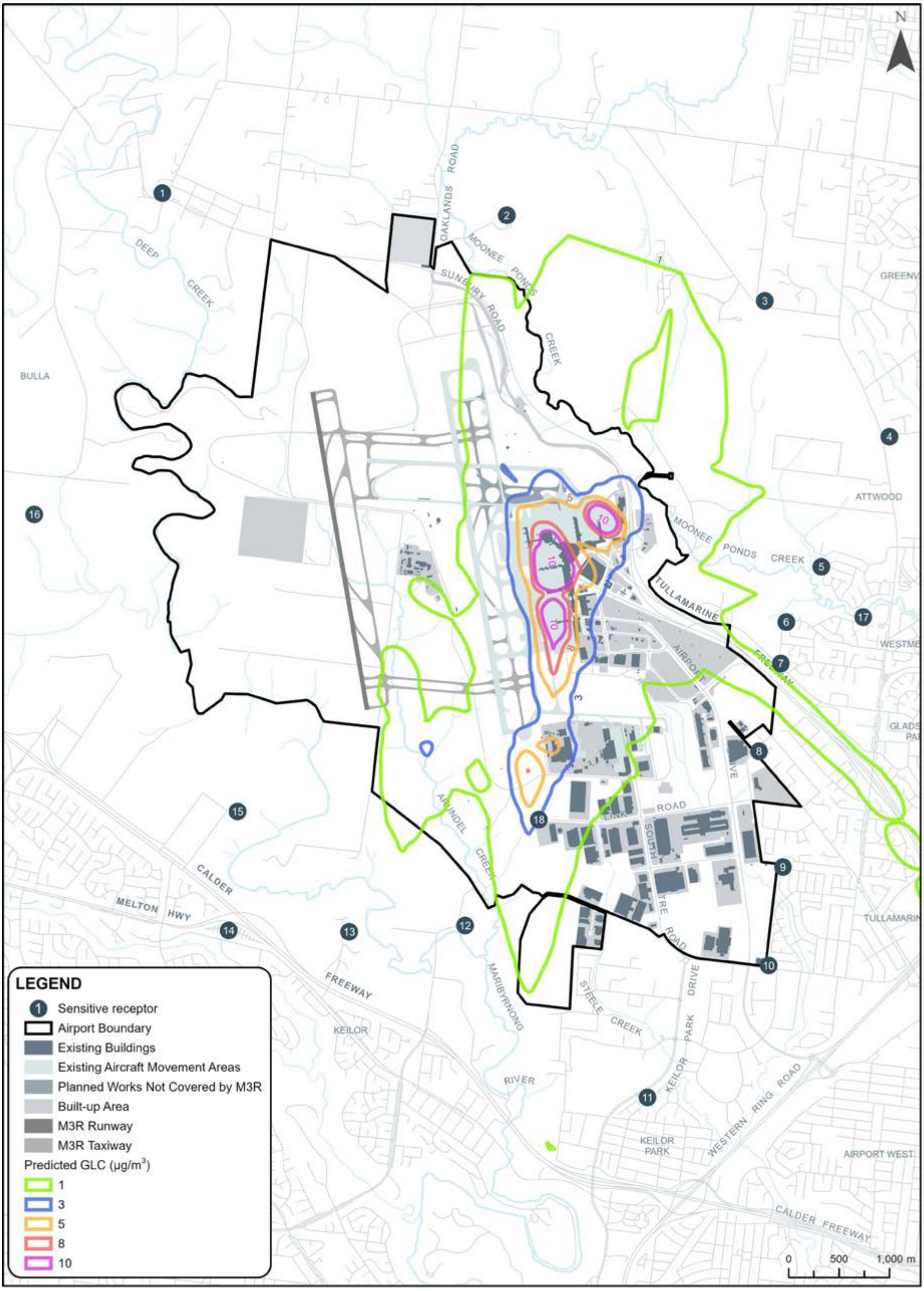
Note: The AAQ NEPM standard for NO_2 (150 µg/m³) is represented by the orange contour and the (former) SEPP (AAQ) criterion for NO_2 (226 µg/m³) is represented by the red contour.

Figure B10.32
M3R Build 2046: AERMOD results for annual NO_2 GLC (ug/m³) (no background)



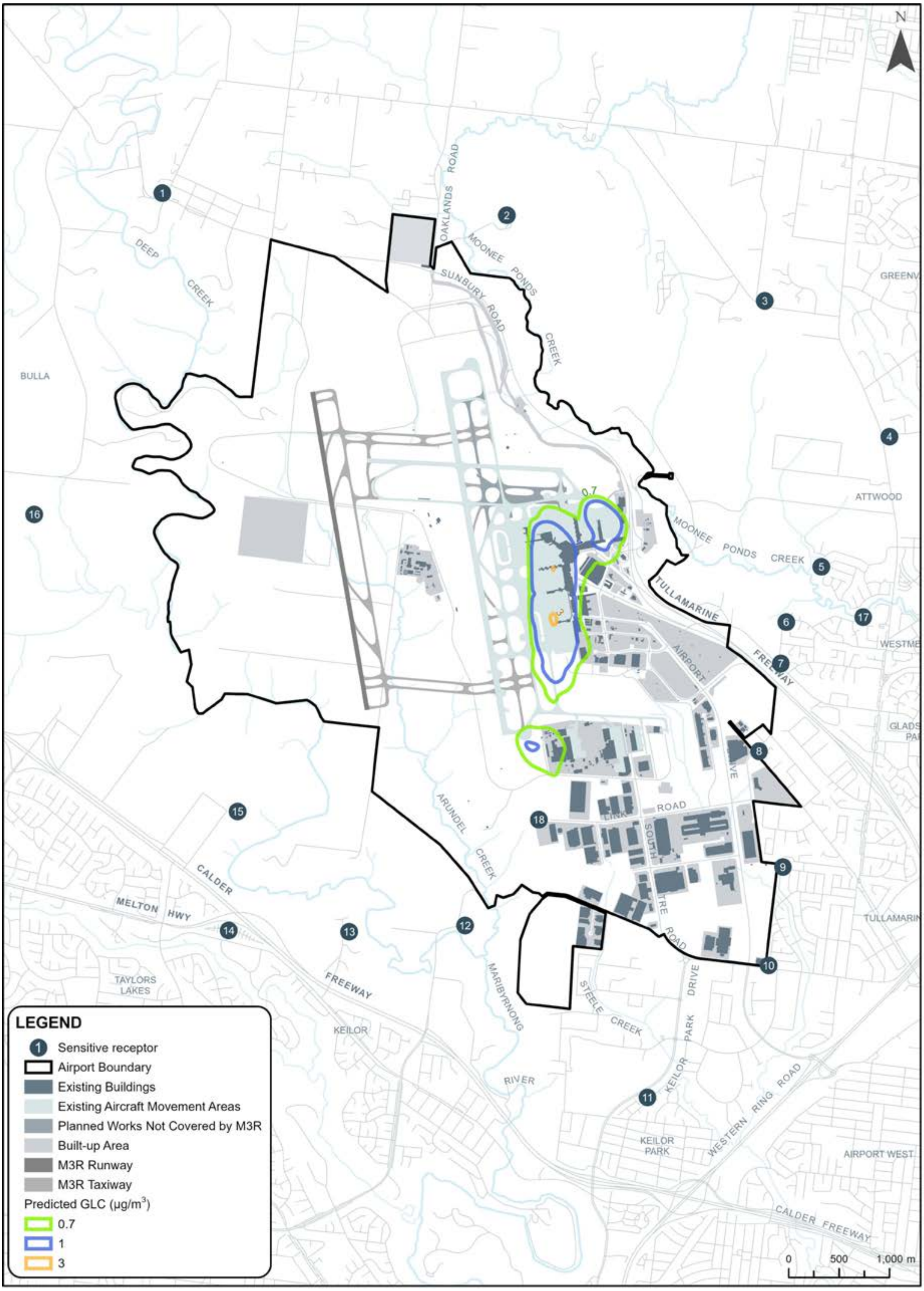
Note: The AAQ NEPM standard for NO_2 (28 µg/m³) is not shown, as modelled results are below this concentration.

Figure B10.33
M3R Build 2046: AERMOD results for maximum 24-hour PM_{10} GLC (µg/m³)



Note: The AAQ NEPM standard for PM_{10} (50 µg/m³) is not shown, and modelled results are below this concentration.

Figure B10.34
M3R Build 2046: AERMOD results for annual average PM_{10} GLC (µg/m³)



Note: EPAV 1961 criterion for PM_{10} yearly average (20 µg/m³) is not shown, as modelled results are below this concentration.

B10.7.5.1
Build 2046: NO_2

The AERMOD results for NO_2 are shown in **Figure B10.31** for the 1-hour average in 2046. The AAQ NEPM standard for NO_2 (150 µg/m³) was used for the assessment. The criterion from the SEPP (AAQ) criterion for NO_2 (226 µg/m³) and SEPP (AQM) criterion (190 µg/m³) are also provided for reference.

As evident from **Figure B10.31**, no exceedances of the AAQ NEPM standard are observed at sensitive receptors. GLCs are shown to be highest to the south of the airport, with concentrations above the standard extending around 200 metres outside of the airport boundary to the southwest, into vacant green wedge land. This coincides with the location where the new runway is closest to the existing site boundary and thus has limited separation distance.

Figure B10.32 shows AERMOD results for the NO_2 annual average. As with the 2019 modelling, there are no exceedances of the AAQ NEPM annual standard (28 µg/m³), and impacts are similar to those predicted in 2019.

B10.7.5.2
Build 2046: PM_{10}

The AERMOD results for PM_{10} are shown in **Figure B10.33** for the 24-hour average, with reference to the AAQ NEPM standard for PM_{10} (50 µg/m³).

As evident from **Figure B10.33**, no exceedances of the AAQ NEPM standard are observed outside of the airport boundary. GLCs above the criteria are observed around the gates, where no sensitive receptors are located.

Table B10.19
M3R summary of results at sensitive receptors for 1-hr NO_2 (µg/m³) (with background)

Discrete receptor	2019	2026			2046		
		No build	Build	% increase	No build	Build	% increase
AAQ NEPM standard (µg/m³)	**150**	**150**	**150**		**150**	**150**	
1. Bulla	67.9	68.9	67.9	-2%	67.9	71.6	6%
2. Living Legends	71.3	71.8	70.5	-2%	70.1	71.8	2%
3. Providence Rd	69.0	69.0	69.0	0%	69.0	71.6	4%
4. Montrose Ct	69.0	69.0	69.0	0%	69.0	71.6	4%
5. Threadneedle St	69.0	71.6	70.8	-1%	69.0	78.1	13%
6. Westmeadows North	76.4	78.3	76.4	-2%	76.4	84.4	10%
7. Westmeadows South	76.2	81.1	81.8	1%	76.2	104.8	37%
8. Melrose Drive	80.5	87.8	84.4	-4%	79.4	97.7	23%
9. Janus St	76.7	77.1	77.2	0%	76.7	86.2	12%
10. Fisher Grove	73.8	72.0	72.5	1%	71.9	80.2	12%
11. Fosters Rd	72.2	72.1	72.1	0%	72.0	74.0	3%
12. Arundel Rd	100.8	115.0	102.0	-11%	100.7	114.3	13%
13. Overnewton Rd	67.9	70.3	69.1	-2%	67.9	95.5	41%
14. Keilor Village	67.9	67.9	67.9	0%	67.9	68.9	2%
15. Highland Rd	67.9	68.9	70.4	2%	67.9	72.3	7%
16. Loemans Rd	66.3	66.3	66.3	0%	66.3	67.9	2%
Model validation							
17. MAE (modelled)	71.6	71.6	71.6	0%	71.6	76.4	7%
18. MAS (modelled)	395.1	460.7	395.1	-14%	395.2	395.3	0%
MAE – measured	65.1	-	-	-	-	-	-
MAS - measured	71.7	-	-	-	-	-	-

Figure B10.34 shows AERMOD results for the PM_{10} annual average. As with the 2019 modelling, there are no exceedances of the EPAV 1961 criterion (20 µg/m³), and impacts are similar to those predicted in 2019.

B10.7.6 Summary of modelling results

The following subsections provide a summary of the AERMOD predicted concentrations at the sensitive receptors identified in **section B10.4.2**, in comparison to the requirements of the AAQ NEPM, noting the original assessment was conducted against the SEPP (AQM), no longer in force.

B10.7.6.1 NO_2

The modelling results for NO_2 GLCs showed that predicted GLCs at all sensitive receptors were below the AAQ NEPM standard (150 µg/m³) for all scenarios. Results are summarised in **Table B10.19**.

Concentrations at sensitive receptors for the Build scenario in 2026 decrease by an average of one per cent compared to the No Build scenario. This is a result of the same number of air traffic movements; however these movements are spread out further in the Build scenario with the third runway. The Build scenario increases average NO_2 concentrations by an average of 12 per cent compared with the No Build scenario in 2046, predominantly due to the large increase in aircraft movements.

Table B10.20
M3R summary of results at sensitive receptors for annual NO_2 (µg/m³) (with background)

Discrete receptor	2019	2026			2046		
Applicable criteria		No build	Build	% increase	No build	Build	% increase
AAQ NEPM standard (µg/m³)	**28**	**28**	**28**		**28**	**28**	
1. Bulla	12.8	12.8	12.8	0%	12.8	12.9	1%
2. Living Legends	13.1	13.2	13.2	0%	13.2	13.4	2%
3. Providence Rd	13.0	13.0	13.0	0%	13.0	13.2	2%
4. Montrose Ct	13.1	13.1	13.1	0%	13.1	13.3	2%
5. Threadneedle St	13.4	13.5	13.5	0%	13.4	13.8	3%
6. Westmeadows North	13.7	13.8	13.8	0%	13.8	14.2	3%
7. Westmeadows South	14.1	14.2	14.2	0%	14.2	14.7	4%
8. Melrose Dve	14.0	14.2	14.2	0%	14.2	14.5	2%
9. Janus St	13.3	13.4	13.4	0%	13.3	13.6	2%
10. Fisher Gve	13.2	13.3	13.3	0%	13.5	13.4	-1%
11. Fosters Rd	13.4	13.4	13.4	0%	13.3	13.5	2%
12. Arundel Rd	13.4	13.6	13.6	1%	13.4	14.1	5%
13. Overnewton Rd	12.8	12.9	13.0	0%	12.8	13.5	5%
14. Keilor Village	12.8	12.8	12.8	0%	12.8	12.9	1%
15. Highland Rd	12.8	12.8	12.8	0%	12.8	12.9	1%
16. Loemans Rd	12.7	12.7	12.7		12.7	12.8	1%
Model validation							
17. MAE (modelled)	13.4	13.4	13.4	-6%	13.4	13.7	2%
18. MAS (modelled)	22.2	23.9	22.4	0%	22.2	23.0	4%
MAE – measured	6.9	-	-	-	-	-	-
MAS - measured	7.0	-	-	-	-	-	-

Table B10.21
M3R summary of results at sensitive receptors for PM_{10} 24-hour average (µg/m³) (2019 – no background)

Discrete receptor	2019	2026			2046		
Applicable criteria		No build	Build	% increase	No build	Build	% increase
AAQ NEPM criteria (µg/m³)	50	50	50		50	50	
1. Bulla	0.12	0.11	0.11	0%	0.12	0.12	0%
2. Living Legends	0.61	0.60	0.60	0%	0.62	0.63	2%
3. Providence Rd	0.47	0.47	0.47	0%	0.47	0.53	13%
4. Montrose Ct	0.54	0.53	0.53	0%	0.54	0.55	2%
5. Threadneedle St	0.59	0.55	0.55	0%	0.58	0.58	0%
6. Westmeadows North	0.75	0.69	0.69	0%	0.74	0.66	-11%
7. Westmeadows South	0.75	0.77	0.77	0%	0.81	0.79	-2%
8. Melrose Drive	0.62	0.63	0.63	0%	0.67	0.61	-9%
9. Janus St	0.37	0.35	0.35	0%	0.36	0.36	0%
10. Fisher Grove	0.40	0.41	0.41	0%	0.41	0.40	-2%
11. Fosters Rd	0.35	0.35	0.35	0%	0.35	0.35	0%
12. Arundel Rd	0.53	0.53	0.53	0%	0.53	0.54	2%
13. Overnewton Rd	0.20	0.19	0.19	0%	0.20	0.32	60%
14. Keilor Village	0.11	0.10	0.10	0%	0.11	0.15	36%
15. Highland Rd	0.11	0.10	0.10	0%	0.11	0.19	73%
16. Loemans Rd	0.11	0.11	0.11	0%	0.11	0.11	0%

Annual average concentrations of NO_2 were also assessed against the AAQ NEPM criterion of 15 ppb (28 µg/m³). Results are shown in **Table B10.20**. As evident from the table, no exceedances were recorded at any receptor.

B10.7.6.2 PM_{10}

The modelling results for PM_{10} GLCs showed that predicted GLCs at all sensitive receptors were below the AAQ NEPM standard (50 µg/m³) when background levels were not included. The Build scenario increases average PM_{10} concentrations by an average of 10 per cent compared with the No Build scenario in 2046. Results are shown in **Table B10.21**.

To assess cumulative impacts (airport sources plus background levels) at and around the airport, the 2019 variable background concentration on PM_{10} was added to the peak modelled 24-hour impacts. Results are shown in **Table B10.22**. Background concentrations increase significantly for receptors R11 and R14 in the Build 2046 scenario due to a higher background concentration when peak impacts from airport operations occurred. Likewise for receptor R10, the time of peak concentration occurred during a lower background concentration, resulting in a significant overall decrease in GLC. Overall, airport operations (with or without M3R) were found to increase GLCs above background concentrations by 2 to 4 per cent, and a maximum of 10 per cent.

Where background concentrations were not available, the 70th percentile average for 2019 (24.3 µg/m³) was applied as background. As evident from the table, the additional of background concentrations of PM_{10} do not result in an exceedance of the standard (50 µg/m³) for the maximum 24-hour averages at the airport. The expansion of activities at the airport is thus shown to have a relatively small impact (generally less than 5 per cent) on PM_{10} concentrations.

B10.7.6.3 $PM_{2.5}$

Predicted impacts of $PM_{2.5}$ emissions at the airport will closely follow predicted impacts for PM_{10}, since 100 per cent of PM_{10} is $PM_{2.5}$ from airport sources. While $PM_{2.5}$ has a more strict standard (25 µg/m³ compared to 50 µg/m³ for PM_{10}), model results demonstrate this standard is met for all scenarios in all modelled years outside of the airport boundary. The maximum impacts from $PM_{2.5}$ are observed in the 2046 'Build' scenario, when GLCs are observed to be around three to five µg/m³ at the airport boundary near the terminals.

Table B10.22
M3R summary of results at sensitive receptors for PM_{10} (µg/m³) (Build – with background)

Discrete receptor	2019	2026			2046		
		No build	Build	% increase	No build	Build	% increase
AAQ NEPM standard (µg/m³)	**50**	**50**	**50**		**50**	**50**	
1. Bulla	11.16	11.2	11.2	0%	11.2	11.2	0%
2. Living Legends	8.70	8.7	8.7	0%	8.7	8.7	0%
3. Providence Rd	12.94	12.9	12.9	0%	13.0	13.0	0%
4. Montrose Ct	13.01	13.0	13.0	0%	13.0	13.0	0%
5. Threadneedle St	30.41	30.4	30.4	0%	30.4	30.4	0%
6. Westmeadows North	n/a	25.0	25.0	0%	25.0	30.5	22%
7. Westmeadows South	30.57	30.6	30.6	0%	30.6	30.6	0%
8. Melrose Drive	7.22	7.2	7.2	0%	7.3	8.7	20%
9. Janus St	8.46	8.4	8.4	0%	8.50	8.5	0%
10. Fisher Grove	27.44	27.4	27.4	0%	27.44	9.8	-64%
11. Fosters Rd	6.95	6.9	6.9	0%	6.9	27.0	289%
12. Arundel Rd	n/a	24.8	24.8	0%	24.8	24.8	0%
13. Overnewton Rd	n/a	24.5	24.5	0%	24.5	24.6	0%
14. Keilor Village	6.70	18.3	18.3	0%	6.7	18.3	173%
15. Highland Rd	23.07	24.4	24.4	0%	24.4	24.5	0%
16. Loemans Rd	47.00	47.0	47.0	0%	47.0	47.0	0%

In addition, $PM_{2.5}$ background concentrations are much lower than PM_{10} concentrations, with no exceedances of AAQ NEPM standard observed in the background concentrations (refer to **section B10.5.2**). For this reason, the addition of emissions of $PM_{2.5}$ from the airport are predicted to be a minor impact.

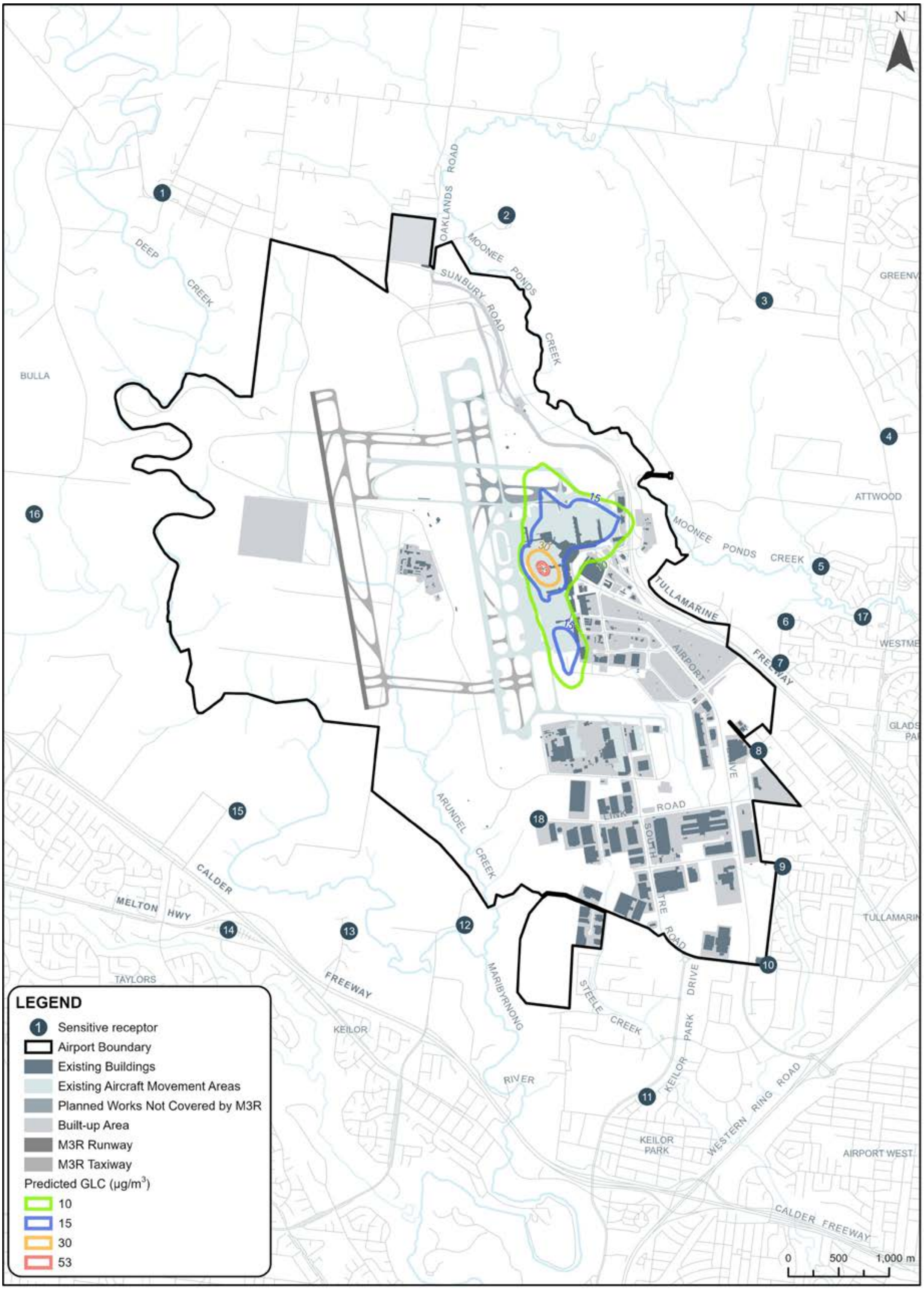
B10.7.6.4
Benzene

Results from the worst-case model run (2046 Build scenario) for benzene GLCs are shown in **Figure B10.35**. The model results for benzene showed that predicted GLCs were well below the SEPP (AQM) criteria (in force at the time of the original assessment) of 53 µg/m³ (3-minute average) at all locations except for a small area around gate 2. At the airport boundary, concentrations were around 10 µg/m³ and lower concentrations were observed at sensitive receptors.

The criterion for benzene was updated in 2022 in EPAV Guideline 1961 from a three-minute average of 53 µg/m³ in SEPP (AQM) to a one-hour average of 580 µg/m³. Emissions modelling results shown in **Figure 10.3.5** were updated using the formula provided in EPA Publication 1551 to scale GLC concentrations back to one hour from a three minute average (noting the same formula was originally used to convert from one hour results from AERMOD to 3 minute averaging times). Correcting for the original scaling, concentrations of benzene in **Figure B10.35** are in the range 5 to 10 µg/m³, thus showing GLCs are below the standard (with maximum GLCs less than 1 per cent of the criteria within the airport boundary).

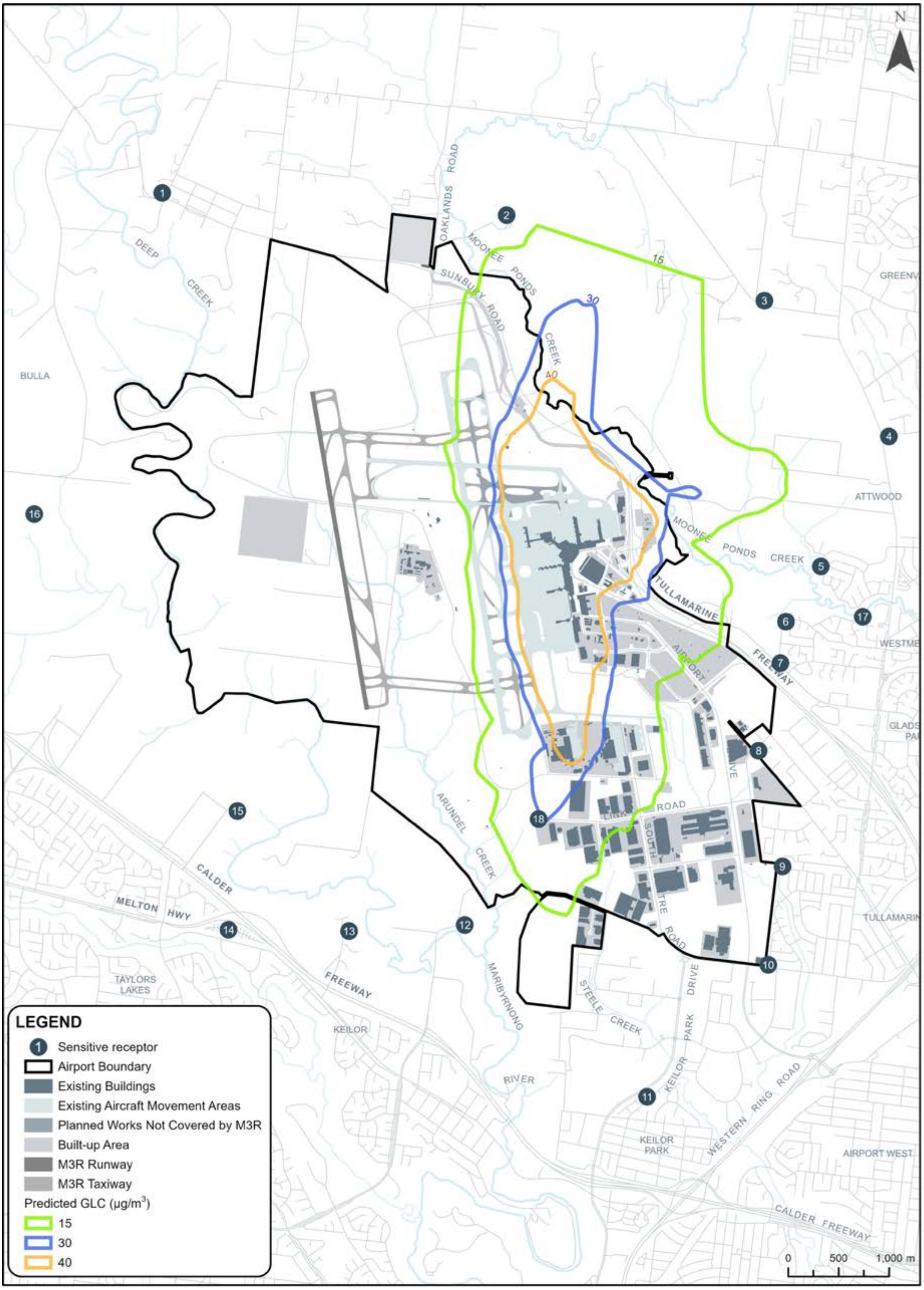
Hourly background concentrations of benzene were not available to use in the assessment, however previous campaign monitoring on benzene at Melbourne Airport estimated annual average concentrations of 0.2 to 1.2 µg/m³. As such, the addition of background levels of benzene to modelled concentrations would result in maximum concentrations around 20 per cent of the SEPP (AQM) criterion at the airport boundary (and even lower when compared to the criteria in EPAV Publication 1961). Actual maximum concentrations are likely to be much lower as background levels are likely to include airport sources (resulting in double-counting of emissions), in addition to the conservative model parameters used including all air traffic movements concentration to the south end of runway 16/34.

Figure B10.35
M3R Build 2046: AERMOD results for 99.9 percentile, 3 minute average benzene (ug/m³) – no background



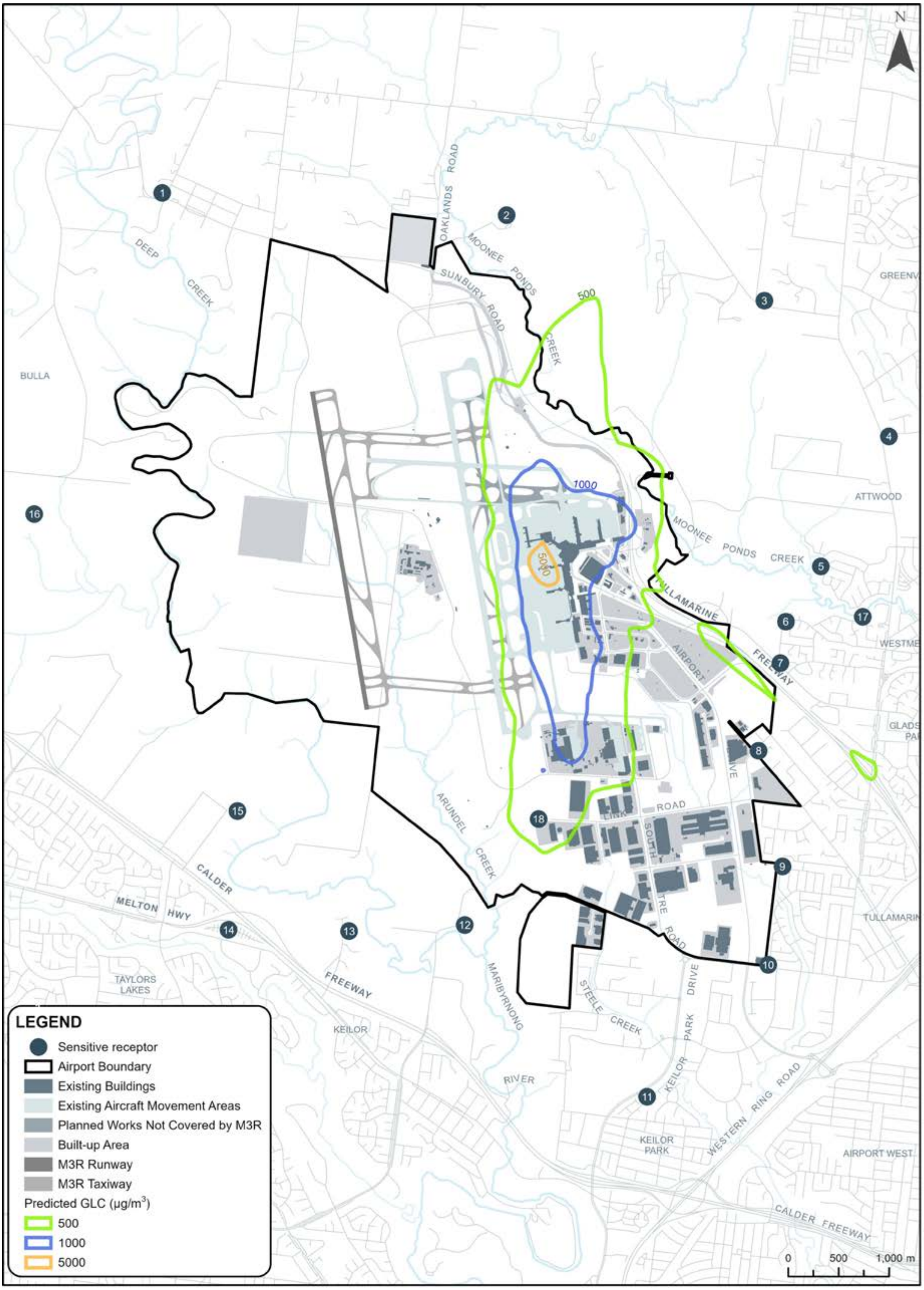
Note: The SEPP (AQM) criteria for benzene (53 μg/m³) is shown by the red contour, used in the original assessment. Emissions modelled (and contours shown) can be divided by 1.82 to translate to a one-hour average as per the updated EPAV 1961 criteria (580 μg/m³).

Figure B10.36
M3R Build 2046: AERMOD results for 99.9 percentile, 3-minute average formaldehyde (ug/m³) – no background



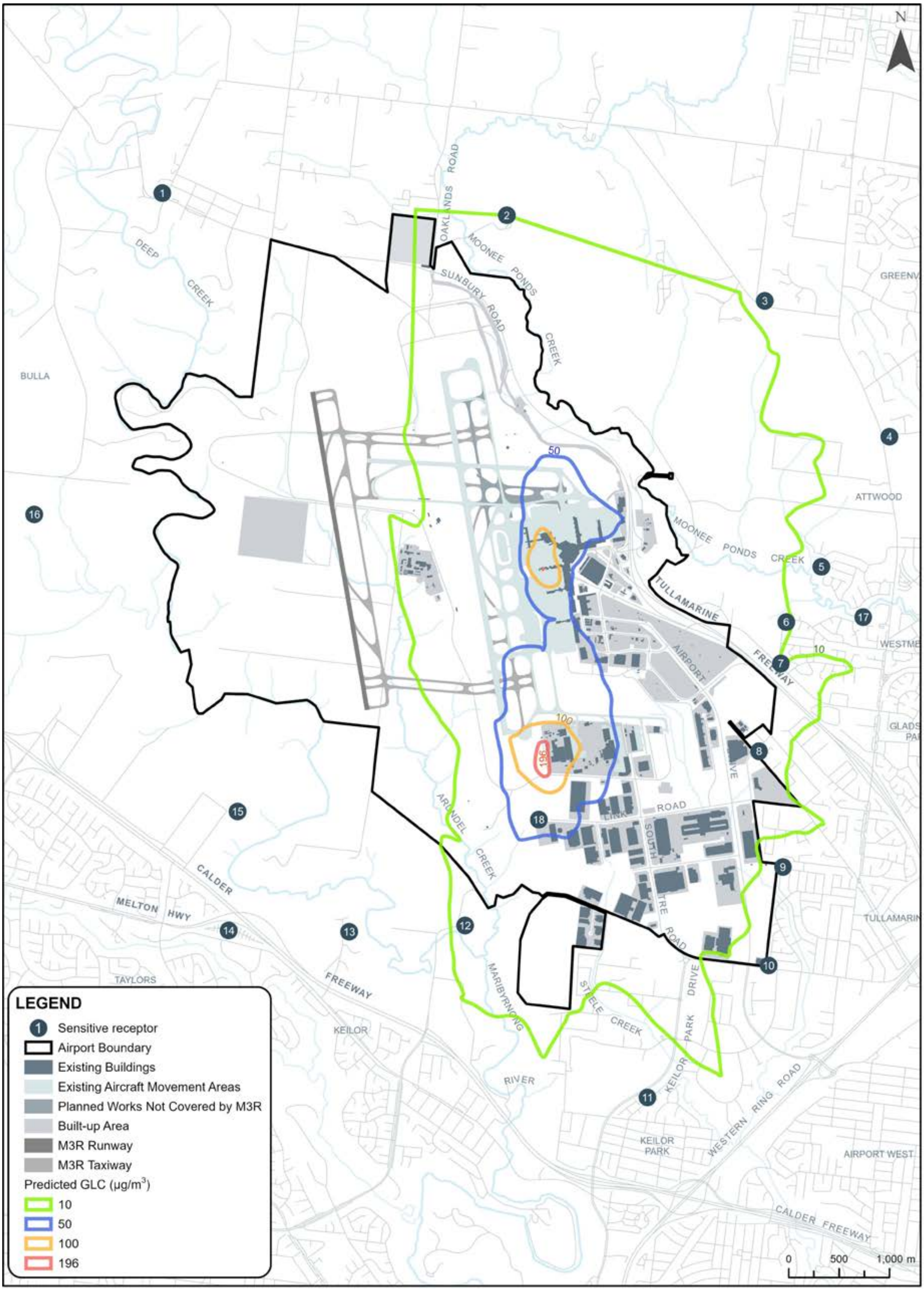
Note: The SEPP (AQM) criterion of 40 µg/m³ is shown as the orange contour used in the original assessment. Emissions modelled (and contours shown) can be divided by 1.58 to translate to a 30-minute average as per the updated EPAV 1961 criteria (100 µg/m³).

Figure B10.37
M3R Build 2046: AERMOD results for 99.9 percentile hourly CO (ug/m³) – no background



Note: The AAQ NEPM eight-hour standard (13,100 µg/m³) and SEPP (AQM) 1-hour objective for CO (29,000 µg/m³) (no longer in force) are not shown, as modelled results are well below these concentrations.

Figure B10.38
M3R Build 2046: AERMOD results for 99.9 percentile hourly SO_2 (ug/m³) – no background



Note: The AAQ NEPM objective for SO_2 (260 µg/m³) is not shown, as modelled results are well below this concentration.

In addition, the NEPM (Air Toxics) Monitoring Investigation Level for benzene (MIL) (9.6 µg/m³ annual average) was also evaluated (not shown in figures). Modelled results show annual concentrations of 0.3 µg/m³ around the airport gates and terminals area, due mostly to operation of the GSE and APUs. Hence the annual average for benzene was well below the MIL.

B10.7.6.5
Formaldehyde

The model results for formaldehyde showed that predicted GLCs at all sensitive receptors were below the SEPP (AQM) criteria of 40 µg/m³ (Figure B10.36) (in force at the time of the original assessment). Concentrations above the criterion are observed at and just beyond the eastern boundary of the airport, where there is insufficient distance between the gates and airport boundary. No sensitive receptors are located in this area.

The criteria for formaldehyde was updated in 2022 in EPAV Guideline 1961 from a three-minute average of 40 µg/m³ in SEPP (AQM) to a 30-minute average of 100 µg/m³. Emissions modelling results above can be updated using the formula provided in EPA Publication 1551 to scale GLC concentrations to 30 minutes from a three minute average (noting the same formula was originally used to convert from one hour results from AERMOD to 3 minute averaging times). Adjusting for the original scaling, concentrations of formaldehyde in Figure B10.36 are in the range 9 to 25 µg/m³, thus showing GLCs are below the standard (with maximum GLCs around 25% of the criteria, but within the airport boundary).

Hourly background concentrations of formaldehyde were not available to use in the assessment, however previous campaign monitoring on formaldehyde at Melbourne Airport estimated average 24-hour concentrations of eight to ten µg/m³ as discussed in section B10.5.2.7. As such, the addition of background levels of formaldehyde to modelled concentrations may increase GLCs at the southern boundary (10 µg/m³ 30-minute average), thereby increasing the distance beyond the boundary where GLCs are above the 30 minute and former 3-minute criterion.

In addition, the NEPM (Air Toxics) MIL for formaldehyde (49 µg/m³ 24-hour average) was also evaluated (not shown in figures). Modelled results show maximum 24-hour average concentrations of 10 µg/m³ around the airport gates and terminals area, due mostly to operation of the GSE and APUs. Hence the maximum 24-hour average for formaldehyde was well below the MIL, at around 20 per cent of the MIL.

B10.7.6.6
CO

Results from the worst-case model run for CO GLCs are shown in Figure B10.37. The modelling results for CO showed that predicted GLCs at all sensitive receptors were well below the SEPP (AQM) 1-hour objective (29,000 µg/m³) at around 500 µg/m³ (noting this criterion is no longer in force but is included for completeness as described above). Background concentrations of carbon monoxide are not shown, to show the signal of the airport sources.

As discussed in section B10.5.2, background concentrations of CO peaked at 7 per cent (720 µg/m³) of the AAQ NEPM eight-hour standard. The addition of background CO levels thus results in a maximum CO concentration of around 10 per cent of the AAQ NEPM and (former) SEPP (AAQ) objective.

GLCs are shown to be highest around the gates and along the taxiway to the south end of the 16/34 runway, with concentrations around 500 µg/m³. At the boundary, concentrations also reach a maximum of around 500 µg/m³.

B10.7.6.7
SO_2

Results from the worst-case model run for SO_2 GLCs are shown in Figure B10.38. The results for SO_2 show that predicted GLCs at all sensitive receptors peaked at around 50 µg/m³, well below the AAQ NEPM standard (260 µg/m³ one-hour average) and 2025 proposed standard (196 µg/m³).

As discussed in section B10.5.2, background concentrations of SO_2 averaged one per cent (3.1 µg/m³) of the AAQ NEPM standard. The addition of background SO_2 levels results in a maximum SO_2 concentration of 20 per cent of the AAQ NEPM standard.

B10.7.7
Ultrafine Particles (PM0.1)

Ultrafine particles (UFP) are a class of particulate matter smaller than 0.1 µm (PM0.1). EPA Victoria in Publication 1961 notes that "the smaller the size of the particles, the deeper they can penetrate into the lungs and the more damage they can do".

While UFP are produced by a range of natural and anthropogenic sources, those detected at elevated levels in the vicinity of airports are typically generated by high temperature processes including the combustion of fuel in internal combustion (e.g. passenger vehicles, buses and trucks) and jet engines. UFP derived from the combustion of petrochemicals are composed of hydrocarbon chains which may carry reactive oxidative species and trace metals associated with morbidity (ACI Europe, 2012).

UFPs are difficult and complex to monitor. There are no permanent large-scale monitoring networks in Australia and limited research on UFPs in Australia. Limited monitoring of UFP has been conducted in the UK and US for urban and traffic sources (Presto, Saha, & Robinson, 2021) (DEFRA, 2018). The lack of consistent monitoring combined with variations in operational and geographic characteristics between study locations means that there are significant knowledge gaps concerning the behaviour of UFP pollutants originating at airports and their potential impacts on public health and the environment.

Studies conducted by Stacey (2019) and Riley et al (2021) at international airports including Copenhagen, Schiphol, Zurich, Heathrow and Los Angeles International utilised temporary mobile equipment to quantify UFP concentrations over discrete study periods. These studies identified:

- Ground-level UFP concentrations close to airports are significantly higher than at upwind locations and distant baseline monitoring locations.
- Ground-level UFP concentrations tend to be highest at locations downwind of the airport. Analysis of air quality downwind of Los Angeles International Airport detected UFP concentrations over twice that of background concentrations up to 16 kilometres downwind, affecting an area up to 60 square kilometres.
- UFP emissions from aircraft have a smaller median size (< 20 nm) than those from road vehicles (30-50 nm). The unique particle size distribution from aircraft allows for the identification of aircraft derived UFP via polar plot analyses, even at a considerable distance from the source.

Scientific knowledge on the topic is evolving and is yet to be reflected in regulations. Nevertheless, the mitigation of UFP from airports will help mitigate health risks to airport staff, passengers, and the community.

B10.7.8
Airspace impacts

Whilst the focus of this chapter is on ground level impacts, there is also the potential for operation of aircraft to impact air quality within the airspace. This section considers these potential impacts.

B10.7.8.1
Normal aircraft operations above 3000 feet AGL

The high release height of aircraft emissions during flight, at heights greater than 3,000 feet above ground level (AGL) (ICAO, 2011) will increase the dispersion of air pollutants such as oxides of nitrogen, particulate matter and hydrocarbons, and therefore reduce the ground-level concentrations of those pollutants, due to:

- The substantial physical separation from sensitive receptors by at least approximately 915 metres
- Wind speeds at this height are higher than those at ground level, and higher wind speeds have greater mixing or dispersive properties
- Emissions of air pollutants are well spread out by fast moving jet aircraft, as opposed to aircraft emissions at and near ground level and other ground operations at the airport
- The hot jet exhaust emissions are buoyant, which increases their dispersion. At higher altitudes, the air temperature is colder than at ground level, which further increases a plume's buoyancy, in comparison with similar releases at ground level.

However, sometimes there could be mixing of air emissions from above 3,000 feet down towards ground level.

The daytime atmospheric 'boundary layer' or 'mixing layer' is characterised by turbulence and mixing of air and the height of this layer can be estimated by measurements of boundary layer cloud heights (Pickett et al. (1996)). Inspection of the BoM ceilometer measurements of lowest cloud base over Melbourne Airport for 2015 indicates the mixing layer varies between approximately 500 metres (approximately 1,640 feet) and more than 2,000 metres (more than 6,560 feet) in height AGL. Therefore, for cases where aircraft are flying low enough to be in the mixing layer (but still above 3,000 feet AGL), there is the potential for emissions to be brought to ground level due to large-scale circulations and mixing of air in the boundary layer. However, even in these cases, the aircraft emissions will be very well dispersed, horizontally and vertically, by the time they reach ground level.

Hence, the expectation is that aircraft emissions released above a height of 3,000 feet AGL would have a negligible impact on air quality at ground level and would likely contribute only a small amount of emissions to the total emissions in the Melbourne airshed (i.e. the total emissions released within the area below the boundary layer).

B10.7.8.2
Depletion of stratospheric ozone

A layer of ozone exists in the atmospheric layer above the troposphere (the lower stratosphere), at altitudes of approximately 15 to 30 kilometres. This altitude is above the highest cruise heights of subsonic jet airliners which are the aircraft that have the highest flight altitude and use Melbourne Airport. Ozone protects life on earth by absorbing ultraviolet radiation from the sun (Department of Environment and Energy, 2017).

This stratospheric ozone is decreased by the presence of ozone depleting substances, primarily chlorofluorocarbons (CFCs) ('the hole in the ozone layer'). CFCs were produced as refrigerants, aerosol propellants and foam-blowing agents. In the stratosphere, CFCs release reactive molecules that destroy ozone (CSIRO, 2016).

Emissions of CFCs and other ozone-depleting substances have now been controlled for many years, including in Victoria (VG, 2001a; VG, 2001b). However, the depletion of ozone in the stratosphere remains an environmental issue of concern (CSIRO, 2016).

An Intergovernmental Panel on Climate Change (IPCC) Special Report on Aviation and the Global Atmosphere (IPCC, 1999) represented an early, comprehensive assessment of the potential effects of aviation on stratospheric ozone depletion and global climate change. IPCC (1999) reported that aircraft NO_x emissions from subsonic aircraft flying in the upper troposphere and lower stratosphere, at altitudes ranging from approximately nine to 13 kilometres, react with atmospheric ozone. Ozone at these heights was expected to increase in response to the increases in aircraft NO_x.

In summary, IPCC (1999) concluded that the effect of subsonic (top of troposphere) aircraft emissions was to create a slight increase of approximately one per cent in stratospheric ozone, but the subject required further evaluation. The overall environmental assessment of ozone is complicated, as ozone is also a greenhouse gas.

At present, ICAO's main concerns about aircraft engine emissions are related to the potential for aircraft emissions to contribute to climate change (ICAO, 2017c).

From the findings of ICAO (1999) and the aviation industry's current focus (ICAO, 2017c), the issue of depletion of stratospheric ozone due to aircraft emissions is inconclusive. The issue is not as important as the potential for aircraft emissions to impact on air quality at ground level and to contribute to climate change.

The depletion of stratospheric ozone by aircraft emissions, if it occurs, is expected to have a negligible effect on air quality at ground level.

B10.7.8.3
Secondary air pollutant formation

Some air pollutants form by physical or chemical processes in the atmosphere such as NO_2 (nitrogen dioxide) and O_3 (ozone) forming due to photochemical processes. These are known as secondary air pollutants (Jacobsen 2002).

Secondary atmospheric PM sources include chemical reactions between SO_2, NO_x, and ammonia that form solid sulphate and nitrate aerosols, as well as the oxidation of non-methane volatile organic compounds, to form organic aerosols. These interactions may take minutes or days and the effects can be seen at great distances from the point of release.

There is non-water secondary particulate formation from jet engine exhausts, primarily from sulphur and hydrocarbons. This will increase the background PM or regional PM levels, although these quantities will be negligible with respect to other sources of PM at ground level.

B10.7.8.4
Condensation trails

Jet airliners flying at high cruise altitudes, typically between 30,000-40,000 feet, sometimes produce visible condensation trails (contrails).

Essentially contrails are clouds composed of ice particles that form when water vapour and other gases in the jet engine exhaust provide the condensation nuclei needed for ice crystals to form. Most of the water forming these ice crystals is provided by water vapour in the ambient atmosphere, not from engine exhaust components. In conditions of low humidity, the contrails do not form, or evaporate quickly.

Shorter-lived, shorter-length condensation trails are sometimes visible streaming behind parts of aircraft wings and engine propellers, often in the more humid conditions at lower levels. These contrails are comprised of atmospheric water only that has condensed into small water droplets in low pressure areas generated behind the aircraft (USEPA, 2000). These contrails are shorter-lived because the small water droplets evaporate quickly after returning to the ambient air with its higher air pressure.

While contrails have an effect on climate by altering the fluxes of sunlight and terrestrial infrared radiation, the effect on ambient air quality at ground level is insignificant (USEPA, 2000). The jet engine exhaust components of contrails, released at very high cruise altitudes, will be very well dispersed prior to reaching ground level. When these components eventually reach ground level their concentrations would be so small as to be undetectable.

B10.7.8.5
Fuel dumping

Fuel jettison or fuel dumping from aircraft in flight is undertaken only rarely, in emergencies, when an aircraft's weight must be reduced quickly to its maximum landing weight.

In Australia, fuel dumping from aircraft in flight will not occur unless permission is given by Air Traffic Control or according to a direction issued by the Civil Aviation Safety Authority (CASA), or in an emergency (where fuel may be released over areas where it does not create a hazard) (Commonwealth Government, 2004).

The Airservices Australia Aeronautical Information Package (18 August 2016) states that:

> *"When fuel dumping is required, the pilot in command should request authority from ATC before commencing a fuel dump, and must:*
>
> - *Notify ATC immediately after an emergency fuel dump*
> - *Take reasonable precautions to ensure the safety of persons or property in the air and on the ground*
> - *Where possible, conduct a controlled dump in clear air above 6,000 feet and in an area nominated by ATC."*

In the vicinity of Melbourne, initially the liquid fuel dumped by a fast-moving jet aircraft at the Airservices Australia (2016) minimum height of 6,000 feet AGL would shatter into small droplets on contact with the atmosphere. It is expected the resulting droplets would disperse and evaporate before reaching the ground. Upon reaching ground level, the concentrations of vapours and any remaining droplets would be very small and undetectable. As such normal fuel dumping operations at heights greater than 6,000 feet Above Ground Level (AGL) by aircraft using Melbourne Airport are expected to have a negligible air quality impact at ground level in the Melbourne airshed and beyond.

B10.7.8.6
Radiative Forcing

Radiative Forcing (RF) is a measure of the imbalance in the Earth's radiation budget caused by additional gases and aerosols in the atmosphere, or by changes in cloudiness (ICAO, 2013). RF is an important consideration for aviation Green House Gas (GHG) inventories, because in addition to the emissions of standard GHGs from aviation fuel combustion, other aviation activities and emissions in the upper atmosphere have the potential to increase radiative forcing, and therefore contribute to global warming. These include emissions of water vapour leading to formation of contrails, emissions of soot, emissions of hydrocarbons and modification of cloud formation and dispersal patterns.

Whilst these interactions and potential effects are relatively well understood, the ability to quantify the effect on a global scale or rationalise it to a single GHG emissions factor per flight is less understood. This is because there are much greater differences in residence time for each of the emissions studied, and the geographical location (and the prevailing climate) has a much greater effect on the potential to contribute to global warming.

B10.8
AVOIDANCE, MANAGEMENT AND MITIGATION MEASURES

This section sets out avoidance, management, and mitigation measures for non-GHG air pollutants such as NO_X, hydrocarbons (e.g., benzene and formaldehyde) and airborne particulate matter. The results of a residual significance assessment of severity (section B10.3) and likelihood were used to estimate impact risk levels using a risk matrix, the purpose being to output 'calibrated' risk results of this air quality assessment so that they can be used with the results from other parts of the Major Development Plan (MDP).

B10.8.1
Construction

Emissions of PM_{10} and $PM_{2.5}$ will be managed with the implementation of a dust management plan, within a CEMP. The CEMP will include the dust controls applied in the modelling such as the use of water carts and sprays on stockpiles. Further details about the dust controls will be set out in the CEMP.

The modelling demonstrates that further dust mitigation measures are appropriate to be set out in the CEMP (i.e. in addition to the dust suppression applied in the modelling). Such measures may include real-time, continuous dust monitoring data and video data feeding back to dust controls and management systems. Other mitigation options that will be considered in the CEMP include the use of the southern access road as an alternate to the northern access road during southerly wind conditions (for the protection of sensitive receptors north of the site) and restricting the use of obvious sources of visible dust in poor meteorological conditions.

More specific guidelines for dust mitigation measures during the M3R construction phase are described in Chapter E2: Environmental Management Framework.

B10.8.2
Operation

B10.8.2.1
Avoidance

In light of the above and particularly having regard to Melbourne Airport's operations and growth, it is not possible to avoid impacts on air quality (e.g. by relocation of infrastructure associated with M3R).

B10.8.2.2
Engineering design options

M3R engineering design options have not wholly mitigated the air quality impacts associated with M3R. Primarily, the predicted air quality impacts are due to the forecast, high, air and road traffic numbers, which cannot be 'designed out' of M3R (rather, these numbers flow from Melbourne Airport's – and Melbourne's – inherent continued growth and are proposed to be mitigated and managed in the manner set out in this chapter). However, the air dispersion modelling for the M3R was based on current ('COPERT') emissions factors for road vehicles. In future, road vehicle emissions technology will continue to improve, and growth in the use of hybrid and electric vehicles is anticipated. An airport rail link may serve to reduce some congestion on the roads. More details about road traffic mitigation measures are explained in Chapter B8: Surface Transport.

B10.8.2.3
Mitigation measures

The AERMOD results for air pollutant GLCs for M3R make it clear that mitigation measures are important for Melbourne Airport now and will be increasingly important in the future. Furthermore, General Environmental Duty (GED) requires that any actors engaging in an activity that gives rise to risks of harm to human health or the environment must minimise risks as far as reasonably practicable. For the immediate term, monitoring and other mitigation measures are implemented via the Environment Strategy within the Master Plan and the existing Air Quality Management Plan.

Melbourne Airport's air quality strategy includes the implementation of an Air Quality Management Plan including a review of existing modelling, data and on and off-monitoring, and recommendations for improvement.

The following paragraphs discuss aspects of Melbourne Airport's objective to apply best practice emissions management.

Some of the key pollutants with high levels of predicted concentrations are mainly emitted by aircraft at ground-level and road traffic. The hydrocarbon emissions, e.g., benzene and formaldehyde, tend to be highest when aircraft are in the terminal areas. These emissions can be mitigated to some extent through the improved efficiency of ground operations primarily by reducing aircraft taxi delays – directly associated with increased capacity of the M3R.

Broadly, the mitigation measures for (non-GHG) air emissions that can be applied to aircraft operations at ground level and their GSE, and for aircraft operating at heights less than 3,000 feet, are:

- Advances in aircraft engine technology and air emissions standards and controls (ICAO, 2017b)
- Aircraft and support equipment operational measures (ICAO, 2017d).

Mitigation measures under consideration by Melbourne Airport are:

- Continue to install fixed electrical ground power and pre- conditioned air with appropriate agreement from airlines for reducing the use of their aircraft APUs on stands/ terminals
- Discourage certain high emitting types of aircraft via a landing emission charge with appropriate agreement from airlines, (i.e. engine-related charging) Civil Aviation Authority (2013), ICAO (2017b)
- Encourage single or reduced engine taxiing
- Encourage the use of alternative aircraft taxiing operations (e.g., main engine starts nearer the runway rather than at the terminal or stand)
- Consider the installation of particle filters to backup generators and other machinery producing combustion exhaust
- Encourage ground handlers to use electric vehicles/ equipment where feasible (electric charging infrastructure is required). Vehicles that do not conform to best practice emissions (e.g. Euro 6 vehicle standards) will be phased out, together with ensuring that only low emissions equipment are introduced to the airport
- Provide park-and-ride services to reduce the need for road traffic access – where parking is situated in an area that is not considered at risk in terms of air quality and potentially limited to low emission vehicles.
- Prioritise and support the uptake of public transport to the airport to reduce ground traffic, including through airport rail, the ongoing operation of Skybus, and other public transport options.

Melbourne Airport can support such measures with additional infrastructure (e.g. electrical connections) and efficient scheduling of runway use, however several of these actions are dependent on terminal (aircraft) operators. As such, Melbourne Airport will continue to engage with these operators and support the use of low-emissions GSE, APUs, and aircraft. Implementation of these measures will be tracked based on continued application of the AQMP as well as annual reporting of fuel use and fuel intensity for aircraft movements.

The mitigation of UFP pollution associated with operations at Melbourne Airport will be considered on a source specific basis. UFP emissions from aircraft engines consist of a combination of soot and volatile compounds containing organic carbon and sulfur. They can be reduced through a reduction in sulfur content of petroleum-based fuels, substitution with biofuels (which are typically free of aromatic compounds and sulfur), and long-term adoption of alternative aviation fuels.

B10.8.2.4
Monitoring, research and reporting

Monitoring, further research and reporting is needed to understand and quantify risks for air quality impacts that cannot be mitigated to a significant degree by lowering emissions. EPA Victoria (in Publication 1961) notes that measuring and monitoring air pollutants can be used to make informed decisions to best manage air emissions and improve the environment and is required under the GED to ensure ongoing compliance. To this end, the airport's air quality monitoring program has already delivered highly valuable data to the airport and M3R for criteria air pollutants and air toxics over its relatively short lifetime and will continue to do so.

Melbourne Airport will review its AQMP in accordance with commitments in the Master Plan 2022, and in response to any relevant regulatory changes.

Current efforts by the U.S. National Aeronautics and Space Administration (NASA) could lead to airlines cutting fuel use in half, pollution by 75 per cent, and noise to nearly one-eighth of today's levels (NASA, 2016a; NASA, 2016b). Technology demonstrations completed by NASA researchers included embedded nozzles to reduce aircraft weight and drag, and new composite materials methods to reduce weight (NASA, 2016a). There are various programs to improve the efficiency and emissions from jet engines, e.g., NASA (2017).

B10.8.2.5
Summary of environmental management

This section provides a summary of the airport's current environmental management, drawing on the Environment Strategy – Air Quality chapter that forms part of the 2018 Master Plan. Many aspects have already been discussed in some depth in this chapter.

Building on the airport's earlier environmental strategies and air quality studies, the Melbourne Airport Master Plan 2013 committed to a five-year review of ambient air quality, to provide information on long-term air quality trends in the vicinity of Melbourne Airport and also to support the airport's third runway. The air quality monitoring station, MAS, was located on the airport and began operating in December 2013. MAS continuously monitors a suite of key air pollutants such as nitrogen dioxide and particulate matter, and meteorological parameters such as temperature, wind speed and wind direction. The MAS monitoring data represent highly valuable information about current air quality as experienced at locations within a radius of approximately 1.5 kilometres from the airport's busy terminals areas.

A second air quality monitoring station, MAE, located outside the airport's boundaries, commenced operating in 2017. Also, a regular program of monitoring for hydrocarbons including benzene and formaldehyde commenced at two locations, Living Legends and Keilor Village, outside Melbourne Airport's boundaries, in December 2014, using diffusive samplers.

In 2016 to 2017, a new air quality impact assessment was undertaken to investigate the effects of ground-based activities on the surrounding environment and compliance with relevant legislation, primarily to support the previous third runway project's assessment (i.e. RDP - the assessment from which this chapter has been updated). The M3R modelling results have become an important input to the Environment Strategy – Air Quality which formed part of the 2018 Master Plan.

In addition to monitoring and assessment, the control of emissions on smaller scales will be important. Air quality management procedures are included in the CEMP, Operational Environmental Management Plans and Permit to Commence Work conditions, to minimise emissions of dust, odour and other air pollutants.

For continuous improvement and alignment with its 2018 Master Plan, Melbourne Airport will continue to review opportunities to replace diesel GSE with electric equipment and to improve the reliability and reported results of its AQMP.

The airport's environmental management relating to air quality was developed further in 2019 through an update to the Air Quality Monitoring Program, in support of the Environment Strategy published in the 2018 Master Plan. The 2022 Airport Environment Strategy has been drafted as part of the 2022 Master Planning process.

B10.9 CONCLUSION

The objectives of this assessment were to:

- identify potential environmental impacts due to air emissions associated with the M3R construction and future Melbourne Airport operations including an operational M3R
- quantify and investigate the predicted air quality impacts, and
- support the development of mitigation measures to eliminate or minimise risk from air pollution as much as reasonably practical as per EPA Victoria guidelines.

AEDT and AERMOD were used to model predicted concentrations of air pollutants associated with existing and future airport operations for Build and No Build scenarios. The assessment then focussed on understanding the implications of each scenario on air pollution based on Federal and Victorian standards, as well as differences between these scenarios.

Extensive and detailed air emissions inventories were developed for the current and potential future airport operating scenarios to cover the widest range of air quality effects predicted to be associated with the airport. The scenarios assessed are listed in the following points:

- Current airport (2019) representing the current operational situation
- M3R opening year (2026) representing M3R opening (Build and No Build)
- M3R 20 years (2046) representing 20 years after M3R opening 'ultimate capacity' (Build and No Build).

The cumulative impact assessment included estimates for background air pollutant levels for the individual pollutants studied. This was a conservative measure in the assessment, since background levels of air pollutants are likely impacted by airport operations resulting in some unavoidable double counting (i.e. airport sources are added on top of background levels).

Emissions sources included all aircraft movements on the airport (including all parts of the aircraft LTO cycle), vehicles on all main roadways on and surrounding the airport, all AEDT default selections for GSE on the airport associated with each aircraft type, and all AEDT default selections for APUs for each aircraft type.

The AERMOD results for the current and future Melbourne Airport operations indicated that the highest risk air quality indicators were NO_2 (99.9 percentile hourly average) due to high emissions from airport sources, and PM_{10} due to high background concentrations around the airport. Other pollutants including $PM_{2.5}$, benzene, and formaldehyde were also considered.

Primary contributors to air emissions from operations were the large amounts of aircraft and road vehicle movements, with forecast traffic increases from M3R representative opening year scenario (2026) to the 20-year scenario (2046). While mitigation measures and emissions controls are limited in their application to aircraft and road traffic movements, the airport considers them to be important and will continue to put these in place and minimise air quality impacts as far as practicable.

Significant conservative measures used in the assessment were:

- The use of the 34 runway for all aircraft movements (landing and take-off) thereby concentrating movements around the southern runway end
- The use of current aircraft for all future years thereby discounting future reductions in aircraft efficiency
- No improvements to road vehicle emissions factors for the future scenarios or any assumed reductions in future background concentrations.

These measures were validated as conservative based on the comparison to monitored concentrations of NO_2 at the MAS monitoring station, which had significantly lower concentrations than those predicted in the model in 2019.

Comparisons of model results for the No Build and Build scenarios indicated that Build leads to slightly worse air quality impacts overall – which is expected given the substantial increases in air and road traffic allowed by Build. In all scenarios however, modelled GLCs were below the AAQ NEPM standard, except where background levels were already high (in the case of PM_{10}).

The assessed risk levels for the operational case Build 2046 for all pollutants all ranged between negligible and medium.

A summary of the air quality impact assessment for M3R construction (existing air quality as baseline) and the worst- case operational scenario Build 2046 (No Build 2046 as baseline) is provided in **B10.7.5**.

The initial risk level for the M3R construction was assessed as high, but consideration of additional mitigation measures decreased this risk level to medium (**section B10.6**). The potential for air quality impacts due to dust emissions from construction activities is anticipated to be mitigated to satisfactory levels through the application of dust suppression techniques implemented through the CEMP. This means the project standards for deposited dust (TSP / nuisance dust), PM_{10} and $PM_{2.5}$ are expected to be met outside the airport boundaries. Melbourne Airport will continue to adopt dust management practices in line with EPA Victoria guidance summarised in Publication 1943 Guidance for assessing nuisance dust (2022) and related documents.

REFERENCES

Airservices Australia. (2018). Fuel Dumping in Flight ENR 1.1. Aeronautical Information Publication (AIP) 2018.

APAM. (2019). Air Quality Monitoring Program. Melbourne: APAM.

Australian Bureau of Statistics (ABS). (2015). Survey of Motor Vehicle Use, Australia, 12 months ended 31 October 2014 . Australian Govt. Pub. Services. Retrieved from http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0

Australian Government . (2012). NPI Emission Estimation Technique Manual for Mining Version 3.1.

Australian Government Department of the Environment and Energy. (2018). Air pollutants. Retrieved from http://www.environment.gov.au/protection/air-quality/air-pollutants#criteria

Civil Aviation Authority (UK) Environmental Research and Consultancy Department. (2013). Environmental charging Review of impact of noise and NO_x landing charges. Retrieved from https://publicapps.caa.co.uk/docs/33/ CAP%201119%20Noise-related%20charging%20review.pdf

Cocheo, C. B. (2009). Field evaluation of thermal and chemical desorption BTEX radial diffusive sampler radiello compared with active (pumped) samplers for ambient air measurements. Journal of Environmental Monitoring, Vol. 11, 297–306.

DEC (WA). (2011). A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities. Perth: Department of Environment and Conservation (DEC).

Department of Agriculture, Water and the Environment. (2020, August 28). Air pollutants. Retrieved from https://www.environment.gov.au/protection/air-quality/air-pollutants#:~:text=Criteria%20pollutants,-'Criteria%20air%20pollutants&text=Australia%20has%20set%20national%20standards,Carbon%20monoxide

EPA Victoria. (2013). Guidance notes for using the regulatory air pollution model AERMOD in Victoria. Melbourne: State Government of Victoria.

EPA Victoria. (2014). Construction of input meteorological data files for EPA Victoria's regulatory air pollution model (AERMOD). Melbourne: State Government of Victoria.

EPA Victoria. (2014). EPA 2014b, Guidance notes for using the regulatory AERMOD air pollution model, Publication 1551, Revision 2,.

EPA Victoria. (2016). EPA 2016a, Air monitoring report 2015 – Compliance with the National Environment Protection (Ambient Air Quality) Measure, Publication 1632.1 .

European Aviation Safety Agency. (2017). ICAO Aircraft Engine Emissions Databank. Retrieved from https://www.easa.europa.eu/document-library/icao-aircraft- engine-emissions-databank

FAA. (2000). Consideration of Air Quality Impacts by Airplane Operations at or above 3000 feet AGL. FAA-AEE-00-01 DTS-34.

Garcia-Naranjo, A. a. (2005). Primary NO_2 from Aircraft Engines Operating over the LTO Cycle. Report RC110187/05/01 . Sheffield, UK.: Department of Mechanical Engineering, University of Sheffield.

Garcia-Naranjo, A., & Wilson, C. (2005). Primary NO_2 from Aircraft Engines Operating over the LTO Cycle. Sheffield, UK: University of Sheffield.

International Civil Aviation Organization. (2011). International Civil Aviation Organization.

International Civil Aviation Organization (ICAO). (2017). Airport Air Quality Manual, First Edition. Retrieved from https://www.icao.int/environmental-protection/Documents/Publications/FINAL.Doc%209889.1st%20Edition.alltext.en.pdf

International Civil Aviation Organization (ICAO) . (2017). Environmental Protection, Aircraft Engine Emissions. Retrieved from http://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx

International Civil Aviation Organization (ICAO). (accessed 28 January 2017). International Civil Aviation Organization (ICAO) 2017a, Environmental Protection, Local Air Quality. Retrieved from http://www.icao.int/environmental- protection/Pages/local-air-quality.aspx

International Civil Aviation Organization (ICAO) . (2017c). Environmental Protection, Aircraft Engine Emissions. Retrieved from http://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx

International Civil Aviation Organization (ICAO). (2017d). Environmental Protection, Operational Measures. Retrieved from http://www.icao.int/environmental- protection/Pages/operational-measures.aspx

International Civil Aviation Organization (ICAO). (n.d.). Environmental Protection, Technology Standards. Retrieved from 2017: http://www.icao.int/environmental- protection/Pages/technology-standards.aspx

Jacobs. (2018). Review of Air Quality Monitoring Program. Melbourne: APAM.

NASA. (2016). Industry Weighs in on Green Aviation Tech. Retrieved from https://www.nasa.gov/aero/industry-weighs-in-on-green-aviation-tech

NASA. (2016). NASA Research Could Save Commercial Airlines Billions in New Era of Aviation. Retrieved from https://www.nasa.gov/press-release/nasa-research-could-save-commercial-airlines-billions-in-new- era-of-aviation

NASA. (2017). NASA Selects Industry Team to Advance Green Aviation Engine Technology. Retrieved from http://www.prnewswire.com/news-releases/nasa-selects-industry-team-to-advance-green-aviation-engine-technology-300397734.html

National Environment Protection Council (NEPC). (2003). National Environment Protection (Ambient Air Quality) Measure.

National Environment Protection Council (NEPC). (2011). National Environment Protection (Air Toxics) Measure. Federal Register of Legislative Instruments F2011C00855.

National Environment Protection Council (NEPC). (2016). National Environment Protection (Ambient Air Quality) Measure. Federal Register of Legislative Instruments F2016C00215.

NEPC. (2003). National Environment Protection (Ambient Air Quality) Measure.

NEPC. (2011). National Environment Protection (Air Toxics) Measure. Canberra: Commonwealth of Australia.

NEPC. (2016). National Environment Protection (Ambient Air Quality) Measure.

NEPC. (2019). Draft Variation to the Naitonal Environment Protection (Ambient Air Quality) Measure for sulfur dioxide, nitrogen dioxide and ozone. Canberra: Commonwealth of Australia.

Pace, T. G. (2005). Examination of the Multiplier Used to Estimate $PM_{2.5}$ Fugitive Dust Emissions from PM_{10}. United States of America Environmental Protection Agency.

PIARC. (2012). Road tunnels: Vehicle emissions and air demand for ventilation. France: World Road Association.

Radiello. (2006). Manual Full Version 01-2006. Retrieved from http://www.radiello. com/english/download_en.html

Smit, R. (2014). Australian Motor Vehicle Emission Inventory for the National Pollutant Inventory (NPI). Department of the Environment.

Smit, R. (2014). Australian Motor Vehicle Emission Inventory for the National Pollutant Inventory (NPI). Department of the Environment.

Smit, R. (2014). Australian Motor Vehicle Emissions Inventory for the NPI. Queensland: UniQuest Pty Ltd.

Smit, R. K. (2015). A Brisbane tunnel study to assess the accuracy of Australian motor vehicle emission models and examine the main factors affecting predict.

Smit, R., Kingston, P., Tooker, R., Neale, D., Torr, S., Harper, R., . . . Wainwright, D. (2015). A Brisbane tunnel study to assess the accuracy of Australian motor vehicle emission models and examine the main factors affecting prediction error. Air Quality and Climate Change Volume 49, Issue 3.

State Pollution Control Commission. (1986). Particle Size Distributions in Dust from Open Cut Coal Mines in the Hunter Valley. State Pollution Control Commission (NSW).

United States of America Environmental Protection Agency. (1995). AP-42 Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources.

United States of America Environmental Protection Agency. (2002). Speciate Version 3.2, Technology Transfer Network, Clearinghouse for Inventories & Emissions Factors.

VicRoads . (2013). Carbon Gauge GHG calculator for Road Projects Version. Retrieved from https://www.mainroads.wa.gov.au/ Documents/Carbon%20Gauge%20Workbook%202013.RCN-D13%5E23352222.PDF

Victorian Government . (2016). Variation to the State Environment Protection Policy (Ambient Air Quality). Retrieved from http://www.epa.vic.gov.au/about-us/legislation/~/media/Files/About%20us/Legislation/Air/GG2016G030-AAQ-SEP

Victorian Government. (1999). State Environment Protection Policy (Ambient Air Quality). Retrieved from http://www.gazette.vic.gov.au/gazette/Gazettes1999/GG1999S019.pdf

Victorian Government. (2001). State Environment Protection Policy (Air Quality Management). Retrieved from http://www.gazette.vic.gov.au/ gazette/Gazettes2001/GG2001S240.pdf

Table B10.23
Impact assessment summary

Aspect of the environment	Baseline condition	Description and characterisation of impact					
		Impact	Mitigation inherent in design/ practice	Temporal	Significance assessment		
					Severity	Likelihood	Impact risk
Air quality – construction							
Construction, 24h PM_{10}	Current ambient air quality; $PM_{2.5}$ and PM_{10} GLCs	Air quality impacts at discrete sensitive receptors north of airport boundaries.	Construction dust mitigation measures (as modelled).	Short-term (M3R construction project lifetime).	High	Likely	High
Construction, annual average PM_{10}		Some increased air quality impacts due to construction, but no exceedances expected outside site boundaries.			Minor	Likely	Medium
Construction, 24h $PM_{2.5}$		Some increased air quality impacts due to construction, but no exceedances expected outside site boundaries.			Minor	Likely	Medium
Construction, annual average $PM_{2.5}$		Modelling indicates air quality impacts for discrete sensitive receptors, primarily due to existing high background $PM_{2.5}$ levels, i.e. not the project.			Moderate	Likely	Medium
Dust deposition (TSP) (Construction)		Air quality impacts at discrete sensitive receptors north of airport boundaries.	Construction dust mitigation measures (as modelled).	Short-term (M3R construction project lifetime).	High	Likely	High
Air quality – operations							
Operations, 1h NO_2	Baseline is model predicted air quality situation for No Build 2046 scenario.	Some air quality impacts for discrete sensitive receptor to east and south; negligible impacts at other points outside and neighbouring the airport boundaries.	Adoption of modern engine technology including emissions controls by the aviation industry.	Long-term (airport lifetime)	Moderate	Likely	Medium
Operations, 24h PM_{10}		No discernible air quality impacts outside the airport boundaries due to the project.			Minor	Likely	Medium
Operations, annual average PM_{10}		No discernible air quality impacts outside the airport boundaries due to the project.			Negligible	Likely	Negligible
Operations, 24h $PM_{2.5}$		No discernible air quality impacts outside the airport boundaries due to the project.			Minor	Likely	Medium
Operations, annual average $PM_{2.5}$		Air quality impacts for discrete sensitive receptors, however primarily due to high background $PM_{2.5}$ levels.			Negligible	Likely	Negligible

Mitigation or management measures	Description of residual impact: Impact	Temporal	Significance assessment: Severity	Likelihood	Impact risk
Air quality – construction (cont.)					
Additional construction dust mitigation measures that could include use of real-time monitoring to trigger additional dust mitigation measures (such as slowing or halting activities observed to be causing dust emissions). Note: dust mitigation measures have the added benefit of aiding aviation operations by improving runway visibility and minimising ingestion of small particles by jet engines.	Air quality impacts confined to within airport boundaries.	Short term (M3R construction project lifetime).	Moderate	Likely	Medium
			Minor	Likely	Medium
			Minor	Likely	Medium
	Air quality impacts confined to within airport boundaries.		Moderate	Likely	Medium
			Moderate	Likely	Medium
Air quality – operations (cont.)					
Potentially some improvements to local air quality from improvements in engine emissions technology and efficiency of airport operations. Note: assessment results dominated by airport activity.	Air quality impact for discrete receptor to north; some air quality impacts at other points outside and neighbouring the airport boundaries.	Long-term (airport lifetime)	Moderate	Likely	Medium
	No discernible air quality impacts outside the airport boundaries due to the project.		Minor	Likely	Medium
	No discernible air quality impacts outside the airport boundaries due to the project.		Negligible	Likely	Negligible
	No discernible air quality impacts outside the airport boundaries due to the project.		Minor	Likely	Medium
	Air quality impacts for discrete sensitive receptors, however primarily due to high background $PM_{2.5}$ levels.		Negligible	Likely	Medium

Aspect of the environment (cont.)	Baseline condition (cont.)	Description and characterisation of impact (cont.)					
		Impact	Mitigation inherent in design/ practice	Temporal	Significance assessment		
					Severity	Likelihood	Impact risk
Air quality – operations (cont.)							
Operations, 3-minute benzene	Baseline is model predicted air quality situation for No Build 2046 scenario. (cont.)	Air quality impact for discrete sensitive receptor to north.			Minor	Likely	Medium
Operations, 3-minute formaldehyde		Air quality impacts for discrete sensitive receptors, and areas adjacent to airport boundaries.			Minor	Likely	Medium
Operations, 1h CO		Air quality impacts for discrete sensitive receptors			Minor	Likely	Medium
Operations, 1h SO_2		Air quality impacts for discrete sensitive receptors			Minor	Likely	Medium

Mitigation or management measures (cont.)	Description of residual impact (cont.)				
	Impact	Temporal	Significance assessment		
			Severity	Likelihood	Impact risk
Air quality – operations (cont.)					
	Air quality impact for discrete receptor to north.		Minor	Likely	Medium
	Air quality impacts for discrete sensitive receptors, and areas adjacent to airport boundaries.		Minor	Likely	Medium
	No discernible air quality impacts outside the airport boundaries due to the project.		Minor	Likely	Medium
	No discernible air quality impacts outside the airport boundaries due to the project.		Minor	Likely	Medium

Virgin
virgin australia

Chapter B11
Greenhouse Gas Emissions

Summary of key findings:

- A detailed greenhouse gas emissions inventory has been prepared for the construction and operation of Melbourne Airport's Third Runway (M3R).
- This assessment identified a difference in predicted greenhouse gas emissions between the Build and No Build scenarios of 348 kilotonnes CO_2-e annually by 2046.
- The biggest source of emissions is from aircraft during the Land and Take-Off cycle (LTO).
- Melbourne Airport has a limited ability to implement measures to reduce these LTO-related emissions but will continue working with airlines to reduce greenhouse gas emissions wherever possible.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B11.1 INTRODUCTION

This chapter describes the existing Greenhouse Gas Emissions (GHG) of the study area, applicable legislation and policy requirements, the potential impacts of Melbourne Airport's Third Runway (M3R) and associated assessment methodology. Where required, this chapter also identifies the specific measures that can be taken to avoid, manage, mitigate and/ or monitor these impacts.

The purpose of this chapter is to:

- Describe the relevant international, Commonwealth and Victorian legislative framework and policy, as well as Melbourne Airport's GHG strategy, that form the context for the GHG assessment
- Set out the methodology, assumptions and technical limitations for the impact assessment, including establishment of the GHG assessment boundary
- Define the existing (i.e. baseline) direct and indirect GHG emissions associated with the operation of Melbourne Airport
- Calculate the likely GHG emissions from both building and not building M3R
- Assess the risks and impacts associated with these predicted GHG emissions
- Identify measures to avoid and mitigate these impacts.

B11.2 STATUTORY AND POLICY REQUIREMENTS

Melbourne Airport is located on Commonwealth land. The Commonwealth *Airports Act 1996* and *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* are the key pieces of legislation setting the regulatory framework for M3R and this assessment. Consideration has also been given to relevant Victorian and local legislation including environmental planning instruments, policies and guidelines.

This section outlines the relevant international, Commonwealth and Victorian statutory and policy requirements for GHGs given that the purpose of this GHG assessment is to address these.

B11.2.1 International framework

The following describes the aviation-specific international greenhouse gas agreements and protocols that are relevant to M3R. International agreements ratified by Australia that inform domestic GHG policy are noted as well as the global accounting protocol. International aviation-specific agreements flowing from Australia's council membership of the United Nations International Civil Aviation Organisation (UN ICAO) are also described, in addition to aviation-specific guidance and working groups.

B11.2.1.1 Global greenhouse gas emissions

Paris Agreement

The United Nations Framework Convention on Climate Change (UNFCCC) conference issued the Paris Agreement in December 2015.

Its main aim is to 'strengthen the global response to the threat of climate change by keeping a global temperature rise this century below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius'. The objective is to stabilise the concentration of GHGs in the atmosphere at a level that would 'prevent dangerous anthropogenic interference with the climate system' (Savaresi 2016). Australia ratified the Paris agreement in 2016, committing the country to five-yearly targets for cutting emissions. This will shape Australia's policy on climate change to achieve the targeted reductions.

Kyoto Protocol

The Kyoto Protocol is an international treaty linked to the UNFCCC adopted in Japan on 11 December 1997 that came into force on 16 February 2005. The Commonwealth Government ratified the Kyoto Protocol on 3 December 2007.

Australia has met its target of limiting emissions to 108 per cent of 1990 levels on average over the protocol's initial 2008-12 timeframe. Over these reporting years, Australia's net emissions averaged 104 per cent of the base-year level (Australian Government Climate Change Authority 2014). Australia has committed to meeting its long-term Kyoto Protocol target by setting a target to reduce emissions by 60 per cent on 2000 levels by 2050. It is understood this remains current despite recent ratification of the Paris Agreement's 2030 target.

GHG emissions from fuel consumption associated with international aviation were excluded from the first period (2008-12) of the Kyoto Protocol (although emissions from domestic travel, and energy use by airports, formed part of the national reduction target). Global targets for international aviation were expected at the 2009 UN Climate Change Conference in Copenhagen but did not materialise. However, in October 2016 the UN ICAO released a program for reducing GHG emissions associated with international aviation (described in Section B11.2.1.2).

Greenhouse Gas Protocol

The international Greenhouse Gas Protocol is a collaboration between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). Globally accepted, it provides guidance on the calculation and reporting of carbon footprints and is the basis for determining GHG emissions associated with M3R.

B11.2.1.2 Aviation greenhouse gas emissions

UN ICAO agreement 2016

As noted above, in 2016 the UN ICAO agreed on a scheme to reduce GHG emissions from international aviation activities. The strategy, known as the *Carbon Offsetting and Reduction Scheme for International Aviation* (CORSIA) involves 'technical and operational improvements and advances in the production and use of sustainable alternative fuels for aviation' (UN ICAO 2016b).

CORSIA involves voluntary pilot and initial phases from 2021-23 and 2024-26 respectively; followed by a mandatory phase for all participants from 2027-35. Australia is intending to participate in CORSIA from the outset of the pilot phases.

The main aim of CORSIA is to work towards the global aspirational goal of carbon neutral growth of international aviation emissions from 2020 onwards. This agreement is relevant to M3R although it is noted that domestic aviation emissions are not subject to CORSIA.

Airports Council International Guidance Manual: Airport Greenhouse Gas Emissions Management

Airports Council International (ACI) is a non-profit association whose prime purpose is the advancement of airport interests and promoting professional excellence in airport management and operations. Its *Guidance Manual: Airport Greenhouse Gas Emissions Management* (ACI 2009) presents a method for defining, quantifying, regulating, reducing, offsetting, reviewing and reporting GHG emissions associated with airport activities and aviation operations. This guidance is relevant because it defines who has primary responsibility for emissions in the aviation sector.

B11.2.2 Commonwealth

B11.2.2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is the* Commonwealth Government's central piece of environmental legislation, which commenced on 16 July 2000. Under the EPBC Act, 'environment' includes consideration of:

- Ecosystems and their constituent parts including people and communities
- Natural and physical resources
- Qualities and characteristics of locations, place and areas
- Heritage values of places
- Social, economic and cultural components of the environment.

The EPBC Act currently has no provisions for GHG emission assessments and Melbourne Airport therefore has no compliance obligations to consider under the Act.

B11.2.2.2 National Greenhouse and Energy Reporting Act 2007

The *National Greenhouse and Energy Reporting Act 2007* (Cth) (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 a number of methodologies to account for GHGs from specific sources which are relevant to Melbourne Airport and M3R. This includes emissions of GHGs from direct fuel combustion (e.g. fuel for transport energy purposes); emissions associated with consumption of power from direct combustion of fuel (e.g. diesel generators used during construction); and from purchased electricity.

Melbourne Airport meets the facility threshold for a controlling corporation to report under the NGER Act. It therefore annually reports GHG emissions from its operations to the Commonwealth Government. GHG emissions associated with the operation of M3R would be included in this ongoing reporting under the NGER Scheme.

B11.2.2.3
Commonwealth renewable energy target

The Commonwealth Renewable Energy Target (RET) commits Australia to generating 41,000 gigawatt hours of additional renewable electricity generation by 2020 (large-scale RET) in order to achieve a 20 per cent share of renewable energy in Australia's electricity supply by 2020. This demonstrates a substantial increase in Commonwealth Government support for renewable energy initiatives.

In June 2015, the Renewable Energy (Electricity) Amendment Bill 2015 was passed which reduced the large-scale RET from 41,000 gigawatt hours, to 33,000 gigawatt hours in 2020 with interim and post-2020 targets adjusted accordingly.

The Clean Energy Regulator oversees the operation of the RET; the Department of Climate Change, Energy, the Environment and Water (DCCEEW) provides policy advice and implementation support for the scheme.

The RET is designed to encourage investment in new large-scale renewable power stations and the installation of new small-scale systems such as solar photovoltaic (PV) and hot water systems in households. It has two core components: the large-scale renewable energy target (LRET) and the small-scale renewable energy scheme (SRES). Together, they give a financial incentive for investment in renewable energy.

M3R will have the potential to include in its scope the installation of renewable energy generation equipment, and to benefit from financial incentives (and reduction in GHGs that on-site generation will deliver). Potential options for renewable energy generation are explored in Section B11.7.

B11.2.3
Victorian Government legislation

The Victorian legislation below is not binding given that the airport is located on Commonwealth land, and is within the Commonwealth's jurisdiction and assessed under Commonwealth requirements. However, Victorian requirements do provide useful guidance to inform the assessment approach and methodology of this assessment.

B11.2.3.1
Climate Change Act 2017

On 23 February 2017, the *Climate Change Bill 2016* (Vic) was passed by the Victorian Parliament to create a new Climate Change Act that repealed the 2010 Act. The *Climate Change Act 2017* (Vic) sets out a clear policy framework and a pathway to 2050 consistent with the Paris Agreement's aim to keep global temperature rise well below 2 degrees Celsius above pre-industrial levels. It provides a platform for subsequent action by the Victorian Government, community and business; and the long-term perspective and policy stability to drive innovation and investment.

The *Climate Change Act 2017* (Vic) includes a long-term carbon reduction target of net zero emissions by 2050; a requirement to set five-yearly targets and strategies; frequent reporting; and mitigation measures that support climate change adaptation.

This MDP addresses the requirements of the *Climate Change Act 2017* (Vic) by providing the GHG impact assessment and placing it in a regional and national context (see Section B11.6).

B11.2.3.2
TAKE2 pledge

TAKE2 is Victoria's collective climate change action initiative to help Victoria reach net zero GHG emissions by 2050. Its name refers to the agreement reached at the UN Conference on Climate Change in Paris whereby 195 countries agreed to keep global temperature rises under 2 degrees.

The TAKE2 pledge encourages organisations, through regular updates and advice, to find ways to reduce their emissions and therefore their potential impact on global warming. Melbourne Airport has taken this pledge.

B11.2.3.3
Environment Protection Act 2017

Protocol for Environmental Management: Greenhouse Gas Emissions and Energy Efficiency in Industry 2002

The *Environment Protection Act 2017* (Vic) (EP Act) provides a legal framework to protect the environment in Victoria. It applies to noise emissions and the state's air, water and land.

The EP Act defines greenhouse gases as per the National Greenhouse and Energy Reporting Act 2007, and regulates emissions of greenhouse gases in reference to the State's long-term emissions targets under the Climate Change Act 2017.

The *Protocol for Environmental Management: Greenhouse gas emissions and energy efficiency in industry (2002)* (PEM) is an EPA Victoria guidance publication for managing greenhouse gas emissions. The PEM was an incorporated document to the State Environment Protection Policy (Air Quality Management), which was replaced by EPA Victoria Publication 1961 *Guideline for Assessing and Minimising Air Pollution* in February 2022 (noting that the original impact assessment was conducted under the SEPP (AQM) when it was still in force).

The PEM specifies the steps taken by businesses to demonstrate compliance with the policy principles and provisions of SEPP (AQM) that are related to energy efficiency and GHG emissions. It is the regulatory instrument used to align the GHG assessment methodology and approach with the requirements of the EP Act and SEPP AQM.

This chapter provides an assessment of emissions of GHGs from energy-related and non-energy related sources in line with PEM requirements.

In July 2021, the *Environment Protection Amendment Act 2018* came into effect. Its General Environmental Duty (GED) is a centrepiece of the new laws and is applicable to all Victorians. It is now mandatory to understand the risks associated with conducting activities that pose a risk to human health and the environment. Organisations must also take reasonably practicable steps to eliminate or minimise them. In an Australian first, the GED is criminally enforceable.

B11.2.4 Melbourne Airport commitments

Although Melbourne Airport requires a significant amount of energy to operate its facilities, a number of energy audits have identified both energy intensive activities and energy efficiency opportunities. Since 2008-09, Melbourne Airport has reduced its per passenger GHG emissions by 7 per cent.

Melbourne Airport's energy strategy focuses on use of 'common energy'. This is energy (electricity and natural gas) over which APAM has direct operational control to service the operation of the airport (aviation processing, lighting, thermal plant, etc) and supporting infrastructure (such as car parks, airfield lighting, data centres and roads).

APAC ESG Strategy

The APAC Environment, Social and Governance (ESG) Strategy was published in February 2022 and applies to Melbourne Airport. This strategy identifies six priority areas which address the issues of highest importance to Melbourne Airport's organisation, stakeholders and community. These priority areas are: carbon emissions, waste, PFAS and water quality, diversity and inclusion, First Nations, and sustainable procurement.

Under the carbon emissions pillar, Melbourne Airport has committed achieving net-zero Scope 1 and 2 emissions by end of 2025 and engaging on Scope 3. Under the strategy, this target will be achieved by:

- Meeting half of the airport's energy needs through onsite solar generation by 2030
- Reducing our energy consumption through continued energy efficiency programmes
- Working with renewable energy providers to secure green energy for the terminals and tenants
- Engaging with tenants, supply chain and airline partners on industry Scope 3 emissions.

In addition to the ESG Strategy targets and actions, Melbourne Airport has achieved Level 2 status under the Airport Carbon Accreditation Scheme of Airports Council International. This recognises Melbourne Airport's commitment to reducing its impacts on the environment, and to managing and reducing carbon emissions. The scheme recognises improved performance by airports in carbon and energy management; and encourages the development of management practices that support the principles of carbon neutrality.

Melbourne Airport has also committed to the Victorian Government's TAKE2 climate change pledge. The TAKE2 initiative aims to reach zero net GHG emissions by 2050. Regarding M3R, this ongoing commitment will require the airfield energy consumption (and associated GHG emissions) modelled in this report to be reduced, generated from renewable sources, and/or offset.

Table B11.1
Severity criteria

Impact severity	Description		Rationale/comments
	Construction	Operation	
Major	A significant level of GHG emissions associated with construction of the project as defined by Scope 1, Scope 2 and Scope 3 emissions representing >0.1 % of Australia's total annual GHG emissions, or > 5 % of Victoria's total GHG emissions, excluding LULUCF#. A significant estimated financial liability (e.g. offsetting of Scope 1 and Scope 2 emissions).	A significant increase in annual operational GHG emissions^ compared to the No Build operational scenario and a significant and irrecoverable estimated financial liability. The increase in GHG emissions represent > 0.1 % of Australia's total annual GHG emissions, or >5 % of Victoria's total annual GHG emissions, excluding LULUCF#.	Financial liability could include capital costs due to implementation of GHG abatement technologies and/or offsetting under a decarbonisation strategy (stakeholder or future Melbourne Airport policy requirement and/or commitment); or financial liability due to future emissions trading scheme and/or carbon tax (measured as $/tCO_2$-e Scope 1 and Scope 2 emissions). Comparison with latest publicly available GHG emissions inventories. Greater than these levels assume negative reputation and media attention globally, with follow-on effects including political implications (affects the Commonwealth Government's ability to comply with agreements at the Paris 2015 UNFCCC¥ Conference of the Parties); project is significantly delayed and/or cancelled.
High	A high level of GHG emissions associated with Scope 1, Scope 2 and Scope 3 emissions representing a non-negligible proportion of Australia's total emissions (> 0.01 % but < 0.1 %), or a non-negligible proportion of Victoria's total GHG emissions (> 1 % but < 5 %), excluding LULUCF#. The estimated financial liability is high (e.g. offsetting of Scope 1 and Scope 2 emissions).	An increase in annual operational GHG emissions^ compared to the No Build operational scenario and a major estimated financial liability. The increase (or decrease) in GHG emissions represent a non-negligible proportion of Australia's total annual emissions (> 0.01 % but <0.1 %), or a non-negligible proportion of Victoria's total annual GHG emissions (> 1 % but < 5 %), excluding LULUCF#.	Financial liability could include offsetting, GHG abatement technologies. Comparison with latest publicly available GHG emissions inventories. Greater than these levels assume negative reputation and media attention nationally, with follow- on effects including political and stakeholder relations implications. Beneficial outcomes include consideration of indirect (Scope 3) emissions such as improved holding (aircraft emissions) due to the unconstrained schedule (Build scenario).
Moderate	Annual Scope 1 and Scope 2 GHG emissions for the construction of the project are greater than the threshold required to report as a separate facility in NGER scheme (25,000 tCO_2-e p.a.). The potential for some additional financial liability (new or additional costs associated with reporting by the contractor are experienced) and requirement to monitor and report emissions.	An increase in annual operational GHG emissions^ compared to the No Build operational scenario, with Scope 1 and 2 operational emissions for the project greater than the threshold required to report as a separate facility in NGER scheme (25,000 tCO_2-e p.a.). The potential for material financial liability (greater than 10% increase in reporting workload) and requirement to monitor and report emissions under NGER scheme.	Assumes emission reduction technologies implemented on M3R may not be eligible for, or Melbourne Airport chooses not to participate in, offsets credited through the Climate Solutions Fund (CSF), i.e. assumes 'material financial liability'. Beneficial outcomes include consideration of indirect (Scope 3) emissions such as improved holding (aircraft emissions) due to the unconstrained schedule (Build scenario).
Minor	Annual Scope 1 and Scope 2 GHG emissions for the construction of the project are below the threshold required to report as a separate facility in NGER scheme (25,000 tCO_2-e p.a.) but above 5,000 tCO_2-e p.a. No change in reporting obligations and no increased financial liability for GHG emissions (costs associated with reporting by the contractor are absorbed in current reporting activities).	An increase in annual operational GHG emissions^ compared to the No Build operational scenario, with Scope 1 and Scope 2 operational emissions below the threshold required to report as a separate facility in NGER scheme (25,000 tCO_2-e p.a.) but above 5,000 tCO_2-e p.a. Some additional financial liability (compared to existing reporting requirements for Melbourne Airport) for reporting of operational Scope 1 and Scope 2 emissions.	Emission reduction technologies implemented on M3R could be eligible for offsets credited through the CSF, i.e. assumes some financial liability. 'Additional financial liability' means more resources required to monitor/report due to complexity and/or scale of the additional emissions. Beneficial outcomes include consideration of indirect (Scope 3) emissions such as improved holding (aircraft emissions) due to the unconstrained schedule (Build scenario).
Negligible	Annual Scope 1 and Scope 2 GHG emissions for the construction of the project are below 5,000 tCO2-e p.a. No obligation to monitor and report emissions and no financial liability for GHG emissions.	No change in annual operational GHG emissions^ compared to the No Build operational scenario. No additional financial liability (compared to existing reporting requirements for Melbourne Airport) for reporting of operational Scope 1 and Scope 2 emissions.	Assumes Melbourne Airport may still trigger reporting requirements under NGERS for actual Scope 1 and 2 emissions, as per 'normal' obligations.

Table Notes: # Land use, land use change and forestry ^ Including Scope 3 emissions e.g. wider transport effects ¥ United Nations Framework Convention on Climate Change

B11.3 DESCRIPTION OF SIGNIFICANCE CRITERIA

To ensure a consistent approach across each impact assessment presented in the MDP, the framework used throughout the document for assessing the significance of impact assessment results is the one detailed in Chapter A8: Assessment and Approvals Process.

Project-specific criteria have been also been developed for the assessment of GHG emissions as described in Table B11.1.

The contribution of GHG emissions to climate change is a global issue, not just a national, state, or local one. The severity assessment of GHG emissions resulting from M3R is therefore assessed in this context. Reporting thresholds have been used to differentiate between the severities of the impacts because they usefully illustrate the importance of emissions levels on a local to global scale.

B11.4 METHODOLOGY AND ASSUMPTIONS

This section details the approach and methodology used in developing the GHG inventory.

B11.4.1 Overview

The GHG emissions associated with Melbourne Airport and its surrounds are explained in this chapter. They include GHGs associated with ground-based activities up to and including the Landing and Take-Off (LTO) cycle; and M3R construction and operational emissions.

Although GHG emissions associated with the airspace are largely out of Melbourne Airport's control they are discussed in this chapter for context. They include aircraft emissions when they have completed climb-out and are cruising to their destination after take-off; and also those associated with being delayed in a holding pattern while waiting to land, these are likely to be experienced under the constrained (i.e. No Build) scenarios.

A GHG inventory is an assessment of the GHG emissions associated with a product, service or event. GHGs such as methane and nitrous oxide are aggregated with carbon dioxide and reported as a single number of 'carbon dioxide equivalents'.

Rising concentrations of GHGs in the atmosphere contribute to climate change. M3R will be a source of GHGs both from ground-based sources and the aircraft using it. Therefore, being able to reduce these emissions across the infrastructure lifecycle would limit any potential adverse impact of M3R on climate change.

GHG emissions can be attributed to a number of sources, both direct and indirect, Melbourne Airport has responsibility and control over some of these sources, but not all. Examples of direct sources from M3R during construction include emissions associated with the combustion of fuel by on-site plant and equipment. Indirect sources may include those attributed to the generation of electricity used on site. Also considered an indirect source, is the manufacture and transport of construction materials to site.

During operation, the key GHG direct emissions sources for M3R would be the increased aircraft emissions in the LTO cycle associated with the new north-south runway (16R/34L); fuel used to power Ground Support Equipment (GSE); and Auxiliary Power Units (APUs). Indirect emissions include those attributed to the generation of electricity used to operate installed assets associated with M3R e.g. new runway lighting and electrical, and ventilation for the potential new tunnel/ underpass structure.

B11.4.2 Approach

The GHG inventory in this chapter is calculated according to the principles of the Greenhouse Gas Protocol (GHG Protocol) (WBCSD 2013). This is recognised as the international standard for calculating GHG inventories. The GHG emissions in the inventory can be divided into three categories known as 'scopes'.

Scopes 1, 2 and 3 defined by the GHG Protocol can be summarised as follows:

- Scope 1: direct emissions from sources owned or operated by a reporting organisation (e.g. combustion of diesel in company-owned vehicles or used in on-site generators)
- Scope 2: indirect emissions associated with acquiring energy from another source (e.g. offsite generation of electricity)
- Scope 3: indirect emissions (other than Scope 2 energy imports) that are a direct result of the operations of the organisation but from sources neither owned nor operated by them (e.g. business travel by air).

Airports Council International (ACI) (ACI 2009) provides additional guidance for airports making a GHG inventory based on the GHG Protocol. It clarifies which scopes should be allocated to specific emissions when completing an airport GHG inventory and divides Scope 3 into two elements:

- Scope 3a: emissions which an airport operator *can* influence (even though it does not control the sources)
- Scope 3b: emissions which an airport operator *cannot* influence to any reasonable extent.

The ACI approach has been followed in this assessment because it is the most relevant for airports and is consistent with the recognised international standard (i.e. the GHG Protocol).

It should be noted that some emissions sources can have more than one scope. For example, electricity *consumption* emissions are classified as Scope 2 but also have a Scope 3 element (relating to emissions associated with transmission losses in the electricity network). Similarly, electricity *generation* emissions (if generated as part of the project) are classified as Scope 1 but have a Scope 3 element (relating to emissions upstream of a power plant regarding extraction, refinement and supply of fuel).

B11.4.3
Scope

The purpose of this assessment is to ascertain the GHG emissions associated with the construction and operation of M3R.

The construction assessment includes all material sources of GHGs for the construction phases (the construction program's duration is four to five years). The operational assessment determines the difference in emissions between Build and No Build scenarios at year of opening (2026), five years after opening (2031) and 20 years after opening (2046).

The operational assessment includes emissions associated with aircraft activity (the LTO cycle), airfield operation, and airside support vehicles and equipment. This is to provide a full picture of M3R's likely impacts regarding GHG emissions; it does not assess emissions associated with terminal or landside activities as these are outside the scope of the MDP. The change in passenger access to the airport (by road) is included for all future scenarios. The boundary of this study area is described in the next section.

B11.4.4
Assessment study boundary

The study boundary determines which sources of emissions are included in the scope of assessment and which are excluded, for both construction and operation of M3R.

The construction assessment includes the sources outlined in Table B11.2. Construction materials which will be material have been considered in this assessment (e.g. concrete, aggregate, steel, PVC conduit and electrical cable). Minor construction materials used in small quantities have been excluded from the inventory. This is because the quantity of emissions from minor construction materials is likely to be below the materiality threshold for foot printing. For this study, the materiality threshold is 1 per cent for individual sources of emissions and 5 per cent when aggregated.

The operational assessment includes the sources outlined in Table B11.3.

Table B11.2
Greenhouse gas – construction assessment boundary

Source	Description	Scope	Notes
Fuel combustion – diesel (transport)	Emissions associated with diesel used in mobile construction equipment.	Scope 1 and 3b	Scope 1 assesses direct emissions from combustion on site and scope 3b assesses emissions associated with the fuel supply chain.
Fuel combustion – diesel (stationary)	Emissions associated with diesel used in stationary construction equipment.	Scope 1 and 3b	Scope 1 assesses direct emissions from combustion on site and scope 3b assesses emissions associated with the fuel supply chain.
Vegetation clearance	Emissions associated with the loss of carbon sink through clearing vegetation during construction.	Scope 1	
Purchased electricity	Emissions associated with electricity purchased and used to power site offices and lighting during construction.	Scope 2 and 3b	Scope 2 assesses direct emissions from the power generation process and scope 3b assesses emissions associated with the power supply chain and transmission and distribution losses.
Construction material purchase	Embedded emissions associated with the manufacture of construction materials.	Scope 3a	
Construction material transport	Emissions associated with transport of construction materials to site from manufacturing location	Scope 3a	
Waste disposal	Emissions associated with disposal of construction waste off-site.	Scope 3a	

Table B11.3
Greenhouse gas – operational assessment boundary

Source	Description	Scope	Notes
Passenger access	Emissions associated with the road network relevant to passengers accessing Melbourne Airport.	Scope 3b	Emissions are modelled based on the Victorian Integrated Transport Model (VITM) outputs within a 10-kilometre radius of the airport (refer to **Chapter B8: Surface Transport**).
Purchased electricity	Emissions associated with the generation of electricity imported to Melbourne Airport.	Scope 2 and 3b	Emissions associated with electricity usage in the airfield only (lighting and aircraft navigational systems).
Fuel combustion – diesel (transport)	Emissions associated with combustion of diesel in transport equipment used airside. This includes ground support equipment (GSE) such as tractors, mobile stairs and baggage trolleys.	Scope 1 or 3a and 3b	The scope of these emissions depends on whether the GSE is owned by Melbourne Airport, or by the airlines/other tenants
Fuel combustion – diesel (stationary)	Emissions associated with combustion of diesel in airside stationary equipment (generators).	Scope 1 & 3b	Generators are used to provide electrical energy to airfield systems in the event of a loss of power.
Aircraft – landing take-off cycle	Emissions from aircraft in the LTO cycle at Melbourne Airport (i.e. including taxiing, take-off, climb out, approach).	Scope 3a (taxi) and 3b (take off, climb out and approach)	Derived from Air Quality modelling undertaken in AEDT software (see **Chapter B10: Air Quality**).
Aircraft – auxiliary power units (APUs)	Emissions from aircraft APUs whilst on stand.	Scope 3a	It is assumed that only APUs are used, no ground power units (GPU). The fleet mix is unknown and this assumption represents a worst-case.

The study assesses emissions from the operation of two runways under a No Build scenario and three runways under a Build scenario. Results are presented as totals for both scenarios; the difference between the two represents the likely GHG emissions due to M3R.

The following have been excluded from the assessment of operational emissions:

- Full-flight emissions from aircraft after the LTO cycle
- Energy consumption associated with the operation of landside infrastructure (including all terminal infrastructure)
- Solid waste disposal associated with the operation of landside infrastructure (including all terminal infrastructure)
- Any sources of emissions below the materiality threshold (either in absolute terms or in terms of the incremental change between Build and No Build scenarios). There are various sources of emissions likely to be below the materiality threshold for foot-printing. For this study, the materiality threshold is 1 per cent for individual sources of emissions, and 5 per cent for all these emissions in aggregate.

B11.4.5
Units and metrics

The results for this study will be scaled to appropriate metrics to provide a meaningful comparator for the emissions. This comparator is often defined as the 'functional unit' in carbon accounting. For this study, the following units will be presented:

- Emissions per Air Traffic Movement (ATM) (both arriving and departing)
- Emissions per passenger (both arriving and departing)
- Total emissions: all relevant/significant airport sources
- Total emissions: airside emissions which will be used in the impact assessment for M3R only (i.e. the subset of emissions relating to aircraft arrivals and airside activities which will compare the boundary used in the impact assessment).

B11.4.6 Methodology

This section details the methodology used to determine the GHG emissions projected to occur due to M3R in both the construction and operation phases.

B11.4.6.1 Construction

To determine likely GHG emissions from construction of M3R, data on emissions, energy use and fuel use from construction activities were sourced in units that allow for calculation of GHG emissions. These activity data sources are described in Table B11.4.

Table B11.4
Data sources for construction GHG assessment

Emission Source	Data Sources
Fuel combustion – diesel (transport)	Construction plant and equipment lists were developed as part of the concept design. These include lists of particular plant and equipment per phase of construction, with an indication on the usage hours per day, and total days construction for each.
Fuel combustion – diesel (stationary)	Two items of stationary equipment were included in the assessment; an asphalt batching plant and a concrete batching plant. Usage data were determined as part of the concept design, and fuel efficiency derived from manufacturer websites.
Vegetation clearance	Data on vegetation clearance type and quantity were sourced from ecological studies completed for the MDP (refer to Chapter B5: Ecology).
Purchased electricity	Electrical energy used to power offices (including lighting) was derived from floor areas for the proposed (temporary) construction building and standard office building electrical energy consumption figures according to the Building Code of Australia.
Construction material purchase	Construction material quantities were determined as part of the concept design process.
Construction material transport	Construction material transport distances were determined by researching an appropriate supplier of each material in close proximity to the airport. Suppliers for each material are not yet confirmed; use of this approach was considered to provide an appropriate estimate of the likely emissions.
Waste disposal	Waste values were informed by Chapter B3: Soils, Groundwater and Waste, with additional assumption made regarding waste types/ classifications where required.

Using these data sources, the GHG inventory was then calculated by applying the following methodology:

- Construction fuel: mobile equipment – vehicle usage data for the different phases of construction was multiplied by indicative fuel consumption figures from the Carbon Emissions Reporting Tool (CERT) version 1.1 developed by Transport for NSW (TfNSW, 2015). This determined the total indicative fuel consumption which was in turn multiplied by the relevant emissions factor to determine GHG emissions
- Construction fuel: stationary equipment – asphalt and concrete batching plant fuel consumption per unit of output was taken from manufacturer websites; and multiplied by expected throughput to determine the total, which was in turn multiplied by the relevant emissions factor to determine GHG emissions. If the emissions associated with batching plants were also covered by emissions factors for construction materials, double counting was avoided (see list of assumptions below)
- Construction fuel: passenger vehicles – assumptions made on the total numbers of passenger vehicles were multiplied by expected time in usage and vehicle fuel efficiency figures from the Australian Bureau of Statistics. Total projected fuel consumption was then multiplied by the relevant emissions factor to determine GHG emissions
- Vegetation clearance: data on vegetation clearance types and areas was fed into the vegetation removal section of the carbon gauge GHG calculator for road projects (version 01.130612 developed by VicRoads 2013). This provided an indicative, regionally tailored, projection of carbon emissions from the loss of vegetation as a carbon sink
- Purchased electricity: consumption projections were based on indicative site office floor area; benchmarks for energy consumption were derived from the Building Code of Australia. The resulting total electrical energy consumption was multiplied by the relevant emissions factor to determine GHG emissions
- Construction materials: embedded emissions – quantities from the concept design were input to the Infrastructure Sustainability Council of Australia (ISCA) materials calculator version 2.0.04 (ISCA, 2019). This provided the emissions of GHGs associated with the manufacture of each material. The exception being electrical cable, for which CERT (TfNSW, 2015) was used to determine GHG emissions. (There were some instances where double counting of emissions would occur by using default ISCA calculations and separately calculating emissions for on-site production steps such as the operation of batching plants. Where this was the case, steps were taken to ensure that emissions were only counted once)
- Construction material transport: calculated using the ISCA materials calculator version 2.0.04 (ISCA, 2019). Total projected fuel consumption was based on articulated or rigid truck delivery, and transport distance was entered based on an identified local supplier. The ISCA materials calculator then provided an output in terms of total GHG for transport
- Waste disposal: quantities of projected green waste, general construction waste, office waste and rubber (tyres) were multiplied by the appropriate emissions factor to determine GHG emissions.

The following assumptions were applied to the assessment:

- All construction plant and equipment will be fuelled by diesel
- The majority of construction passenger vehicles will be fuelled by diesel
- Data on expected usage of plant and equipment included indicative operating hours and days of operation (assuming continuous operation during this time – a likely overestimate)
- Assumptions around plant operating efficiency used worst-case (i.e. maximum) GHG emissions when a range was given
- Although the contractors' site office area is as yet undefined, an allocation of temporary compound space of 10,000 metres squared was assumed and (conservatively) estimated that 50 per cent would be office space.
- Assumptions for concrete mixes:
  - For all mixes, it was assumed that no Supplementary Cementitious Material (SCM) was used
  - Portland Cement Concrete (PCC) aircraft pavements
  - Cement content in the range 360 kilogram to 420 kilogram per cubic metre was indicated
  - The higher value was used as a conservative assumption. Default mixes within the ISCA calculator for remaining materials was assumed
  - For lean (low strength) concrete (five megapascals) no emissions factors were available. The 20 megapascals emissions factor was used as a conservative assumption
  - For high strength (40 megapascals) concrete – standard mixes in the ISCA calculator were used.
- The ISCA calculator provides an emissions factor for concrete production at a batch plant, which is automatically added to the output. As concrete batching plant emissions were separately calculated from the ISCA calculator, these were removed from the ISCA outputs to avoid double counting.
- Assumption for asphalt mix:
  - The ISCA calculator was used to determine emissions associated with supply of asphalt
  - The value selected was for 'asphalt, standard mix 5.5 per cent virgin bitumen' which represents the highest value (in terms of emissions per unit output). As the emissions factor for this material included emissions associated with the batch plant, the (separately calculated) batch plant emissions were subtracted from the total value calculated to avoid double counting.
- Waste disposal
  - A 100 per cent recycling rate has been applied to green waste because all native trees and vegetation will be mulched and re-used on site.
  - An 80 per cent recycling rate has been applied to demolition waste
  - An average recycle rate of 69 per cent (Sustainability Victoria, 2020) has been applied to paper waste.

A summary of activity data used in the construction assessment is provided in **Table B11.5**.

Table B11.5
Construction GHG assessment – summary of activity data

Activity	Sub-activity	Value	Units
Fuel usage	Construction plant and equipment – diesel	34,911	kl
	Passenger vehicles – diesel	300	kl
	Stationary plant (asphalt and concrete batching) – diesel	1,848	kl
Land clearing	Riparian woodland	1.26	Ha
	Plains grassland	225.97	Ha
	Plains grassy woodland	0.25	Ha
	Plains woodland	130.35	Ha
	Creekline grassy woodland	1.33	Ha
	Escarpment shrubland	0.75	Ha
	Hills herb-rich woodland	43.45	Ha
	Aquatic herbland	0.01	Ha
	Tall marsh	0.49	Ha
Electricity use	Electricity use – offices	3,942,000	kWh
Materials	Asphalt	200,800	t
	Concrete, ready mix (airfield PCC)	189,633	m^3
	Concrete, ready mix, lean	56,286	m^3
	Concrete, 40 MPa structural concrete	53,580	m^3
	Concrete, precast	128,592	t
	Aggregate	990,497	m^3
	Steel	13,429	t
	PVC conduit	420	t
	Electrical cabling – 6mm, 70mm and 240mm	392	km
Waste	Green waste	0	t
	Construction and demolition waste	120,000	t
	Office waste (paper, etc.)	28	t
	Rubber (tyres)	150	t

Table B11.6
Emissions factors – National Greenhouse Accounts Factors 2019 – construction

Source	Reference unit	Emissions ($kgCO_{2}e$ per reference unit)				Additional upstream emissions (scope 3) $kgCO_{2}e$
		CO_2	CH_4	N_2O	Total ($CO_{2}e$)	
Diesel oil (transport energy)	kL	2,698.14	3.86	19.3	2,721.30	138.96
Diesel oil (stationary energy)	kL	2,698.14	3.86	7.72	2,709.72	138.96
Paper and cardboard	t	-	-	-	2.9	-
Garden and green waste	t				1.4	
Rubber and leather	t				2.9	
Construction & demolition waste	t				0.2	

The emissions factors used in the assessment of construction GHG emissions are presented in **Table B11.6** and **Table B11.7**.

Table B11.6 presents carbon dioxide equivalent (CO_2-e) emissions factors for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) developed and published by the Commonwealth Government in its annual National Greenhouse Accounts Factors 2019 (DoEE, 2019).

Table B11.7 presents emissions factors used in the assessment, embedded in the ISCA materials calculator (ISCA 2019).

Table B11.7
Emissions factors – ISCA materials calculator (ISCA 2019)

Source	Emission factor ($tCO_{2}e$ / t)
Asphalt	0.06363
Cement	0.984022
Fine aggregates	0.004303
Coarse aggregates	0.010899
Mains water	0.000743
Additives	4.39
Manufactured sand	0.007601
Crushed rock	0.0109
Steel reinforcing bar	1.5
PVC	2.7340

B11.4.6.2 Operations

To determine the GHG emissions associated with operation of M3R, data on emissions, energy use and fuel use from operational activities was sourced in units that allowed for the calculation of GHG emissions. The activity data sources used for the operational assessment are identified in **Table B11.8**.

Table B11.8
Data sources for operational GHG assessment

Emission source	Data sources
Passenger access	Data regarding passenger road access (volumes of traffic on different access routes to Melbourne Airport) were sourced from transport studies carried out as part of this assessment (refer to **Chapter B8: Surface Transport**). This data gave total volume of traffic based on the Victorian Integrated Transport Modell (VITM), covering all access roads that would see a difference associated with traffic, for baseline and future years.
Purchased electricity	Airfield electricity consumption data were primarily sourced from meter readings taken for the baseline year where available, with assumptions made to fill gaps
Fuel combustion – diesel (transport)	This emissions source refers to emissions from GSE. The emissions were projected based on standard fuel consumption figures which estimate consumption per aircraft movement for two different aircraft types. The aircraft data (movements and type) were sourced from master spreadsheets which forecast flights under both the Build and No Build scenarios.
Fuel combustion – diesel (stationary)	This emissions source refers to emissions from standby generation units for airfield lighting. By their nature, these generators are only run during testing or emergencies, so consumption is low. Data are taken from recent National Greenhouse and Energy Reporting (NGER) reports filed by Melbourne Airport.
Fuel combustion kerosene – for use as fuel in an aircraft (transport energy)	The main source of GHG emissions in this assessment is from aircraft. This includes use of APUs on stand and the LTO cycle. The main sources of data for this part of the assessment were master spreadsheets which forecast flights under both the Build and No Build scenarios. These were processed in AEDT to determine both air quality and GHG related emissions. The source spreadsheets included actual and forecast individual flights, including aircraft type, length of flight to first destination, terminal allocation and runway allocation. This information, combined with the outputs from AEDT, was used to determine emissions from this source.

The methodology for calculation of the operational GHG inventory includes:

Passenger access

This impact assessment includes the effects of GHG emissions associated with the road network used by passengers, employees and trucks accessing Melbourne Airport. It compares road-based transport emissions of the Build scenario and the No Build scenario using outputs from the VITM (see next paragraph). Comparison of GHG indicators for Build vs No Build is considered a useful approach to assess a project's longer-term operational impacts. It is often used for state projects assessed under the *Environment Effects Act 1978 (Vic)* or the *Major Transport Projects Facilitation Act 2009 (Vic)*. This approach has therefore been used to assess road network emissions associated with M3R.

VITM is Public Transport Victoria's (PTV) four-step strategic traffic model that was used in the surface transport assessment of M3R (refer to **Chapter B8: Surface Transport**).

Both VITM and its predecessor, Melbourne Integrated Transport Model (MITM), have been used extensively by PTV and VicRoads for strategic modelling in metropolitan Melbourne. The assessment boundary for this analysis has been limited to the VITM extent necessary in order to detect the transport effects of M3R, and applies to 11 key road links within approximately 10 kilometres of Melbourne Airport.

Key VITM outputs used for the GHG assessment include:

- Daily average vehicles per hour on each road link analysed
- AM peak vehicles per hour on each road link analysed
- PM peak vehicles per hour on each road link analysed.

To ensure consistency with the air quality assessment (**Chapter B10: Air Quality**) Victorian average vehicle fleet fuel efficiency figures were extracted from COPERT Australia using input data for the Victorian context. GHG emissions factors are sourced from the national greenhouse gas accounts factors 2019 (DoISER, 2020).

Purchased electricity

Electricity use on-site is documented at a high level in the NGER inventory. This data details total imports to the site, as well as electricity sold to tenants (i.e. directly purchased from suppliers by tenants). The remainder is used by Melbourne Airport. As landside electricity consumption is outside the scope of this MDP's approval, detail was provided on airside electricity consumption to determine the emissions specifically relevant to M3R. This was in the form of meter readings for substations supplying electricity to the airfield. The majority of meter readings were available but, where there were gaps, assumptions were made to ensure all electricity usage was represented.

Future electricity consumption associated with M3R was assumed to be an additional 50 per cent of baseline consumption (representing a move from two runways to three). This is in line with data available on power consumption in the concept design report, which indicates load increase for the airfield from 8 megavolt amperes to 12 megavolt amperes for M3R.

Future electricity grid emissions intensity was determined from analysis undertaken by Jacobs for the Commonwealth Government to determine Victorian emissions projections to 2034-35 (Jacobs, 2016).

Fuel combustion: liquid fuels and oils

Fuel combustion in the airfield included stationary sources (two backup generators for airfield and terminal buildings) and mobile sources (GSE). The approaches to calculating emissions from these sources included:

- GSE: ICAO default data (ICAO 2011) provides default carbon dioxide emissions factors for all GSE per aircraft movement (inbound or outbound) based on operations at Zurich Airport. These are 18-kilogram CO_2/movement for narrow body aircraft and 58-kilogram CO_2/movement for wide body aircraft. These factors were applied to each aircraft movement in Build and No Build schedule files to determine total contribution. These emissions were converted to GHG (CO_2-e) using standard emissions factors. As Melbourne Airport do not own or control the GSE, 100 per cent of emissions was allocated to the airlines/tenants.
- Backup generation: emissions from the baseline year were increased proportionally (according to changes in number of aircraft movements for each scenario modelling the likely increase associated with the M3R).

Aircraft: Landing take-off cycle

Emissions associated with the LTO cycle were determined through the Aviation Environmental Design Tool (AEDT) model, which was based for each of the future Build and No Build scenarios on full forecast flight schedules (see **Chapter B10: Air Quality**). AEDT determined emissions for each aircraft type in the following LTO components:

- Descend below mixing height: includes the following components:
  - Approach/descent from 10,000 feet (~3000m) (including reverse thrust)
  - Landing ground roll
  - Taxiing (in) and idle
- Climb below mixing height:
  - Taxiing (out) and idle
  - Engine start-up
  - Takeoff ground roll
  - Climb out to 10,000 feet (~3000m)

Output files from AEDT were post-processed to allocate emissions from the above movements to each ATM in the schedule. The outputs from AEDT were presented in direct CO_2 emissions only (as AEDT does not output values for CH_4 and N_2O emissions associated with aviation fuel combustion). These values, as well as Scope 3 (upstream) emissions were determined from the appropriate emissions factors for aviation fuel combustion. Note that emissions for future years are scaled based on the number of aircraft movements. Emissions estimates for the Build scenarios do not include additional taxi-in and taxi-out time as a result of the third runway (however, this is a relatively small component of overall emissions). In addition, estimates do not factor in improvements in aircraft efficiency, nor efficiency of GSE, APUs and taxiing. A sensitivity analysis of next-generation aircraft shows emissions per aircraft movement could fall by around 10 per cent should the aircraft fleet be entirely upgraded by 2046.

Aircraft: auxiliary power units

ICAO (ICAO, 2011) provides an approach to calculating auxiliary power units (APU) emissions for either short-haul or long-haul flights (with specific definition of the aircraft types that this refers to).

This approach gives a standard duration of APU operation and associated fuel burn calculation for each air traffic movement (80 kilograms of fuel for short-haul flight ATMs and 300 kilograms of fuel for long-haul flight ATMs). These values were applied to each movement in the Build and No Build schedules to determine total emissions associated with APU use for each year assessed.

The following assumptions were used in determining the operational GHG emissions.

Passenger access:

- It was assumed that vehicles travelling on the modelled roadways were representative of the Victorian fleet average
- By 2046, 30 per cent of Victoria's vehicle fleet will be electric (the central scenario from CSIRO 2020); in 2026, the percentage is assumed to negligible (in-line with the central scenario)
- Improvements in the fuel efficiency of Victoria's fossil fuel vehicle fleet are assumed to be negligible (a conservative assumption).

Electricity:

- Emissions associated with airfield operation only were included (excluding the control tower or activities on the apron). Electricity usage included mid-markers, radar, Doppler, glide paths, stores, runway lighting and localiser
- Energy usage for one of the airfield lighting equipment rooms was unavailable and assumed to be the same as one for which data were available. The same approach was applied to a mid-marker
- Emissions intensity of grid electricity in Victoria was derived for future years from modelling undertaken by Jacobs (Jacobs, 2016). See Table B11.12.

Ground support equipment:

- It was assumed for the purposes of allocating the emissions to the correct scope, that 100 per cent of GSE is owned and operated by airlines and other tenants (Scope 3a).

Aircraft – LTO cycle:

- AEDT provides outputs as total CO_2 for each stage of the LTO cycle, summed by aircraft type.

A summary of the activity data used in determining operational GHG emissions for the future Build and No Build scenarios is presented in Table B11.9.

The information presented is headline (i.e. totals only). There is a wide array of data that sits underneath these totals (such as breakdown by vehicle type and time of day for Vehicle Kilometres Travelled (VKTs)). However, it would not be feasible to present all of these inputs. Note that ATMs for 2021 are the same for both Build and No Build scenarios. Under the Build scenario, Melbourne Airport would be operating these flights over three runways; under No Build only two runways would be operating.

The emissions factors used in the assessment of operational GHG emissions are presented in Table B11.10 to Table B11.12.

Table B11.10 presents emissions factors developed and published by the Commonwealth Government in its annual National Greenhouse Accounts Factors 2020 (DoISER), 2019).

Table B11.11 presents emissions factors derived from ICAO (ICAO 2011).

The emissions factors in Table B11.12 represent the Scope 2 emissions factors used for future electricity consumption in Victoria. Scope 3 emissions associated with electricity generation were unavailable for future years and conservatively assumed to stay at present-day levels.

Table B11.9
Operational GHG assessment – summary of annual activity data

Activity	Data	Scenario	Value	Units
Passenger access	Total VKT for all vehicles on access network per year (with Airport Rail)	2026 No Build	454,227,715	VKT
		2026 Build	465,318,012	VKT
		2031 No Build	513,949,730	VKT
		2031 Build	548,900,982	VKT
		2046 No Build	693,115,774	VKT
		2046 Build	799,649,891	VKT
Purchased electricity	Electricity consumption in the airfield.	2026 No Build	1,310,167	kWh
		2026 Build	1,965,251	kWh
		2031 No Build	1,310,167	kWh
		2031 Build	1,965,251	kWh
		2046 No Build	1,310,167	kWh
		2046 Build	1,965,251	kWh
Fuel Combustion – Diesel (transport)	Fuel (diesel) consumption by GSE. Activity available in CO_2 only (due to emissions factors used)	2026 No Build	9,919	tCO_2
		2026 Build	9,917	tCO_2
		2031 No Build	10,767	tCO_2
		2031 Build	11,438	tCO_2
		2046 No Build	10,908	tCO_2
		2046 Build	15,990	tCO_2
Fuel combustion – diesel (stationary)	Fuel (diesel) consumption by standby generators.	2026 No Build	7.97	kL
		2026 Build	7.97	kL
		2031 No Build	8.65	kL
		2031 Build	9.19	kL
		2046 No Build	8.78	kL
		2046 Build	12.90	kL
Fuel combustion kerosene - for use as fuel in an aircraft (transport fuel) – landing and take-off cycle and APU usage	Aircraft movements (total) projected, and part of the input into AEDT	2026 No Build	299,832	ATMs (number)
		2026 Build	299,780	ATMs (number)
		2031 No Build	325,468	ATMs (number)
		2031 Build	345,748	ATMs (number)
		2046 No Build	329,732	ATMs (number)
		2046 Build	483,340	ATMs (number)

Table B11.10
Emissions factors – National Greenhouse Accounts Factors 2019 – operational

Source	Reference unit	Emissions ($kgCO_2$-e per reference unit)				Scope 3 $kgCO_2$-e
		CO_2	CH_4	N_2O	Total (CO_2-e)	
Kerosene – for use as fuel in an aircraft (transport energy)	kL	2,572.32	0.37	22.08	2,594.77	132.48
Kerosene – for use as fuel in an aircraft (stationary energy (APU usage))	kL	2,561.28	0.74	7.36	2,569.38	132.48
Gasoline (other than for use as fuel in an aircraft) (transport energy)	kL	2,305.08	17.1	61.56	2,383.74	123.12
Diesel oil (transport energy)	kL	2,698.14	3.86	19.3	2,721.30	138.96
Diesel oil (stationary energy)	kL	2,698.14	3.86	7.72	2,709.72	138.96
Electricity (Vic.)	kWh	–	–	–	0.98	0.11

Source: NGER, 2019

Table B11.11
Emissions factors from ICAO

Source	Reference unit	Emissions ($kgCO_2$-e per reference unit)			
		CO_2	CH_4	N_2O	Total (CO_2-e)+++
Ground support equipment – narrow bodied aircraft	ATM	18	0.03 +	0.13 +	18.16
Ground support equipment – wide bodied aircraft	ATM	58	0.08 +	0.41 +	58.49
Auxiliary power units – narrow bodied aircraft ++	ATM	256.13	0.04	2.21	258.38
Auxiliary power units – wide bodied aircraft ++	ATM	960.48	0.14	8.28	968.90

Source: ICAO, 2011
Table Notes: + Emissions for CH_4 and N_2O in the above table are derived from NGA factors, as only CO_2 is reported from the source. ++ Data are presented in the source in fuel consumption and are converted here into emissions based on the emissions presented in Table B11.10 for kerosene for use as fuel in an aircraft (transport energy). Original data are 80 kilograms fuel and 300 kilograms fuel per ATM for narrow body and wide body aircraft respectively. +++Where figures have been rounded discrepancies may occur between totals and the sums of component items.

Table B11.12
Future electricity greenhouse gas emissions intensity

Year	Emissions intensity – scope 2 ($kgCO_2$-e/kWh)
2026	0.98
2031	0.92
2046	0.53

Source: Jacobs, 2016
Table Notes: The emission factors are derived from Jacobs (2016) by developing a scaling factor from their modelling and applying it to the M3R scenarios for 2026, 2031 and 2046.

B11.5
EXISTING CONDITIONS

For the GHG assessment, only operational emissions are detailed in the baseline assessment as the construction emissions are not relevant.

B11.5.1
Baseline results

The baseline results are presented in **Table B11.13** and **Figure B11.1** and **Figure B11.2**. The emissions have been presented in the scope classifications as recommended by Airports Council International (ACI, 2009).

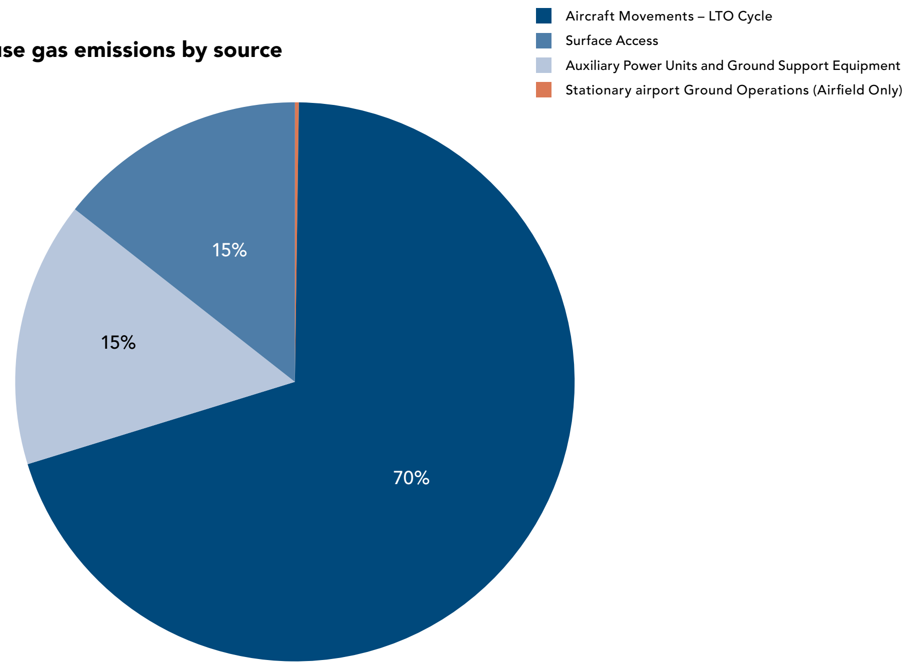
Table B11.13
Baseline operational GHG emissions

Source	Emission Factor	Activity data	Activity data unit	Scope 1 greenhouse gases (tCO_2-e)	Scope 2 greenhouse gases (tCO_2-e)	Scope 3a greenhouse gases (tCO_2-e)	Scope 3b greenhouse gases (tCO_2-e)	Total greenhouse gases (tCO_s-e)
Stationary airport Ground Operations (Airfield Only)								
Electricity – airfield	Electricity	1,310,167	kWh		1,284		144	1,467
Diesel – standby generators	Diesel oil (stationary energy)	6,754	L	18			1	19
Sub-total				18	1,284		145	1,486
Aircraft movements – LTO cycle								
Aircraft – descent	Kerosene – for use as fuel in an aircraft (transport energy)	N/A	AEDT				102,203	102,203
Aircraft – taxiing and idle	Kerosene – for use as fuel in an aircraft (transport energy)	N/A	AEDT			68,721		68,721
Aircraft – take off	Kerosene – for use as fuel in an aircraft (transport energy)	N/A	AEDT				48,937	48,937
Aircraft – climb out	Kerosene – for use as fuel in an aircraft (transport energy)	N/A	AEDT				225,295	225,295
Sub-total				–	–	68,721	376,435	445,155
Auxiliary power units and ground support equipment								
Auxiliary power units	Kerosene – for use as fuel in an aircraft (transport energy)					84,816	4,370	89,186
Ground support equipment	Diesel oil (transport energy)					8,412		8,412
Sub-total						93,228	4,370	97,598
Surface access								
Road	Multiple			-	-	-	91,612	91,612
Sub-total				-	-	-	91,612	91,612
TOTAL				18	1,284	161,948	472,562	635,812

The largest source of baseline operational GHG emissions comes from the aircraft movements (70 per cent) as shown in **Figure B11.1**. The next largest component is the use of APUs and GSE for aircraft while on the ground, closely followed by surface access. Ground-based stationary energy (diesel for generators and airfield electricity consumption) is relatively insignificant.

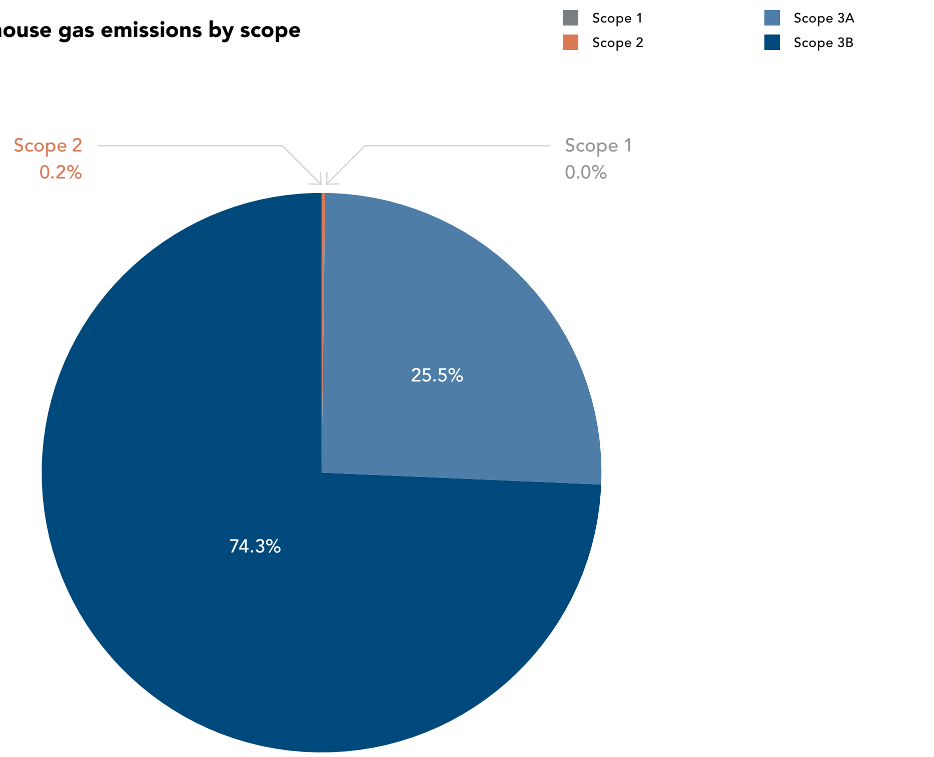
Figure B11.2 shows that the vast majority of emissions fall into a Scope 3 category. This means Melbourne Airport can influence, but does not have direct control over, these emissions sources. These emissions are mostly the responsibility of the airlines, the LTO cycle of aircraft and operation of APUs/ GSE which they do not own or control. The Melbourne Airport Scope 1 and Scope 2 emissions sources are much smaller.

Figure B11.1
Baseline operational greenhouse gas emissions by source



Source: APAM

Figure B11.2
Baseline operational greenhouse gas emissions by scope



Source: APAM

B11.5.2
Baseline emissions

Table B11.14 provides a summary of the results for the baseline, with detail on the units and metrics assessed – i.e. the total emissions, the total emissions per passenger, and the total emissions per ATM. Emissions associated with the LTO cycle are included.

Table B11.14
Baseline GHG emissions results – units and metrics

Parameter	Baseline
Passengers (no.)	37,395,992
Air traffic movements (no.)	254,280
Total emissions (Scope 1, 2 & 3 tCO_2-e/year)	635,812
Emissions per passenger (Scope 1, 2 & 3 tCO_2-e/passenger)	0.017
Emissions per ATM (Scope 1, 2 & 3 tCO_2-e/ATM)	2.50

Table Notes: Passenger numbers have been taken from the 2018/19 NGER Report Total emissions differ those presented in the 2018/19 NGER Report due to different emissions inventory boundaries and emissions scopes included.

B11.6
ASSESSMENT OF POTENTIAL IMPACTS

The assessment of potential impacts for GHG emissions is presented as a construction assessment and an operational assessment, before the results are combined.

B11.6.1
Construction

The results of the construction GHG assessment are presented in Table B11.15, Figure B11.3 and Figure B11.4.

Table B11.15
Results – construction GHG assessment

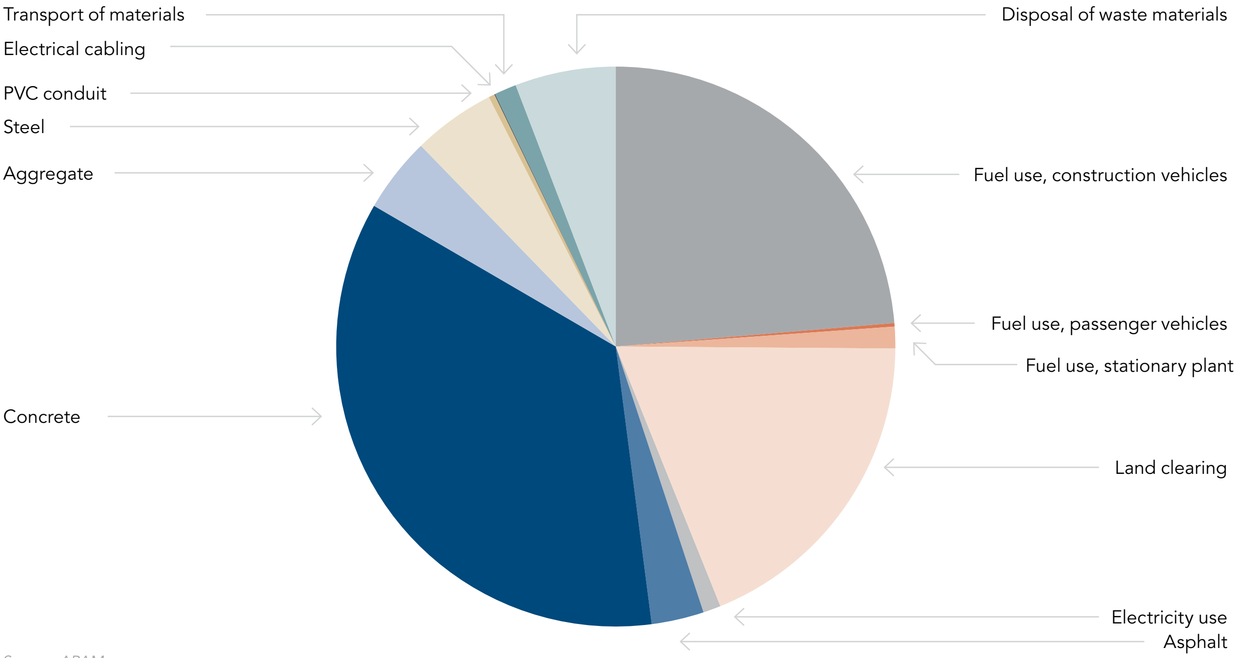
Source	Emissions (tCO_2-e)			
	Scope 1	Scope 2	Scope 3	Total
Fuel use, construction vehicles	95,018		4,851	99,869
Fuel use, passenger vehicles	816		42	858
Fuel use, stationary plant	5,008		257	5,265
Land clearing	79,315			79,315
Electricity use		3,836	434	4,297
Asphalt			12,777	12,777
Concrete			149,571	149,571
Aggregate			18,352	18,352
Steel			20,144	20,144
PVC conduit			1,453	1,453
Electrical cabling			224	224
Transport of materials			5,366	5,366
Disposal of waste materials			24,603	24,603
Total	180,157	3,836	238,074	422,094

Table Notes: Where figures have been rounded discrepancies may occur between totals and the sums of component items.

The results in **Figure B11.3** and **Figure B11.4** show that the emissions are dominated by Scope 1 and 3 sources. This is largely due to fuel use by construction vehicles, land clearing (both Scope 1) and embedded emissions in the concrete used during construction (Scope 3).

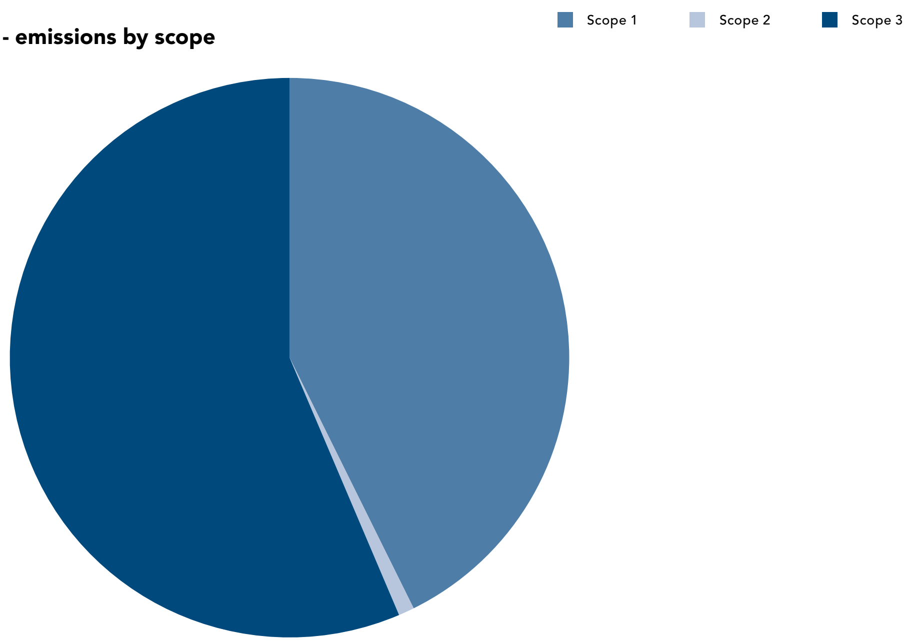
The duration of the construction program is four to five years. Four years (48 months) has been conservatively applied for following calculations. Assuming emissions were generated linearly across this period, this would result in annual average emissions of 46,005 tonnes CO_2-e/year (for Scope 1 and 2 sources) and 105,524 tonnes CO_2-e/year (for all scopes). Emissions from potential NGER reportable emissions sources (scopes 1 and 2 minus land clearing emissions) would be approximately 26,176 tonnes CO_2-e/year.
This would represent an approximate 47 per cent increase on 2019/20 NGER emissions for Melbourne Airport for the four years of construction (however note that assumptions regarding fuel and electricity consumption for construction are conservative, and this number would be expected to be at the upper limit of the expected range).

Figure B11.3
Construction GHG assessment – emissions by source



Source: APAM

Figure B11.4
Construction GHG assessment - emissions by scope



Source: APAM

The severity of construction related emissions has been categorised as minor adverse where they relate to those sources forming a significant contribution to the identified impact (i.e. from fuel combustion or material use). This is because the projected emissions, based on worst-case assumptions, sit on the borderline of the annual NGER threshold of 25,000 tonnes CO_{2-}e/year. It is expected the actual amount would be low enough to warrant a minor adverse rating.

B11.6.2
Operation

The results of the operational GHG assessment are presented in **Table B11.16** and **Figure B11.5** and **Figure B11.6**.

The results show that emissions substantially increase in the period 2026 to 2046 between the No Build and Build scenarios (approximately 0.27 megatonnes CO_2-e/year). This is the expected result given the additional air traffic that will use M3R.

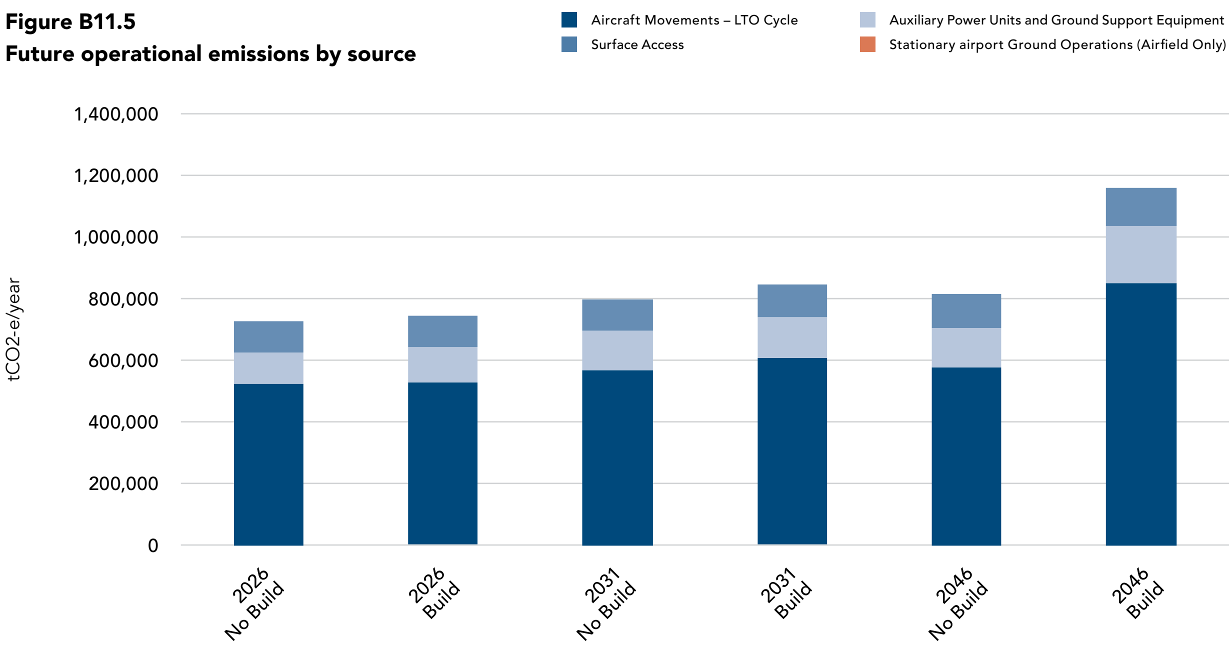
Decreases in emissions associated with electricity consumption on-site over time are related to the future reduction in the electricity grid's emissions intensity.

Table B11.16
Results – operational GHG assessment

Source	Emission Factor	Annual GHG emissions (tCO_2-e)					
		2026 No Build	2026 Build	2031 No Build	2031 Build	2046 No Build	2046 Build
Electricity – airfield	Electricity	1,428	2,142	1,355	2,032	841	1,262
Diesel – standby generators	Diesel oil (stationary energy)	23	23	24	26	25	37
Sub-total		1,451	2,165	1,379	2,058	866	1,299
Aircraft – descent	Kerosene – for use as fuel in an aircraft (transport energy)	120,600	120,600	130,820	138,997	132,864	195,208
Aircraft – taxi	Kerosene – for use as fuel in an aircraft (transport energy)	81,090	81,090	87,962	93,460	89,337	131,256
Aircraft – take off	Kerosene – for use as fuel in an aircraft (transport energy)	57,745	57,745	62,639	66,554	63,618	93,469
Aircraft – climb out	Kerosene – for use as fuel in an aircraft (transport energy)	265,848	265,848	288,378	306,401	292,884	430,314
Sub-total		525,284	525,284	569,799	605,412	578,702	850,247
Auxiliary power units	Kerosene – for use as fuel in an aircraft (transport energy)	89,186	105,145	114,154	121,267	115,650	169,526
Ground support equipment	Diesel oil (transport energy)	9,919	9,917	10,767	11,438	10,908	15,990
Sub-total		99,105	115,062	124,921	132,705	126,558	185,516
Surface Access - Road	Multiple	101,530	104,199	103,261	109,602	108,454	125,812
Sub-total		101,530	104,199	103,261	109,602	108,454	125,812
TOTAL		727,370	746,710	799,361	849,777	814,580	1,162,874

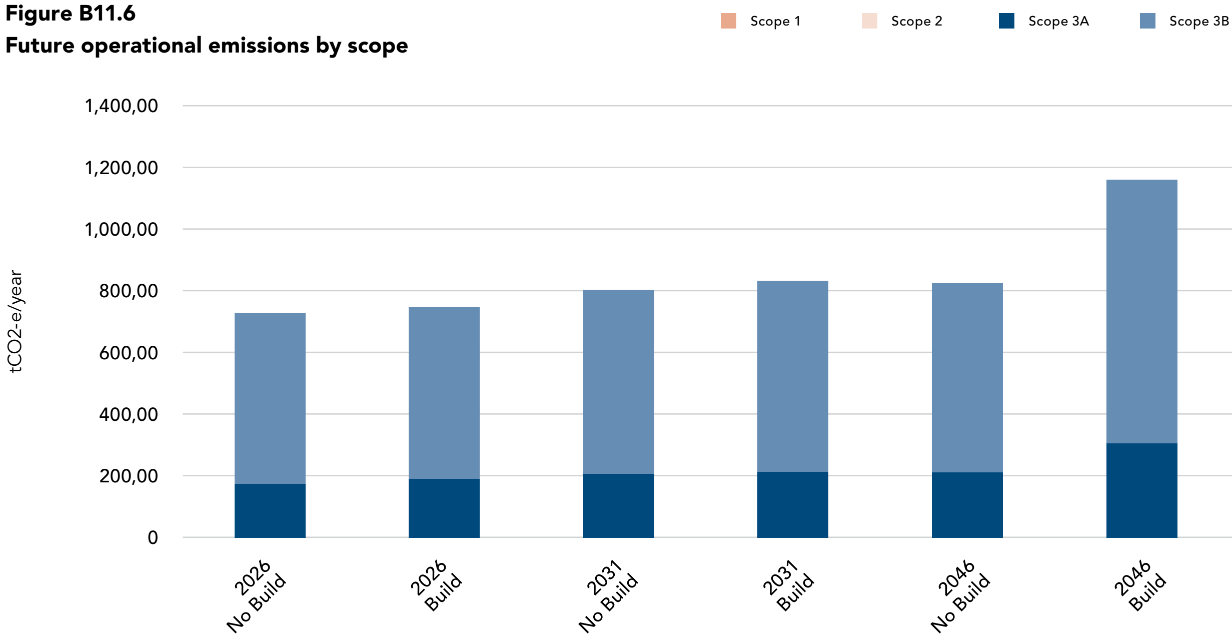
Table Notes: Where figures have been rounded discrepancies may occur between totals and the sums of component items.

Figure B11.5
Future operational emissions by source



Source: APAM

Figure B11.6
Future operational emissions by scope



Source: APAM

Figure B11.7 shows a cumulative emissions profile for M3R. This focuses on the construction emissions, and the difference between the Build and No Build scenarios only. C1-C4 represent the four years of construction. The difference between Build and No Build emissions for 2026 and 2046 is inserted, and linearly interpolated for the years in between. The figures show that over the construction period, and for 21 years of operation, M3R will contribute approximately 4.3 megatonnes CO_2-e above forecast emissions for the No Build scenario.

B11.6.3
Summary and review relative to functional units

Table B11.17 compares the results for each of the scenarios modelled according to the functional units (i.e. the total emissions, the total emissions per passenger and the total emissions per ATM). These results include emissions for two operational runways in the No Build scenarios, and three runways in the Build scenarios.

For emissions per ATMs, the No Build scenarios slightly increase between 2026 and 2046 while there is a slight decrease in emissions per ATMs under the Build scenario.

Figure B11.7
Cumulative emissions profile – construction and operation

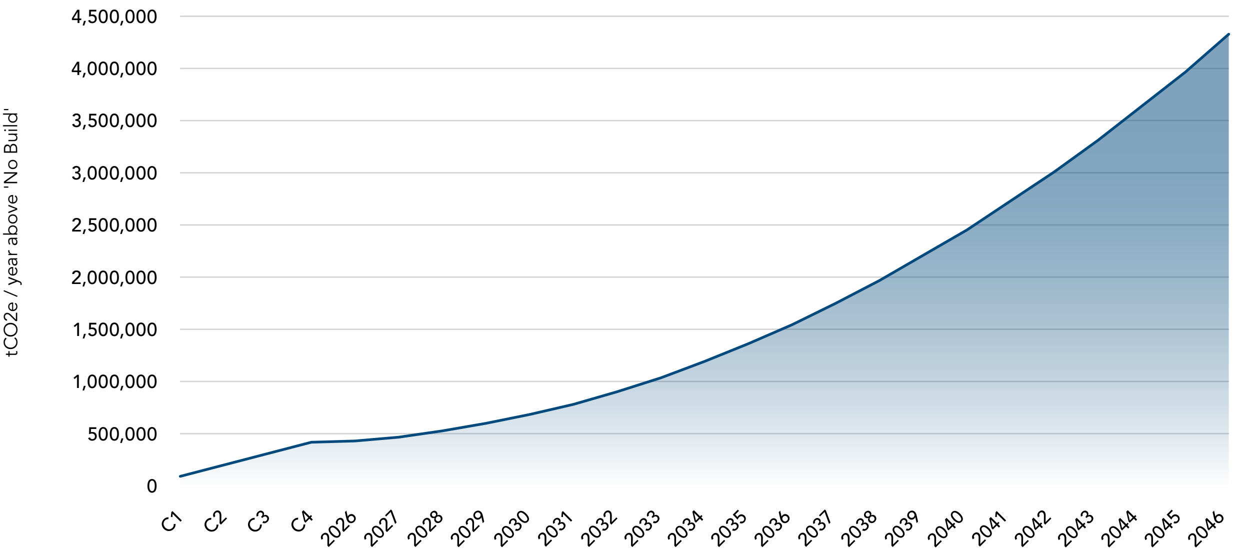


Table B11.17
GHG emissions results – functional unit comparison

Parameter	Annual GHG emissions (tCO_2-e)					
	2026 No Build	2026 Build	2031 No Build	2031 Build	2046 No Build	2046 Build
Passengers (no.)	47,300,000	47,300,000	54,400,000	56,900,000	60,000,000	83,800,00
ATM (no.)	299,832	299,780	325,468	345,748	329,732	483,340
Total emissions (all scopes) (tCO_2-e/year)	727,370	746,710	799,361	849,777	814,580	1,162,874
Emissions per passenger (all scopes) (tCO_2-e/passenger)	0.015	0.016	0.015	0.015	0.014	0.014
Emissions per ATM (all scopes) (tCO_2-e/ATM)	2.43	2.49	2.46	2.46	2.47	2.41

Latest data available for Australian and Victorian annual GHG emissions is 2018 data (AGEIS, 2020). This shows emissions inventories of:

- 537,446 kilotonnes CO_2-e per year – for Australia
- 102,189 kilotonnes CO_2-e per year – for Victoria.

The additional impact of M3R above the No Build scenario would be:

- 2026 – 19 kilotonnes CO_2-e per year (0.004 per cent of national emissions/0.02 per cent of Victorian emissions)
- 2031 – 50 kilotonnes CO_2-e per year (0.009 per cent of national emissions/0.05 per cent of Victorian emissions)
- 2046 – 348 kilotonnes CO_2-e per year (0.06 per cent of national emissions/0.34 per cent of Victorian emissions).

Based on **Table B11.1's** severity ratings, Scope 1 and 2 emissions impacts associated with operational energy consumption (airfield electricity consumption and generator fuel use) have been rated as negligible. Impacts associated with aircraft fuel consumption have been rated as high adverse, based on the relative contribution they make to current national and Victorian emissions inventories.

B11.7 AVOIDANCE, MANAGEMENT AND MITIGATION MEASURES

This section gives an overview of the carbon-emission abatement initiatives being reviewed as part of M3R, focusing on measures under the control of Melbourne Airport.

Section B11.7.2 presents the results of the residual significance assessment after taking these measures into account.

B11.7.1
Abatement options

M3R still requires its final detailed design, airline negotiations and construction feasibility. It is therefore not possible at present to identify all the initiatives to reduce the projected construction and operational GHG emissions under Melbourne Airport's control.

However, Melbourne Airport is committed to abate emissions by reducing M3R's:

- Construction GHG emissions where possible
- Operational GHG emissions under the control of Melbourne Airport (Scope 1 and 2) where possible.

To inform the selection of GHG mitigation measures in the detailed design the following options have been identified.

B11.7.1.1
Construction

Measures to reduce emissions production during construction of the new north-south runway (16R/34L) include:

- Minimising the construction footprint and vegetation removal
- Greater substitution of cementitious materials for Portland cement during concrete works, and greater use of recycled steel
- Local sourcing strategies (i.e. selection of construction materials from local suppliers)
- The potential to use alternative forms of concrete reinforcements, where feasible, to reduce steel consumption (including polymer, fibre and steel fibre reinforcement)
- The potential to specify warm-mix asphalt over hot-mix asphalt to reduce the embodied energy of this essential construction material
- Focusing on an overall reduction in the total construction material requirement where feasible
- Managing site works (and broader construction opportunities) to achieve as closely as possible a neutral cut-and-fill balance (that is, to reuse excavated materials on-site where feasible)
- Managing any contaminated land in situ where feasible to avoid the bulk export and import of materials to and from site (subject to legislative and regulatory requirements)
- The use of energy efficient vehicles and biofuels in the construction process
- Re-use of green waste on site e.g. compost.

B11.7.1.2
Operation

Measures to reduce emissions production during operations of the new north-south runway (16R/34L) include:

- Sustainable energy generation, including solar
- Low emission options for on-site transport given airports require a significant variety of on-site transport such as shuttle buses and luggage handling vehicles. Electrification, high efficiency and E10 (unleaded petrol blended with 9 to 10 per cent ethanol) are potential options for to be further explored
- Efficient taxiing of aircraft (thereby reducing the time from taxi to runway) is explained in the mitigation measures section of Chapter B10: Air Quality
- The use of high energy efficiency plant and equipment (such as tunnel lighting and ventilation) where appropriate
- Operational commitments associated with Melbourne Airport's TAKE2 pledge and the APAC ESG Strategy.

B11.7.2
Significance assessment

The assessment of severity (based on the descriptions in Table B11.1) has taken a broad approach whereby:

- The non-mitigated severity of construction related emissions has been categorised as minor adverse where they relate to sources forming a significant contribution to the identified impact (i.e. from fuel combustion or material use). This is because the projected emissions are, using worst-case assumptions, on the borderline of the annual NGER threshold of 25,000 tonnes CO_2-e/year. It is expected the actual amount would be low enough to warrant a minor adverse rating.
- The severity of operational emissions has been categorised based on the emissions of the nominated source (rather than the total emissions of operation).

The full summary assessment is contained in Table B11.19, with a summary of the residual significance assessment provided in Table B11.18. This assessment considers the application of the above mitigation measures.

Attaining Victorian, national and international commitments for carbon neutral growth, and achievement of carbon neutrality, would make a significant change to the identified severity ratings. However, these are outside the scope of the MDP and are instead considered by the Master Plan 2022 and Environment Strategy for the airport.

Table B11.18
Results of residual significance assessment – GHG impact

Impact	Severity	Likelihood	Impact risk
Construction			
Construction materials – embodied carbon – indirect (scope 3) impact associated with the manufacture of construction materials used (material manufacture).	Minor adverse	Likely	Medium
Construction materials – embodied carbon – indirect (scope 3) impact associated with the transport of construction materials used (material transport).	Minor adverse	Likely	Medium
Earthworks – GHG emissions – direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 3) impacts associated with off-site haulage – reducing haulage emissions.	Minor adverse	Likely	Medium
Earthworks – GHG emissions – direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 2 and scope 3) impacts associated with material treatment in off-site facilities (management of contaminated land).	Minor adverse	Likely	Medium
Earthworks – GHG emissions – direct (scope 1) impacts associated with fuel use in construction vehicles, plant and equipment on site; direct (scope 1) emissions relating to loss of carbon sink.	Minor adverse	Likely	Medium
Construction fuel and energy use – GHG emissions – direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 3) emissions associated with fuel supply chain.	Minor adverse	Likely	Medium
Operation			
Purchased electricity for lighting (airfield) – GHG emissions – indirect (scope 2) impacts associated with imported electricity use (incremental electricity consumption compared to the No Build scenario). Note: airfield lighting makes up approximately half of the overall electrical load of M3R.	Negligible	Likely	Negligible
Purchased electricity for ventilation/lighting (tunnel) – GHG emissions – indirect impact (scope 2 emissions): jet fans required for longitudinal ventilation and smoke control within tunnel; in-tunnel lighting.	Negligible	Likely	Negligible
Fuel consumption from aircraft movements – GHG emissions – indirect (scope 3) impacts associated with aircraft fuel use during LTO cycle up to 10,000 feet AGL, and whilst on stand.	High adverse	Likely	High

B11.8 CONCLUSION

The greenhouse gas assessment has determined the expected emissions of GHGs associated with the construction and operation of M3R compared to the No Build scenarios. It identified that the construction of M3R would result in emissions of 422 kilotonnes CO_2-e over the four years of construction (Scopes 1, 2 and 3).

Operation of M3R would result in the following emissions:

- 2026 – 19 kilotonnes CO_2-e per year (0.003 per cent of national emissions/0.02 per cent of Victorian emissions)
- 2031 – 50 kilotonnes CO_2-e per year (0.009 per cent of national emissions/0.05 per cent of Victorian emissions)
- 2046 – 348 kilotonnes CO_2-e per year (0.06 per cent of national emissions/0.34 per cent of Victorian emissions).

The vast majority of these emissions are related to aircraft in the LTO cycle and auxiliary power units. These are both Scope 3 sources, i.e. emissions associated with M3R but from sources not owned or operated by Melbourne Airport. Emissions associated with surface access (employees and passengers accessing the airport using the current road network) are also a material contributor to forecast emissions; however, Scope 1 and 2 emissions (direct emissions from sources owned and operated by Melbourne Airport, as well as emissions associated with electricity consumption) are minimal given the magnitude of other sources.

While these emissions are relatively low, Melbourne Airport understands the importance of taking action and is committing to abate emissions by reducing M3R's:

- Construction GHG emissions where possible
- Operational GHG emissions under the control of Melbourne Airport (Scope 1 and 2) where possible.

Melbourne Airport is committed to the TAKE2 pledge, part of a strategy to achieve carbon neutrality in Victoria by 2050. Melbourne Airport has also committed to clear carbon emission reduction targets and actions as outlined in the APAC ESG Strategy. This includes a commitment to achieve net-zero for Scope 1 and Scope 2 carbon emissions by 2025. In addition, there is a range of national commitments to support sustainable aviation including:

- Improvement in aircraft energy efficiency
- Improvement in aircraft routing and handling
- Increased use of low energy technology for aircraft at stand
- Research for sustainable aviation biofuels
- Establishment of forums for the exchange of best practice ideas.

Table B11.19
GHG impact assessment summary

Environmental aspect & baseline condition	Description and characterisation of impact					
	Original Impact	Mitigation inherent in design/ practice	Temporal	Significance assessment		
				Severity	Likelihood	Impact risk
Construction						
Construction materials – embodied carbon (material manufacture) N/A	Without mitigation management measures and controls, indirect (scope 3) impact associated with the manufacture of construction materials used	Roads: potential for alternate and reuse of material to reduce embodied impact and carbon profile	Permanent	Minor adverse	Likely	Medium
Construction materials – embodied carbon (material transport) N/A	Without mitigation management measures and controls, indirect (scope 3) impact associated with the transport of construction materials used	Roads: potential for alternate and reuse of material to reduce embodied impact and carbon profile	Permanent	Minor adverse	Likely	Medium
Earthworks – GHG emissions – reducing haulage emissions N/A	Without mitigation management measures and controls, direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 3) impacts associated with off-site haulage	Earthworks: minimise cut and fill to reduce material impacts and carbon profile, potential for conservation of on-site resources. Minimise any off-site disposal. Unsuitable material will be used in landscaping. All topsoil will be reused on-site.	Permanent	Minor adverse	Likely	Medium
Earthworks – GHG emissions – management of contaminated land N/A	Without mitigation management measures and controls, direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 2 and scope 3) impacts associated with material treatment in off- site facilities.	Earthworks: minimise cut and fill to reduce material impacts and carbon profile, potential for conservation of on-site resources.	Permanent	Minor adverse	Likely	Medium
Earthworks – GHG emissions – vegetation clearance N/A	Without mitigation management measures and controls, direct (scope 1) impacts associated with fuel use in construction vehicles, plant and equipment on site; direct (scope 1) emissions relating to loss of carbon sink.	Airfield pavements, including landscaping: potential for alternate and reuse of material to reduce embodied impact and carbon profile, use of native vegetation for landscaping and urban design considerations	Permanent	Minor adverse	Likely	Medium
Construction fuel and energy use – GHG emissions N/A	Without mitigation management measures and controls, direct (scope 1) impacts associated with fuel use in construction vehicles on-site and indirect (scope 3) emissions associated with fuel supply chain.	Optimising sourcing of fill for M3R on-site to minimise haulage transport consumption.	Permanent	Minor adverse	Likely	Medium

Melbourne Airport has now achieved Level 2 carbon accreditation under the Airport Carbon Accreditation (ACA) framework. The framework will also capture its revised carbon reduction target and associated carbon management plan recently developed.

Internationally, ICAO has reached a commitment to achieve carbon neutral growth in international aviation emissions from 2020. Australia committed to participating in this scheme from the outset. This involves baselining international aviation emissions in 2019 and 2020 and offsetting any emissions from 2021 onwards that are in excess of this baseline. Table B11.19 below provides a summary of the GHG impact assessment.

Mitigation or management measures	Description of residual impact				
	Impact	Temporal	Significance assessment		
			Severity	Likelihood	Impact risk
Construction (cont.)					
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by up to 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by up to 10 per cent	Permanent	Minor adverse	Likely	Medium
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by 10 per cent	Permanent	Minor adverse	Likely	Medium
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by 10 per cent	Permanent	Minor adverse	Likely	Medium
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by 10 per cent	Permanent	Minor adverse	Likely	Medium
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by 10 per cent	Permanent	Minor adverse	Likely	Medium
Melbourne Airport commitment to reduce M3R construction greenhouse gas emissions by 10 per cent below a business as usual approach	Reduction in construction greenhouse gas emissions by 10 per cent	Permanent	Minor adverse	Likely	Medium

Environmental aspect & baseline condition (cont.)	Description and characterisation of impact (cont.)					
	Original Impact	Mitigation inherent in design/ practice	Temporal	Significance assessment		
				Severity	Likelihood	Impact risk
Operation						
Purchased electricity for lighting (airfield) – GHG emissions Note: total M3R demand approximately 4MW, compared to Melbourne Airport 30MW peak demand.	Without mitigation management measures and controls, indirect (scope 2) impacts associated with imported electricity use (incremental electricity consumption compared to the No Build scenario). Note: airfield lighting makes up approximately half of the overall electrical load of the M3R.	Airfield ground lighting: reduction in energy profile through low energy lighting/reward prevention of light spill. The lighting design for operation complies with AS4282 'control of the obtrusive effects of outdoor lighting' and AS1158 'road lighting'.	Permanent	Negligible	Likely	Negligible
Purchased electricity for ventilation/ lighting (tunnel) – GHG emissions Note: total M3R demand approximately 4MW, compared to Melbourne Airport 30MW peak demand.	Without mitigation management measures and controls, indirect impact (scope 2 emissions): jet fans required for longitudinal ventilation and smoke control within tunnel; in-tunnel lighting.	Tunnel and structures: reduce energy consumption associated with mechanical tunnel ventilation and tunnel lighting	Permanent	Negligible	Likely	Negligible
Fuel consumption from aircraft movements – GHG emissions N/A	Without mitigation management measures and controls, indirect (scope 3) impacts associated with aircraft fuel use during LTO cycle up to 10,000 feet AGL, and whilst on stand.	Airfield planning: airfield layout to minimise impact on ground based environmental and heritage aspects and to seek opportunities for enhancement. Airline carbon offset mitigation programs.	Permanent	High adverse	Likely	High

Mitigation or management measures (cont.)	Description of residual impact (cont.)				
	Impact	Temporal	Significance assessment		
			Severity	Likelihood	Impact risk
Operation (cont.)					
Melbourne Airport commitment to reduce M3R operational greenhouse gas emissions, under the control of Melbourne Airport (scope 1 and 2), by 10 per cent below a business as usual approach	Reduction in operational greenhouse gas emissions by 10 per cent	Permanent	Negligible	Likely	Negligible
Melbourne Airport commitment to reduce M3R operational greenhouse gas emissions, under the control of Melbourne Airport (scope 1 and 2), by 10 per cent below a business as usual approach	Reduction in operational greenhouse gas emissions by 10 per cent	Permanent	Negligible	Likely	Negligible
Support ongoing state, national and international commitments to reduce and offset aviation emissions	These emissions are outside the scope of Melbourne Airport to directly control and therefore the residual impact remains	Permanent	High adverse	Likely	High

REFERENCES

Airports Council International (ACI) (Europe) 2014, Airport Carbon Accreditation, accessed 2017, http://www.airportco2. org/actions.html

Airports Council International (ACI) 2009, Airports Council International – Guidance Manual: Airport Greenhouse Gas Emissions Management, accessed 2017, http://www.aci. aero/Media/aci/file/Publications/2009/ACI%20Guidance%20Manual%20Airport%20Greenhouse%20Gas%20Emissions%20Management.pdf

Australian Bureau of Statistic (ABS) 2015, Australian Bureau of Statistics, Survey of Motor Vehicle Use, Australia, 12 months ended 31 October 2014, accessed October 2015, http://www. abs.gov.au/ausstats/abs@.nsf/mf/9208.0

Australian Commonwealth Government 2015, Australia's Intended Nationally determined Contribution to a new Climate Change Agreement, Australian Govt. Pub.

Australian Government Department of the Environment and Energy, Australian Greenhouse Emissions Information System (AGEIS), Australian Govt. Pub. Services, accessed 2020 http:// ageis.climatechange.gov.au/

Australian Government Department of Industry, Science, Energy and Resources, National Greenhouse Accounts Factors, October 2020. Accessed at: https:// https://www.industry.gov.au/sites/default/files/2020-10/national-greenhouse-accounts-factors-2020.pdf

Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), (UN ICAO, 2016b)

Infrastructure Sustainability Council of Australia (ISCA), 'Infrastructure Sustainability Council of Australia (ISCA) materials calculator Version 2.0.04, ISCA, 2019.

International Civil Aviation Organization (ICAO) 2011, Airport Air Quality Manual, accessed 2020, https://www.icao.int/publications/Documents/9889_cons_en.pdf

Jacobs 2016, Modelling undertaken by Jacobs for the Federal Government to assess the likely carbon intensity of Victorian Electricity supply to 2034/35: Confidential, Melbourne.

National Greenhouse Accounts Factors, Department of Environment and Energy, 2019

Savaresi A. 2016, The Paris Agreement: An Early Assessment, Environmental Policy and Law Vol. 46, Issue 1, 2016, pp. 14-18.

Services, accessed 2020, https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Australia/1/Australias%20Intended%20Nationally%20Determined%20Contribution%20to%20a%20new%20Climate%20Change%20Agreement%20-%20August%202015.pdf

State of the Climate, CSIRO, 2020

Sustainability Victoria 2020, Victorian recycling industry annual report 2018-19. Accessed 2020, https://www.sustainability.vic.gov.au/Government/Victorian-Waste-data-portal/Victorian-Recycling-Industry-Annual-Report

Transport of New South Wales (TfNSW) 2015, Carbon Emissions Reporting Tool (CERT) Version 1.1, NSW Govt. Pub. Services, accessed 2017, http:// www.transport.nsw.gov.au/ sites/default/files/b2b/projects/cert-user-guide.pdf

United Nations Framework Convention on Climate Change (UNFCCC) 2014, Paris Agreement, accessed 2016, http:// unfccc.int/files/essential_background/convention/ application/pdf/english_paris_agreement.pdf

VicRoads 2013, Carbon Gauge GHG calculator for Road Projects Version 01.1

https://www.rms.nsw.gov.au/about/environment/sustainability/energy-greenhouse.html#Carbonemissionsandtools

World Business Council for Sustainable Development (WBCSD) 2013, The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard: Revised edition, Geneva, WBCSD and World Resource Institute, Geneva.

Chapter B12
Landscape and Visual

Summary of key findings:

- Melbourne Airport has been operating since the early 1970s, so is well established within the landscape. The proposed development of Melbourne Airport's Third Runway (M3R) is generally consistent with the airport planning framework contemplated by the Commonwealth Government's 1990 Environmental Impact Statement. The community has been informed of proposed developments and impacts through subsequent statutory Master Plans that have been approved since 1997.
- Construction of M3R has the potential to impact the site's landscape values due to the removal of vegetation, and earthworks that will alter the landform. The visual impacts caused by earthworks and the removal of part of the Grey Box Woodland would be permanent; however, the visual impacts caused by other construction activity will be short term. These impacts will be seen in the context of the existing airport and are unlikely to be significant.
- When M3R becomes operational, there will be a moderate impact on views from rural landscapes due to vistas being opened to M3R and existing areas of the airport.

CHAPTER B12 CONTENTS

CHAPTER B12 CONTENTS (cont.)

CHAPTER B12 FIGURES

CHAPTER B12 FIGURES (cont.)

CHAPTER B12 TABLES

B12.1
INTRODUCTION

This chapter describes the study area's existing landscape and visual conditions and the applicable legislation and policy requirements. It then identifies the potential impact of Melbourne Airport's Third Runway (M3R) on the area's existing landscape and views in the daytime and night-time. Where practicable, this assessment identifies the specific measures that can be used to avoid, manage, mitigate and/or monitor impacts.

This work was undertaken for Melbourne Airport by specialist consultants IRIS Visual Planning and Design.

For the purposes of this chapter, 'study area' refers to the M3R project area and the surrounding landscape that may be impacted by the project. The 'project area' refers only to that area defined by the maximum extent of disturbance associated with the M3R construction process (as shown in **Chapter A4: Project Description**, **Figure A4.1: M3R Overview**).

B12.2
METHODOLOGY AND ASSUMPTIONS

This landscape and visual impact assessment was undertaken in the following stages:

- Identification of the existing landscape and visual conditions
- Identification of M3R's proposed components and character
- Assessment of M3R's landscape impact
- Assessment of M3R's daytime visual impact
- Assessment of M3R's night-time visual impact
- Identification of the opportunities to mitigate M3R's impact
- Developing an impact assessment that takes into account the proposed mitigation measures.

B12.2.1
Guidance for landscape and visual assessment

There is a range of guidance available for landscape and visual assessment. The methodology for this assessment is based on two nationally and internationally accepted guidance documents: the *Guidance Note for Landscape and Visual Assessment*, (Australian Institute of Landscape Architects, 2018) and *Guidance for Landscape and Visual Impact Assessment* (GLVIA) Third Edition (Landscape Institute and Institute of Environmental Management & Assessment UK, 2013). Regard has also been given to the methodology suggested by the *Landscape Assessment Guidelines* (Heritage Victoria, 2009) that advises on the assessment of impacts on Victoria's culturally significant landscapes.

The assessment of night-time visual impacts draws on the terminology of *AS4282 Control of the Obtrusive Effects of Outdoor Lighting* (Council of Standards Australia, 2019).

The landscape and visual impact significance criteria have been based on the guidance in the above documents as well as the parameters of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act), *Significant impact guidelines 1.2 – actions on, or impacting upon, Commonwealth land and actions by Commonwealth agencies* (DSEWPC, 2013).

However, these documents do not prescribe a method for landscape and visual impact assessments. The following method has therefore been developed for the project. It is based on the above documents and is applicable to the type and scale of M3R.

B12.2.2
Relevance to previous regulatory frameworks

This assessment takes into account the 1990 Environmental Impact Statement (EIS) approved by the Commonwealth Government and reinforced by community engagement and Ministerial approval of master plans since 1997. Based on the regular community consultation and public notice required for these statutory processes, it is reasonable to assume the community is aware of the scale and intent of the airport's development (including the proposed M3R development covered by this framework).

B12.2.3
Existing visual conditions

An inspection of the study area was carried out in September and October 2016, and additional photographs were provided by the project team in 2018 and 2020. These site inspections (plus additional desktop analysis) were used to evaluate the area's existing landscape character, with the photographs representing a variety of views.

B12.2.4
M3R components

The components of M3R have been described in terms of the proposed infrastructure; and the activities visible during its construction, operation and maintenance in both daytime and night-time. They are described in terms of their form, shape, mass and scale, material, movement and lighting (where known).

B12.2.5
Landscape impact assessment

The landscape impact assessment was based on identifying the sensitivity of the landscape and the level of modification caused by M3R. These were then used to assign a level of likely landscape impact.

B12.2.5.1
Landscape sensitivity

Landscape sensitivity refers to the value placed on a landscape element or character area, and the level of service it provides to the community. 'Sensitivity' may reflect the frequency and volume of users in a location; it may also refer to the value of characteristics such as tranquillity, visual relief, and contribution to microclimate.

The value of landscapes is often described in council planning schemes, Victorian Government master plans and planning policy documents. This shows the importance of landscape resources to local, regional and state-wide communities.

The sensitivity of landscape features is therefore considered in the broadest context of possible landscapes: from those of national importance through to those considered to have a local or neighbourhood landscape importance (**Table B12.1**).

In this table, the terms 'state' and 'regional' landscape sensitivity describe the value placed on the landscape by the community. (Landscape features afforded legislative protection are specifically identified in the policy context section of this assessment.)

Table B12.1
Landscape sensitivity levels

Landscape sensitivity level	Description
National	Landscape feature protected with national or international legislation. A landscape feature or place that attracts international visitors and is iconic to the nation (e.g. the public realm of the World Heritage listed Sydney Opera House, Lake Burley Griffin, and the beaches of the Twelve Apostles Marine National Park).
State	Landscape feature or urban place that is heavily used and is iconic to the state (e.g. Federation Square, Birrarung Marr and the Royal Botanic Gardens Melbourne).
Regional	Landscape feature that is moderately used or valued by residents of a major portion of a city or a non-metropolitan region (e.g. Organ Pipes National Park and Woodlands Historic Park).
Local	Landscape feature valued and experienced by concentrations of residents and/or local recreational users. Provides a service to the local community. For example, it provides a place for gathering, recreation, sport or trail walking.
Neighbourhood	Landscape feature valued and appreciated primarily by a small number of residents, workers or visitors (e.g. trees lining a rural road, or scattered across a field or a vineyard). For example, it provides an opportunity for passive recreation and/or some shade and shelter to a road.

B12.2.5.2
Landscape modification

Landscape modification refers to the change in the landscape caused by a project. It includes direct impacts (such as the removal of trees or parkland, and changes to topography and landform) and indirect impacts (the functional change of an area of open space due to altered land use and accessibility).

Landscape modification can result in either adverse or beneficial effects. Table B12.2 lists the terminology used to describe the levels of landscape modification.

B12.2.6
Visual impact assessment

The assessment of visual impact is based on identifying the sensitivity of the viewer ('visual sensitivity') and the level of visual modification created by M3R. When combined, they determine the level of likely visual impact. (This approach is explained more fully in the following sections.)

In order to assess impacts on the visual conditions of the project area, representative viewpoints have been selected to illustrate the range of views to M3R. These viewpoints represent publicly accessible views from a variety of locations and viewing situations. Particular attention was paid to views near residential properties; and places where viewers might congregate such as parks and reserves, approach roads and elevated lookouts.

B12.2.6.1
Visual sensitivity

Visual sensitivity (as distinct from landscape sensitivity above) refers to the nature and duration of views. Locations with a higher number of potential viewers – where visual amenity is important to viewers, and where a view may be seen for longer – can be regarded as having a higher visual sensitivity. Views that are recognised in local, Victorian or Commonwealth planning documents will have a higher sensitivity level.

To ensure a reasonable assessment of impact, a viewpoint's sensitivity is considered in the broadest context of possible views: from those of 'national' visual importance down to those considered to be of 'neighbourhood' visual importance. The terminology in Table B12.3 is used to describe the five levels of visual sensitivity.

B12.2.6.2
Visual modification

Visual modification describes the extent of change resulting from M3R and the compatibility of its new elements with the surrounding landscape. General principles determining the level of visual modification include elements relating to the view itself such as distance, landform, backdrop and contrast. In addition, there are the characteristics of the development, namely scale, form and alignment.

Visual modification can result in either an improvement or a reduction in visual amenity.

A high degree of visual modification occurs when a development contrasts strongly with the existing landscape.

A low degree of visual modification occurs if there is minimal visual contrast, and a high level of integration (of form, line, shape, pattern, colour or texture values), between the development and its environment in which it is viewed. In this situation, the development may be noticeable, but does not markedly contrast with the existing modified landscape.

Table B12.4 lists the terminology used to describe the level of visual modification.

Table B12.2
Landscape modification levels

Landscape modification level	Description
Considerable reduction in landscape quality	The quality of the landscape (character and function) will be substantially reduced. This may include substantial changes to the amount, location and distribution of landscape features of the site, including waterways, vegetation, changes to landform etc, that detract from the values of the landscape.
Noticeable reduction in landscape quality	The quality of the landscape (character and function) will be somewhat reduced. This may include changes to the amount, location and distribution of landscape features of the site, including waterways, vegetation, changes to landform etc., that detract from the values of the landscape.
No perceived reduction or improvement in landscape quality	Either the quality of the landscape (character/function) will be unchanged or, if changed, it is largely consistent with the quality (character/function) of the remaining landscape areas and/or mitigated by proposed improvements.
Noticeable improvement in landscape quality	The quality of the landscape (character and landscape function) will be somewhat improved. This may include changes to the amount, location and distribution of landscape features of the site, including waterways, vegetation, changes to landform etc., that enhance the values of the landscape.
Considerable improvement in landscape quality	The quality of the landscape (character and landscape function) will be substantially improved. This may include changes to the amount, location and distribution of landscape features of the site, including waterways, vegetation, changes to landform etc., that enhance the values of the landscape.

Table B12.3
Visual sensitivity levels

Visual sensitivity level	Description
National	Heavily experienced view to a national icon, e.g. view to the Twelve Apostles from the Loch Ard Gorge or visitor centre viewing area, Sydney Opera House from Lady Macquarie's Chair and a view to Parliament House along Anzac Parade, Canberra.
State	Heavily experienced view to a feature or landscape that is iconic to the state, e.g. views from the summit of Mt Buller in the Australian Alps National Park, view from Craig's Hut on Mt Stirling or a view to the Melbourne central business district skyline across the Yarra from the Main Yarra Trail, Alexandra Gardens.
Regional	Heavily experienced view to a feature or landscape that is iconic to a major portion of a city or a non-metropolitan region, or an important view from an area of regional open space, e.g. views from Guilfoyle's Volcano in the Royal Botanic Gardens Melbourne, a view from along the Esplanade to the entry of Luna Park, St Kilda, or a view to the basalt columns at the Organ Pipes National Park.
Local	View of high quality or experienced by concentrations of residents and/or local recreational users, and/or large numbers of road or rail users, e.g. view from Woodlands Historic Park or view from the Melbourne Airport aircraft viewing area on Sunbury Road.
Neighbourhood	Views where visual amenity is important at a neighbourhood scale, such as views seen from local roads, briefly glimpsed views to landscape features and views from scattered and groups of residences.

Table B12.4
Visual modification levels – day time

Visual modification level	Description
Considerable reduction in visual amenity	Changes the amenity of the view fundamentally, a substantial part of the view is altered and/or the change is not visually compatible with the character of the view.
Noticeable reduction in visual amenity	Changes the amenity of the view somewhat, the alteration to the view is clearly visible and/or the change is somewhat visually compatible with the character of the view.
No perceived reduction or improvement in visual amenity	Either the view is unchanged or, if it is changed, the change in the view is generally unlikely to be perceived by viewers and/or it is absorbed into the character of the view.
Noticeable improvement in visual amenity	Changes the amenity of the view somewhat, the alteration to the view is clearly visible and/or the change somewhat enhances the view.
Considerable improvement in visual amenity	Changes the amenity of the view fundamentally, a substantial part of the view is altered and/or the change transforms and enhances the character of the existing view.

B12.2.7
Assessment of night-time visual impact

An assessment of the potential visual impacts of M3R at night has been undertaken for each viewpoint.

The assessment of night-time impact has been carried out using a similar methodology to the daytime assessment. However, the night-time assessment also draws upon guidance in *AS4282 Control of the obtrusive effects of outdoor lighting* (Standards Australia, 2019).

AS4282 identifies four main potential effects of lighting: on residents, transport system users, transport signalling systems and astronomical observations. Of relevance to this assessment is the effects of lighting on the visual amenity of residents and transport system users.

AS4282 identifies environmental zones (shown in Table B12.5) which are useful for categorising night-time landscape settings. The following assessment will use these environmental zones to describe the existing night-time visual condition and assign a sensitivity to these settings.

B12.2.7.1
Night-time visual sensitivity

The environmental zone (defined in AS4282 and shown in Table B12.5) which best describes the existing night-time visual condition of the site has been selected. These zones are typical night-time settings and reflect the predominant light level of the site and visual study area. Each environmental zone is assigned a level of sensitivity, as described in the table.

Table B12.5
Environmental zone sensitivity – night-time

Environmental Zones (from AS4282:2019)		
Sensitivity level	**Zone Description**	**Examples**
Very high	A0: Intrinsically dark	UNESCO Starlight Reserve IDA Dark Sky Parks Major optical observatories No road lighting – unless specifically required by the road controlling authority Relatively uninhabited rural areas
High	A1: Dark	Relatively uninhabited rural areas No road lighting – unless specifically required by the road controlling authority
Moderate	A2: Low district brightness	Sparsely inhabited rural and semi-rural areas
Low	A3: Medium district brightness	Suburban areas in towns and cities
Negligible	A4: High district brightness areas	Town and city centres and other commercial areas Residential areas abutting commercial areas

Table B12.6
Visual modification levels – night-time

Modification	Description
Very high	• Substantial change to the level of skyglow, glare or light spill would be expected. • The lighting of the proposal would transform the character of the surrounding setting at night. • The effect of lighting would be extensive, dominating, and permanent.
High	• Considerable change to the level of skyglow, glare or light spill would be expected and/or • The lighting of the proposal would noticeably contrast with the surrounding landscape at night and/or • The effect of lighting would be experienced across a considerable portion of the landscape and/or • Be experienced for a long duration.
Moderate	• Alteration to the level of skyglow, glare or light spill would be expected and/or • The lighting of the proposal would contrast somewhat with the surrounding landscape at night and/or • The effect of lighting would be experienced across a moderate portion of the landscape and/or • Be experienced for a moderate duration.
Low	• Alteration to the level of skyglow, glare or light spill would be expected and/or • The lighting of the proposal would not contrast substantially with the surrounding landscape at night and/or • The effect of lighting would be experienced across a small portion of the landscape and/or • The effect of lighting would be experienced for a short duration.
Negligible	• Either the level of skyglow, glare and light spill is unchanged or • The change is generally unlikely to be perceived by viewers or compatible with the existing or intended future use of the area and/or • The effect of lighting would be experienced for a short duration and/or temporarily.

B12.2.7.2
Night-time visual modification

Following the sensitivity assessment, the degree of visual modification expected in the visual study area at night is then identified. These changes are described, as relevant, in terms of:

- Sky glow: the brightening of the night sky
- Glare: a condition of vision in which there is discomfort or a reduction in the ability to see
- Light spill: the light emitted by a lighting installation that falls outside the design area.

Table B12.6 describes each night-time visual modification level.

B12.2.8
Impact assessment

Impact has been assigned by combining the sensitivity and modification levels. This approach is described further in Section B12.4. In addition to the assigning of impact, the significance assessment incorporates the severity, duration and likelihood of the impacts.

B12.2.9
Mitigation measures

Opportunities for mitigation have been identified to avoid, reduce and/or manage the severity and/or likelihood of the impact where possible during construction and operation phases of M3R.

The impacts identified for M3R are then reassessed, and the residual effects and associated impacts of M3R identified.

B12.2.10
Impact significance, risk assessment, and residual effects

To conclude this assessment, a summary table has been completed. This includes the description and characterisation of impacts, mitigation or management measures, and an assessment of the residual impact based on these measures.

For each assessment, the characterisation of the impacts considers the temporal nature of the impact, and an assessment of significance, incorporating an identification of severity, likelihood and the resulting impact.

B12.2.11
Assumptions and limitations

The following assumptions and technical limitations have informed this study:

- The night-time conditions of the project area have been assumed from the daytime field work.
- There is an element of judgment used in the rendering of photomontages. The photomontages produced for this assessment were based on information available at the time and reviewed by the design team for consistency with the design intent.
- As both a two-dimensional and static medium, photographs and photomontages cannot capture the complexity of the visual experience. The views assessed and represented by photographs in this assessment therefore give only an approximate impression of the scene as it would be experienced by a person; a true understanding of impact will only be achieved by visiting the location from which a photograph was taken.
- The assessment of landscape and visual impact requires a level of considered judgment that may be subjective. Every effort has been made to reduce the subjectivity of this assessment and peer reviews undertaken to achieve consistency in the assignment of impacts.
- Simulations from four viewpoints were used to develop photomontages that demonstrate the scale and features of M3R from varying angles and distances. Although photomontages were not created for every viewpoint, four photomontages and a three-dimensional model were used to estimate what would be seen from the other viewpoints.
- Several site visits were undertaken between 2016 and 2018. Due to COVID-19 restrictions, additional photographs were taken in 2020 by a member of the project team guided by landscape and visual assessment specialists.

B12.2.12
Photography and photomontages

The approach to photography and photomontages was adapted from the Landscape Institute (UK) *Technical guidance note 06/19, Visual representation of development proposals (2019).*

The photographs used in this assessment were taken with a 35-millimetre single-lens reflex digital camera adjusted to achieve a 50-millimetre equivalent focal length, to most closely represent what the human eye sees.

The photomontages prepared for M3R are intended to act as artist's impressions: showing the general location, layout, scale and relationship of key elements of M3R to the surrounding landscape. They were created by using a photograph, computer modelling and photo-editing techniques as follows:

- Photography: a one-frame shot selected to replicate what will be seen by a person in any one view
- Data interpretation: a 3D model developed based on a digital-terrain model with one-metre data and 3D-design information provided by M3R engineers
- Photograph alignment: the model was positioned over the existing photograph using the Global Positioning System (GPS) coordinates of the location, and with a minimum of three existing elements within the photograph as reference points.
- Rendering: editing photographs using Adobe® Photoshop® software to render the finishes of the M3R elements (including the addition of colour, texture and shadow).

B12.3
STATUTORY AND POLICY REQUIREMENTS

Melbourne Airport is located on Commonwealth land leased by APAM (Australia Pacific Airports (Melbourne)). The Commonwealth *Airports Act 1996* (Airports Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) are the key pieces of legislation that set the regulatory framework for M3R and this assessment. However, consideration has also been given to relevant Victorian and local legislation (including environmental planning instruments, policies, and guidelines) as part of a holistic approach to environmental management.

There are Commonwealth, state and local government legislation, planning instruments, guidelines and reference documents which are relevant to the visual and landscape character values of the study area. These include the following Commonwealth, Victorian government and local authority statutory and policy requirements.

- *Environment Protection and Biodiversity Conservation Act 1999* (Cth)
- *National Parks Act 1975* (Vic)
- *Organ Pipes National Park Management Plan* (Parks Victoria, 1998)
- *Airports Act 1996 and Airports (Environmental Protection) Regulations 1997* (Cth)
- *Melbourne Airport Master Plan 2022* (Australia Pacific Airports Melbourne, *2022*)
- *Metropolitan Planning Strategy 2017-2050: Plan Melbourne* (DELWP, 2017)
- *Maribyrnong River Valley Design Guidelines* (Department of Planning and Community Development Victoria, 2010)
- *Keilor Market Gardens Cultural Landscape* (Victorian Heritage, 1999)
- *Hume Planning Scheme* (Hume City Council)
- *Brimbank Planning Scheme* (Brimbank City Council)
- *Brimbank Green Wedge Management Plan* (Brimbank City Council, 2010).

The following content summarises the relevant clauses contained in these documents.

B12.3.1
Commonwealth statutory and policy requirements

B12.3.1.1
Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The EPBC Act protects those places and components of the environment that are unique, rare, or considered to have special value at a national level.

As the airport is on Commonwealth-owned land, the Act's significant impact guidelines require consideration *(Actions on, or impacting upon Commonwealth land and actions by Commonwealth agencies, Significant impact guidelines 1.2, (DSEWPC, 2013, page 14))*. Subsequently referred to as EPBC Act (Significant impact guidelines 1.2).

Among other environmental factors relevant to this chapter, the Significant impact guidelines 1.2 state that in relation to impacts on landscapes and soils a significant impact includes one that has 'a real chance or possibility that the action will … substantially alter natural landscape features'.

This consideration has been incorporated into the significance criteria for this assessment, so that any impact that substantially alters the natural landscape features will therefore be deemed to constitute a high landscape and visual amenity risk for M3R.

The EBPC Act does not define 'landscape feature'. This assessment therefore uses the definition in the South West Victoria Landscape Assessment Study (Department of Planning and Community Development Victoria and Planisphere, 2013):

> *'A landscape feature is a topographic feature or prominent landmark such as a headland, mountain range or volcanic cone that is visually dramatic and provides the landscape with its 'wow' factor. The prevalence or concentration of a particular landscape element or vegetation type e.g. River Red Gums, rocky outcrops, dry stone walls, etc, may also be classified as a landscape feature.' (page 30).*

Appendix A of the Significant impact guidelines 1.2 includes a list of questions to assist in identifying the environmental and, in this case, landscape context for M3R. Although this list is not exhaustive, it states in relation to 'Landscapes and landforms' that the following questions be answered:

- What landscape features or landforms are present?
- What landscape features or landforms are likely to be directly or indirectly impacted by the action?
- Are there any outstanding, rare, unusual, valuable or important landscape features or landforms?

These questions are answered throughout this assessment as the existing landscape condition is described, any features identified and any direct or indirect impacts identified. The sensitivity of these views and landscape features incorporates the consideration of any rare, unusual, valuable or important features.

In addition, Appendix A of the Significant impact guidelines 1.2 identifies issues that are to be considered in relation to people and communities, including: *'Will the action impact upon public amenity?'*. Public amenity includes, among other factors, visual amenity. This requirement will therefore be partially addressed through the undertaking of this assessment.

B12.3.1.2
National Parks Act 1975

Organ Pipes National Park is located approximately 2.5 kilometres west of M3R. It is reserved and managed under the provisions of the *National Parks Act 1975* (Vic) (National Parks Act). This includes 'the protection and preservation of indigenous flora and fauna and of features of scenic or archaeological, ecological, geological, historic or other scientific interest in those parks'.

B12.3.1.3
Organ Pipes National Park Management Plan 1998

The landscape objectives of this plan include preservation of 'viewscapes within and into Jacksons Creek valley' and enhancement of 'viewscapes across the Keilor Plains' (section 3.5).

The plan's relevant landscape management strategies include to 'exercise opportunities presented by planning scheme referrals to minimise the visual impacts of adjacent developments on the Park' (Parks Victoria, 1998, section 3.5). These objectives and strategies will be addressed by the identification and assessment of a view from Organ Pipes National Park.

B12.3.1.4
Airports Act 1996 and Airports (Environmental Protection) Regulations 1997

The Airports (Environment Protection) Regulations 1997 establish a framework for protecting the existing aesthetic values of local areas such as the Grey Box Woodland and other vegetation within Melbourne Airport. Specifically, *Regulation 4.04 General duty to preserve* states:

> *The operator of an undertaking at an airport must take all reasonable and practicable measures to ensure that, in the operation of the undertaking, and in the carrying out of any work in connection with the undertaking: (a) there are no adverse consequences for: … (ii) existing aesthetic, cultural, historical, social and scientific (including archaeological and anthropological) values of the local area. (R4.04 (1))*

This landscape and visual impact assessment will identify any potential adverse effects on the local area's aesthetic values.

B12.3.1.5
Melbourne Airport Master Plan 2022

This assessment was originally undertaken when Master Plan 2018 was the current Master Plan for the airport. Since then Master Plan 2022 has become the current approved Master Plan.

In Master Plan 2022, the airport is divided into three precincts, each with a set of planning requirements for development. M3R is in the Aviation Precinct which includes the existing runways and former rural lands to the south-west of the existing runways. As stated in Section 8.3.1 of the Master Plan the Aviation Precinct "is in the centre of the airport estate and critical to the Melbourne Airport's operation and function. A large portion of it is (or will be) a restricted airside area".

This precinct contains nationally significant vegetation of the Victorian Volcanic Plains including a block of Grey Box Woodland (on airport land). These landscapes are considered in this assessment. The guidelines for the Landside Main require its use and development to provide 'a high level of visual amenity'.

Master Plan 2022 shows the third runway aligned north-south; and the long-term development concept plan shows four runways in a hashtag layout. (This ultimate layout has been shown in the Master Plan since 1990.)

B12.3.2
Victorian government statutory and policy requirements

B12.3.2.1
Metropolitan Planning Strategy 2017-2050: Plan Melbourne

This document (Plan Melbourne) is Melbourne's overarching metropolitan planning strategy. Plan Melbourne's vision for the city is guided by nine principles. Principle 2 seeks to 'develop and deliver infrastructure to support its competitive advantages in sectors such as business services, health, education, manufacturing and tourism'.

This principle is supported by outcomes and policy directions including Outcome 4 'Melbourne is a distinctive and liveable city with quality design and amenity'. This outcome is supported by Direction 4.5 'plan for Melbourne's green wedges and peri-urban areas', which provides for food production, stone supply, biodiversity, recreation, tourism and critical infrastructure including airports. (Peri-urban areas are hybrid landscapes of fragmented urban and rural characteristics.)

The direction seeks to use green wedges and peri-urban areas to protect state infrastructure and is further supported by Policy 4.5.2, which endeavours to 'protect and enhance valued attributes of distinctive areas and landscapes', including 'significant views' and 'high-value landscape features' such as open farmed landscapes, ranges, hills and ridges. A desired outcome for green wedges and peri-urban areas is to protect state significant infrastructure, including airports and flight paths.

In this strategy, Melbourne Airport is located within Melbourne's northern green wedge land at Sunbury (between three major growth areas) and identified as 'Victoria's primary gateway' (Policy 1.1.5). Green Wedge Zones (Map 19) and the urban growth boundary are legislated to manage the non-urban areas of metropolitan Melbourne. The plan also notes that 'green wedges and peri-urban areas are immensely important' and that managing these landscapes will have a range of beneficial impacts on Melbourne including its 'local amenity' (Policy 1.4.2).

The airport is adjacent to a major open space (Woodlands Historic Park) and between two watercourses (Moonee Ponds Creek and the Maribyrnong River) in one of Melbourne's main river corridors. The airport is identified as 'state-significant infrastructure' which should be protected as a 'regionally significant asset' (Policy 4.5.2). However, the airport is not identified as one of the 'high-value landscape features' or 'iconic landscapes' within Melbourne's green wedge or peri-urban area in Policy 4.5.2. (Refer to **Chapter B2: Land Use and Planning** for further information.)

B12.3.2.2
Maribyrnong River Valley Design Guidelines 2010

The Maribyrnong River Valley Design Guidelines prepared by the former Victorian Government Department of Planning and Community Development in 2010 identify the existing and preferred character of the Maribyrnong River. They also outline an action plan to preserve and enhance this preferred character. The entire length of the river, from the Organ Pipes National Park to the river mouth, is considered. Capital works, planning scheme amendments, detailed planning, improved governance and community engagement strategies are proposed.

The Brimbank section of the river (extending south-east from the Organ Pipes National Park) is within the landscape and visual study area. The existing condition here is described (in Section 2.2 of the document) as:

> *'The river flows between complex rolling slopes and rural parkland. Bounded at the valley rim by urban settlement, the Calder Freeway to the north and the railway trestle bridge to the south, there is an absence of urban settlement in the river valley.'*

The vision for the preferred character is described as follows (also in Section 2.2):

> *'The naturalistic and remote character of this length of the river is its most valued characteristic. Extensive pest control and revegetation has restored much of the natural feel of this length of the river valley … There is a need to continue to strike a balance between recreation and conservation/revegetation outcomes. There is also a need to control urban intrusions in order to maintain the uninhabited and remote feel of this length.'*

This vision for a naturalistic landscape around the Maribyrnong River (and limiting urban intrusions that may alter the landscape's remote qualities) is considered through the viewpoint assessment – particularly views from the Organ Pipes National Park (Viewpoint 15). M3R is located in the 'General study area' for the masterplan, not in the 'Main study area'. As such, M3R is not subject to the design and development guidelines contained in this document (Map 4, page 37).

B12.3.2.3
Victorian Heritage Database, Keilor Market Gardens Cultural Landscape 1999

The Keilor Market Gardens cultural landscape (located on Arundel and Milburn Roads, Keilor) has a local heritage listing. The statement of significance which was last updated in 1999 states (page 1):

> *'The market gardens of Keilor are of regional historical significance as they are associated with the beginnings of irrigated horticulture in Victoria and have been continuously cultivated since the mid-nineteenth century.'*

> *'The landscape is of regional significance as an expression of the early and long-lived farming practices adapted to the richer soils of the river terraces. The farms themselves also have long links with local families, such as the Milburns and Senserricks, and the pattern of houses and farm buildings reflect the original population distribution.'*

This landscape includes a number of other heritage items that contribute to its character. They include Arundel Farm and several heritage-listed farmhouses from the late 19th and early 20th centuries, weir, and trestle bridges.

This steeply sloping landscape was terraced with sloping ground between, and utilises the Maribyrnong River for irrigation. The landscape is visually bounded by the top of the escarpment on the opposite side of the river to the north and east, the Calder Freeway to the south, and the Overnewton College grounds to the west.

M3R would not have a direct landscape impact on this cultural landscape. The potential for a visual impact will be addressed in the viewpoint assessment, including the visibility analysis shown on the zone of visual influence mapping (Figure B12.26) and assessment of Viewpoint 8 (a nearby rural location).

B12.3.3
Local statutory and policy requirements

B12.3.3.1
Hume Planning Scheme

M3R is located within Commonwealth land and therefore not controlled by the Hume Planning Scheme. However, the planning scheme does include the Melbourne Airport Environs Overlay (MAEO, clause 45.08) that relates to areas surrounding the airport. This overlay does not include any objectives relating to landscape or visual amenity.

The Hume Planning Scheme refers to Victoria's Landscapes policy (clause 12.05-2S) to 'protect and enhance significant landscapes and open spaces that contribute to character, identity and sustainable environments' (such as waterway corridors and forests).

To the west and south of M3R, the valleys of Deep Creek and the Maribyrnong River are subject to the Environmental Significance Overlay (ESO). The planning scheme refers to the following Victorian policy objective to protect the landscape character of these rural waterways, which is:

> *'To ensure that the scenic qualities and visual character of waterway corridors, creek valleys and their surrounding environs are not compromised by the inappropriate siting of buildings, the placement of fill, the removal of soil, or lack of screening vegetation' (Schedule 1, clause 42.01 Environmental Significance Overlay).*

The decision guidelines relating to the Environmental Significance Overlay (clause 42.01) also consider the 'the effect of the height, bulk and general appearance of any proposed buildings and works on the environmental values and visual character of the waterway' (schedule 1 to clause 42.01 Environmental Significance Overlay).

The rural landscape is a recognised as a 'key characteristic of Hume's image and identity' including 'wide expanses of flat open woodland and grassland, cleared grazing land and natural features such as largely undeveloped hills and ridges, and very steep creek valleys' (clause 21.04-3 Landscape Character). These features are 'highly valued by the community and are often highly visible, providing an important backdrop to urban areas within the Hume Corridor and the Sunbury township' (clause 21.04-3 Landscape Character).

Relevant objectives of the landscape character policy include:

- 'To ensure development protects significant and unique landscape values which contribute to Hume's character and identity
- To protect significant views and vistas of hilltops, escarpments, ridgelines, and creek valleys and waterways
- To protect significant vistas and long range views towards the Melbourne CBD and surrounding mountain ranges from Hume's hilltops, escarpments and ridgelines
- To protect and encourage significant roadside vegetation that contributes to Hume's landscape character' (clause 21.04-3).

The rural area to the north, east and west of M3R is located within the Green Wedge Zone. The Hume City planning scheme refers to the State zoning for the management of the Green Wedge Zone, which aims to 'protect, conserve and enhance the cultural heritage significance and the character of open rural and scenic non- urban landscape' (clause 35.04).

Hume supports a 'rich natural heritage which contributes to the municipality's character', including remnant vegetation such as scattered trees, woodlands, grasslands, scrub-lands and riparian vegetation (clause 21.08-1). A key objective of the Natural Heritage clause for Hume is to 'protect, conserve and enhance natural heritage for biodiversity, amenity and landscape character purposes' (clause 21.08-1, objective 1).

Other notable landscapes within the study area include Organ Pipes National Park and Woodlands Historic Park. Woodlands Historic Park is located north-east of M3R. It is zoned Public Conservation and Resource and includes the homestead (state heritage listed; item 25 within the Heritage Overlay) and gardens set within 820 hectares of rural parkland established in the mid-19th century. A key objective of the Public Conservation and Resource Zone is 'to protect and conserve the natural environment and natural processes for their historic, scientific, landscape, habitat or cultural values' (clause 36.03).

Other relevant heritage items near the project area include the local heritage-listed Arundel Farm (including homestead, gardens and agistment) and state heritage-listed Glenara (including the homestead and gardens).

Further details on the planning requirements relating to heritage and ecology are contained in chapters **B5: Ecology, B6: Indigenous Cultural Heritage** and **B7: European Heritage**.

B12.3.3.2
Brimbank Planning Scheme

M3R is located within Commonwealth land and therefore not controlled by this planning scheme. However, the planning scheme includes the Melbourne Airport Environs Overlay (MAEO, clause 45.08) that relates to areas surrounding the airport. This overlay does not include any objectives relating to landscape or visual amenity.

To the south and south-west of the airport, the planning scheme identifies an Environmental Significance Overlay (ESO) along the Maribyrnong River. The ESO extends from Organ Pipes National Park, past Sydenham Park, through Keilor towards the Yarra River valley. The character of this waterway is described as 'a natural river with a remote and natural non urban character' (Section 1.0, Schedule 5 to the ESO5). The planning scheme includes the following objectives for this area regarding 'Vegetation, Landscape Character and Views':

- Ensure planting and revegetation reinforces the preferred character of the river (Objective 7, Schedule 5 to the ESO5)
- Maintain and protect views along the river corridor, including escarpments and other highly visible areas from visually intrusive development (Objective 8, Schedule 5 to the ESO5)
- Minimise the visual impact of buildings and works on the river corridor (Objective 10, Schedule 5 to the ESO5).

Protection and enhancement of the Maribyrnong River valley is also a priority in the Rural Conservation and Public Conservation and Resource zone provisions. These aim to:

- 'Protect and enhance the natural environment and natural processes for their historic, archaeological and scientific interest, landscape, faunal habitat and cultural values' (Rural Conservation Zone, clause 35.06)
- 'Protect and conserve the natural environment and natural processes for their historic, scientific, landscape, habitat or cultural values' (Public Conservation and Resource Zone, clause 36.03).

There are no areas identified on the Significant Landscape Overlay (clause 42.03) within the study area.

Further details on the planning requirements relating to heritage and ecology is contained in chapters **B5: Ecology, B6: Indigenous Cultural Heritage** and **B7: European Heritage**.

B12.3.3.3
Brimbank Green Wedge Management Plan 2010

Brimbank Council has prepared a Green Wedge Management Plan (Brimbank Council, 2010) that covers the Brimbank section of the Sunbury Green Wedge south of Melbourne Airport. This plan identifies a vision, objectives and actions for the sustainable use and development of this green wedge.

This green wedge includes volcanic plains and low plateaus dissected by deeply-cut stream channels, particularly those of the Maribyrnong River and its tributaries. It contains the large township of Sunbury, the smaller town of Bulla, and areas of Melbourne Airport.

It identifies the key features and values of the Sunbury Green Wedge, including:

- High-quality agricultural land
- Areas of significant landscape value
- Melbourne Airport and related flight paths
- Parklands
- Rural lifestyle opportunities.

This management plan identifies key parklands (including Woodlands Historic Park and Organ Pipes National Park) and describes them as important regional assets.
The steeply-incised valleys of the Maribyrnong River and its tributaries Jacksons Creek and Deep Creek are identified as having significant landscape values including 'scenic views across the valley and a sense of seclusion along the valley floor'. It also identifies the low hills in the north as providing 'contrasting landscape elements' (pages 5 to 6).

The management plan is divided into themes, one of which is Landscape. The objective of Theme D (Landscape) is 'Protection and enhancement of the Maribyrnong Valley's rural atmosphere and scenic landscape' (page 15). It adds, 'The area's scenic views and rural atmosphere are highly valued by the community. Opportunity exists to protect these landscape qualities by ensuring new development integrates within the landscape and does not compromise view corridors to key features such as the city skyline' (page 25).

Within this landscape theme, it identifies several features having visual value. These include:

- Views of grassy plains, rocky outcrops and lava flows from Organ Pipes National Park
- Views across the Maribyrnong Valley to the distant mountain ranges from Sydenham Park
- Views from the Calder Freeway across the grassy plains to the airport and city skyline
- The Maribyrnong Valley's natural qualities and dramatic landscape
- The patchwork landscape of the Keilor Market Gardens
- The unspoilt qualities of the Maribyrnong River and the seclusion from urban development experienced from the valley floor (page 25).

These views and features were reviewed on-site and helped select representative viewpoints. The values of these views will be considered to have an increased landscape value due to their identification in this management plan.

B12.4
DESCRIPTION OF SIGNIFICANCE CRITERIA

The assessment of significance has applied the framework described in Chapter A8: Assessment and Approvals Process. For severity, project specific criteria have been developed for the assessment of impacts on landscape and visual values. These are described in Table B12.7, Table B12.8 and Table B12.9.

These are based on a combination of landscape and visual sensitivity (Table B12.1, Table B12.3 and Table B12.5) and the magnitude of change (Table B12.2, Table B12.4 and Table B12.6).

The assessment of significance has applied the standard framework described in Chapter A8: Assessment and Approvals Process.

Table B12.7
Impact severity criteria – landscape

Impact severity	Description
Major	Considerable reduction in quality of a landscape of national sensitivity Noticeable reduction in the quality of a landscape of national sensitivity or Considerable reduction in the quality of a landscape of state sensitivity
High	Noticeable reduction in the quality of a landscape of state sensitivity or Considerable reduction in the quality of a landscape of regional sensitivity
Moderate	Noticeable reduction in the quality of a landscape of regional sensitivity or Considerable reduction in the quality of a landscape of local sensitivity
Minor	Noticeable reduction in the quality of a landscape of local sensitivity or Considerable reduction in the quality of a landscape of neighbourhood sensitivity
Negligible	Noticeable reduction in the quality of a landscape of neighbourhood sensitivity or No alteration to a landscape
Beneficial	Noticeable improvement to the quality of a landscape of any sensitivity

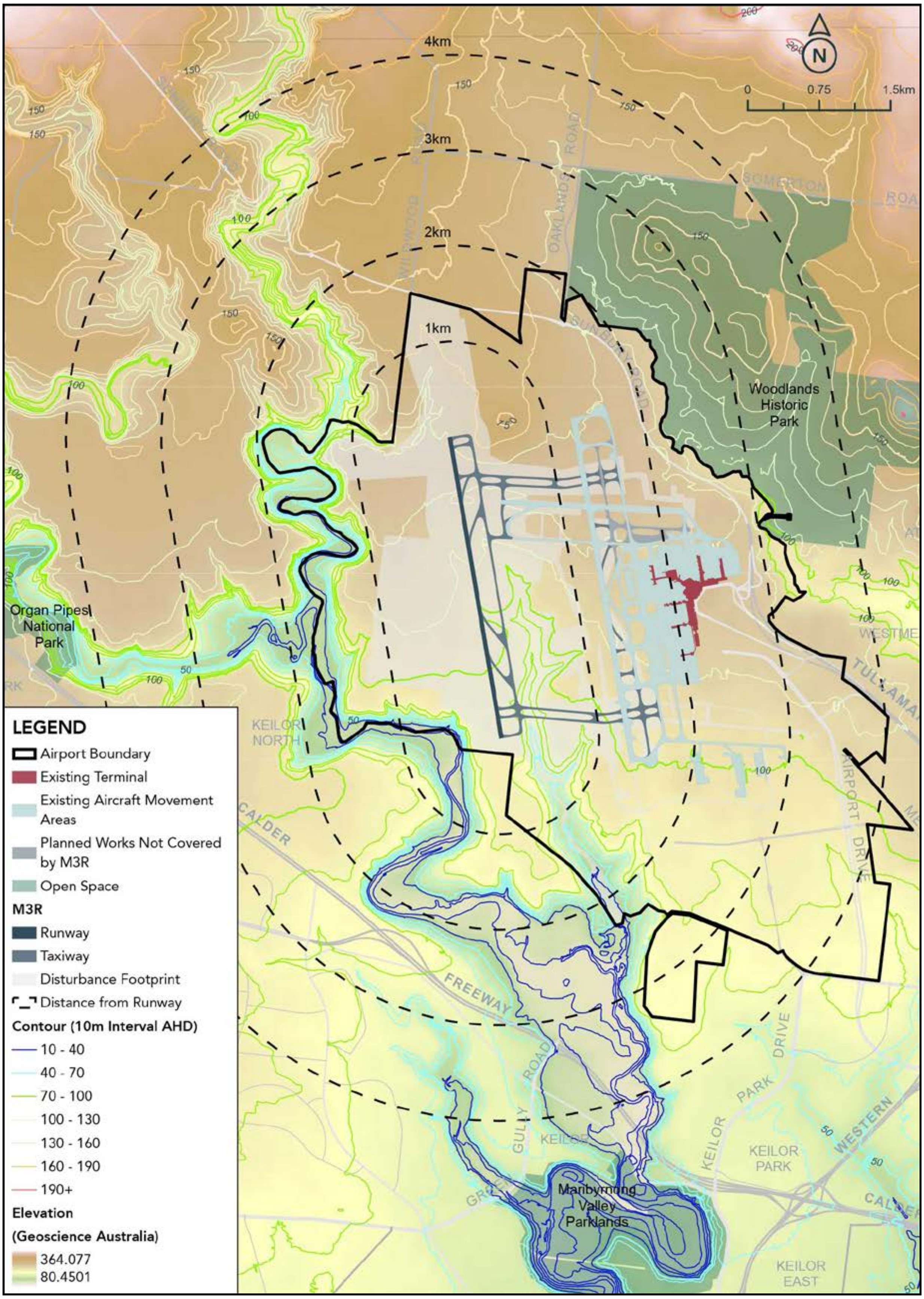
Table B12.8
Impact severity criteria – visual

Impact severity	Description
Major	Considerable reduction in the amenity of a view of national sensitivity Noticeable reduction in the amenity of a view of national sensitivity or Considerable reduction in the amenity of a view of state sensitivity
High	Noticeable reduction in the amenity of a view of state sensitivity or Considerable reduction in the amenity of a view of regional sensitivity
Moderate	Noticeable reduction in the amenity of a view of regional sensitivity or Considerable reduction in the amenity of a view of local sensitivity
Minor	Noticeable reduction in the amenity of a view of local sensitivity or Considerable reduction in the amenity of a view of neighbourhood sensitivity
Negligible	Noticeable reduction in the amenity of a view of neighbourhood sensitivity or No perceived change in the amenity of a view of any sensitivity
Beneficial	Noticeable improvement to the amenity of a view of any sensitivity

Table B12.9
Impact severity criteria – visual (night time)

Impact severity	Description
Major	Considerable reduction in the amenity of an A0: Dark landscape or A1: Intrinsically dark landscape
High	Noticeable reduction in the amenity of an A0: Dark landscape or A1: Intrinsically dark landscape Considerable reduction in the amenity of an area of A2: Low district brightness
Moderate	Noticeable reduction in the amenity of an area of A2: Low district brightness Considerable reduction in the amenity of an A3: Medium district darkness
Minor	Noticeable reduction in the amenity of an area of A3: Medium district brightness Considerable reduction in the amenity of an area of A4: High district brightness
Negligible	Noticeable reduction in the amenity of an area of A4: High district brightness No perceived change in the amenity of a view of any sensitivity
Beneficial	Noticeable improvement to the amenity of a view of any sensitivity at night

Figure B12.1
Topographic Plan



B12.5 EXISTING CONDITIONS

B12.5.1 Landform

Melbourne Airport and the M3R project area are located on a relatively flat plateau. There is some steep undulation associated with Deep Creek and Arundel Creek to the west of the existing north-south runway (Figure B12.1).

To the south and west of M3R, Jacksons Creek, Deep Creek and the Maribyrnong River dissect this plateau landscape; with steep banks descending approximately 70 metres below the plateau in parts. To the south of the airport, the southern banks of the Maribyrnong River have been modified through historic agricultural land uses and a widened river valley created.

To the north-west of M3R, the landform becomes more steeply undulating and is divided by the upper reaches of the Maribyrnong River. In the north-east, the landform rises to a number of peaks, including Woodland and Gellibrand hills, rising up to a height of up to 200 metres.

B12.5.2 Existing landscape conditions and views

B12.5.2.1 The Airport

Melbourne Airport is located approximately 22 kilometres north-west of Melbourne's central business district. It comprises a north-south runway (16/34) and an east-west runway (09/27); and is supported by taxiways, aprons, freight handling facilities and a terminal complex.

Two air traffic control towers rise above the landscape to the south-west of the intersection of the existing runways. These structures create a local visual landmark that identifies the airport in views from surrounding areas. (Figure B12.3)

Melbourne Airport is located within an area of the Western Basalt Plains landscape (Parks Victoria, 1998, section 3.5, page 23) characterised by flat open grasslands and the deeply incised Deep Creek, which forms the western boundary of the airport property. The existing runways and airside areas of the airport are enclosed by chain wire or welded mesh fencing allowing views across the airfield.

Figure B12.2
View east from Operations Road aircraft viewing area

Figure B12.3
View south from Sunbury Road to air traffic control towers

Figure B12.4
Grey Box Woodland

Figure B12.5
Concrete crushing (recycling) plant

To the south-west of the airport, and within the M3R project area, an aircraft viewing area is located on Operations Road that enables viewing of the existing runways and an area for parking (Figure B12.8).

To the north-west of the existing runways is the Grey Box Woodland. This is a eucalypt forest of mature specimens combined with recent plantings (Figure B12.4). A mature avenue of eucalypts lines a track from Sunbury Road along the eastern side of the woodland. The woodland screens views to the airport and provides amenity to views from Sunbury Road and residential areas to the north.

This woodland is set within a working rural landscape. There are therefore light industrial uses including quarry operations and a concrete crushing (i.e. recycling) plant (Figure B12.5), farm sheds and equipment spotted around the landscape to the west of the woodland.

B12.5.2.2
Rural landscapes to the west and north-west of the airport

To the airport's north and north-west there is a rural landscape of open, grassy plains and elevated plateaus divided by deeply incised creeks. This flat and sparsely treed landscape enables open views across wide expanses of cleared grazing land, and across the existing 09/27 runway and to the air traffic control towers and terminals beyond.

Several roads traverse this landscape. They include Loemans Road, which runs generally north to south and parallel to the airport, offering views across this landscape and to the airport (Figure B12.6). There is a mixture of land use in this landscape including rural residential blocks and small pastoral properties. There are several large and visually prominent residences located atop the plateaus (Figure B12.7) with expansive, elevated views over the river valleys and airport, viewed against the backdrop of Gellibrand and Woodlands hills and Melbourne's central business district skyline to the south-east.

Figure B12.6
View south along Loemans Road

Figure B12.7
Homestead on Deep Creek, Loemans Road

Figure B12.8
Aircraft seen from viewing area

Figure B12.9
Solar farm on Oaklands Road

B12.5.2.3
Township of Bulla and rural landscapes to the north

Directly north of M3R, Sunbury Road is a moderately trafficked two-lane roadway lined with street trees in some areas. An aircraft viewing area (including car park, sloped lawn and often a hot food van) is located at the corner of Sunbury and Oaklands roads. This popular viewing location offers views to the existing north-south runway (16L/34R) and arriving and departing aircraft which fly directly overhead (**Figure B12.8**). A 12 MW solar farm is located north of this viewing area, west of Oaklands Road (**Figure B12.9**).

To the north-west of M3R, a state heritage listed homestead and garden, Glenara, is located on the banks of Deep Creek in the outskirts of Bulla (**Figure B12.10**). This property provides a 'contrast between the open plains and the oasis of the garden' and its 'dramatic setting on a gorge of Deep Creek' (Heritage Victoria, 1997). The house is oriented away from the airport and enclosed largely by a mature framework of trees in its gardens and the surrounding grounds.

To the west on Sunbury Road, the township of Bulla is centred on the banks of Deep Creek (**Figure B12.11**). There are some heritage properties in its centre, and the landform rises steeply from the creek to a small hill on Green Street. Properties on the outskirts and east of Bulla have views across the surrounding cleared grazing land to the vegetated banks of Deep Creek and woodland areas. Where vegetation and landform allow, there are views across this landscape to runway 09/27 and the air traffic control towers.

B12.5.2.4
Woodlands Historic Park

Woodlands Historic Park is located to the north-east of the airport (**Figure B12.12** and **Figure B12.13**). It includes a historic 1840s homestead; trails for walking, cycling and horse riding; lookouts and picnic facilities. The property includes areas of natural bushland with distinctive granite boulders, as well as paddocks where retired champion racehorses are rested. Woodlands Historic Park is referred to in the Green Wedge Management Plan, which states that, 'in the context of an area where substantial native vegetation remnants are rare, the habitat values of these parks and other smaller reserves are particularly important' (Brimbank City Council, 2010, pages 5-6).

Figure B12.10
Glenara set within the vegetated banks of Deep Creek

Figure B12.11
View to Sunbury Road and Bulla from the air

Figure B12.12
Open woodland on Gellibrand Hill

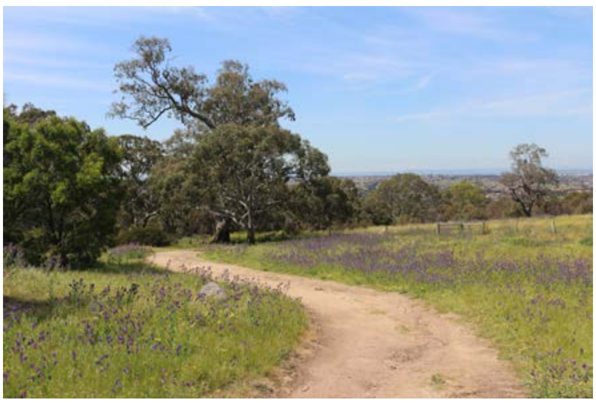


Figure B12.13
Woodlands Historic Park homestead

The park rises to two elevated vantage points: Gellibrand Hill and Woodlands Hill. Gellibrand Hill offers a 360-degree view including Melbourne's central business district (CBD), Port Phillip Bay, the Great Dividing Range and across Melbourne Airport. There are also glimpsed views through trees from the Moonee Ponds Creek trail to the existing High Intensity Approach Lighting (HIAL) structures located on airport land east of Sunbury Road.

B12.5.2.5
Rural landscapes, golf courses and residential areas to the south and south-west

To the south, the landscape consists of a largely rural landscape of open, grassy plains and hills divided by the steep banks of the Maribyrnong River. This undulating landscape is a patchwork, with trees lining fields and McNabs Road and Arundel Road. These allow for framed and filtered views across the surrounding cleared grazing and farmland to runway 09/27, air traffic control towers and airport terminals.

Residential properties are a mixture of heritage and contemporary buildings set within a landscape of rural land uses. The farming activities across this landscape include traditional market gardening on rich alluvial flats, equine agistment, broad-acre grazing, and vineyards. Arundel Farm Estate is a locally heritage-listed property in this landscape and includes a bluestone homestead, winery, agistment and café (Figure B12.14).

The Keilor Market Gardens Cultural Landscape is bounded by the Maribyrnong River in the north, Calder Freeway in the south, and Overnewton College grounds in the west.

This area has local heritage listing as a significant cultural landscape. It includes numerous heritage features including several farm houses, a weir and trestle bridge (Figure B12.15) on the Maribyrnong River. The landscape is visually enclosed by the top of the escarpment of the opposite side of the river, which rises distinctly above the southern bank of the river to create a distinctive valley. Although the airport is not visible from this landscape, regularly approaching and departing aircraft are a consistent feature seen above this landscape.

North-west of the Keilor Market Garden Cultural Landscape, Overnewton College and Overnewton Castle are in a locally elevated location (Figure B12.16). The airport may be visible in windows from the upper levels of the castle; however, due to intervening landform and vegetation it is unlikely to be seen from the grounds.

Figure B12.14
Winery at the Arundel Farm Estate

Figure B12.15
Heritage listed trestle bridge on the Maribyrnong River

Figure B12.16
Views near Overnewton Castle and College

Figure B12.17
Keilor Public Golf Course

This area also includes the Keilor and Melbourne Airport golf courses to the south and south-west of the airport (**Figure B12.17**). The manicured lawns of these golf courses are largely visually enclosed by mature perimeter vegetation planting and mature remnant trees. Melbourne Airport Golf Course, in particular, uses its proximity to the airport and views to the existing runways and airport operations as a marketing tool: 'the feature hole is the 17th, with a green location that places players less than 60 metres below the flight paths of aircraft, including the daily flights of A-380s' (Melbourne Airport Golf Club, 2020).

B12.5.2.6
Organ Pipes National Park to the south-west

Organ Pipes National Park is located approximately 2.5 kilometres west of M3R. The park protects the basalt columns known as the Organ Pipes (also of state geological significance) and the adjacent volcanic plains grassland and shrubland. The park covers 121 hectares of gorge country along Jacksons Creek in the Maribyrnong Valley.

Its landscape provides a dramatic and sudden drop in landform, enclosing views and evoking a sense of remoteness: a strong contrast to the surrounding exposed flat land. The valleys and gorges are 'highly valued by the community and are often highly visible, providing an important backdrop to urban areas within the Hume Corridor and the Sunbury township.' (clause 21.04-3, Hume Planning Scheme).

The park includes trails to the valley floor as well, as a viewing platform near the visitor centre that offers elevated views to the Organ Pipes and surrounding urban and rural landscape (**Figure B12.20** and **Figure B12.21**). Due to distance and intervening vegetation, the airport is not a dominant feature in these views (aircraft can however be seen flying overhead).

B12.6
ASSESSMENT OF POTENTIAL IMPACTS

B12.6.1
Visual character of M3R

M3R has several processes and elements with the potential to change the landscape character of the project area, and the amenity of views from the wider study area. (Details of M3R are described in **Chapter A4: Project Description**.)

Figure B12.18
Elevated residential areas of Keilor

Figure B12.19
View north from the Calder Freeway

Figure B12.20
Organ Pipes National Park visitor centre

Figure B12.21
View north-east along the Jackson Creek valley

B12.6.1.1
Construction phase

The impact of M3R's construction phase is estimated to span three to five years. The main likely activities contributing to visual impact during construction will be:

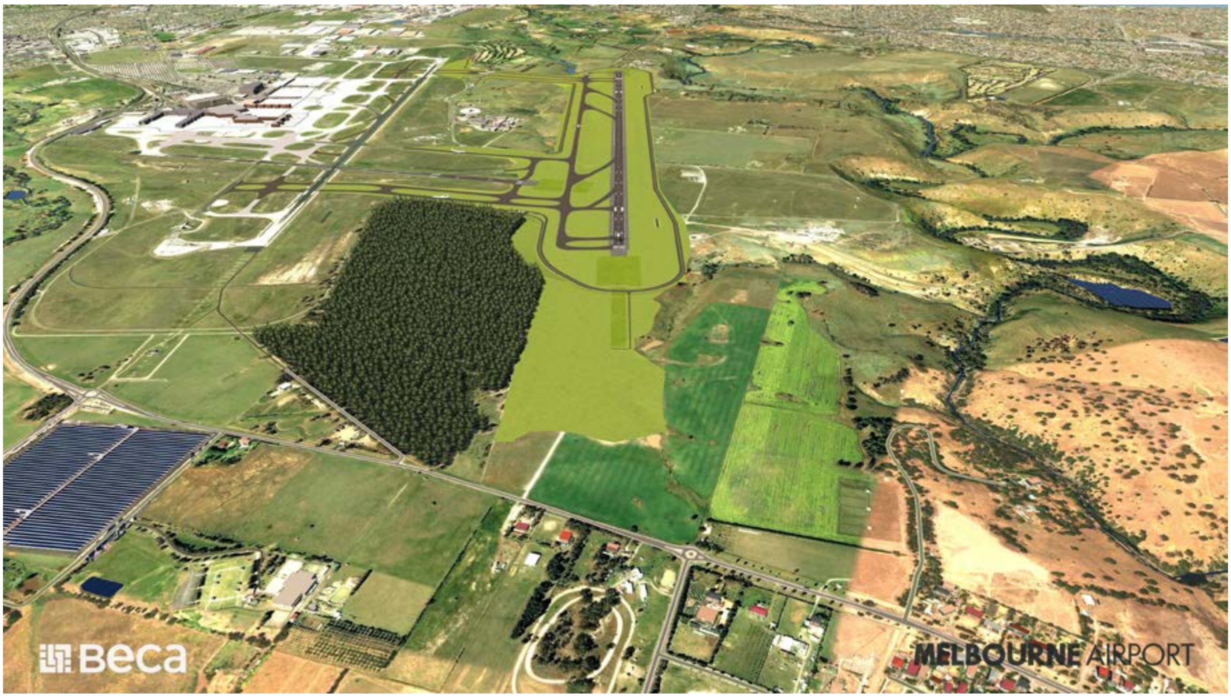
- A construction compound including site offices and amenities, storage containers, vehicle parking, concrete batching plant, asbestos spoil storage areas, stockpiles of material deliveries and fencing (refer to **Chapter A5 Project Construction** for indicative construction plans)
- Site clearing works such as removal of some vegetation (including the western part of the Grey Box Woodland south of Sunbury Road), fences and gates, access roads and telegraph poles
- Localised stockpiling of cleared material, and installation of sedimentation fencing
- Services removal and relocation including high voltage cable, water mains, sewer mains, airfield ground lighting cable duct, and communications
- Diversion of existing Operations Road to facilitate the new cross-field taxiways, including provision of a new underpass tunnel structure
- Removal of existing McNabs Road and Barbiston Road (because they form part of the M3R disturbance area, in particular the site earmarked for the new north-south runway (16R/34L))
- Conversion of sections of Arundel Creek to a culvert structure as required to facilitate taxiway construction
- Bulk site earthworks, including earth moving vehicles working on much of the project area
- Temporary construction access roads (including construction access road off Sunbury Road)
- Removal of all vegetation within the disturbance area including part of the Grey Box Woodland
- Asphalt and/or concrete batching plants (each approximately 50 x 50 metres footprint x 20 metres high) to provide pavement for construction
- Machinery including B-double trucks hauling material in and out of the project area, tipper trucks, D8 excavators, excavators, graders, padfoot rollers, concrete trucks, mobile crane and light vehicles
- If required, night-time airfield construction works will include low-glare and downward-focused task lighting to avoid disruption of existing airport operations.

B12.6.1.2
Operation phase

The impact of M3R's operation phase is estimated to last at least 50 years. Its likely sources of landscape and visual impact during operations are:

- Formation of a new parallel north-south runway (16R/34L) including a full-length parallel taxiway to its immediate east, with connecting runway entrance/exit taxiways
- Modification of existing north-south runway (16L/34R) with additional taxiway infrastructure

Figure B12.22
3D Modelled image, south-facing view of the new north-south runway



- Shortening of the existing east-west runway (09/27) at the western end, including parallel taxiway and runway entry/exit taxiways
- Airside road and fencing
- Realigned section of Arundel Creek where intersected by the new entry/exit taxiways via box culverts or pipes
- The remaining project area will be either grassed or hardstand, with some temporary uses as required
- Commercial passenger aircraft utilising the new airfield infrastructure
- A High Intensity Approach Lighting (HIAL) system on steel truss towers would extend 720 metres towards Sunbury Road at the northern end of the new runway
- Airfield ground lighting including all ground based and approach lighting such as taxiway lighting, runway lighting, and potential road lighting.

Patterns of air traffic will change (refer to **Chapter C2: Airspace Architecture and Capacity**) including:

- An increase, over time, in north-south aircraft movements due to the additional north-south runway.

B12.6.2
Landscape assessment

The following section describes the assessment of landscape impact, including identification of landscape sensitivity and impacts during construction and operation.

B12.6.2.1
Landscape sensitivity levels

The airport's landscape has no specific landscape value within the local planning scheme. It does, however, have some continuity with the rural landscapes to the north, west and south of the project area. Overall, the airport's landscape is of local sensitivity.

B12.6.2.2
Assessment

Potential landscape impacts during construction

Construction of M3R will include the removal of all existing vegetation within the project area including part of the Grey Box Woodland south of Sunbury Road and vegetation along Barbiston Road. This includes windbreaks of peppercorn, cypress and sugar gum trees within the paddocks of former Barbiston Farm (a de-listed state heritage item). Further detail is in **Chapter B5: Ecology.**

The open grassland fields will be removed and the landform modified to create a flat platform for the runway. This will require excavation in the northern areas of the runway footprint and filling to the south. The earthworks would avoid the Maribyrnong River (to the west) but include modifications to Arundel Creek valley (to the east). Part of Arundel Creek will be diverted via box culverts or pipes, where intersected by the new cross-field taxiways.

Figure B12.23
3D Modelled image, south-west facing aerial perspective view M3R

The removal of part of the Grey Box Woodland and substantial changes to the local landform would alter the patterns and natural boundaries within the landscape. The project would expand the area of hardstand while reducing the area of grassland across the project area. Overall, this will create a noticeable reduction in the site's landscape values, resulting in a minor adverse landscape impact.

Potential landscape impacts during operation

During operation, the open grassland of the airport will be replaced with large areas of paved runways and taxiways. Due to the operational requirements of the runways, and the potential for birds, bats and other wildlife to interfere with airport operations, tree planting (for the purpose of aesthetics and screening) within the airport site is undesirable. There is therefore no tree planting proposed within M3R. However, trees and grasses will remain in the undisturbed areas; and temporarily disturbed areas of the project area will be reinstated with grassland.

Figure B12.24
3D Modelled image, north-facing view along the new north-south runway

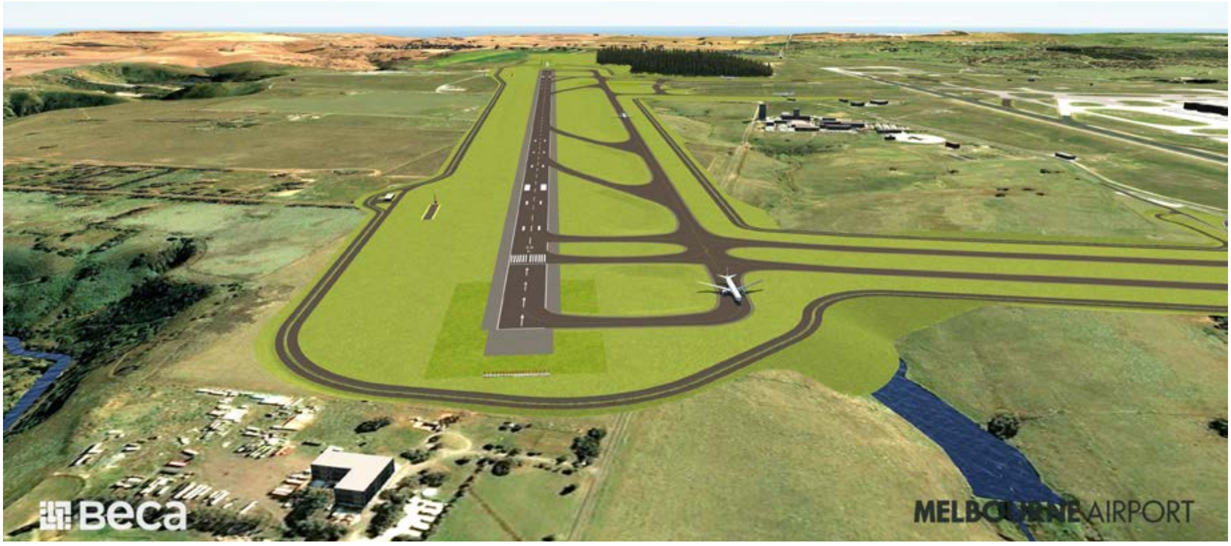


Figure B12.25
3D Modelled image, north-east facing view to the new north-south runway

Overall, this will create a noticeable reduction in the landscape values of the site which are of local sensitivity, resulting in a minor adverse landscape impact.

B12.6.3
Visual assessment

The following section describes the assessment of visual impact in daytime and night-time conditions. It includes identification of visual sensitivity and impacts during M3R construction and operation.

B12.6.3.1
Visual influence of M3R

A Zone of Visual Influence (ZVI) diagram has been used to establish the theoretical area from which M3R will be visible (**Figure B12.26**). This map uses a digital terrain model to identify areas from which views to the project area may be possible (based on a grid of points across the proposed and existing runways at the height of a typical aircraft fuselage). It does not incorporate the screening effect of vegetation however; the landform within the disturbance area and vegetation can limit visibility in this analysis. This mapping therefore shows a worst-case scenario.

The ZVI shows M3R's potential visual influence extending west across Deep Creek and across the rural landscape to residential properties on the outskirts of Bulla, across Sunbury Road in the north to the elevated areas of the Woodlands Historic Park, to rural areas in the south across the Calder Freeway, and to residential areas in the south and west (and potentially to the Organ Pipes National Park in the west). This area was the basis of field investigations identifying views to M3R.

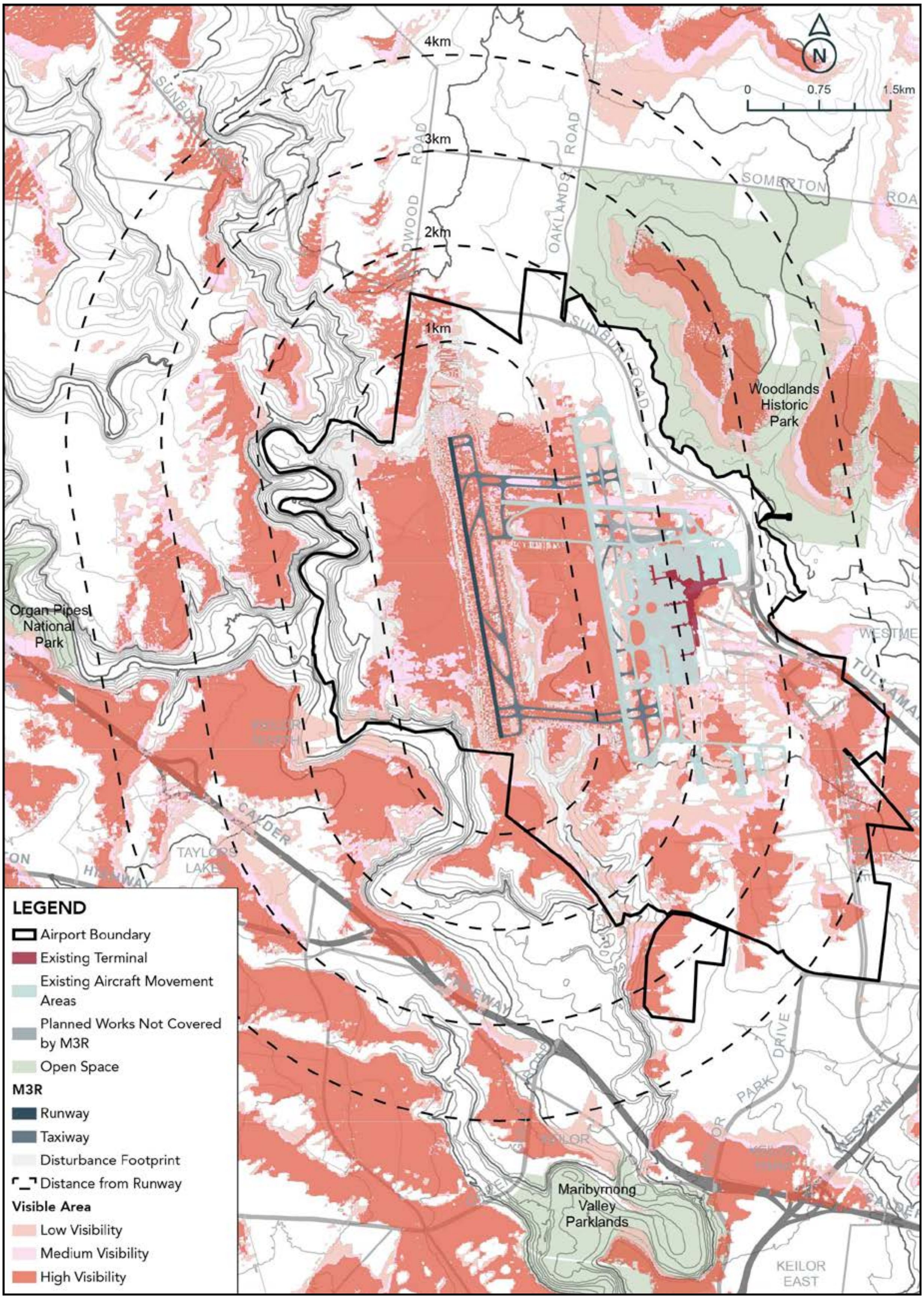
B12.6.3.2
Daytime visual sensitivity levels

The following sensitivity levels will be used in the assessment of daytime visual impact (**Table B12.10**).

Table B12.10
Daytime visual sensitivity levels

Location	Values	Visual sensitivity level
Rural properties and farmsteads	• These properties are used mainly by residents and their visitors • Provisions to protect scenic views and rural character in the Green Wedge Management Plan, Hume and Brimbank planning schemes.	Neighbourhood
Woodlands Historic Park	• Woodlands Historic Park is a part of the Parks Victoria estate, and is managed in accordance with the Parks Victoria Act 1998 • This environmental and recreational asset attracts residents and visitors from across the region to use the walking, cycling and horse riding trails, lookouts and picnic facilities • The recreational nature of these views means that there is an increased value placed on the amenity of views within this area • Woodlands Historic Park is open to vehicles daily from 9am to 4.30pm. Pedestrian access is 24 hours.	Regional
Urban residential areas	• These properties are used mainly by residents and their visitors.	Neighbourhood
Melbourne Airport Golf Course Keilor Public Golf Course	• Used by locals and visitors to the area • The recreational nature of these views means that there is an increased value placed on the amenity of views within this area • Provisions to protect scenic views and rural character in the Green Wedge Management Plan.	Local
Organ Pipes National Park	• Organ Pipes National Park is a part of the state-wide network of environmental and recreational assets, and is protected by the National Parks Act (Vic) • The recreational nature of these views means that there is an increased value placed on the amenity of views within this area • This park attracts residents and visitors from across the region. The park is opened to vehicles daily from 8.30am to 4.30pm.	Regional
Calder Freeway	• The Calder Freeway is a key arterial route between Melbourne and Bendigo, passing in this section through Keilor • This route provides views to locals and visitors from across the region • Vehicles on this route are moving at a speed of approximately 80km/h, and experience both urban and rural views.	Local
Sunbury Road	• Sunbury Road is a key arterial route north of Melbourne Airport, connecting the Tullamarine Freeway with Bulla • This route provides views to locals and visitors from across the region • Vehicles on this route are moving at a speed of approximately 80km/h, and experience mainly rural views north of the airport.	Local

Figure B12.26
Zone of visual influence



B12.6.4
Viewpoint assessment

A range of viewpoints have been selected to represent the visibility of M3R. These viewpoints have been grouped by their location and are as follows:

Views from rural landscapes to the west

- Viewpoint 1 – view south-east from Loemans Road (Table B12.11)
- Viewpoint 2 – view south-east from Loemans Road (north) (Table B12.12).

Views from Bulla and rural landscapes to the north

- Viewpoint 3 – view south-east from Glenara Road (Table B12.13)
- Viewpoint 4 – view south from Sunbury Road (Table B12.14).

Views from Woodlands Historic Park

- Viewpoint 5 – view south from the Woodlands Historic Park Homestead (Table B12.15)
- Viewpoint 6 – view west from Gellibrand Hill, Woodlands Historic Park (Table B12.16)

Views from residential, rural properties and golf courses to the south and west

- Viewpoint 7 – view north from the Melbourne Airport Golf Course (Table B12.17)
- Viewpoint 8 – view north from the Arundel Farm Estate (Table B12.18)
- Viewpoint 9 – view north from McNabs Road (Table B12.19)
- Viewpoint 10 – view north from Skyline Drive, Keilor (Table B12.20)
- Viewpoint 11 – view north-east from Kiuna Road, Keilor North (Table B12.21)
- Viewpoint 12 – view north-east from Keilor Public Golf Course (Table B12.22).

Views north-east from the Calder Freeway

- Viewpoint 13 – view north-east across the Kings Road overbridge (Table B12.23)
- Viewpoint 14 – view north-east from the Calder Freeway (Table B12.24)

Views from Organ Pipes National Park to the south-west

- Viewpoint 15 – view east from Organ Pipes National Park (Table B12.25).

The location of these representative viewpoints is shown in Figure B12.27.

B12.6.5
Summary of daytime visual impact

Key observations from the viewpoint assessment of daytime visual impact are described in the following paragraphs.

B12.6.5.1
Views from rural landscapes to the west

From Loemans Road (viewpoints 1 and 2) and residences within properties to the east of this road (shown on Figure B12.28), views towards the airport are panoramic, extending across a plateau and the deeply incised Deep Creek with limited tree cover. This landform results in clear views to the existing Runway 09/27, airport terminals and air traffic control towers. These views also include the distant skyline of the Melbourne Central Business District (CBD).

During construction, there will be a change in character as activities such as vegetation clearing, major earthworks, stockpiling, pavement and civil works occur over a large area. These elements will be in the middle ground of these views, and closer to the viewer than the existing airport. While the removal of the western part of the Grey Box Woodland would reduce the amenity of these views during construction, the remaining woodland would continue to screen the view to the northern areas of the existing airport. This will result in a considerable reduction in the amenity of views from the rural landscapes to the west (which are of neighbourhood sensitivity) resulting in a minor adverse visual impact during construction.

During operation, the new north-south runway would be visible across views, particularly on Loemans Road. The character of M3R will be generally consistent with the existing elements of the airport seen within the existing views. The new parallel north-south runway will increase the footprint of the airport and bring the runway and associated air traffic closer to viewers in the rural landscapes west of the airport. The new runway will be prominent in these views and will approximately double the area of airfield and tarmac visible. This will create a larger-scale airfield and bring elements closer to viewers.

While M3R's built elements will not obstruct views to the CBD skyline (visible to the south-east and in the background) increased air traffic movements will be seen across the view as aircraft take off and land across the two runways. These elements will all be seen unobstructed due to the open farmland landscape setting. While there will be removal of some vegetation within the Grey Box Woodland, part of it would remain, providing amenity and a backdrop to the northern part of these views. There will also be a visual compatibility between the rural landscape and the similarly flat and open landscape of the airfield.

Overall, M3R will result in a considerable to noticeable reduction in the amenity of views from the rural landscapes to the west (depending on the distance and visibility of M3R). These views are of neighbourhood sensitivity, resulting in a minor adverse to negligible visual impact during operations (Figure B12.29, Figure B12.30 and Figure B12.31).

Figure B12.27
Viewpoint location plan

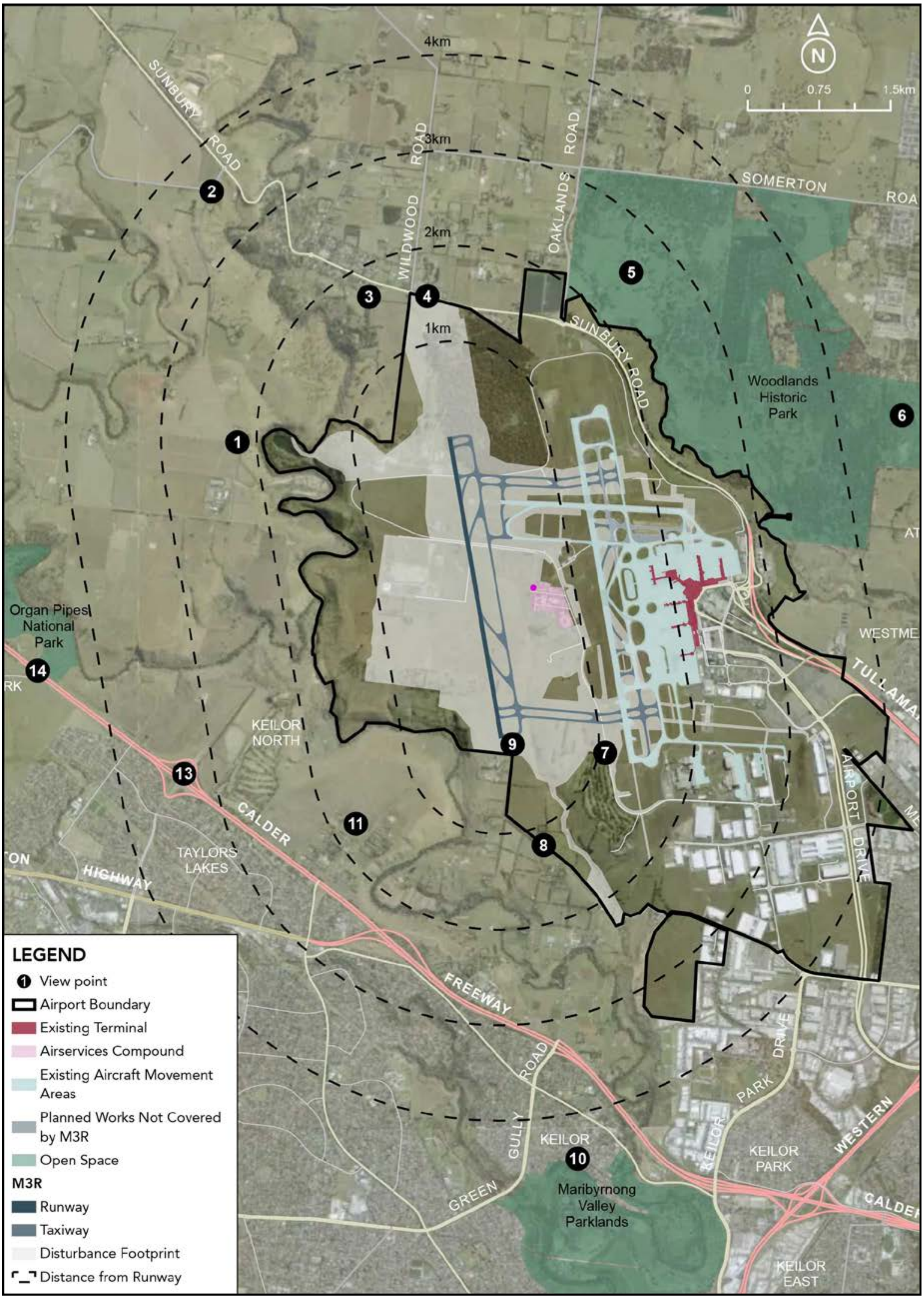


Figure B12.28
Views from rural landscapes to the west

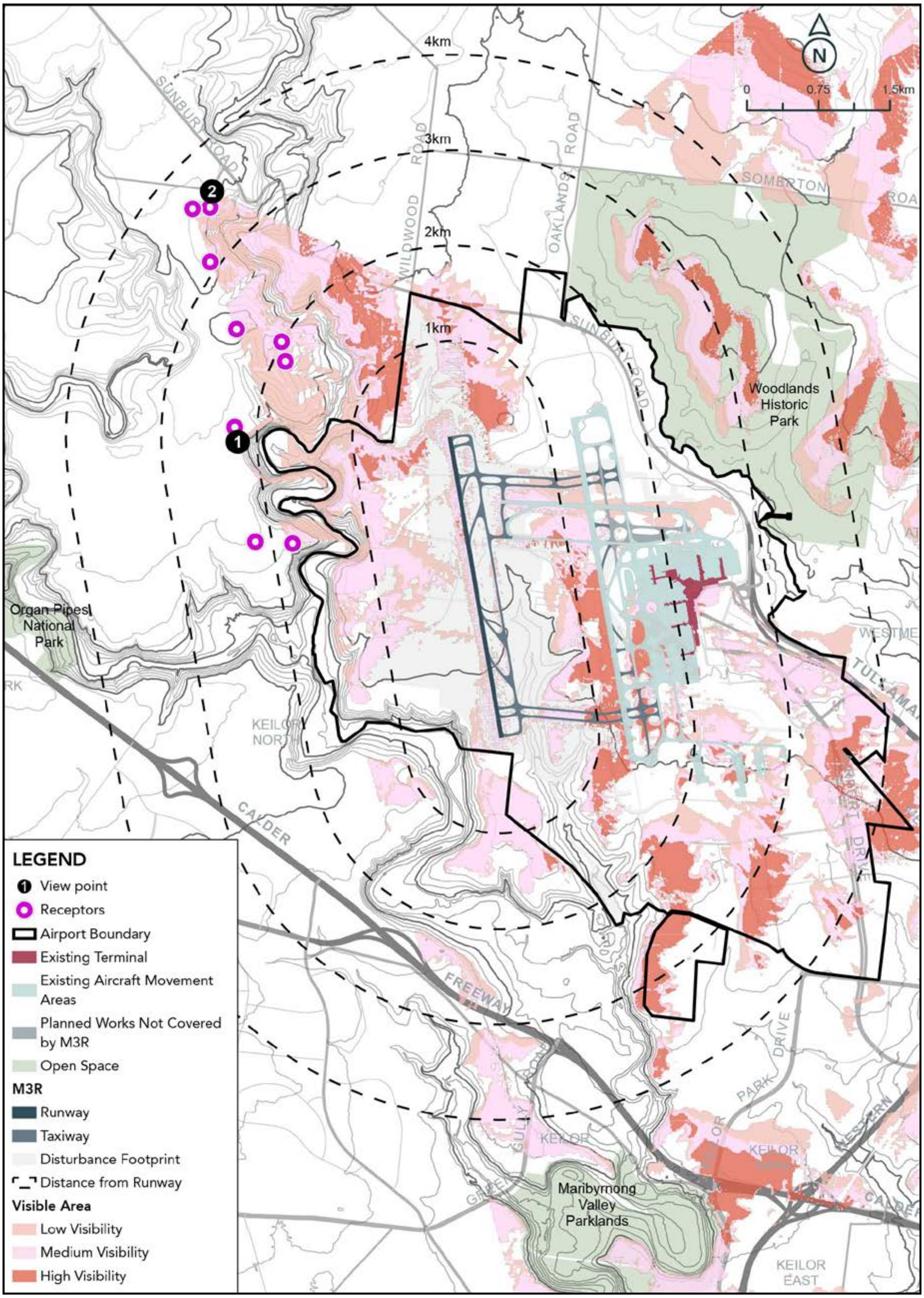


Figure B12.29
Viewpoint 1 – view east from Loemans Road

Figure B12.30
Viewpoint 1 – view east from Loemans Road – artist's impression, M3R opening year

Table B12.11
Viewpoint 1 – view south-east from Loemans Road

Visual assessment

Existing view (distance to M3R >1km):

- Panoramic view across the steep valley of Deep Creek to the airport
- Quarry visible on banks of Deep Creek in foreground
- Air traffic control towers, runways, and terminal buildings visible in middle ground (right of view)
- Vegetation along Barbiston Road visible in middle ground (right of view)
- Terminal precinct and northern part of the existing north-south runway is screened by the Grey Box Woodland (left of view)
- Aircraft seen on the existing runways, taxiways, and at the terminal
- Aircraft arriving and departing the existing 16L/34R across the view and intermittent aircraft seen travelling directly overhead on the 09/27.

Visual sensitivity: neighbourhood

View during construction:

- Vegetation removal on Barbiston Road and removal of western part of the Grey Box Woodland
- Establishment of a construction support site
- Major earthworks for the new north-south runway and taxiways, spoil stockpiling, asphalt / concrete batching plant
- Sedimentation control fencing along Deep Creek
- Movement of construction vehicles and presence of machinery.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, opening year:

- New north-south runway aligned across this view, including HIAL, taxiways, airside access road and security fencing
- Aircraft visible on both runways, air traffic with aircraft arriving and departing overhead
- View to airport terminal will remain.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, year five:

- Additional air traffic travelling overhead and across the view, closer to the viewer.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic travelling overhead and across the view, closer to the viewer.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- If required, night works will be seen extending across much of this view and towards the viewer and be seen in the middle ground.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

Operation, night:

- Light associated with M3R including aircraft intermittently will be seen in the middle ground
- Less vegetation would increase the visibility of the airport at night, including the new runway and HIAL
- This lighting will be seen against the existing brightly lit airport terminal and largely absorbed into the existing night scene.

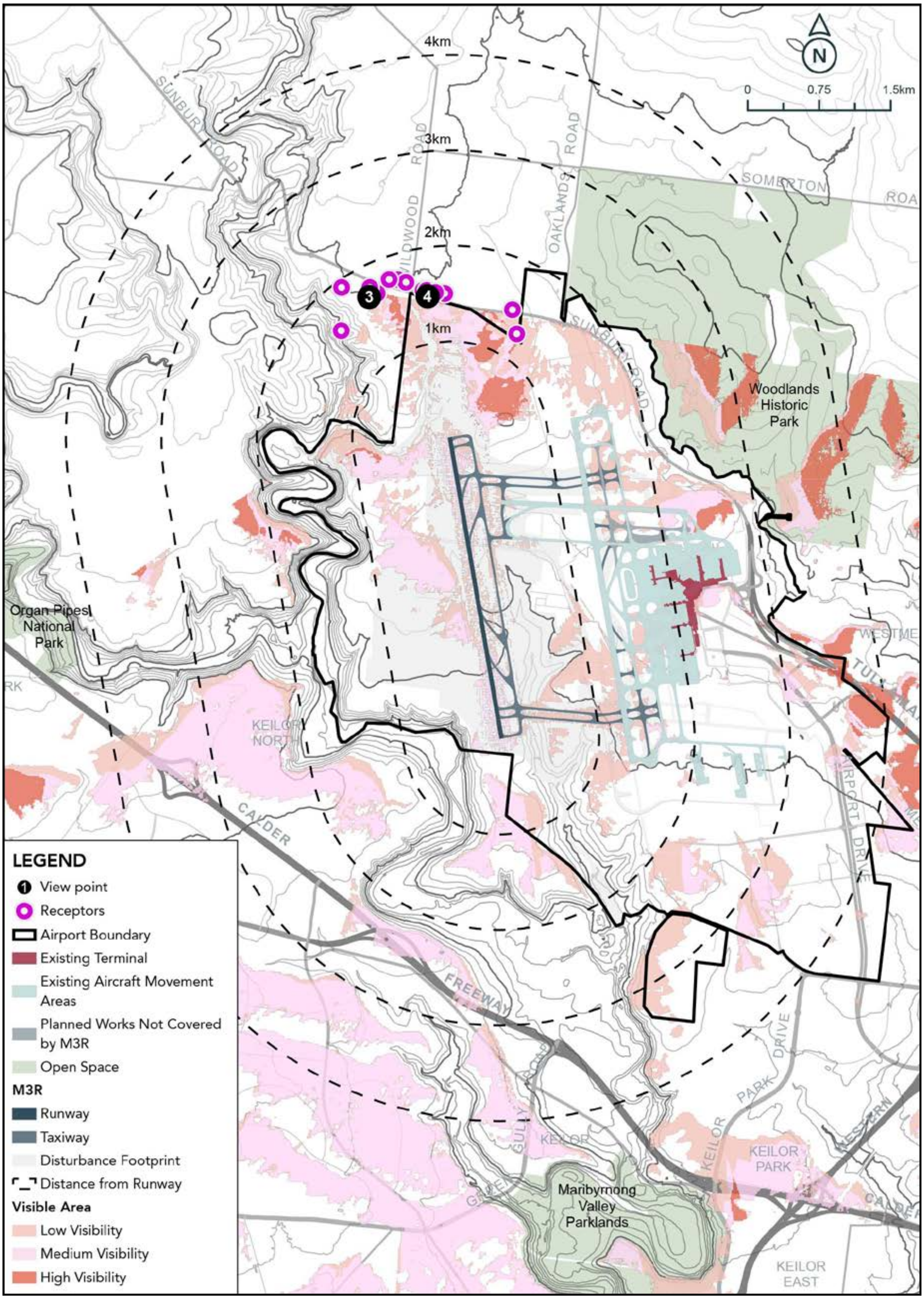
Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long term

Figure B12.31
Viewpoint 2 – view south-east from Loemans Road (north)

Table B12.12
Viewpoint 2 – view south-east from Loemans Road (north)

Visual assessment		
Existing view (distance to M3R 2.5km): • Rural properties on the outskirts of Bulla visible to the north (left of view) in the middle ground • View across undulating landscape valley with scattered farmhouses and trees • Air traffic control towers, terminal buildings and east-west runway visible in the background • Terminal precinct and northern part of the existing north-south runway is screened by the intervening vegetation • Melbourne central business district skyline in the distance • Intermittent aircraft seen travelling across the view and overhead from the existing runways.		
Visual sensitivity: neighbourhood		
View during construction: • Construction activity within the project area, including earthworks, pavement and civil works for the new north-south runway in the background • Establishment and use of a construction support site and stockpiling of spoil may be visible • Movement of construction vehicles and presence of machinery.		
Visual modification: noticeable reduction	**Visual impact:** negligible	**Duration:** short-term
View during operation, opening year: • New north-south runway aligned across this view, including HIAL, taxiways and airside access roads • Increased north-south air traffic with aircraft seen arriving and departing the new runway across the view and closer to the viewer. • Aircraft visible on both runways, air traffic with aircraft arriving and departing overhead • View to airport terminal and central business district will remain.		
Visual modification: noticeable reduction	**Visual impact:** negligible	**Duration:** short-term
View during operation, year five: • Additional air traffic travelling across the view and overhead.		
Visual modification: noticeable reduction	**Visual impact:** negligible	**Duration:** medium-term
View during operation, year 20: • Additional air traffic travelling across the view and overhead.		
Visual modification: noticeable reduction	**Visual impact:** negligible	**Duration:** long-term
Visual sensitivity at night: A2: Low district brightness		
Construction, night: • Night works will be seen in the background of the view, between intervening elements (including landform and vegetation in foreground of view) and would generally be absorbed into the night scene.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term
Operation, night: • New lighting associated with the new and existing runways will be seen in the background • Additional lighting would be seen against existing brightly lit airport terminals.		
Visual modification: noticeable reduction	**Visual impact:** moderate	**Duration:** long-term

Figure B12.32
Views from Bulla and rural landscapes to the north



B12.6.5.2
Views from Bulla and rural landscapes to the north

From Sunbury Road and residential properties on the outskirts of Bulla (Viewpoint 3 and 4) views towards the airport are restricted to slot views framed by vegetation along Deep Creek, within fields and the Grey Box Woodland. This vegetation screens views to the existing runways 16L/34R and 09/27, terminals and air traffic control towers so that only partial views to the airport are typically seen from this area. The state heritage listed Glenara Homestead is located on the banks of Deep Creek, surrounded by extensive gardens and a mature framework of trees. Views from this property are expected to be contained by this landform and vegetation and not extend to the existing airport.

During construction, there will be a change in character because activities including vegetation removal, major earthworks, stockpiling, pavement and civil works will be visible in the middle and background of these views. This will result in a considerable reduction in the amenity of views from the outskirts of Bulla and rural landscapes to the north (of neighbourhood and local sensitivity) resulting in a minor and moderate adverse visual impact during construction.

During operation, the new north-south runways will be visible from Sunbury Road and properties on the south-eastern outskirts of Bulla. The removal of vegetation (including the western part of the Grey Box Woodland) will reduce the amenity of these views. It will also increase the area of the airport (including the runways, taxiways, terminal) and associated air traffic seen within these views. The landform may partly screen the runway as it will be in cutting at its northern end, however, parts of the parallel runway and air traffic overhead will be seen in the middle ground of these views. Views from Glenara will include
M3R and there will be an increase in air traffic seen overhead from this property.

Overall, M3R will result in a considerable reduction in the amenity of views from the rural landscapes and residential properties to the north. However, these views are of neighbourhood and local sensitivity, resulting in a minor to moderate adverse visual impact during operations.

Figure B12.33
Viewpoint 3 – view south east from Glenara Road

Table B12.13
Viewpoint 3 – view south east from Glenara Drive

Visual assessment

Existing view (distance to M3R 10m):

- View across adjacent rural property and to the Grey Box Woodland trees and woodland
- Existing vegetation screens views to airport terminal buildings, and existing 16L/34R
- Air traffic can be seen including intermittent aircraft travelling across the view and overhead from the existing runways.

Visual sensitivity: neighbourhood

View during construction:

- Removal of western part of the Grey Box Woodland will be seen in middle ground
- Works to construct the new 16R/34L will be prominent, in front of the Grey Box Woodland, including major earthworks (excavation and fill), stockpiling of spoil, equipment storage, vegetation clearing, pavement and civil works
- Establishment of a construction support site, including concrete/asphalt batching plant will be seen in background
- Presence of large-scale machinery and movement of construction vehicles within the site will be seen in the middle and background.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, opening year:

- The eastern part of the Grey Box Woodland would remain and will continue to provide a backdrop to this view
- The HIAL structures and northern end of new runway, taxiways and terminal will be seen in the background
- M3R will bring the airport closer to this view, replacing the woodland and parts of the adjacent rural field with fenced airport land
- Aircraft visible at the airport and an increase in air traffic will be seen across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, year five:

- Additional air traffic travelling across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic travelling across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- Lighting on the new runway will be seen in the middle to background of this view.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** short-term

Operation, night:

- Light associated with M3R will extend across large part of the middle ground of this view and will be seen against the eastern portion of the Grey Box Woodland
- The back of the HIAL structures would be seen extending north towards Sunbury Road, north of the new runway, but the lights will not be seen.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long-term

Figure B12.34
Viewpoint 4 – view south from Sunbury Road

Figure B12.35
Viewpoint 4 – view south from Sunbury Road – artist's impression, M3R opening year

Table B12.14
Viewpoint 4 – view south from Sunbury Road

Visual assessment

Existing view (distance to M3R 10m):

- View across Sunbury Road to gently undulating landscape with trees and woodland
- Grey Box Woodland screens views to the airport terminal buildings, air traffic control towers and existing 16L/34R
- Western end of existing 09/27 visible in the centre of this view
- Foreground consisting of fields with cattle grazing create a rural character
- Concrete crushing (recycling) plant visible in the middle ground
- Air traffic can be seen including intermittent aircraft travelling across the view and overhead from the existing runways.

Visual sensitivity: local

View during construction:

- Removal of the western part of the Grey Box Woodland will be prominent in foreground, opening up the view to part of the existing airport in the background
- Works to construct 16R/34L will be prominent, including major earthworks (excavation and fill), stockpiling of spoil, equipment storage, vegetation clearing, pavement and civil works
- Establishment of a construction support site, including concrete/asphalt batching plant will be seen in background
- Presence of large-scale machinery and movement of construction vehicles along Sunbury Road and site access road seen in close proximity.

Visual modification: considerable reduction | **Visual impact:** moderate | **Duration:** short-term

View during operation, opening year:

- The new and existing runways, HIAL structure at northern end of new runway, taxiways and terminal in the background
- M3R will bring the airport closer to this view, replacing the rural fields with fenced airport land
- Aircraft visible at the airport and an increase in air traffic will be seen across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** moderate | **Duration:** short-term

View during operation, year five:

- Additional air traffic travelling across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** moderate | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic travelling across the view and overhead.

Visual modification: considerable reduction | **Visual impact:** moderate | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- Removal of the western part of the Grey Box Woodland will reveal some of the existing lighting at the airport
- Lighting on the new runway will be seen in the middle to background of this view.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

Operation, night:

- Light associated with M3R will extend across large part of the middle ground of this view and will be seen against the brightly lit airport terminal
- The back of the HIAL structures would be seen extending north towards Sunbury Road, north of the new runway, but the lights will not be seen.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long-term

B12.6.5.3
Views from Woodlands Historic Park

From Woodlands Historic Park (viewpoints 5 and 6) there are views from its homestead and Gellibrand Hill. From the homestead, views to the airport are restricted by existing vegetation including the Grey Box Woodland. There are, however, views to the existing 16L/34R, part of the terminal and air traffic control towers. These include air traffic travelling across the view and overhead. From Gellibrand Hill, there are elevated, open views across the entire airport. The airport is a feature in the panoramic views from Gellibrand Hill, as is the CBD which can also be seen from this local highpoint.

During construction, works would be seen in the background of the view from Woodlands Historic Park. While the existing Grey Box Woodland will screen the northern end of the new runway and HIAL lighting, activities such as major earthworks, stockpiling, pavement and civil works, and the presence of large-scale plant and equipment will be visible.

These elements will be seen in the context of the existing airport. Construction traffic along Sunbury Road and vehicles accessing the site would be seen from the homestead. Overall, this will result in a noticeable reduction in the amenity of views from Woodlands Historic Park, which are of regional sensitivity, resulting in a moderate adverse visual impact during construction.

During operation, the character of M3R will be generally consistent with the existing airport elements seen within the middle and background of these views. M3R will not be prominent in this view as it will be viewed over the existing airfield and partly screened by the Grey Box Woodland. There will be an increase in air traffic visible overhead and travelling across the view. Overall, the M3R will result in no perceived change in the amenity of views from the Woodlands Historic Park Homestead and adjacent areas. These views are of regional sensitivity, resulting in a negligible visual impact during operations (Figure B12.36, Figure B12.38 and Figure B12.39).

Figure B12.36
Viewpoint 5 – view south from the Woodlands Historic Park Homestead

Figure B12.37
Views from Woodlands Historic Park

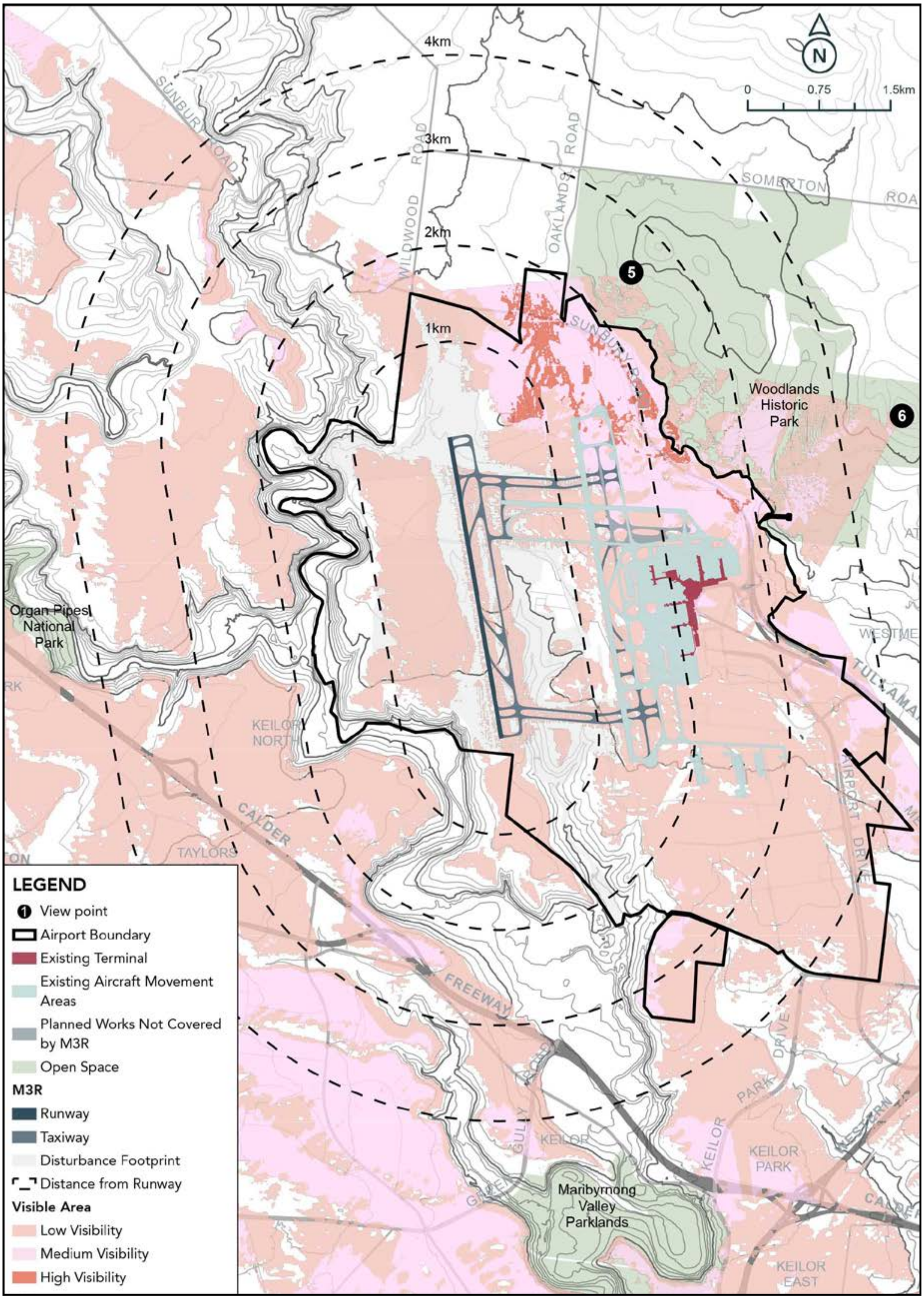


Table B12.15
Viewpoint 5 – view south from the Woodlands Historic Park Homestead

Visual assessment

Existing view (distance to M3R 1km):

- Slightly elevated vantage point
- Rural landscape visible in the foreground, Sunbury Road in the middle ground
- Grey Box Woodland screens views to western part of east-west runway
- Air traffic control towers are visible rising above the horizon
- Aircraft travelling overhead

Visual sensitivity: regional

View during construction:

- Establishment and operation of a construction compound including concrete/asphalt batching plant
- Construction of new parallel runway and taxiways would be visible to the south of the Grey Box Woodland and in the background of the view
- Construction of additional taxiways around the existing 09/27 in middle ground
- Presence of large-scale machinery within the project area and movement of construction vehicles on Sunbury Road.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

View during operation, opening year:

- Aircraft visible on the northern end of the existing 16L/4R and new 16R/34L and taxiways south of the Grey Box Woodland
- The entire existing 09/27 will be visible in the centre of view
- Increase in air traffic seen across this view with aircraft seen using both north-south runways.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, year five:

- Additional air traffic travelling across the view.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic travelling across the view.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night: (view not accessible at night)

- Any night works will be seen in the middle ground of this view and seen in the context of the existing brightly lit terminal and traffic lights on Sunbury Road.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night: (view not accessible at night)

- The lighting associated with the east-west runway, central and southern parts of the new runway will be seen in the background of this view, seen in the context of an existing brightly lit airport.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Figure B12.38
Viewpoint 6 – view west from Gellibrand Hill, Woodlands Historic Park

Figure B12.39
Viewpoint 6 – view west from Gellibrand Hill, Woodlands Historic Park – artist's impression, M3R opening year

Table B12.16
Viewpoint 6 – view west from Gellibrand Hill, Woodlands Historic Park

Visual assessment

Existing view (distance to M3R: 2km):

- Elevated, panoramic view over the airport from Woodlands Historic Park
- Control towers, existing 16L/34R and 09/27 runways, terminal precinct, apron and adjacent open grassy plains alongside Deep Creek visible in the background
- Maribyrnong River valley visible to the south of the airport in the far background
- Grey Box Woodland visible to the north (right of view)
- Air traffic including intermittent aircraft travelling across the view.

Visual sensitivity: regional

View during construction:

- Works to construct the new north-south (16R/34L) runway and taxiways including major earthworks (excavation and fill), stockpiling, pavement and civil works, and removal of Barbiston Road and McNabs Road would be seen
- Some vegetation clearing, including glimpses to the western part of the Grey Box Woodland and vegetation on Barbiston Road would be visible
- Establishment and operation of a construction compound
- Presence of large-scale machinery within the project area and movement of construction vehicles.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

View during operation, opening year:

- The central and southern areas of the new 16R/34L and taxiways will be seen across the view
- The Grey Box Woodland would continue to screen
- Aircraft will be visible on all runways, taxiways and at the terminals
- Increase in north-south air traffic with aircraft seen across the view spread across the view, arriving and departing from the new 16R/34L and also the existing 16L/34R.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, year five:

- Additional air traffic travelling across the view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic travelling across the view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night: (view not accessible at night)

- Night works will be restricted to areas adjacent to the terminal and be generally absorbed into the night scene.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night: (view not accessible at night)

- Light associated with aircraft using the new north-south runway will be seen in the middle ground of this view and will be generally absorbed into the night scene.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

B12.6.5.4
Views from residential properties, rural areas and golf courses to the south and west

From residential and rural properties on McNabs Road and Kiuna Road (viewpoints 9 and 11) there are broad, open views to the existing 16L/34R, airport terminal and air traffic control towers. These views also include air traffic travelling across the view and overhead.

During construction, activities such as vegetation clearing, major earthworks, stockpiling, pavement and civil works; and the presence of plant and equipment, will be seen in the foreground, middle ground and background of these views. The realignment of Operations Road, construction of a vehicle underpass, and removal of McNabs Road and Barbiston Road, within the project area, will be seen from several residential properties within the semi-rural areas to the south and west of the site. This construction activity will screen some portions of the view to the existing airport. Overall, this will result in a considerable reduction in the amenity of views from these properties, which are of neighbourhood sensitivity, resulting in a minor adverse visual impact during construction.

From these locations during operation, the new 16R/34L runway will be seen unobstructed, west of the existing 16L/34R. Features including the southern embankments, and aircraft located on the runway and arriving and departing across the view. will be the main features seen. Due to the scale of the works, M3R will result in a considerable reduction in the amenity of these views and a minor adverse impact. (Figure B12.43, Figure B12.44, and Figure B12.46).

Views from the Melbourne Airport Golf Course, on Operations Road (Viewpoint 7) and the Keilor Public Golf Course (Viewpoint 12) also offer views to the existing runway and airport terminal facilities. Melbourne Airport is in the middle ground of these views, partly filtered by mature trees. There are also glimpses to the airport from the surrounding rural areas of the heritage listed Arundel Farm. The farm's homestead (Viewpoint 8) is located to the west of Arundel Road and intervening trees along the road, and within the surrounding fields screen views to the airport.

During construction, activities including vegetation removal, major earthworks, stockpiling, pavement and civil works; and the presence of plant and equipment will be seen in the middle to background of these views. These elements will replace views to the existing airport. Overall, this will result in a noticeable and considerable reduction in the amenity of views from these locations, which are of local sensitivity, resulting in a minor adverse and moderate visual impact during construction.

During operations, activities associated with M3R will extend closer to these locations, and rise above the surrounding landform. Aircraft will be seen in close proximity, and associated air traffic seen overhead and travelling across these views. From the Keilor Public Golf Course, the new runway and taxiways will be visible filtered through trees to the north-east; however, much of the golf course includes screening vegetation that blocks views to the airport. From the Melbourne Airport Golf Course, however, the new runway, taxiways and realignment of Operations Road will be seen in close proximity and elevated above the surrounding landform. Overall, due to the filtering effect of the intervening vegetation, and precedent of the existing airport and runways seen in these views, M3R will create a noticeable reduction in the amenity of views from these locations. These views are of local visual sensitivity, and this will result in a minor adverse visual impact during operations. (Figure B12.41, Figure B12.42, and Figure B12.47).

There are distant views to the airport from elevated areas to the south of the study area, including views from areas of Keilor (Viewpoint 10), approximately four kilometres from M3R. In these views, the airport can be seen in the background, and air traffic can be seen approaching the site from the east and west. During construction, it is unlikely construction works will be seen from this location, resulting in a negligible visual impact.

During operations, there will be additional air traffic seen flying overhead, arriving, and departing from the new runway. Views from these elevated residential areas are of neighbourhood sensitivity, resulting in a negligible visual impact during M3R operation (Figure B12.45).

Figure B12.40
Views from residential, rural properties and golf courses to the south and west

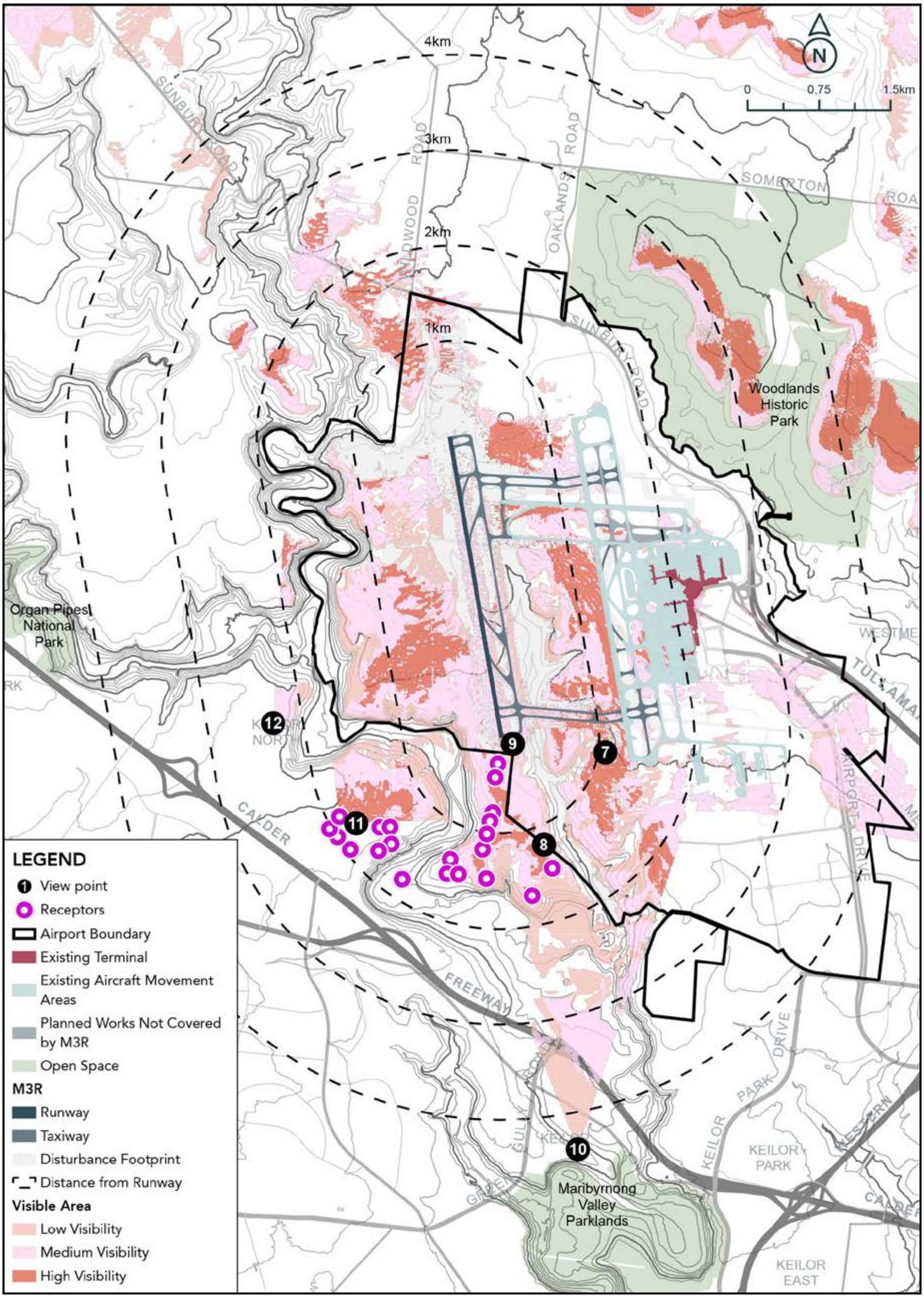


Figure B12.41
Viewpoint 7 – view north from the Melbourne Airport Golf Course

Figure B12.42
Viewpoint 8 – view north from the Arundel Farm Estate

Table B12.17
Viewpoint 7 – view north from the Melbourne Airport Golf Course

Visual assessment

Existing view (distance to M3R 50m):

- Golf course green in the foreground
- Mature vegetation within the golf course filter views to the airport
- The existing 09/27, apron and adjacent grassy plains are visible in the middle ground
- Distant views to the Great Dividing Range
- Grey Box Woodland at northern end of the airport seen in the background
- Air traffic including intermittent aircraft travelling across the view.

Visual sensitivity: local

View during construction:

- Works to form the new 16R/34L including major earthworks (excavation and fill), stockpiling, pavement and civil works
- Vegetation clearing would be seen in middle and background of view
- Diversion of Operations Road to the west and across this view in middle ground
- Construction of a new vehicle tunnel under the southern cross-field taxiways and stormwater drainage network in middle ground of view, including new pipework, swales and culverts
- Construction of the new 16R/34L, including apron, taxiways, airside access road and fencing in middle ground of this view
- Presence of large-scale machinery with the project area and movement of construction vehicles in middle ground.

Visual modification: considerable reduction | **Visual impact:** moderate | **Duration:** short-term

View during operation, opening year:

- Diverted Operations Road extending across this view in middle ground
- Aircraft visible on the new 16R/34L, glimpsed through trees within the golf course
- Increase in north-south air traffic with aircraft seen arriving and departing the runways visible overhead.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, year five:

- Additional aircraft overhead, arriving and departing from the new north-south runway.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** medium-term

View during operation, year 20:

- Additional air traffic seen overhead, arriving and departing the new north-south runway.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night: (view not accessible at night)

- Light will be seen extending across and extending north from this view to construct the new runway, Operations Road and Arundel Creek diversions. This work will bring lighting towards this location, in the middle ground where it is not screened by trees.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night:

- Light associated with Operations Road, and aircraft on the new north-south runway (16R/34L) will be seen in the middle ground of this view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Table B12.18
Viewpoint 8 – view north from the Arundel Farm Estate

Visual assessment

Existing view (distance to M3R 600m):

- Vineyard seen in the foreground is part of Arundel Farm Estate
- Small-scale rural character, with rolling landform, vineyard in the foreground, paddocks in the middle ground, defined by trees
- Northern areas of the airport including north-south runway, terminal precinct, apron and backdrop of the Great Dividing Range visible in background
- Air traffic including intermittent aircraft travelling across the view.

Visual sensitivity: local

View during construction:

- Construction of the new 16R/34L, taxiways, airside access road and fencing, including major earthworks (excavation and fill), stockpiling, vegetation clearing would be in the background and partly screened by vegetation
- Works to form and construct the new southern cross-field taxiways and stormwater drainage network would be seen in the middle to background of the view between the trees
- Diversion of Operations Road to the west will be screened by vegetation
- Views to large-scale machinery within the project area and movement of construction vehicles.

Visual modification: noticeable reduction	**Visual impact:** minor adverse	**Duration:** short-term

View during operation, opening year:

- New east-west southern cross-field taxiways and stormwater drainage network in middle ground of view, slightly elevated on embankment in the background of view, seen through trees within the rural landscape
- Aircraft visible on the new 16R/34L and increase in north-south air traffic with aircraft seen overhead.

Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term

View during operation, year five:

- Additional aircraft seen overhead arriving and departing from the new runway.

Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** medium-term

View during operation, year 20:

- Additional aircraft seen overhead arriving and departing from the new runway.

Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- Additional light will be seen adjacent to the existing brightly lit environment of the terminal in the background.

Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term

Operation, night:

- Light associated with Operations Road, and aircraft on the new north-south runway (16R/34L) will be seen in the background of this view and be absorbed into the existing brightly lit terminal in the background.

Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** long-term

Figure B12.43
Viewpoint 9 – view north from McNabs Road

Figure B12.44
Viewpoint 9 – view north from McNabs Road – artist's impression, M3R opening year

Table B12.19
Viewpoint 9 – view north from McNabs Road

Visual assessment

Existing view (distance to M3R 0m – located on southern boundary of M3R project area):

- Undulating and partly vegetated rural landscape visible in foreground
- Airport air traffic control towers, runways, terminal precinct and apron visible in middle ground
- Vegetation along Barbiston Road visible in foreground and Grey Box Woodland seen in the background of view
- Rural landscape in the middle ground
- Distant views to the Great Dividing Range
- Air traffic including intermittent aircraft travelling across the view and overhead.

Visual sensitivity: neighbourhood

View during construction:

- Removal of vegetation along Barbiston Road and the western part of the Grey Box Woodland
- Closure of McNabs Road in the foreground
- Works to form the new 16R/34L including major earthworks (excavation and fill), and stockpiling in fore and middle ground of view
- Construction of new 16R/34L, apron, taxiways, airside access road and fencing
- Drainage relocations and upgrade works to the east of view, including installation of new pipework, swales, culverts and new vehicle tunnel under southern cross-field taxiways
- Presence of large-scale machinery within the project area and movement of construction vehicles.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, opening year:

- New 16R/34L elevated on embankment, visible to the west (left of view)
- Aircraft visible on the new 16R/34L, and cross-field taxiways
- Increase in north-south air traffic with aircraft seen across the view and overhead
- Obstruction of the distant views to the rural landscape including trees and woodland.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, year five:

- Additional aircraft travelling across the view.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** medium-term

View during operation, year 20:

- Additional aircraft travelling across the view.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- Light will be seen the middle ground and extending across this view for M3R construction, including the reconfiguration of Operations Road and works at Arundel Creek (right of view).

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

Operation, night:

- Light associated with aircraft on the new north-south runway (16R/34L) will be seen in the middle ground of this view, seen in the context of the existing lit airport.

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long-term

Figure B12.45
Viewpoint 10 – view north from Skyline Drive, Keilor

Figure B12.46
Viewpoint 11 – view north-east from Kiuna Road, Keilor North

Table B12.20
Viewpoint 10 – view north from Skyline Drive, Keilor

Visual assessment

Existing view (distance to M3R 4km):

- Elevated northerly view with suburban residential landscape in the fore and middle ground
- Rural landscapes of the Maribyrnong River and Arundel Creek valleys, including the Keilor Market Gardens Cultural Landscape, in the middle to background
- Terminal precinct and apron areas visible in background
- Mature vegetation alongside roads and paddocks near Arundel Farm and within Melbourne Airport Golf Course screen views to the runways
- Distant views to the Great Dividing Range
- Air traffic including intermittent aircraft travelling across the view and overhead.

Visual sensitivity: neighbourhood

View during construction:

- Intervening vegetation will screen most construction activity to the west of the project area
- Some work at the south eastern end of the project area may be visible in the background, including the construction of new and cross-field taxiways.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, opening year:

- Aircraft visible overhead, arriving and departing the new north-south runway (16L/34R), in background of view
- There will be an increase in north-south air traffic currently seen overhead and across the view but distributed across three runways.

Visual modification: noticeable reduction | **Visual impact:** negligible | **Duration:** short-term

View during operation, year five:

- Additional aircraft travelling overhead.

Visual modification: noticeable reduction | **Visual impact:** negligible | **Duration:** medium-term

View during operation, year 20:

- Additional aircraft travelling overhead.

Visual modification: noticeable reduction | **Visual impact:** negligible | **Duration:** long-term

Visual sensitivity at night: A3: Medium district brightness

Construction, night:

- Light associated with night works is unlikely to be seen from this location due to the distance.
- Any additional lighting will be absorbed into the existing lit view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night:

- Light associated with aircraft on the new north-south runway and taxiways (16R/34L) will be seen in the middle ground.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** long-term

Table B12.21
Viewpoint 11 – view north-east from Kiuna Road, Keilor North

Visual assessment

Existing view (distance to M3R 1.5km):

- Flat and sparsely vegetated landscape in the foreground and middle ground allow expansive views over the Maribyrnong River valley to the airport
- Airport air traffic control towers, terminal precinct, and runway visible in middle ground
- Southern part of airport screened by mature vegetation within Melbourne Airport Golf Course
- Vegetation on Barbiston Road visible in middle ground
- Grey Box Woodland visible in background of view, beyond the air traffic control towers
- Air traffic including intermittent aircraft travelling across the view.

Visual sensitivity: neighbourhood

View during construction:

- Works to prepare and construct the new 16R/34L and taxiways will be seen in middle and background, including major earthworks (excavation and fill), vehicle tunnel works (under new southern cross-field taxiways), stockpiling, stormwater drainage works, and removal of vegetation on Barbiston Road in the background
- Removal of the western part of the Grey Box Woodland will be seen in background of view
- Diversion of Operations Road and removal of Barbiston Road and McNabs Road in middle ground
- Presence of machinery within the project area and movement of construction vehicles.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, opening year:

- New 16R/34L elevated on embankment, new apron, taxiways, airside access road and security fencing, extending across the middle ground
- Increase in north-south air traffic visible overhead, arriving and departing the new 16R/34L and travelling along the taxiways
- Diversion of Operations Road, stormwater drainage network and new vehicle tunnel under the southern cross-field taxiways will be visible.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, year five:

- Additional aircraft travelling across the view, arriving and departing from the new runway.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** medium-term

View during operation, year 20:

- Additional aircraft travelling across the view, arriving and departing from the new runway.

Visual modification: considerable reduction | **Visual impact:** minor | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- Light will be seen extending across the middle ground of this view to construct the runway. This work will be seen in a broad view which includes the existing, brightly lit terminal

Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** short-term

Operation, night:

- Light associated with Operations Road and aircraft on the new north-south runway (16R/34L) will be seen in the middle ground of this view, in context of existing lit airport.

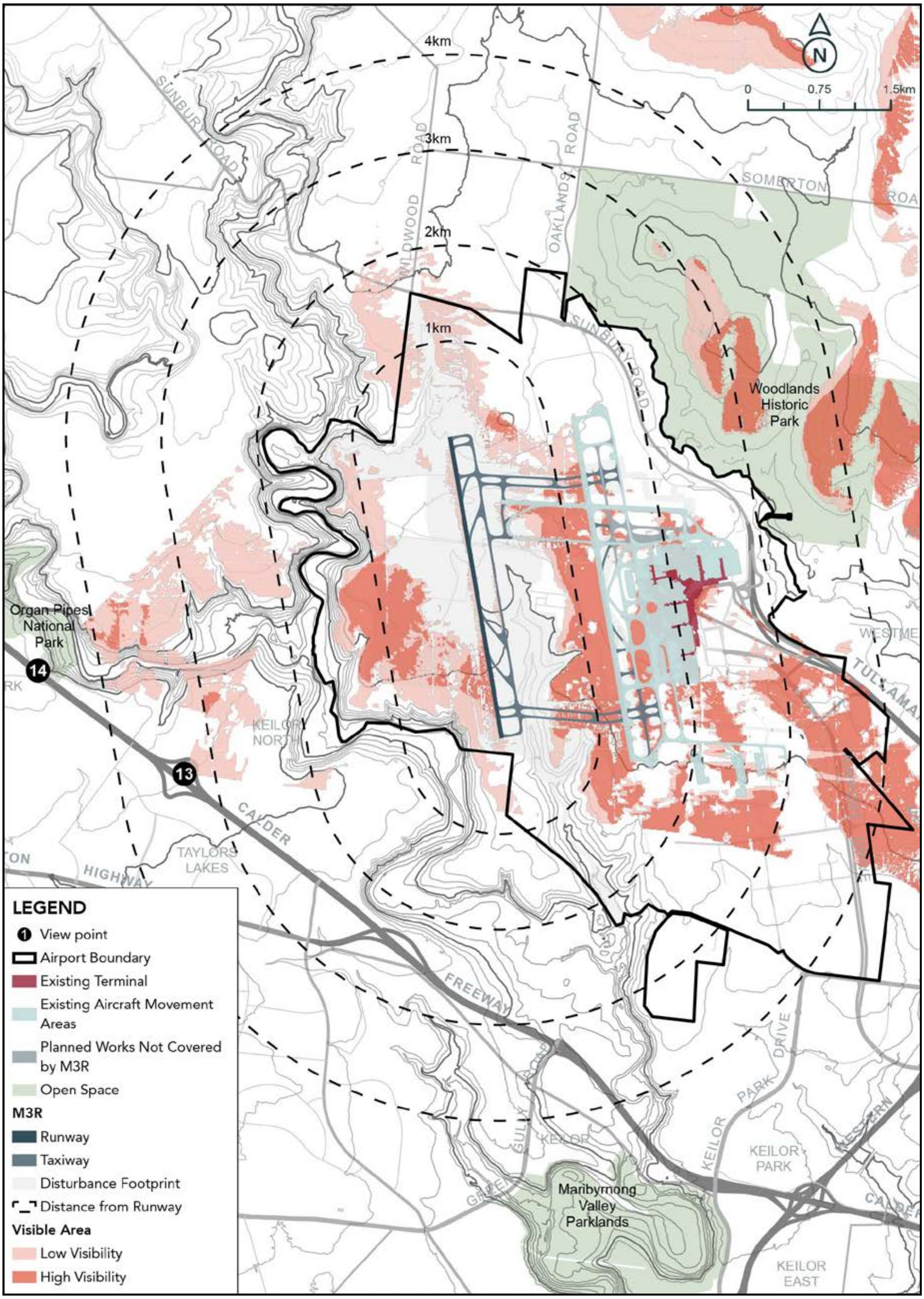
Visual modification: noticeable reduction | **Visual impact:** moderate | **Duration:** long-term

Figure B12.47
Viewpoint 12 – view north-east from Keilor Public Golf Course

Table B12.22
Viewpoint 12 – view north-east from Keilor Public Golf Course

Visual assessment		
Existing view (distance to M3R 1km): • Golf course fairway in the foreground • Mature vegetation within the golf course filter views to the airport • Trees along Barbiston Road can be seen aligned across the view in the background • Grey Box Woodland visible in the far background (right of view) • Distant views to the Great Dividing Range (left of view) • Air traffic including intermittent aircraft travelling across the view.		
Visual sensitivity: local		
View during construction: • Works to construct the new 16R/34L, including major earthworks (excavation and fill), stockpiling, civil and pavement works, seen in the background (right of view) • Vegetation clearing within the project area, including along Barbiston Road and the western part of the Grey Box Woodland • Presence of large-scale machinery with the project area and movement of construction vehicles.		
Visual modification: noticeable reduction	**Visual impact:** minor	**Duration:** short-term
View during operation, opening year: • New 16R/34L elevated on embankment, new apron, taxi way hardstands, airside access road and security fencing would be seen in the background (right of view) • Removal of trees including part of the woodland would open up the background of this view, allowing longer range views into the airport and towards Sunbury Road • Aircraft visible on the new and existing runways and an increase in north-south air traffic, with aircraft seen overhead, arriving and departing the airport, glimpsed through trees within the golf course.		
Visual modification: noticeable reduction	**Visual impact:** minor	**Duration:** short-term
View during operation, year five: • Additional air traffic travelling overhead and aircraft arriving and departing the runway.		
Visual modification: noticeable reduction	**Visual impact:** minor	**Duration:** medium-term
View during operation, year 20: • Additional air traffic travelling overhead.		
Visual modification: noticeable reduction	**Visual impact:** minor	**Duration:** long-term
Visual sensitivity at night: A2: Low district brightness		
Construction, night: (view not accessible at night) • Light associated with the construction works will be seen in the background, where not screened by trees within the golf course (right of view).		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term
Operation, night: (view not accessible at night) • Light associated with Operations Road and aircraft on the new north-south runway (16R/34L), will be seen in the background (right of view) and seen in the context of the existing lit airport.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** long-term

Figure B12.48
Views from Calder Freeway



B12.6.5.5
Views north-east from the Calder Freeway

From the Calder Freeway and overbridges (viewpoints 13 and 14) there are broad open views across the rural landscape and towards Melbourne Airport. In these views, the terminals and air traffic control towers can be seen in the background, across the creek valleys. Existing blocks of vegetation and intervening landform screen views to the existing runways.

During construction, activities including vegetation removal, major earthworks, stockpiling, civil and pavement works and the presence of plant and equipment will be mostly screened by intervening elements. There may be glimpses to the upper portions of construction equipment over and through the intervening vegetation. The works will be seen mainly from vehicles moving at speed and viewed within the context of the airport. Overall, this will result in a noticeable reduction but no perceived change in the amenity of views from these locations, which are of local sensitivity, resulting in a minor adverse and negligible visual impact during construction.

During operation, the character of M3R will be generally consistent with the existing elements of the airport seen within these views. The realignment of Operations Road and new runway 16R/34L will be seen in front of the airport. Increased air traffic will also be seen, aligned parallel with the existing north-south air traffic currently seen overhead. Overall, due to the precedent of the existing airport in this view, M3R will not create a perceived change in the amenity of views from the Calder Freeway, resulting in a negligible visual impact (**Figure B12.49** and **Figure B12.50**).

Figure B12.49
Viewpoint 13 – view north-east across the Kings Road overbridge

Table B12.23
Viewpoint 13 – view north-east across the Kings Road overbridge

Visual assessment

Existing view (distance to M3R 2km):

- Elevated view to undulating rural landscape in middle ground of view
- Mature vegetation along the Maribyrnong River and within Keilor Public Golf Course partially screen views to the airport
- Upper part of the terminal and control towers visible rising above the horizon in the background
- Woodlands Historic Park, in far background of view
- Distant views to the Great Dividing Range (right of view)
- Air traffic including intermittent aircraft travelling across the view.

Visual sensitivity: local

View during construction:

- Intervening vegetation will screen the majority of construction activity
- Vegetation clearing and the upper parts of tall machinery may be seen in background.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, opening year:

- Increase in north-south air traffic with aircraft seen across the view, arriving and departing from the new runway.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, year five:

- Additional aircraft travelling across the view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** medium-term

View during operation, year 20:

- Additional aircraft travelling across the view.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Visual sensitivity at night: A2: Low district brightness

Construction, night:

- The glow of night works will be seen in the background, west of the existing airport terminal above intervening vegetation in the background.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night:

- Light associated with aircraft on the new north-south runway (16R/34L) may be seen in the background of this view.
- This additional light would be seen in the context of an existing lit airport.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Figure B12.50
Viewpoint 14 – view north-east from the Calder Freeway

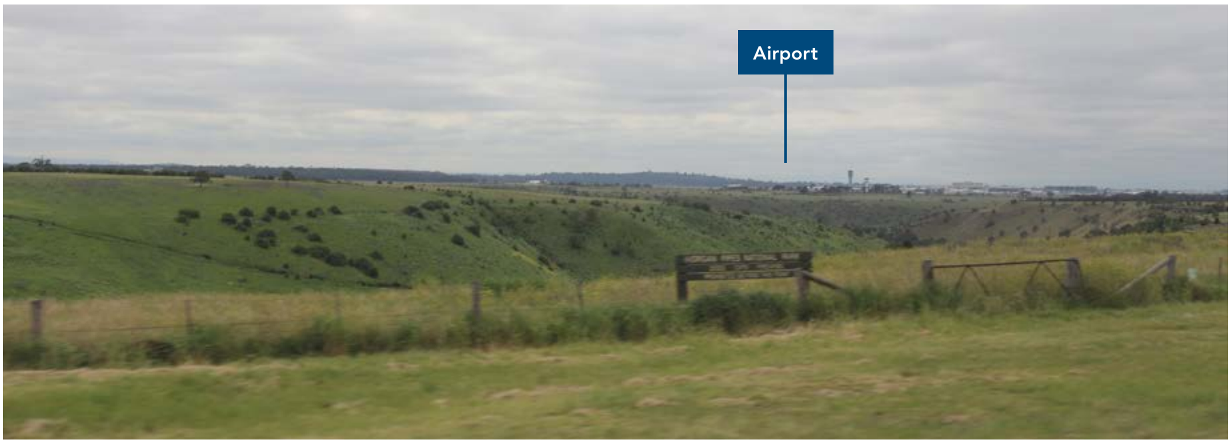


Table B12.24
Viewpoint 14 – view north-east from the Calder Freeway

Visual assessment

Existing view (distance to M3R 3.5km):

- Open and level views across the Jackson Creek valley to Melbourne Airport
- Undulating rural landscape including the deeply incised banks of Jacksons Creek
- Airport terminal and control towers visible, rising above the horizon in the background of view
- Elevated vegetation at Woodlands Historic Park seen in far background of view
- Grey Box Woodland visible at northern end of airport, in view background (left of view)
- Air traffic including intermittent aircraft travelling across the view
- The project area is visible in the background of this view, beyond the Jacksons Creek valley,

Visual sensitivity: local

View during construction:

- Construction of the new north-south runway, including major earthworks (excavation and fill), stockpiling, vegetation clearing, civil and pavement works visible in background
- Construction of new taxiways, airside access road and security fencing may be glimpsed in the background
- Presence of large-scale machinery with the project area and movement of construction vehicles.

Visual modification: noticeable reduction | **Visual impact:** minor | **Duration:** short-term

View during operation, opening year:

- New runway, taxiways, airside access road and security fencing would be glimpsed in the background
- Aircraft visible arriving and departing the new north-south runway and travelling along taxiways, increasing the amount of air traffic seen across the view in the background.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

View during operation, year five:

- Additional aircraft travelling across the view, arriving and departing from the new runway.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** medium-term

View during operation, year 20:

- Additional aircraft travelling across the view arriving and departing from the new runway.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

Visual sensitivity at night: A3: Medium district brightness

Construction, night:

- Light associated with night works is unlikely to be seen from this location due to intervening vegetation
- Any additional lighting will be absorbed into the setting of the existing lit areas at the terminal and surrounds.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** short-term

Operation, night:

- Light associated with aircraft on the new north-south runway (16R/34L) would be seen in the background of this view, in the context of an existing lit airport.

Visual modification: no perceived change | **Visual impact:** negligible | **Duration:** long-term

B12.6.5.6
Views from Organ Pipes National Park to the south-west

Views from within the Organ Pipes National Park (Viewpoint 15) are largely contained within the valley of Deep Creek. While the airport cannot be seen, air traffic can be seen flying across the view, detracting from the wilderness and remote character of these views.

During construction there will be no change in amenity of views from the Organ Pipes National Park, resulting in a negligible visual impact. During operations, there will be increased air traffic seen aligned across the view. As there is already air traffic seen in this view, it is unlikely that there will be a perceived reduction in the amenity of this view, which is of local visual sensitivity, resulting in a negligible visual impact during operations (Figure B12.51).

Figure B12.51
Viewpoint 15 – view east from Organ Pipes National Park

Figure B12.52
Views from Organ Pipes National Park to the south-west

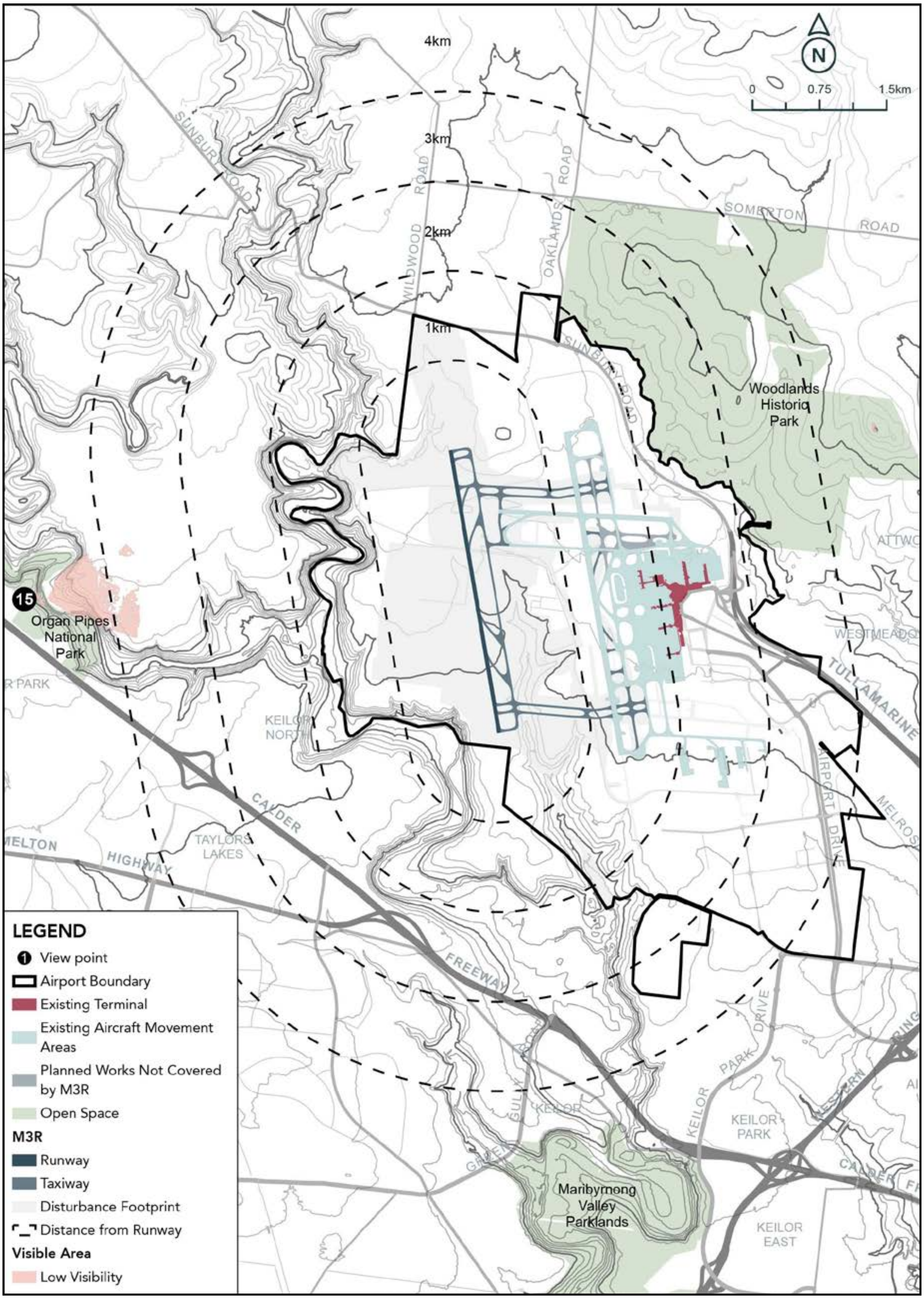


Table B12.25
Viewpoint 15 – view east from Organ Pipes National Park

Visual assessment		
Existing view (distance to M3R 3.5km): • View from the ridgeline, into the Jackson Creek valley from a trail within the National Park • Vegetation and landform in the middle ground enclose views • Landform and vegetation screen views to the airport • Air traffic, including intermittent aircraft, travelling across the view.		
Visual sensitivity: local		
View during construction: • Intervening landform will screen any view to the construction activity within the project area.		
Visual modification: noticeable reduction	**Visual impact:** minor adverse	**Duration:** short-term
View during operation, opening year: • Intervening landform and vegetation will screen construction activity. • Glimpses to aircraft arriving and departing from the new runway and additional air traffic will be seen across the view.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term
View during operation, year five: • Additional aircraft seen overhead and travelling across the view.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** medium-term
View during operation, year 20: • Additional aircraft seen overhead and travelling across the view.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** long-term
Visual sensitivity at night: A2: Low district brightness		
Construction, night: (view not accessible at night) • Works undertaken at night will not be seen due to intervening landform and vegetation.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** short-term
Operation, night: • Aircraft arriving and departing from the new runway may be seen in the background of this view and travelling overhead.		
Visual modification: no perceived change	**Visual impact:** negligible	**Duration:** long-term

B12.6.6
Night-time sensitivity levels

The criteria described in Table B12.26 are used to describe night-time visual impact sensitivity.

B12.6.7
Views from rural landscapes to the west

During construction, night works will be seen unobstructed and would extend across a large area of the view from properties to the east of Loemans Road (refer to Viewpoint 1 and 2). It is not expected that there would be any light trespass onto the residences in this area due to the separation provided by Deep Creek. These night works will be seen against the existing brightly lit airport terminal, which is prominent in existing views. Overall, there will be noticeable reduction in the amenity of views at night from this area of A2: low district brightness, and a moderate adverse visual impact during construction.

During operations, the new north-south runway will be seen, with some lighting on the runway and HIAL at its northern end (directed upwards to guide aircraft). There will also be lighting associated with air traffic overhead and along the parallel runways. There will be no light trespass onto these properties due to the separation of the residences from the airport by Deep Creek, and this lighting will be viewed against the existing brightly lit airport terminal, which is prominent in the existing view. This will result in a noticeable reduction in the amenity of views at night, from this area of A2: Low district brightness, and a moderate adverse visual impact during operations.

Table B12.26
Night-time sensitivity levels

Location	Values	Visual sensitivity level
Airport terminal precinct	• Brightly lit buildings, car parking structures, streets and apron areas • High level of night-time activity.	A4: High district brightness area
Bulla, Sunbury Road, Calder Freeway, Keilor	• Concentration of lighting from residential properties and vehicles on local streets in Bulla • Urban locations such as Keilor include lighting from residences and moderately well-lit roadways • Moderate levels of activity at night • Moderately sensitive visual settings at night.	A3: Medium district brightness area
Rural areas to the south, west and north of the airport	• Includes rural areas with scattered residential properties in relatively dark locations • Limited night-time activity on courses so that views are not accessible at night • Highly sensitive visual setting at night.	A2: Low district brightness area
Golf courses	• Activity is limited (daytime opening hours 6.30am-6pm) and views are not accessible at night from the course • The clubhouse and car parking areas at the Melbourne Airport Golf Course can be hired for functions.	A2: Low district brightness area
Organ Pipes National Park, Woodlands Historic Park	• National park and state park are largely unlit at night, with some limited lighting at park entries • No night-time activity and views are not accessible at night • Very highly sensitive visual setting	A1: Intrinsically dark landscape

B12.6.8
Views from Bulla and rural landscapes to the north

During construction, views from Bulla and rural landscapes to the north will be in close proximity to the construction of the northern end of the new north-south runway (16R/34L) (refer to viewpoints 3 and 4). Views to construction activity within the remainder of the project area will also be possible in the middle and background of views. During night works, there would be lighting seen on visible areas of the site. It is not expected that there would be any light trespass onto adjacent residences as lighting would be focused on the project area and due to the nature of the rural landscapes. The night works would be seen in the context of the existing brightly-lit airport terminal and in an area where air traffic would currently be seen travelling across these views at night. This will result in a noticeable reduction in the amenity of views at night from this area of A2: Low district brightness, and a moderate adverse visual impact during construction.

During operations, aircraft arriving on the new north-south runway (16R/34L) will be seen arriving and departing across the views, parallel with but closer to this location. The new HIAL north of the new runway would be visible, but light would be directed upwards, towards air traffic. It is expected that there will be no light trespass on adjacent residences. Overall, there will be a noticeable reduction in the amenity of views at night, from this area of A2: Low district brightness, and a moderate adverse visual impact during operations.

B12.6.9
Views from Woodlands Historic Park

Views from Woodlands Historic Park will not be available at night and, for this reason, no impact will be experienced.

B12.6.10
Views from residential, rural properties and golf courses to the south and west

It is not expected that there will be access to views from the golf courses at night. For this reason, no impact will be experienced (refer to viewpoints 7 and 12). Although there may be access to the golf course clubhouses during functions there are no views to the works expected from these locations.

During construction, from residential properties within this rural landscape (such as on Kiuna and McNabs roads) there will be unobstructed views to the night works (refer to Viewpoint 8, 9, 10 and 11). Night works will include major earthworks and involve forming of the runway and taxiways, raised up above the surrounding landform and taxiways. Because works will be contained within the project area it is not expected there would be light trespass on these residences. Although these night works will be seen within the context of the existing brightly -lit airport terminal, these works would bring lighting closer to these viewers, extending across much of these views, elevated above these viewing locations, and in close proximity. It is expected that there will be a noticeable reduction in the amenity of views at night from this area of A2: Low district brightness, and a moderate adverse visual impact during construction.
In elevated residential areas to the south (such as Keilor) it is expected that any additional lighting seen during construction would be absorbed into existing lit views.

As this is an area of A3: Medium district brightness, there would be no perceived change and a negligible visual impact during construction.

During operations, lighting on the new north-south runway (16R/34L) will be located at a level above these residences and directed upwards to guide aircraft and therefore unlikely to be seen. There will, however, be some light on the wing and tail tips of aircraft arriving and departing across the view. There will not be any light trespass onto these residential properties, and the lighting will be viewed in the context of the existing brightly lit airport terminal. This will result in a noticeable reduction in the amenity of views at night, from these properties, which are in an area of A2: Low district brightness, and a moderate adverse visual impact during operations. In elevated residential areas to the south, such as Keilor, the light associated with aircraft on the new north-south runway and taxiways will be seen in the middle ground of views, resulting in a noticeable reduction in the amenity of views at night from this area of A3: Medium district brightness, and a minor adverse visual impact during operation.

B12.6.11
Views north-east from the Calder Freeway

Views from the Calder Freeway, and overpasses, include open views across the landscape and include the brightly lit airport in the background (refer to Viewpoint 13 and 14).

During construction, night works may be required and will be seen in areas around the terminal and extending to the west. These elements will be glimpsed between intervening trees and landform and be seen mainly from fast moving vehicles. This will result in no perceived change in the amenity of these views at night, from this area of A3: Medium district brightness and a negligible visual impact during construction.

During operations, where the new north-south runway (16R/34L) will be seen, the lighting levels will be consistent with the existing areas of runway, with some minimal lighting, and additional aircraft arriving and departing across the view. This will result in no perceived change in the amenity of views from this area of A2: Low district brightness, and a negligible visual impact during operations.

B12.6.12
Views from Organ Pipes National Park to the south-west

Views from Organ Pipes National Park will not be available at night and for this reason, no impact will be experienced.

B12.7
AVOIDANCE, MANAGEMENT AND MITIGATION MEASURES

The following section identifies mitigation measures that will be incorporated into M3R design and activity during construction and operation.

B12.7.1
Construction

A Construction Environmental Management Plan (CEMP) will be prepared. During construction, the following measures will be undertaken where feasible to avoid, manage and mitigate the construction impacts of M3R on the landscape and visual amenity of the project area. The following will be considered:

- Mulch, hydro mulch or soil binder to be used to minimise impacts of open excavation where appropriate
- Set construction vehicles, equipment, stockpiling, asphalt, and concrete batching plants away from sensitive receptors such as occupied properties on Loemans, Operations, McNabs and Sunbury roads.

B12.7.2
Operation

Due to the operational requirements of an airport, it is not desirable to introduce planting and trees that will attract birds and wildlife. On-site mitigation measures will therefore be restricted considering the location and treatment of airport structures and facilities.

To avoid, manage and mitigate the impact of M3R operations, the following measures will be considered:

- Investigate relocation of the airport viewing area from Operations Road
- Screen planting (in accordance with obstacle limitations) to the north of the new 16R/34L runway (where possible, adjacent to Sunbury Road) in order to screen ground level views into the airport from nearby residences at Bulla and from rural areas to the north.

All planting proposed for the mitigation of landscape and visual impact will be undertaken in accordance with the Melbourne Airport Planting Guidelines (2014).

B12.8 CONCLUSION

An impact assessment has been undertaken and is contained in Table B12.27. In summary, the key findings of this study are as follows.

B12.8.1 Landscape impacts

There is a likely moderate adverse landscape impact during construction and a short-term medium rating, which will reduce to a minor adverse landscape impact during operations, and a long-term medium rating. These impacts are due particularly to the removal of the western part Grey Box Woodland and landform changes.

The moderate adverse landscape impact expected during construction is acceptable as it is temporary in nature. The minor adverse landscape impact during operations, while permanent, is also acceptable as the airport land is a relatively low sensitivity landscape compared with the higher sensitivity landscapes in the vicinity, such as the Keilor Market Gardens Cultural Landscape which are unaffected by M3R.

B12.8.2 Visual impacts

In the daytime during construction, the visual impact of M3R will be a short-term minor to moderate adverse visual impact, with a short-term rating of medium. The main sources of impact will be vegetation clearing, major earthworks, plant and equipment. The nature of these impacts is mainly due to the precedent of the existing airport runways and terminals, seen in views to the site, and the restricted visibility of the site due to vegetation in areas to the north and south.

During daylight operations the visual impact of M3R will be generally minor adverse to negligible visual impact, with a long-term rating of medium to negligible. The main sources of impact will be the proximity of the new north-south runway (16R/34L) to adjacent rural, recreational and residential areas, realignment of Operations Road and increased air traffic seen overhead and travelling north-south across views.

The minor to moderate adverse visual impact expected during construction would be acceptable as these are temporary in nature. Where there are minor adverse visual impacts during operation, while permanent, these are also acceptable as they are experienced from a small number of receivers and are from the lower sensitivity viewing locations.

At night, during construction, there will be a moderate adverse visual impact with a medium rating in views from Bulla and rural landscapes to the north, rural landscapes to the west, and rural properties to the south and west. This will be due to the unobstructed nature and expanse of work that would be seen in views from Loemans Road and the proximity of views from residential properties on Kiuna, McNabs and Sunbury roads and extent of view to this work. This impact will be short-term. During operation this impact will reduce to minor adverse and negligible, with a long-term low rating due to the existing brightly lit context of the existing airport terminal and the limitations on lighting night works in the vicinity of airport operations.

At night, the moderate adverse visual impact expected in views from Bulla and rural landscapes to the north, and rural properties to the south and west during construction are acceptable. These impacts would be temporary in nature and are areas where night-time activity is either limited or at a distance from the works.

At night, and during operation, there will be a moderate adverse visual impact with a medium rating in views from rural landscapes to the west, views from Bulla and rural landscapes to the north, and views from rural properties to the south and west. This is due to lighting associated with the runways, intermittent headlights on Operations Road, and increased air traffic seen overhead and across these views. The moderate adverse visual impact at night, while permanent, is acceptable as this is an increase to already impacted viewing locations. This results from an increased intensification of the existing airport which is currently seen within these views.

At night, during construction and operation, there will be a negligible impact on views from golf course to the south and from the Calder Freeway, as the additional light would be seen in the context of an existing lit airport and the golf course fairways would not be accessed at night. This would result in a negligible rating during construction and operation.

Table B12.27
Impact assessment summary

Environment aspect & baseline condition	Assessment of original impact					
	Original Impact	Mitigation inherent in design/practice	Duration	Significance		
				Severity	Likelihood	Impact
Construction						
Airport landscape	Local	N/A	Short Term	Moderate adverse	Likely	Medium
Views from rural landscapes to the west	Neighbourhood sensitivity	N/A	Short Term	Minor adverse and negligible	Likely	Medium
Views from rural landscapes to the west (at night)	A2: Low district Brightness	N/A	Short Term	Moderate adverse and negligible	Likely	Medium
Views from Bulla and rural landscapes to the north	Neighbourhood / local sensitivity	N/A	Short term	Moderate and minor adverse	Likely	Medium
Views from Bulla and rural landscapes to the north (at night)	A2: Low district brightness	N/A	Short term	Moderate and minor adverse	Likely	Medium
Views from Woodlands Historic Park	Regional sensitivity	N/A	Short term	Moderate adverse and negligible	Likely	Medium
Views from residential properties, rural areas and golf courses to the south and west	Neighbourhood / local sensitivity	N/A	Short term	Minor-moderate adverse and negligible	Likely	Medium and negligible

Mitigation and/or management measures	Assessment of residual impact: Residual Impact	Duration	Significance: Severity	Significance: Likelihood	Significance: Impact
Minimise removal of vegetation within the Grey Box Woodland where possible outside of construction requirements	On-site	Short Term	Moderate adverse	Likely	Medium
Set construction vehicles, equipment, stockpiling, asphalt and concrete batching plants away from sensitive receptors on Loemans Road	Off-site	Short Term	Minor	Likely	Medium
N/A	Off-site	Short Term	Moderate adverse	Likely	Medium
N/A	Off-site	Short term	Moderate adverse	Likely	Medium
N/A	Off-site	Short term	Moderate adverse	Likely	Medium
N/A	Off-site	Short term	Moderate adverse and negligible	Likely	Medium and negligible
Set construction vehicles, equipment, stockpiling, asphalt and concrete batching plants away from sensitive receptors on Operations and McNabs roads	Off-site	Short term	Minor adverse and negligible	Likely	Medium and negligible

Environment aspect & baseline condition (cont.)	Assessment of original impact (cont.)					
	Original Impact	Mitigation inherent in design/practice	Duration	Significance		
				Severity	Likelihood	Impact
Construction (cont.)						
Views from residential properties, rural areas and golf courses to the south and west (at night)	A2: Low district brightness and A3: Medium district brightness	N/A	Short term	Moderate adverse and negligible	Likely	Medium and negligible
Views north-east from the Calder Freeway	Local sensitivity	N/A	Short term	Minor adverse and negligible	Likely	Medium
Views north-east from the Calder Freeway (at night)	A2: Low district brightness and A3: Medium district brightness	N/A	Short term	Negligible	Likely	Negligible
Views from Organ Pipes National Park to the south west	Regional sensitivity	N/A	Short term	Negligible	Likely	Negligible
Operation						
Airport landscape	Local sensitivity	N/A	Long term	Minor adverse	Likely	Medium
Views from rural landscapes to the west	Neighbourhood sensitivity	Existing runways and terminal in view	Long term	Minor adverse-negligible	Likely	Medium-negligible
Views from rural landscapes to the west (at night)	A2: Low district brightness	Existing runways and terminal in view	Long term	Moderate adverse	Likely	Medium

Mitigation and/or management measures (cont.)	Assessment of residual impact (cont.)				
	Residual Impact	Duration	Significance		
			Severity	Likelihood	Impact
N/A	Off-site	Short term	Moderate adverse	Likely	Medium and negligible
N/A	Off-site	Short term	Minor adverse	Likely	Medium
N/A	Off-site	Short term	Negligible	Likely	Negligible
N/A	Off-site	Short term	Negligible	Likely	Negligible
Relocation of airport viewing area	On-site	Long term	Minor adverse	Likely	Medium
N/A	Off-site	Long term	Minor adverse-negligible	Likely	Medium-negligible
N/A	Off-site	Long term	Moderate adverse	Likely	Medium

Environment aspect & baseline condition (cont.)	Assessment of original impact (cont.)					
	Original Impact	Mitigation inherent in design/practice	Duration	Significance		
				Severity	Likelihood	Impact
Construction (cont.)						
Views from Bulla and rural landscapes to the north	Neighbourhood / local sensitivity	N/A	Long term	Minor and moderate adverse	Likely	Medium
Views from Bulla and rural landscapes to the north (at night)	A2: Low district brightness	N/A	Long term	Moderate adverse	Likely	Medium
Views from Woodlands Historic Park	Regional sensitivity	N/A	Long term	Moderate adverse	Likely	Negligible
Views from residential properties, rural areas and golf courses to the south and west	Neighbourhood / Local sensitivity	N/A	Long term	Minor adverse and negligible	Likely	Medium and negligible
Views from residential properties, rural areas and golf courses to the south and west (at night)	A2: Low district brightness and A3: Medium district brightness	N/A	Long term	Moderate and minor adverse and negligible	Likely	Medium and negligible
Views north-east from the Calder Freeway	Local sensitivity	N/A	Long term	Negligible	Likely	Negligible
Views north-east from the Calder Freeway (at night)	A2: Low district brightness and A3: Medium district brightness	N/A	Long term	Negligible	Likely	Negligible
Views from Organ Pipes National Park to the south west	Regional sensitivity	N/A	Long term	Negligible	Likely	Negligible

Mitigation and/or management measures (cont.)	Assessment of residual impact (cont.)				
	Residual Impact	Duration	Significance		
			Severity	Likelihood	Impact
Screen planting north of the new north-south runway, adjacent to Sunbury Road	Off-site	Long term	Minor adverse – negligible	Likely	Medium
N/A	Offsite	Long term	Moderate adverse	Likely	Medium
N/A	Offsite	Long term	Negligible	Likely	Negligible
N/A	Offsite	Long term	Minor adverse and negligible	Likely	Medium and negligible
N/A	Offsite	Long term	Moderate adverse	Likely	Medium and negligible
N/A	Offsite	Long term	Negligible	Likely	Negligible
N/A	Offsite	Long term	Negligible	Likely	Negligible
N/A	Offsite	Long term	Negligible	Likely	Negligible

REFERENCES

Airports Act 1996 and Airports (Environmental Protection) Regulations 1997

Australian Government Department of Sustainability, Environment, Water, Population and Communities 2013, Significant impact guidelines 1.2 – Actions on, or impacting upon, Commonwealth land, and actions by Commonwealth agencies, Environment Protection and Biodiversity Conservation Act 1999, accessed 22 November 2016, https://www.environment.gov.au/epbc/publications/significant-impact-guidelines-12-actions-or-impacting-upon-commonwealth-land-and-actions

Australian Institute for Landscape Architects 2018, Guidance Note for Landscape and Visual Assessment, June 2018.

Brimbank City Council 2010, Brimbank Green Wedge Management Plan, Sunshine, https://www.brimbank.vic.gov.au/plans-policies-and-strategies/plans/green-wedge-management-plan (accessed 16 April 2021).

Brimbank City Council, Brimbank Planning Scheme (last updated 05/08/2020), https://planning-schemes.delwp.vic.gov.au/schemes/brimbank (accessed 16 April 2021).

Council of Standards Australia, 2019, AS4282 Control of the obtrusive effects of outdoor lighting.

Ecology and Heritage Partners & Melbourne Airport 2015, Melbourne Airport Planting Guidelines Version 12, https://www.melbourneairport.com.au/Corporate/Planning-projects/Aircraft-hazards (accessed 18 August 2020).

Heritage Victoria 1997, Glenara House and Garden, https://vhd.heritagecouncil.vic.gov.au/places/65915/download-report (accessed 18 August 2020).

Heritage Victoria 1998, Arundel Farm, https://vhd.heritagecouncil.vic.gov.au/places/65246 (accessed 18 August 2020).

Heritage Victoria 1999, Victorian Heritage Database Report, Keilor Market Gardens Cultural Landscape, https://vhd.heritagecouncil.vic.gov.au/places/45835 (accessed 18 August 2020).

Heritage Victoria 2009, Landscape Assessment Guidelines for Cultural Heritage Significance, 2009.

Hume City Council, Hume Planning Scheme (last updated 24/06/2020), https://planning-schemes.delwp.vic.gov.au/schemes/hume (accessed 16 April 2021).

Landscape Institute and Institute of Environmental Management & Assessment UK 2013, Guidelines for Landscape and Visual Impact Assessment, 3rd Edn. Abingdon, Routledge.

Landscape Institute UK 2019, Technical Guidance Note 06/19 Visual Representation of Development Proposals, London, Landscape Institute.

Melbourne Airport Golf Club, 2020, website, http://melbourneairportgolfclub.com.au/ (accessed 18 August 2020).

Parks Victoria 1998, Organ Pipes National Park Management Plan, https://www.parks.vic.gov.au/-/media/project/pv/main/parks/documents/management-plans/organ-pipes-national-park-management-plan.pdf (accessed 18 August 2020).

Victorian Government Department of Environment, Land, Water and Planning Victoria 2002, Melbourne 2030 – Planning for sustainable growth, https://www.planning.vic.gov.au/policy-and-strategy/planning-for-melbourne/melbournes-strategic-planning-history/melbourne-2030-planning-for-sustainable-growth (accessed 18 August 2020).

Victorian Government Department of Environment, Land, Water and Planning 2017, Metropolitan Planning Strategy 2017-2050: Plan Melbourne, http://www.planmelbourne.vic.gov.au/the-plan (accessed 16 April 2021).

Victorian Government Department of Planning and Community Development and Planisphere 2013, South West Victoria Landscape Assessment Study, Vic. Govt. Pub. Service, https://www.planning.vic.gov.au/policy-and-strategy/south-west-landscape-assessment-study (accessed 18 August 2020).

Victorian Government Department of Planning and Community Development Victoria and Planisphere 2002, Sense of Place: Urban Design Principles for the Metropolitan Strategy, Technical Report 12, Melbourne, https://www.planning.vic.gov.au/__data/assets/pdf_file/0012/100713/Sense-of-Place-Urban-Design-Principals-for-the-Metropolitan-Strategy,-October-2002.pdf (accessed 18 August 2020).

Victorian Government Department of Planning and Community Development Victoria 2010, Maribyrnong River Valley Design Guidelines, https://www.planning.vic.gov.au/policy-and-strategy/waterways-planning/maribyrnong-river/maribyrnong-river-planning/maribyrnong-river-valley-design-guidelines (accessed 18 August 2020).

Chapter B13
Climate Change and Natural Hazard Risk

Summary of key findings:

- Natural hazards and climate variables have the potential to affect the construction or operation of Melbourne Airport's Third Runway (M3R).
- Melbourne Airport is in a benign climatic location and does not experience extremes such as cyclone, snowstorm or coastal flooding that affect many other international airports.
- However, climate events and natural hazards do sometimes affect Melbourne Airport. The likelihood of some of these impacts occurring is expected to increase during the operational life of M3R.
- M3R has been designed to standards that will control most physical climate risks.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CHAPTER B13 CONTENTS

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CHAPTER B13 FIGURES

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B13.1 INTRODUCTION

This chapter describes the existing natural hazards and aspects of the local climate of the study area, the potential impacts on Melbourne Airport's Third Runway (M3R) and applicable legislation and policy requirements. Where required and practicable, specific measures to avoid, manage, mitigate and/or monitor climate change and natural hazard impacts are detailed.

B13.2 METHODOLOGY AND ASSUMPTIONS

This chapter describes current climate conditions, and how climate is expected to change in and around Melbourne Airport by focusing on a medium-term (2030) and a long-term future (2070). The chapter then presents an assessment of how risks related to natural hazards and the current and future climate may affect M3R; and recommends how they can be managed over the operational lifetime of M3R. (For the purpose of this study, a natural hazard is defined as any natural phenomenon with the potential to have a negative effect on M3R.)

The assessment has focused on those risks to M3R that can be controlled. Where relevant, it has also taken into account the risks to the operation of M3R which cannot be managed within the project itself.

The risk assessment in this study has been carried out in accordance with *AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk-based approach* and *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*. The assessment followed the first five steps of the six-step risk management process identified in ISO 31000, with implementation to be undertaken through the design, construction and operation of M3R.

This chapter contains the following sections:

- Establishing the context
- Risk identification
- Risk analysis
- Risk evaluation
- Risk treatment
- Implementation of management strategies, monitoring and review.

B13.2.1 Establishing the context

The context for this study is the current situation at Melbourne Airport regarding natural hazards and climate, and how it can be expected to change over the operational lifetime of M3R.

Current climate conditions have been established using Bureau of Meteorology (BoM) records from its weather station at Melbourne Airport supplemented with additional information from sources such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Victorian Government. These current climate conditions have been used as the baseline for considering future climate change.

The latest climate projections for the area around Melbourne Airport were reviewed to gain an understanding of how the climate is expected to change. The primary source of this information was CSIRO's Climate Change in Australia website and Climate Futures suite of tools (CSIRO, 2016). The following three Climate

Futures tools were used to generate the projections presented in **Section B13.5.2**:

- Summary data explorer - provides bar plots and data files of multi-model regional average seasonal changes in eight variables. The region used for this study was the Southern Slopes cluster, which includes southern Victoria and Tasmania.
- Extremes data explorer - provides bar plots and data files of multi-model regional average seasonal changes in six extremes variables.
- Thresholds calculator - generates location-specific data for minimum and maximum temperature using eight pre-selected climate models.

Some projections are presented as a median (i.e. middle) value and a range that excludes the lower and upper 10 per cent of climate model results. Data from Climate Futures tools was supplemented with information from additional sources including:

- CSIRO's *Climate Change in Australia Projections Cluster Report – Southern Slopes* (Grose, 2015)
- Bushfire Cooperative Research Centre's *Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts* (Lucas, 2007)
- South Eastern Australian Climate Initiative's *Projected changes in climate and runoff for south-eastern Australia under 1 °C and 2 °C of global warming* (Post, 2012).

B13.2.2
Climate change scenarios

For this study, two future timescales have been considered: a medium-term scenario of 2030 and a long-term scenario of 2070, which cover the expected lifespan of M3R. The extent of climate change over these scenarios depends in part on future trajectories of greenhouse gas emissions. To manage this uncertainty the Intergovernmental Panel on Climate Change has developed several emissions scenarios. These scenarios, called Representative Concentration Pathways (RCPs), result in different projected changes in the climate.

Projections for 2030 do not diverge greatly regardless of RCP due to a lag between the emission of greenhouse gases and their effect on the climate. For that reason, this study has considered only one emissions scenario for 2030 (RCP4.5). RCP4.5 is a medium-emissions scenario which assumes emission reductions after a peak at around 2040, leading to a carbon dioxide concentration of about 540 parts per million by 2100 compared to around 400 parts per million in 2016.

By 2070, the scale of projected changes to climate is more sensitive to the world's future emissions pathway. This study has considered two alternative emissions scenarios by 2070: RCP4.5 and RCP8.5. RCP8.5 is a high-emission, business-as-usual scenario that assumes increases in emissions leading to a carbon dioxide concentration of approximately 940 parts per million by 2100. Using the high-emission scenario to assess climate risk in 2070 reduces the inherent uncertainty in looking more than 50 years ahead. For this reason, the RCP8.5 emission scenario has been used when evaluating risks for this analysis.

In other words, RCP4.5 is broadly analogous to a future where the global average temperature reaches 2°C above pre-industrial levels by 2100 (i.e. a 2° future); RCP8.5 is broadly analogous to a 4° future.

Table B13.1 shows a sample of recent climate events that have affected operations at Melbourne Airport. Some relate to risks outside the scope of this study but they do show how natural hazards can affect the airport.

B13.2.3
Risk identification, analysis, evaluation and treatment

The relevant impacts to be assessed within this study are the potential risks posed by climate change and natural hazards on M3R construction and operational activities. This includes risks that are physical in nature as well as those that arise from society's responses to climate change (i.e. transition risks). Physical risks have been identified and assessed using the judgment of climate-change specialists, and M3R engineering and environment and sustainability teams. This work builds on previous climate risk assessments undertaken by Melbourne Airport. The update also involved the identification and assessment of transition risks through a multi-disciplinary workshop.

The process of identifying risks considered the following types of impact:

- Direct weather events such as heatwaves or heavy rainfall
- Hazards strongly influenced by weather conditions such as drought and flood
- Hazards affected by weather and climate such as wildlife distribution
- Additional non-weather-related natural hazards
- Regulatory and market responses to climate change.

This study distinguishes between direct and indirect impacts. Direct impacts are those such as damage to airport infrastructure, or weather conditions preventing the use of a runway. Indirect impacts are those which affect M3R as a result of a direct impact on an external system, such as flooding of a road leading to Melbourne Airport or a cyclone in Asia affecting inbound flights.

The sources of information used to identify, analyse, evaluate and treat these risks were:

- Melbourne Airport staff with knowledge of airport operations and development, airspace operations and air-traffic management initiatives, and the challenges of natural hazards
- Performance data and previous studies carried out by Melbourne Airport
- Published climate-change risk assessments and initiatives from other international airports
- Consultation with Melbourne Airport staff and specialists working on M3R.

Table B13.1
Recent climate and natural hazard events and their impacts on Melbourne Airport

Climate event	Impact on Melbourne Airport	Date
Bushfire smoke	Delayed flights. The airport was forced down to a single runway as heavy bushfire smoke covered the city and impacted visibility.	Jan 2020
Strong winds	Runway closed, more than 30 flights delayed, and others cancelled	Jul 2019
Dust Storm	Brief reduction in visibility	Mar 2019
Storm – 23mm in 24 hours after a wet week; low cloud	Runway closed and flights delayed.	Jul 2016
Fog – visibility down to 400m	More than 30 flights cancelled, and others delayed.	Jun 2016
Ice – temperature 0.6°C	18 flights delayed after ice formed on plane wings (de-icing truck broken).	Jul 2015
Storm – Lightning (within 8nm of airport)	Ground staff stopped working on asphalt as per airport rules. Flight delays of up to two hours.	Oct 2014
Fog	20 domestic flights cancelled.	Jul 2014
Bushfires in Kilmore area	Air traffic control tower evacuated briefly due to smoke penetration causing some flights to undergo emergency landings and half-hour delays for outbound flights.	Feb 2014
Heatwave – 4 days 40°C+	Multiple disruptive incidents including airfield fuel spills, suspension of outdoor construction and temporary closure of Departure Drive due to expansion of connection joints.	Jan 2014
Fog	Several international and domestic flights were diverted to Sydney and Adelaide airports.	Oct 2013
Storm – 90km/h wind gusts	Delayed flights.	Dec 2012
Storm – rain, hail, lightning	Flights delayed, passenger disruption, aircraft damaged requiring precautionary inspections.	Dec 2011
Storm – strong wind, lightning	Airport closed, inbound flights diverted, outbound planes grounded.	Dec 2011
Storm – 50mm rainfall in an hour	Disrupted flights for four hours. Persistent flight delays continuing into the next day. Transport to and from the airport ceased for a period.	Sep 2011
Dust storm	Delayed flights.	Sep 2009

The results of the climate risk analysis have been recorded in a risk register summarised in **Appendix B13.A**. Risks have been rated according to their significance, which is a product of the severity and likelihood of the impact. Impact severity has been rated using the assessment framework for this study (**Table B13.2**). Risk likelihood has been rated using M3R standard criteria, and overall impact level has been assigned using the M3R impact matrix as described in **Chapter A8: Assessment and Approvals Process**.

Risks have been rated according to the judgment of the M3R design team and staff at Melbourne Airport. The rating is qualitative, although where possible the assessment has been supported by quantitative information.

Risks have been assessed over three time periods; current, medium-term (2030) and long-term (2070). Evidence about natural and climate hazards at Melbourne Airport was taken as evidence of current risk. Medium and long-term risks were rated using the climate projections summarised in **Section B13.5**.

B13.2.4 Assumptions

The following assumptions were made in this study:

- Present-day climate and natural hazards at Melbourne Airport are well understood by staff and the M3R team
- Climate science provides realistic projections of the future climate at Melbourne Airport
- The study assesses risks to the construction and operation of M3R due to climate, climate change and natural hazards. It is not an assessment of how M3R will impact the environment or contribute to climate change.

Chapter B11: Greenhouse Gas Emissions details assessments of how M3R will contribute to greenhouse gas emissions.

B13.3 REQUIREMENTS AND EXPECTATIONS

This section details the statutory and policy environment that the airport needs to consider regarding climate risk. Non-statutory and international frameworks related to climate risk (e.g. recommendations of the Taskforce for Climate-related Financial Disclosures) are discussed in the transitional risk register (Appendix B13.A).

B13.3.1 Statutory requirements

There is currently no Commonwealth or Victorian legislation that explicitly requires Melbourne Airport to take account of climate risks as part of M3R. Neither the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (referred to as the EPBC Act) nor the *Airports Act 1996* (Cth) (referred to as the Airports Act) explicitly addresses climate change. However, it is reasonable to expect that Melbourne Airport manages climate risk as it has potential for wide-ranging impacts including potentially affecting the operations and legislative compliance of M3R.

B13.3.1.1 Melbourne Airport Master Plan 2022

The Airports Act requires Melbourne Airport to regularly produce a master plan, which includes an environment strategy. Section 14.4.3 of *Melbourne Airport's Environment Strategy* (2022) includes a number of actions relating to energy and carbon, with a focus on carbon emission reductions.

B13.3.2 Victorian Climate Change Act 2017

The *Climate Change Act 2017* (Vic) (referred to as the CC Act) requires the relevant minister to produce a climate-change strategy by October 2020 and renew it every five years. Victoria's Climate Change Strategy articulates the Victorian Government's long-term vision and approach to climate change. The strategy describes the transition required across different sectors of the economy and the challeneges to be addressed (the relevant sectors are built environment, education and training, health and human services, natural environment, primary production, transport and water cycle).

The CC Act also requires the relevant minister to produce an adaptation action plan by October 2021 and renew it every five years. The Victorian Government has prepared Adaptation Action Plans (AAPs) across the seven relevant sectors listed above, which apply to the period 2022-2026. These seven AAPs address a number of areas including existing adaptation responses, roles and responsibilities, key strategies and priorities, and partnerships.

B13.3.3 Emergency Management Amendment (Critical Infrastructure Resilience) Act 2014 (Vic)

The *Emergency Management Amendment (Critical Infrastructure Resilience) Act 2014* (Vic) (referred to as the EMA (CIR) Act) created new arrangements for the Victorian Government, and public and private sector stakeholders, to work together to enhance Victoria's arrangements for critical infrastructure resilience. The ministerial guidelines for critical infrastructure resilience aim to help stakeholders meet their requirements under the arrangements. The guidelines set out an approach considering all types of hazards, recognising that planning for one kind of hazard or disaster event can also increase the resilience of a community facing a different kind of event. Hazards related to climate change are not explicitly identified but all types of natural hazard are included within the all-hazards approach.

B13.3.3.1 Victorian Government

All Victorian critical infrastructure is recorded by the Victorian Government in the critical infrastructure register. Melbourne Airport is listed as 'vital' – the highest category of significance, meaning disruption could adversely impact the continuity of an essential service to Victoria or the economic or social wellbeing of Victoria. At the operator of vital critical infrastructure, Melbourne Airport is required to carry out certain tasks such as the preparation of an emergency risk-management plan and execution of exercises to test this plan.

B13.3.4 Policy requirements

There are no specific policies relating to the adaptation of airport infrastructure to climate change. However, assessment and management of climate risk is consistent with the strategies and policy outlined below.

B13.3.4.1 Commonwealth strategies

National Climate Resilience and Adaptation Strategy 2015

This strategy sets out how Australia is managing climate risks. One of its guiding principles is that all decisions will take account of the current climate and future change.

Another guiding principle is that responsibility for adaptation is shared; and that governments at all levels, businesses, communities and individuals have important roles to play.

Critical Infrastructure Resilience Strategy 2015

This strategy aims for the continued operation of critical infrastructure in the face of all hazards. One of the policy objectives is that critical infrastructure owners and operators such as Melbourne Airport are effective in managing foreseeable risks to the continuity of their operations.

Council of Australian Governments, roles and responsibilities for climate change adaptation in Australia 2013

This document, issued by the Council of Australian Governments (COAG), outlines the principles for the management of climate-change risks. It identifies that governments are primarily responsible for managing risks to public goods and assets, and private parties are responsible for managing risks to private assets. The Commonwealth Government's role also includes promoting effective climate-risk management in the private sector by:

- Providing the best available information about climate change
- Setting appropriate policy, regulation and planning frameworks.

The CC Act is the basis for achieving the Victorian Government's commitment to position Victoria as a leader in climate-change mitigation by reducing emissions and adapting to the impacts of climate change. Victoria's Climate Change Framework sets out the state government's long-term approach to climate change, including how Victoria is preparing for a changing climate.

Victoria's Climate Change Strategy (Department of Environment, Land, Water and Planning, 2021) sets out the priorities for the Victorian Government to better understand and manage the current and long-term risks of climate change.

B13.3.5
Expectations

While Melbourne Airport is not subject to definitive statutory or policy obligations in relation to the management of climate-related risks and opportunities, it does recognise that stakeholder expectations have increased significantly in recent years. Similarly, investors' concerns about climate-related risks have become significantly more pronounced. These concerns have precipitated multiple legal challenges globally and led to the formation of the G20 Financial Stability Board's Taskforce for Climate-related Financial Disclosures (TCFD) which has issued a set of recommendations on the matter. In Australia, these recommendations have been reinforced by the Australian Securities and Investments Commission (ASIC) which in December 2019 launched a new surveillance program to ensure Australia's biggest companies are dealing with the risks of climate change. Similarly, the Australian Prudential Regulation Authority (APRA) continues to actively encourage the adoption of voluntary frameworks to assist entities with assessing, managing and disclosing their financial risks associated with climate change (with reference to the TCFD).

The implementation of the TCFD recommendations is progressively becoming mainstream for several reasons: namely great business value, investors seeking assurance, risk-management improvements, and demonstrating duty of care and diligence from company directors.

In light of these continuing developments, Melbourne Airport considers it possible that it will become subject to statutory and/or policy obligations in relation to climate-related risks in the future.

This chapter represents one step in an ongoing process of continuous improvement through which Melbourne Airport will:

- Continue to monitor and manage its climate-related risks, with disclosure to stakeholders
- Meet any statutory or regulatory obligations as and when they arise.

B13.4
DESCRIPTION OF SIGNIFICANCE CRITERIA

The assessment of significance has applied the framework described in **Chapter A8: Assessment and Approvals Process**. For severity, project-specific criteria have been developed for the climate change and natural hazards study, and these are described in **Table B13.2**. The identification of five categories of impact (environmental, financial, regulatory, safety and reputation) reflects the fact that climate change can affect the severity of a wide range of risks to M3R.

Table B13.2
Severity assessment framework

Assessment	Environment	Financial	Regulatory	Safety	Reputation
Catastrophic	Permanent, widespread and irreversible contamination to land, air, groundwater or surface water environment Permanent loss of species, habitat, community amenity or heritage sites Enforcement action undertaken by DOE/EPA	> 15% EBITDA	Very serious breach of legislation, regulation, agreements or contracts, that is difficult to rectify and results in one or more of: Prosecution or civil action leading to imprisonment or significant sanction Ministerial or formal intervention by regulator Licence/permit revocation Public inquiry	Event causing two or more fatalities and/ or permanent total disability of any employee, visitor or contractor	Very serious public outcry (community action or protests, including online) (3+ days) Sustained negative media coverage at state or national level (3+ days) Lasting impact to reputation (1+ year) Critical impact on relations with key stakeholders (loss of government support)
Major	Very serious contamination to land, air, groundwater or surface water environment (clean-up / recovery 1 to 4 years) Major impact on species, habitat, community amenity or heritage sites (restoration period 1 to 4 years) Enforcement action undertaken by DOE/EPA in the form of an enforceable undertaking or court prosecution	> 5% – 15% EBITDA	Serious (but isolated) breach of legislation, regulation, agreement or contracts, that requires considerable investment to rectify and results in one or more of: Prosecution or civil action with high compensation (or fine) and -ve precedent Ministerial or formal intervention by regulator (enforceable undertaking) Restrictions or conditions placed on licence/permit	Event causing single fatality and/ or total and permanent disability of any employee, visitor or contractor	Serious public outcry (community action or protests, including online) (2 to 3 days) Adverse state media coverage (2 to 3 days) Negative impact to reputation but repairable (within 1 year) Adverse impact on relations with key stakeholders (expressed displeasure by department or government)
Moderate	Serious contamination to land, air, groundwater or surface water environment (clean-up / recovery within 1 year) Moderate impact on species, habitat, community amenity or heritage sites (restoration within 1 year) Enforcement action undertaken by EPA in the form of a Penalty Infringement Notice (or similar)	> 2.5% – 5% EBITDA	Non-compliance with legislation regulation, agreements or contracts that is reportable and/or requires an immediate response to an external party. This may result in: Infringement notice (or similar) External review or audit	Event causing a serious or permanent injury or long-term illness with immediate admission to hospital of any employee, visitor or contractor	Public outcry (sustained and numerous customer complaints including online) Adverse state media coverage (1 to 2 days) Limited, repairable damage to reputation Some concern on relations with key stakeholders (explanation required)
Minor	Minor contamination to land, air, groundwater or surface water environment (clean-up / recovery of a localised event within weeks) Minor impact on species, habitat, community amenity or heritage sites (restoration within weeks) Enforcement action undertaken by DOE/ EPA in the form of a warning	> 1% – 2.5% EBITDA	Minor non-compliance with legislation, regulation, agreements or contracts that is reportable but has minimal impact to operations and no urgency for rectification	Event resulting in injury or disease that resulted in a treatment given by a medical practitioner but without permanent disability of any employee, visitor or contractor	Localised complaints that can be managed to achieve an effective outcome Limited, adverse local media attention (single instance) Negligible impact to reputation with freedom to operate unaffected
Limited	Temporary contamination (days) to land, air, groundwater or surface water environment to immediate area around asset or activity No lasting impact (days) on species, habitat, community amenity or heritage sites Self-reporting or notification to DOE/EPA	<= 1% EBITDA	Insignificant non-compliance with legislation, regulation, agreements or contracts that has no impact to operations and/or no requirement to report	Slight and recoverable injury or discomfort requiring first aid response with no follow up required of any employee, visitor or contractor	Local complaint, no media coverage Quickly forgotten with freedom to operate unaffected
Beneficial	A positive impact on the natural environment.	Saving realised compared with project or project/ airport operating budget	N/A	N/A	Positive media coverage.

B13.5 CLIMATE

B13.5.1 Current climate

Melbourne Airport is located within a temperate climate with warm to hot summers, mild springs and autumns, and cool winters. The region is showery with fairly consistent rainfall throughout the year and fairly low average annual rainfall. Frosts can occur in winter but it has never snowed at Melbourne Airport.

The region is on the boundary of hot inland areas and the cool Southern Ocean. This results in temperature differences that can cause strong cold fronts to form, which sometimes lead to severe weather conditions such as gales, thunderstorms and heavy rain. The region can also experience extreme heat in summer.

The information in section **Section B13.5.1.1** shows the current climate at Melbourne Airport, based on records from the Bureau of Meteorology's weather station at the airport (station number 86282). Weather-station data is available from 1970 to 2019 (Bureau of Meteorology 2019) for most variables, when available. This current climate has been used as the baseline for considering future climate change.

B13.5.1.1 Precipitation

The highest mean rainfall occurs in November (61.7 millimetres) and the lowest in July (35.3 millimetres). In general, both median and mean values show greatest precipitation in early spring through to the end of summer (**Table B13.3**).

The heaviest rainfall in a 24-hour period occurs in late summer and autumn with the highest recorded falls in February (138.8 millimetres) and April (132.4 millimetres) (**Table B13.4**).

Rainfall events greater than one millimetre are most common in winter; those greater than 10 millimetres and 25 millimetres are most common from November to February. This indicates that rainy days are most frequent in winter while the precipitation intensity is greatest in summer (**Table B13.5**).

Table B13.3
Mean monthly recorded precipitation (millimetres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mean	40.0	41.2	36.2	43.0	39.8	40.7	35.3	43.9	46.4	52.6	61.7	51.8	534.9
Lowest	1.6	1.0	4.4	4.8	8.0	10.4	7.0	15.4	8.2	5.6	18.2	1.6	310.2
Highest	101.6	200.6	142.2	141.6	155.5	126	94.4	97.1	127	143.8	158	139	820.8

Table B13.4
Highest accumulated 24-hour precipitation (millimetres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Highest daily	50.6	138.8	98.2	132.4	52.4	75.8	44.6	37.0	50.8	70.8	80.8	76.4
Date	6/1 1995	3/2 2005	23/3 2001	8/4 1977	16/5 1974	1/6 2013	30/7 1987	7/8 1978	29/9 2011	16/10 1983	19/11 1978	27/12 1999

B13.5.1.2
Temperature

Mean maximum temperature data shows highest mean maximum temperatures generally occur in December, January and February (24.6°C, 26.6°C and 26.7°C respectively). The highest daily maximum temperatures have also occurred during these months (43.8°C, 46.0°C and 46.8°C respectively) (see **Table B13.6**). On average there are 32.7 days over 30°C, 10.2 days over 35°C and 1.5 days over 40°C each year (see **Table B13.7**).

Mean minimum temperature data (see **Table B13.8**) show that the coldest temperatures generally occur in June, July and August (6.2°C, 5.5°C and 5.9°C respectively) with temperatures historically falling below 2°C between May and October and below 0°C between June and September. On average the minimum temperature drops below 2°C 8.4 times and below 0°C 1.1 times per year respectively (see **Table B13.9**).

B13.5.1.3
Relative humidity

Humidity data at the Melbourne Airport weather station is collected twice daily at 9am and 3pm. At 9am, mean relative humidity is highest in June and lowest in December. For 3pm, the highest mean relative humidity is also in June, whereas the lowest occurs in January and February. The relative humidity is higher at 9am than at 3pm throughout the year (see **Table B13.10**).

B13.5.1.4
Solar radiation

Daily solar radiation data has been collected at Melbourne Airport since 1990. The mean daily solar radiation is greatest in January and least in June at 24.2 megajoules per square metre and 6.2 megajoules per square metre respectively. The annual average daily solar radiation is 15.0 megajoules per square metre (see **Table B13.11**).

Table B13.5
Mean number of days per month where 24-hour rainfall exceeded 1, 10 and 25 millimetres

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
days ≥ 1 mm	5.1	4.3	5.6	6.3	7.5	8.3	8.2	9.7	9.1	8.6	7.7	6.2	86.6
days ≥ 10mm	1.3	1.1	1.0	1.1	0.8	0.8	0.5	0.8	1.0	1.4	1.8	1.6	13.3
days ≥ 25mm	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.4	2.4

Table B13.6
Mean monthly maximum and daily maximum temperatures (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	26.6	26.7	24.3	20.3	16.7	13.7	13.2	14.4	16.7	19.5	22.1	24.6	19.8
Highest daily	46.0	46.8	40.8	34.5	27	21.8	22.7	25.6	30.2	36	39.6	43.8	46.8

B13.5.1.5
Evaporation

Evaporation data has been collected at Melbourne Airport since 1998. Mean daily evaporation is greatest in January and least in June at 8.1 millimetres and 1.8 millimetres respectively. The annual mean daily evaporation is 4.7 millimetres (see Table B13.12)

B13.5.1.6
Moisture and runoff

Soil moisture and run-off data in Melbourne have been modelled with the Bureau of Meteorology's Australian Water Resources Assessment Modelling System. Data are presented as percentile values relative to the 1911-2016 mean value. Both these metrics reached all-time low levels in 2007 and peaked in 2011 (see Table B13.13 Table B13.14).

B13.5.1.7
Drought

Drought is a prolonged, abnormally dry period when the amount of available water is insufficient to meet normal use. 'Drought' is therefore not simply low rainfall but a measurement of the severity of rainfall deficiency. Over the last 10 years, Melbourne Airport experienced a serious annual rainfall deficiency in 2008 (below 10th percentile of the historic annual rainfall record) and a severe rainfall deficiency in 2009 (below 5th percentile of the historic annual rainfall record).

B13.5.1.8
Bushfire

The region in which Melbourne Airport is located is one of the most bushfire-prone in the world. The worst bushfires recorded since European settlement in Australia occurred in Victoria in 2020 and resulted in several delayed flights. The airport was reduced to a single runway as heavy bushfire smoke covered the city and impacted visibility.

Table B13.7
Mean number of days per month above 30°C, 35°C and 40°C

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
days > 30°C	8.5	8.5	5.0	0.4	0.0	0.0	0.0	0.0	0.0	1.1	3.0	6.2	32.7
days > 35°C	3.8	2.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	2.0	10.2
days > 40°C	0.8	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.5

Table B13.8
Mean monthly minimum and daily minimum temperatures (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	13.9	14.2	12.8	10.2	8.3	6.2	5.5	5.9	7.1	8.5	10.4	12.1	9.6
Lowest daily	6.0	4.8	3.7	1.2	0.6	-0.9	-2.5	-2.5	-1.1	1.0	0.9	3.5	-2.5

Bushfire risk is measured using the Forest Fire Danger Index (FFDI) which combines observations of temperature, relative humidity, wind speed and drought factor.

The drought factor depends on both short-term and long-term rainfall. The FFDI is often converted into a fire-danger rating that reflects the fire behaviour and the difficulty of controlling a particular fire. At Melbourne Airport the average number of days each year with a fire danger rating of severe or worse is 3.1 (CSIRO, 2016d).

The land surrounding Melbourne Airport is designated a bushfire-prone area by Victoria's Department of Environment, Land, Water and Planning (DELWP) and there is a region of bushfire management overlay in the north west quadrant of the site (Figure B13.1). A bushfire-prone area is an area of land that can either support a bushfire or is likely to be subject to bushfires. A bushfire management overlay is a planning control applying to land with the highest fire risk and is likely to be particularly exposed to the impact of bushfire.

B13.5.1.9 Wind

Wind-speed data at the Melbourne Airport weather station is recorded twice daily at 9am and 3pm. Average 9am and 3pm wind speeds are highest in September at 22.1 kilometres per hour and 24.4 kilometres per hour respectively. Across all months, wind speeds are greater at 3pm than 9am (**Table B13.15**).

Highest recorded wind-gust speeds over all months range from 102 kilometres per hour in June to 139 kilometres per hour in November. The three highest recorded wind-gust speeds have occurred in November, January and August, showing that strong winds can potentially occur in both winter and summer (**Table B13.16**).

Table B13.9
Mean number of days per month below 2°C and 0°C

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
days < 2°C	0.0	0.0	0.0	0.0	0.1	2.1	3.0	1.9	1.1	0.2	0.0	0.0	8.4
days < 0°C	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.2	0.1	0.0	0.0	0.0	1.1

Table B13.10
9am and 3pm mean relative humidity (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean 9am relative humidity (%)	65	69	70	72	79	83	81	77	72	66	67	64	72
Mean 3pm relative humidity (%)	44	44	47	52	60	67	65	59	56	52	49	45	53

Table B13.11
Mean daily solar exposure 1990-2019 (megajoules per square metre)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Solar radiation (MJ/m2)	24.2	21.1	16.5	11.4	7.7	6.2	7.0	10.0	13.5	17.9	21.3	23.7	15.0

Table B13.12
Mean daily evaporation 1998-2019 (millimetres)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Evaporation (mm)	8.1	7.1	5.8	3.8	2.5	1.8	2	2.7	4.1	5.2	6.0	7.4	4.7

Table B13.13
Root-zone soil moisture percentile to a 1911-2016 baseline (%)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Soil moisture (%)	0.0	2.83	0.98	50.5	93.5	67.3	23.3	6.54	7.52	32.7	47.7	20.6	11.52

Table B13.14
Run-off percentile relative to 1911-2016 baseline (%)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Run-off (%)	0.0	1.86	0.98	66.31	94.4	58.9	29.9	6.54	7.52	35.6	44.0	19.6	13.28

Figure B13.1
Proximity of Melbourne Airport to bushfire-prone areas and bushfire management overlays (VicPlan, 2020).

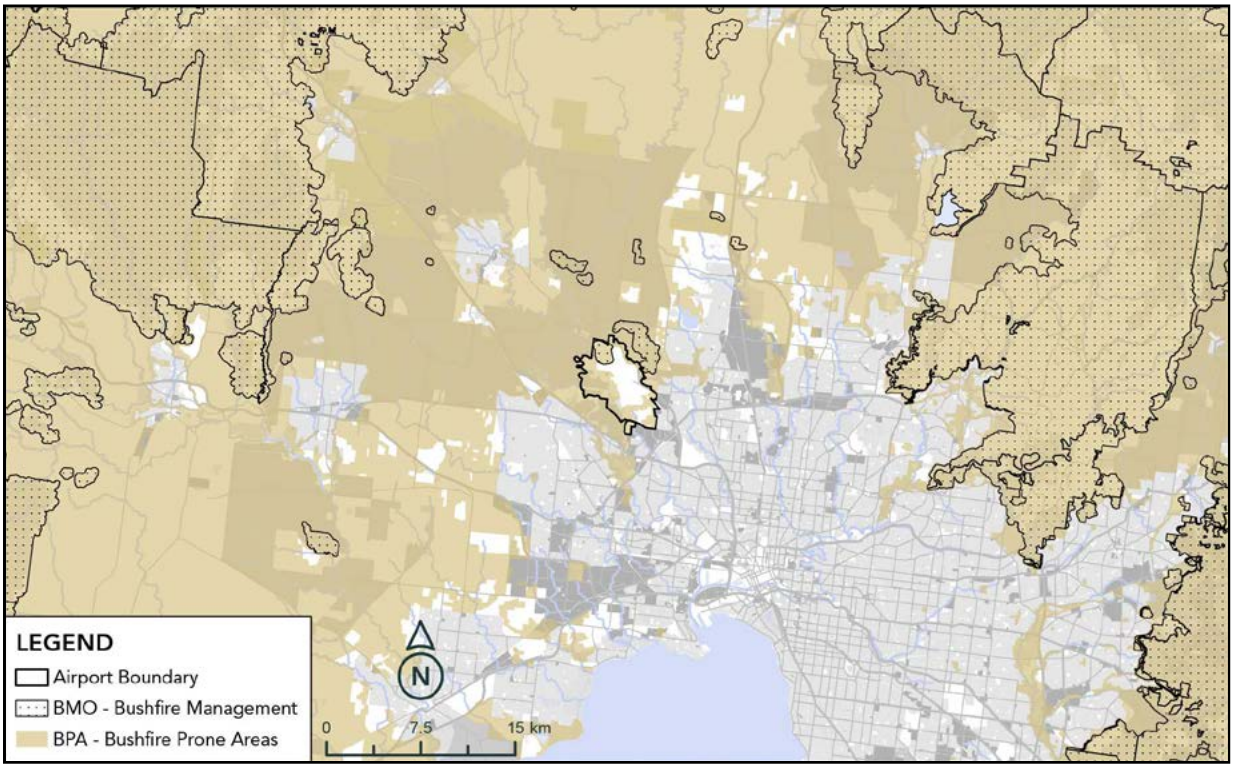


Table B13.15
9am and 3pm average wind speed (kilometres per hour)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am wind speed (km/h)	18.5	17.0	16.9	16.7	17.2	18.3	20.2	21.6	22.1	21.8	19.0	18.7	19
3pm wind speed (km/h)	22.3	21.2	20.6	19.9	19.7	20.8	22.7	23.9	24.4	23.5	22.4	22.7	22

Table B13.16
Maximum wind gust speed (kilometres per hour)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wind speed (km/h)	137	122	113	107	108	102	108	124	115	122	139	113
Date	3/1 1981	28/2 2015	26/3 1984	2/4 2008	21/5 1989	28/6 1991	30/7 1993	10/8 1992	2/9 2002	3/10 1971	15/11 1982	21/12 1973

B13.5.1.10
Fog

Fog is low-lying cloud which reduces visibility to less than 1,000 metres. The annual average number of fog days experienced by Melbourne Airport is 13 a year, with most fogs occurring in late spring and early winter. May and June experience the highest number of fog days, both averaging 2.5 days each year (Bureau of Meteorology, 2016).

B13.5.1.11
Frost

The Bureau of Meteorology forecasts frost potential based on temperature thresholds across Australia. The number of potential frost days at Melbourne Airport can be equated to the number of days each year when the temperature drops below 2°C, equating to 8.6 days per year (Table B13.9).

B13.5.1.12
Fauna strike

Fauna strike is the collision between an aircraft and an animal, usually a bird and occasionally a bat. There are multiple incidents of fauna strike at Melbourne Airport every year, with the most common birds involved being magpies, starlings, ravens and pigeons. The FY19 average strike rate at Melbourne was 4.2 strikes per 10,000 aircraft movements. By comparison, the strike rate per 10,000 movements for high-capacity air transport operations across Australia as recorded by the Australian Transport Safety Bureau (ATSB) for 2004-2013 has varied from 6.67 in 2007 to a high of 8.38 in 2013. Damaging fauna strikes are rare (about 0.2 per 10,000 air traffic movements) and their long-term trend is downward (Steele, 2015).

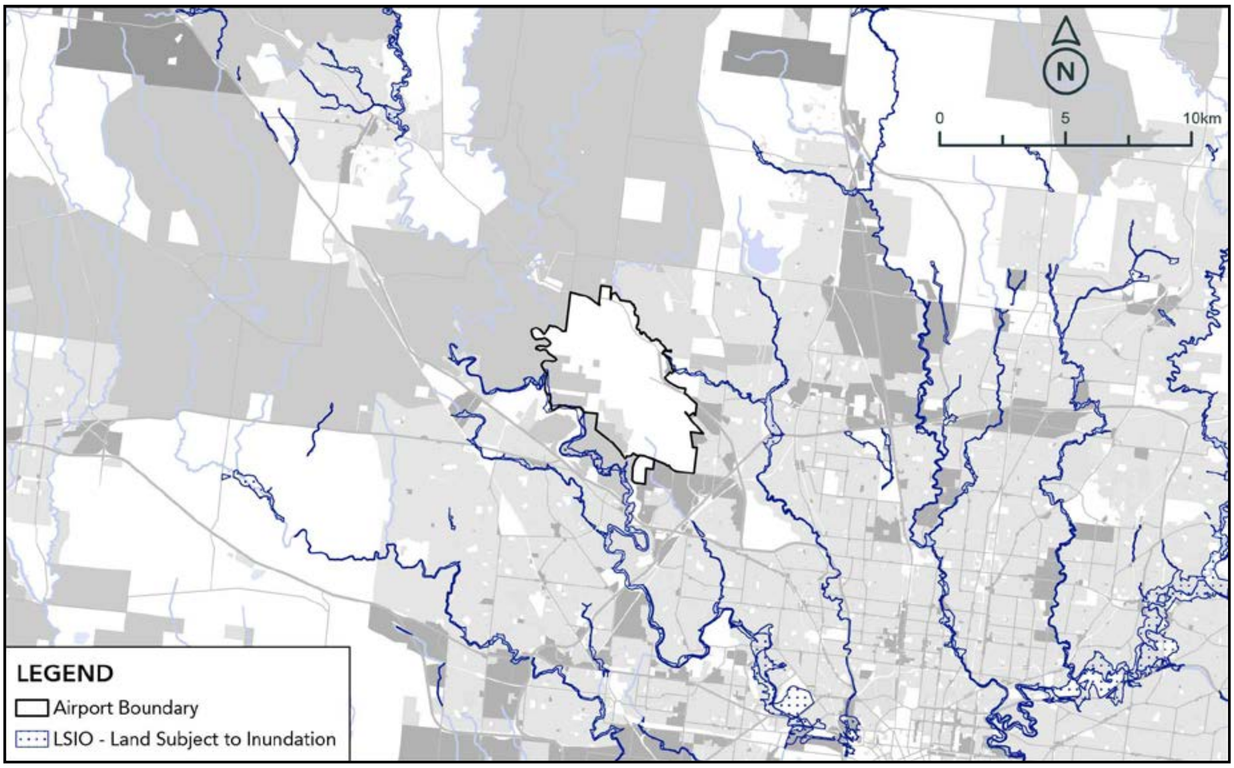
B13.5.1.13
Riverine flooding

Riverine flooding is unlikely to affect Melbourne Airport, and flooding from rivers has never impacted airport operations. However, the Hume Planning Scheme records two local Land Subject to Inundation Overlays (LSIO) which are based on the extent of flooding resulting from a one-in-100-year storm (Figure B13.2). The LSIO to the east of Melbourne Airport relates to Moonee Ponds Creek and the flood overlay does not encroach onto airport property. The LSIO to the west relates to the Maribyrnong River, which forms part of the airport's western boundary. This section of the Maribyrnong River is in a deep ravine and is unlikely to cause flooding at Melbourne Airport.

B13.5.1.14
Dust storm

The two major dust storms affecting Melbourne in the recent past occurred in 2009 and 2019. In addition, severe dust-haze observations have been recorded

Figure B13.2
Land subject to LSIO near Melbourne Airport (VicPlan, 2020).



through DustWatch since 2011 at Loddon Plains, the closest dust-observing station to Melbourne (two hundred kilometres north-west of the airport). Dust observations are given as hours of dust observed per year (Table B13.17).

Table B13.17
Hours of dust observed yearly at Loddon Plains (DustWatch, 2019)

	2011	2012	2013	2014	2015	2016	2017	2018
Dust observed (hours)	0	1	2	6	2	9	0	0

B13.5.2
Climate projections

The climate projections contained in this section are sourced from a range of publicly available Australian references.

The climate in the region is expected to become warmer and drier, with a greater incidence of very hot days, drought, grass fires and bushfires. Extreme events such as flooding and storms are projected to increase in frequency and intensity.

Different levels of confidence are associated with projected changes in climate variables. Confidence levels are based on the strength and extent of the evidence and the degree of scientific agreement. CSIRO assigns five levels of confidence (very high, high, medium, low and very low) to climate projections.

Current projections used here refer to the future years 2030 and 2070, which are in fact 20-year periods centred on 2030 and 2070. For example, the 2030 projections encompass changes from the period 2020 to 2039. Changes are compared to a baseline period of 1986-2005. Where a range of projections is shown (for example in **Table B13.13**) the range relates to the 10th to 90th percentile range of climate-model results.

B13.5.2.1
Precipitation

There is a lack of consensus among climate models about the direction of change in average annual rainfall in Melbourne (**Table B13.18**). Overall, the projections suggest small decreases in annual rainfall although within the bounds of natural variability until at least 2030.

Lower rainfall in the coolest six months of the year is projected with high confidence and by 2070 these declines could be outside the bounds of natural variability.

The direction of change for rainfall in Victoria during the warmer months is not reliably projected by current models.

Table B13.18
Projected rainfall differences (per cent) for Greater Melbourne (Department of Environment, Land, Water and Planning, 2015)

	2030 RCP4.5	2070 RCP4.5	2070 RCP8.5
Annual	-2 (-7 to +3)	-2 (-7 to + 3)	-5 (-23 to +4)
Summer	-1 (-17 to +14)	-1 (-17 to +14)	-1 (-21 to +25)
Autumn	-3 (-15 to +15)	-3 (-15 to +15)	-7 (-20 to +14)
Winter	-3 (-14 to +7)	-3 (-14 to +7)	-7 (-17 to +5)
Spring	-7 (-21 to +4)	-7 (-21 to +4)	-14 (-39 to +4)

Extreme rainfall

An increase in the intensity of extreme rainfall events is projected with high confidence, although there is more uncertainty about the magnitude of the increase. For the RCP4.5 medium-emissions scenario, the projections for 2030 and 2070 are similar; for example, a median projection of a 7 per cent increase by 2070 (**Table B13.19**).

For the RCP8.5 high-emissions scenario, the projected increases in extreme rainfall are more significant. Some models project it increasing by up to 20 per cent for the wettest day in a year and over 30 per cent for the wettest day in 20 years (CSIRO 2016a).

Table B13.19
Projected percentage changes in wettest day in Victoria (CSIRO 2016a)

	2030 RCP4.5	2070 RCP4.5	2070 RCP8.5
Annual wettest day	4 (-1 to +10)	7 (-3 to +13)	13 (3 to +20)
1 in 20-year wettest day	7 (-2 to +16)	9 (2 to +17)	18 (5 to +33)

B13.5.2.2
Temperature

Annual average temperatures are projected to increase by 0.5 to 0.9°C by 2030 (RCP4.5) and by 1.0 to 3.0°C by 2070 (Table B13.20). This projected warming is large compared to natural variability (Grose, 2015).

Projected changes for daily maximum and minimum temperature are similar to those of the mean temperature. By 2070, there is expected to have been a substantial increase in the temperature reached on the hottest days; the frequency of hot days; and the duration of warm spells (Table B13.21). The temperature on the coldest winter night will increase by 0.7°C by 2030; 1.3°C by 2070 (RCP4.5) and 2.0°C by 2070 (RCP8.5). This would mean that by 2070 the temperature would rarely, if ever, reach freezing point at Melbourne Airport.

Table B13.20
Projected temperature change (°C) for Greater Melbourne, compared to 1986-2005 (Department of Environment, Land, Water and Planning, 2015)

	2030 RCP4.5	2070 RCP4.5	2070 RCP8.5
Temperature change (°C)	0.9 (0.6 to 1.3)	1.5 (1.2 to 1.9)	2.6 (2.1 to 3.1)

Table B13.21
Average annual number of days above 35°C and 40°C for Melbourne Airport (CSIRO, 2016b)

	Baseline (1981-2010)	2030 RCP4.5	2070 RCP4.5	2070 RCP8.5
Days >35°C	10	13 (12-15)	16 (15-18)	21 (16-25)
Days >40°C	1	2 (2-3)	4 (3-5)	5 (3-7)

** Data generated with thresholds calculator using Melton as proxy location due to its proximity to Melbourne Airport and similar historical record of high-temperature days. The given figures are an average of the eight models in the thresholds calculator, with the full range of model results in brackets.*

B13.5.2.3
Relative humidity

Reductions in relative humidity are expected to contribute to drier conditions this century. By 2030 these reductions will be small (less than 1 per cent). By 2070 the reductions are projected to be larger (up to 4 per cent), particularly in winter and spring under higher emissions scenarios (CSIRO, 2016c; Grose, 2015).

B13.5.2.4
Solar radiation

An increase in average annual solar radiation of less than 3 per cent is projected by 2030. By 2070 there could be slightly larger increases in winter and spring of up to 4 per cent (CSIRO, 2016c; Grose, 2015).

B13.5.2.5
Evaporation

All climate models project increases in potential evaporation in Victoria in all seasons. By 2030 this increase is unlikely to be greater than 5 per cent. By 2070 the increase is expected to be larger, 5 to 10 per cent, particularly in winter (CSIRO, 2016c; Grose, 2015).

B13.5.2.6
Moisture and run-off

The projected increases in potential evaporation combined with likely decreases in rainfall will lead to decreases in soil moisture and run-off. Table B13.22 shows that these decreases could be quite significant, even for modest increases in mean temperature. However, there is low confidence in these estimates (Grose, 2015).

B13.5.2.7
Drought

The time spent in drought is projected with medium confidence to increase over the course of the century. There is moderate consensus that this increase will be large (more than 25 per cent) by 2070 under RCP4.5 and 8.5. The number of droughts every 20 years is projected to increase and could double by 2070 under RCP8.5 (Table B13.23).

Table B13.22
Projected changes to run-off (millimetres) for Maribyrnong River catchment for 1°C and 2°C increases in mean temperature (Post, 2012)

Baseline run-off (mm)	Change in run-off for 1°C mean working (%)			Change in run-off for 2°C mean working (%)		
	Worst-case	Median	Best-case	Worst-case	Median	Best-case
68	-27	-17	-7	-47	-29	-12

Table B13.23
Duration and frequency of extreme drought in Victoria (Grose, 2015)

	Baseline (1981-2010)	2030 RCP4.5	2070 RCP4.5	2070 RCP8.5
Percentage of time in drought (%)	37	42	48	47
Percentage of time in extreme drought (%)	23	26	29	26
Frequency of extreme droughts (per 20 years)	1.4	1.9	2.0	2.9

B13.5.2.8
Bushfire

Climate change resulting in a harsher fire-weather climate in the future is projected with high confidence. Bushfire risk is expected to increase through both an increase in the duration of the bushfire season as well as the level of risk during the season. However, there is low confidence in the magnitude of the change to fire weather.

The current average annual cumulative Forest Fire Danger Index (FFDI) for Melbourne Airport is 2591 (Clarke et al, 2013). Projections for Melbourne Airport indicate that the annual FFDI will increase by about 12 per cent by 2030, around 17 per cent under RCP4.5 by 2070 and 25 per cent under RCP8.5 by 2070 (CSIRO, 2016d).

The number of days with a 'severe' fire danger rating is projected to increase from 2.7 (baseline) to 3.5 by 2030 (noting that the present-day value is 3.1), about 3.8 under RCP4.5 by 2070 and 4.2 under RCP8.5 by 2070 (CSIRO, 2016d).

B13.5.2.9
Wind

Overall climate models estimate little change in average wind speed this century in comparison to natural variability (however, there is a high degree of uncertainty). By 2070, wind speeds are projected to decrease in western Victoria in winter and spring but these decreases are not expected to exceed 10 per cent under RCP8.5.

For maximum wind speeds, such as the one-in-20-year wind gust, there is projected to be little change (plus or minus 5 per cent) by 2070 (Grose, 2015).

B13.5.2.10
Fog

The formation of fog depends on several climate variables and there are no studies on the impact of climate change on the frequency of fog. However, increased temperatures may lead to a decrease in fog and this is already being observed worldwide (Klemm, 2016).

B13.5.2.11
Frost

The average annual number of potential frost days at Melbourne Airport is projected to decrease from nine days to six days by 2030, and three days by 2070 (CSIRO, 2016).

B13.5.2.12
Fauna strike

The number of birds at Melbourne Airport depends on a number of natural variables and operational activities. This makes it difficult to predict the effect of climate change on the likelihood of fauna strike.

B13.5.2.13
Dust storm

Dust storms could become more common with climate change. Although there are no specific projections available, decreased rainfall, increased evaporation and the associated drying of soil would point to a projected increase in the risk of dust storms occurring (Dineley, 2013).

B13.6
ASSESSMENT OF POTENTIAL IMPACTS

B13.6.1
Description of likely impacts on M3R

All the climate variables and natural hazards described in **Section B13.5** have, to varying degrees, the potential to impact on the operation and asset management of Melbourne Airport. However, only some of these have the potential to affect construction or operation of M3R, which is the focus of this section.

Table B13.24 provides an overview of the natural hazard and climate risks to M3R. This is a summary of the impact-assessment table in **Section B13.6.2**. The table shows a broad range of climate impacts that may affect M3R during both construction and operation.

Section B13.6.1.3 outlines the transition risks associated with the transition to a lower-carbon economy for Melbourne Airport.

Table B13.24
Summary of physical risks to M3R during construction and operations

	Extreme rainfall	Extreme heat	Drought	Lightning	High Wind	Bushfire
Construction						
Access to site	L		L			L
Condition of laydown area or construction site	M					L
Worker wellbeing/ability to work		L				L
Operation						
Longevity of runway and other asphalt areas	L	M				
Performance/ usability of runway and other asphalt areas	L	M	M			
Worker wellbeing/ability to work		M				
On-site vegetation		L	L			M
Impacts on natural environment (WQ, AQ, ecology)	M		M			

Table includes only risks which are within the scope of M3R to control. 'L' - low risk, 'M' - medium risk. The risk levels shown are the maximum level between now and 2070. 'WQ' - Water Quality. 'AQ' - Air Quality

B13.6.1.1 Construction phase

As M3R will be completed within 10 years, natural hazards but not climate change have been included in the assessment of potential impacts during the construction phase.

Access to site

During the construction phase there will need to be continuous access to the site to deliver materials, equipment and staff. This access will be provided from the north and south from public roads. The use of these roads could be affected by any of the following factors:

- Bushfire
- Heavy rain leading to surface-water flooding.

Conditions of the construction site

The natural hazards that could impact the movement of materials and staff during construction are:

- Localised surface-water flooding
- A grass fire on site, or close by Melbourne Airport (e.g. vegetation along creeks and streams).

Operating conditions during construction

The main natural hazards that could impact workers' health, comfort, wellbeing or efficient working are heatwaves and bushfire smoke. If temperatures climb above 35°C, or if air quality is too poor, outdoor construction will normally be required to cease. If this occurs for a prolonged period, it has the potential to disrupt the construction schedule.

Interaction of climate with M3R construction

During construction of M3R there may be a period when movements on the existing north-south runway (16L/34R) are restricted. At this time, the only operational runway will be the existing east-west runway (09/27). As such, Melbourne Airport will be particularly susceptible to strong winds – especially prevailing northerly winds. Landing and take-off will be suspended when crosswinds exceed safe aircraft operating conditions.

B13.6.1.2 Operational phase

Once in operation, the new airfield infrastructure is projected to face a wide range of climate and natural hazards. The significance of some of these risks is likely to change during the 50-year design life of M3R due to climate change. For this reason, the assessment of risks to operations has considered medium-term (2030) and long- term (2070) climate projections.

Climate change is unlikely to create new risks for the operation of M3R. It will, however, change the severity of some existing climate and natural-hazard risks, typically by changing their likelihood. According to current projections, the most significant changes for the Greater Melbourne region are likely to be from increases in the incidence of drought months, extreme-heat days, storms and bushfire. The effect of climate change on operational risks has been considered as part of the impact assessment (**Section B13.6.2**).

There are varying degrees of confidence associated with projected changes in climate variables. For some, such as temperature, there is high or very high confidence in the direction of change but lower confidence in the magnitude of change. For other variables such as fog, wind and lightning, there is low or very low confidence in both the magnitude and direction of change due to climate change.

The starting point for understanding risks to the operation of M3R is those currently experienced by Melbourne Airport. These have been assessed using the knowledge of Melbourne Airport staff, and media reports of weather-related disruption.

Operating conditions at the airport

The key climate-related impacts that can cause issues with the operation of M3R include:

- Heatwaves – sustained high temperatures will impact the health and wellbeing of staff and passengers, especially airside staff such as ground handlers, refuellers, safety officers etc, and any passengers who traverse the tarmac to/from aircraft
- Bushfire on site or near to Melbourne Airport - may mean people (staff and visitors) can't access the airport, thereby impacting operations and business activity
- Regional bushfire - leading to smoke and particulate matter in the 'airshed' (i.e. part of the atmosphere that behaves in a coherent way with respect to the dispersion of emissions). This results in poor visibility affecting flights; and could result in reduced passenger numbers, staff and public health problems (e.g. reduced staff as personnel are unable to access the airport and/or they may be protecting their homes and/or volunteering with local fire authorities).

Longevity of surfaces

A number of climate variables can affect the integrity of the runway and other airfield pavement surfaces such as taxiways and aprons. This can reduce the lifespan of the asphalt materials and affect their maintenance regime.

These impacts may not always operate in isolation but can combine in the following ways to cause degradation:

- Drought and an increase in variation of wet and dry spells, which can lead to subsidence or heave that damages structures
- Excessive hot weather (higher than 38°C) that can weaken asphalt bindings in airfield pavements and lead to cracking and deformation, especially when they are subject to the structural loading from aircraft parking and ground manoeuvres
- Regular saturation of the subgrade layers of the airfield pavement, leading to degradation over time
- The combined effects of heat, solar radiation and heavy rain, resulting in asphalt degradation and reduction in the lifecycle performance of materials and foundations.

Performance of runway and other asphalt areas

Some impacts could affect the short-term performance or maintenance of the runways, including:

- Heavy rain, particularly on soils compacted by drought, could overwhelm the drainage system and lead to inundation of the airfield creating more hazardous conditions for aircraft
- Residue can build up on airfield surfaces during a dry period. Then when it rains, the residue could cause surfaces to become slippery and more hazardous
- Hot weather can lead to an increased build-up of rubber on runway and a consequent increase in rubber-removal resources and costs.

On-site flora and fauna

Some natural hazards may cause a negative impact on the flora and fauna at Melbourne Airport from:

- Drought and hot weather, leading to die-back of habitat and vegetation, erosion and dust generation, and changes in species composition
- Waterlogging of the root zone of airfield grasses and vegetation, resulting in changes in species composition.

Impacts on natural environment

Some climate events could indirectly negatively impact the environment through:

- The release of pollutants when the airport drainage and treatment system are full (after heavy rain) into local watercourses, degrading water quality and aquatic biota
- Ponding after heavy rain attracts birds, leading to greater risk of 'fauna strike'.

Indirect and uncontrollable impacts

The assessment identified and evaluated a number of potential impacts that cannot be controlled within the scope of M3R. Melbourne Airport will consider how to mitigate them as part of its broader efforts to improve climate resilience.

B13.6.1.3 Transition Risks

The following sections provide an overview of the key categories of transition risks.

Policy and legal risks

The policy landscape is evolving in response to climate change and its impacts. The two major aims of this emerging climate policy are mitigation and adaptation. In addition, policymaking is becoming increasingly adaptive as the speed of knowledge creation and distribution increases. Examples of policy-related transition risks include carbon pricing and emissions-reporting obligations. Climate-change adaptation policies may present opportunities such as the promotion of energy and efficiency solutions, or sustainable land-use practices.

Transition to a lower-carbon economy may also result in increased legal challenges to stop carbon-intensive development. The recent decision in the United Kingdom to stop the expansion of the Heathrow Airport is an example of legal action that has already occurred.

Technology Risks

Technological innovations associated with the transition to a lower-carbon economy may present both risks and opportunities to organisations. Advances in renewable energy production; and storage, energy-efficiency and carbon-capture and storage technologies, present risks for many organisations relying on traditional fuel sources either directly or as part of their supply chain. For example, airports are directly reliant on traditional forms of jet fuel for the supply of fuel to aircraft; and on fossil fuels throughout their supply chain and for transport within and to the airport. Fossil fuels are further used throughout an airport's supply chain in the manufacture of materials and goods needed for airport operations. Further risks arise from uncertainty around the speed and nature of technological development. Conversely, falling prices and increasing demand for technology such as renewable energy sources and electrified transport present opportunities for organisations to market and invest in these developments.

Market Risks

The considerable uncertainty and complexity around how markets may be affected by climate change poses major risks to organisations. For example, changing customer preferences and costs of raw materials may result in abrupt changes in demand and a compromised ability to meet that demand.

Reputation Risks

Customer and stakeholder perceptions of an organisation will be increasingly shaped by how they see that organisation contributing to, or hindering, the transition to a lower-carbon economy. A further risk may arise from public sentiment towards the aviation sector as a whole which could affect demand, production capacity and workforce management.

B13.6.2 Risk assessment

The climate change risk assessment has been conducted using the methodology described in Section B13.2. The full risk assessment is recorded in the climate change and natural hazards physical-and-transitional risk register (Appendix B13.A).

The risk register categorises risks as follows:

- Risks to M3R construction
- Risks to the operation of M3R
- Transition risks.

The assessment has identified eight risks to construction and 22 risks to operations from natural hazards and climate. Most have been assessed as low severity. Four construction-related risks and four operational risks are of medium severity in the present day.

A further three operational risks increase in severity from low to medium by 2070, taking climate projections into account.

The assessment shows that none of the risks from climate change or natural hazards is rated as high or extreme, and that no impacts are rated as major adverse.

B13.6.2.1 Uncertainty with regard to climate projections

This assessment has considered the most likely climate projections according to current scientific evidence. However, there is some uncertainty about aspects of the projections. For temperature there is strong evidence that mean and extreme temperatures will increase, albeit with uncertainty about the magnitude of the change.

For other variables such as wind and lightning, there is either a lack of strong evidence about the direction of change or the evidence is ambiguous. For these variables, no assumptions have been made about the direction of change, meaning climate change has no effect on the risk rating. However, in designing critical airfield infrastructure such as a runway it is prudent to consider increases in such variables, and design accordingly.

B13.6.2.2 Cumulative and interactive impacts

The climate-change and natural-hazards risk register (Appendix B13.A) follows a standard approach of linking weather events to distinct adverse consequences. Although such an approach is crucial for identifying the range of risks it does not fully address the complexity of the impact of climate change.

In reality, climate risks tend to coincide, interact and have a cumulative effect. For example, individual adverse-weather events can lead to complex situations with many interacting impacts. It is extremely difficult to predict this type of impact or to evaluate the severity of the risk. However, this demonstrates that climate change is a systemic risk with significant uncertainties, and mitigation measures will therefore have to take this into account.

B13.7 AVOIDANCE, MANAGEMENT AND MITIGATION MEASURES

At a minimum, Melbourne Airport has committed to implementing mitigation measures sufficient to ensure there are no residual risks rated as either high or extreme in both current or future climate scenarios. The mitigation measures will have the potential to reduce the likelihood and/or consequence of potential impacts.

The assessment for this study (**Section B13.6**) has shown there are no risks related to climate change or natural hazards that are rated as high or extreme. This is partly because M3R has been designed to high standards that already control most climate risks. The absence of any high or extreme risks in this study means the level of risk to M3R from climate change and natural hazards is acceptable even without additional mitigation measures.

However, Melbourne Airport has opted to implement mitigation measures for some physical risks initially assessed as being medium. It has done this where the measures are low cost, easy to implement, or have ancillary benefits. **Table B13.25** shows the mitigation measures Melbourne Airport proposes to implement for medium-level risks and the residual risk rating once the measures are in place. It has been possible to mitigate most medium to low-level risks.

B13.7.1 Climate change consideration in design

Some aspects of M3R will be designed to take into account certain climate thresholds. Examples include:

- Drainage system designed for a one-in-100-year rainfall event – in line with the Australian Rainfall and Runoff (ARR) Guidelines
- Asphalt bindings in airfield pavements and asphalt sub-layer designed to take account of ambient air temperature up to a certain threshold.

For this type of climatic threshold, M3R design team will factor in a climate change allowance. For example, for the drainage system the design team has carried out a climate change sensitivity analysis for the one-in-100-year rainfall event. This sensitivity analysis has incorporated a 19 per cent increase in rainfall intensity for the pre and post-development condition. This is in line with Melbourne Water's projections under RCP8.5 (the high-emission scenario).

Where practical, the design will be adapted so the M3R can withstand future climate changes. Another approach will be to allow flexibility in the design so additional mitigation measures can be added later if required.

B13.7.2 Mitigation measures for cumulative and interactive impacts

As explained in **Section B13.6.2.2**, climate risks will interact and accumulate in a way that is difficult to assess. The systemic nature of climate risk calls for mitigation measures which increase M3R's climate resilience regardless of climate scenarios. These measures include incorporating climate risk into emergency planning and implementing a system for climate risk monitoring and review.

Climate risk in emergency planning

M3R operations will occasionally be disrupted by weather-driven events. Some of these events will have multiple interacting impacts which are hard to predict. One way to prepare for them is through emergency planning and testing of emergency scenarios. Melbourne Airport will therefore take account of climate risks such as extreme weather in its airport emergency planning.

Climate risk monitoring, reporting and review

The M3R Team will periodically review the risks from climate change and natural hazards. These periodic reviews will take account of new climate science as well as the monitoring system described in **Section B13.7.3.**

Table B13.25
Mitigation measures for current medium-level physical risks and residual risk rating

Natural hazard/ climate variable	Risk event and consequence	Mitigation measures	Residual risk rating		
			Consequence	Likelihood	Risk level
Construction					
Extreme rainfall	Without mitigation and management measures and controls, localised surface water flooding leads to inundation of laydown area, construction site or access road(s) and consequent disruption to construction schedule.	In the final design phase, a Sedimentation and Erosion Control Plan will be developed as part of the CEMP detailing mitigation measures such as stabilisation of identified areas of instability. (See **Chapter B4: Surface Water and Erosion**).	Minor	Probably not	Low
	Polluted run-off affects local/ downstream water quality of local waterways. Water quality limits breached. Potential for impact on aquatic and riparian flora and fauna.	In the final design phase, a best practice IECA Sediment and Erosion Control Plan will be developed as part of the CEMP.	Moderate	Almost Certainly Not	Low
Bushfire	Without mitigation and management measures and controls, smoke impacts worker health, particularly those with asthma or other chronic respiratory condition(s).	Melbourne Airport will encourage the contractor to include specific procedures in its Occupational Health & Safety Management Plan to ensure safety in smoky conditions.	Moderate	Almost Certainly Not	Low
Winds	Strong E/W winds during the period of construction when the east-west runway is closed. After construction of the North-South runway the East-West runway will be closed whilst it is being altered, which may cause disruptions in certain wind conditions.	Wherever possible, existing runways will remain open during M3R construction. Necessary closures for works will be optimised to reduce risk of unavailability due to weather conditions.	Minor	Probable	Medium
Operation					
Bushfire	Regional bushfires or grassfires lead to smoke and particles in the airshed. This results in poor visibility affecting aircraft, and could result in reduced passenger and staff numbers as they can't access airport (or may be looking after their homes and/or volunteering)	N/A	Moderate	Probably Not	Medium
Drought	On-site vegetation dies due to period of drought and hot weather Potential degradation of protected ecological communities or habitat	Ongoing monitoring to record any changes to protected communities	Moderate	Almost Certainly Not	Low
Extreme Changes in soil conditions	An increase in variation of wet and dry spells causes subsidence or heave, damaging the runway foundations, taxiways and surfaces	The runway pavement has been designed to withstand projected variations in subgrade moisture condition	Moderate	Almost Certainly Not	Low

Natural hazard/ climate variable (cont.)	Risk event and consequence (cont.)	Mitigation measures (cont.)	Residual risk rating (cont.)		
			Consequence	Likelihood	Risk level
Operation (cont.)					
Extreme rainfall	Spillage or release of contaminants such as fire retardant at a time when heavy rain has completely inundated the drainage and treatment network Mobilisation of contaminants in stormwater run-off affecting downstream water quality. Water quality limits breached. Potential for impact aquatic and riparian flora and fauna	Stormwater Management Plan, regular inspections of airport drainage system including outfalls, retarding basins and water sensitive urban design	Moderate	Almost Certainly Not	Low
High temperature	Sustained high temperatures impacting the health and wellbeing of outside workers (especially airside staff such as ground handlers, refuellers, flight dispatchers, etc.)	Sun protection, first aid kits, medical facilities, hydration stations and cool zones are provided for all staff, ground handlers and contractors. Airport guidelines include safety procedures for working in hot conditions	Minor	Chances about even	Low
	High temperatures leading to lower air density air Prolonged heatwaves lead to increased aviation disruptions. Noting that high temperatures lead to lower air density (which reduces aerodynamic lift and jet engine power output). This can lead to restrictions in take-off weight (meaning plane weights may need to be reduced), or service disruptions	Ensure runway lengths are fit for purpose at various climate change scenarios. This will be determined in planning based on appropriate assumptions about future temperatures and aircraft capabilities.	Moderate	Almost Certainly Not	Low
Winds	An increase in the frequency of high winds can result in damage to High Intensity Approach Lighting (HIAL) structures.	HIAL will be built to the Australian Standard for structural design actions (AS1170.2) and designed to withstand, without collapse, wind of a magnitude of up to and including that with a 100-year ARI	Moderate	Almost Certainly Not	Low
	High wind during a prolonged drought leads to dust storms generated in arid inland areas.	The airport has numerous controls in place, including tie-down procedures to follow when high wind alerts are issued. This means that all loose objects within the airfield and construction sites are tied down and/or covered	Moderate	Probably Not	Medium

B13.7.3
Monitoring and reporting

Melbourne Airport regularly monitors incidents related to climate events or natural hazards. They are recorded and managed through Melbourne Airport's existing Enterprise Risk Management system.

Melbourne Airport periodically reviews the data to determine the greatest weather-driven risks and the measures most effective in improving resilience. Ongoing monitoring of the data enables Melbourne Airport to identify any long-term increases in particular risks as the climate changes.

B13.8
CONCLUSION

B13.8.1
Physical Risks

This study has assessed the natural hazards and the aspects of the local climate that may affect the design, construction and operation of M3R. It has described the current climate, as well as the future climate in 2030 and 2070 based on climate projections.

Melbourne Airport is in a fairly benign climatic location and does not experience extremes such as cyclone, snowstorm or coastal flooding that affect many other international airports. Despite this, climate events and natural hazards do sometimes affect Melbourne Airport and the likelihood of some of these impacts occurring is expected to increase during the operational life of M3R.

This study has concluded there are no physical risks from climate change or natural hazards rated as high or extreme and no impacts are rated as major adverse. Several risks are rated as medium, which means they are within the risk tolerance of M3R.

However, this study has taken a conservative approach and has proposed mitigations for most medium-level risks so their severity is low.

Appendix B13.A describes seven physical climate change and natural-hazard risks that have the potential to result in physical impacts to M3R construction. None of these potential impacts have been found to represent significant or high risks.

However, three risks draw an inherent 2020 rating of medium during M3R construction. These relate to impacts associated with:

- Localised surface-water flooding
- Surface-water flooding leading to mobilising of contaminants from construction area affecting flora and fauna
- Bushfires resulting in smoke and diminishing air quality for workers.

All are expected to be reduced to a low rating following the application of planned controls.

B13.8.2
Transitional Risks

Appendix B13.A summarises the key transition risks and opportunities across the various categories of transition risk: political, legal, technological, market and reputation.

Two risk events were classified as medium in 2020. These were:

- Increased risk associated with climate-related regulation - a recent decision in the United Kingdom to stop the expansion of the Heathrow airport highlights the risks to future carbon-intensive development
- Abrupt/unexpected shifts in energy costs - although it is unlikely that this sort of event will occur (likelihood rated as 'probably not'), the consequences of another global jet-fuel crisis would be moderate.

The key risks foreseen to become significant in the longer term are:

- Emissions-reporting obligations – net zero/carbon neutrality targets and/or a price on carbon. The financial consequences of having to be carbon neutral could be major as the price of carbon offsets may increase significantly when demand outstrips supply across all sectors of the economy. In addition, the likelihood of mandatory net zero emissions for companies and assets will most likely increase over time
- Climate-related regulation – a recent decision in the United Kingdom to stop the expansion of the Heathrow airport highlights these risks to carbon-intensive development in the future
- Changing customer behaviour – consumers decide to travel less frequently by aircraft due to concerns about carbon emissions.

REFERENCES

Australia Pacific Airports Corporation (Melbourne), Airport Emergency Plan, 'Crisis Management Plan', Figure 12.5.1: 2014. Melbourne Airport, 37o40'S, 144o50'E. Planning Maps Online (Designated Bushfire Prone Areas; Bushfire Management Overlay). http://services.land.vic.gov.au/maps/ pmo.jsp [date viewed 19 July 2016].

Australian Government Bureau of Meteorology 2016, Climate Change in Australia, [website], accessed 12 July 2016-24 September 2016, http:// www.climatechangeinaustralia.gov.au

Australian Government Bureau of Meteorology 2016, Climate Data Online [website], accessed 14 July 2016, http://www. bom.gov.au/climate/ averages/tables/cw_086282_All.shtml

Biosis, Melbourne Airport M3R: Preliminary fauna strike hazard assessment draft, Melbourne, 2016.

Clarke, H., Lucas, C. and Smith, P. (2013), Changes in Australian fire weather between 1973 and 2010. Int. J. Climatol., 33: 931-944. doi:10.1002/joc.3480

Commonwealth Science and Industrial Research Organisation 2016a, 'Extremes data explorer – Projected change for Southern Slopes for Annual Monthly Maximum 1-day Precipitation', Climate Change in Australia, [website], accessed 31 July 2016, http://www.climatechangeinaustralia.gov.au

Commonwealth Science and Industrial Research Organisation 2016b, 'Thresholds calculator – Maximum Temperature', Climate Change in Australia, [website], accessed 31 July 2016, http://www.climatechangeinaustralia.gov.au

Commonwealth Science and Industrial Research Organisation 2016c, 'Summary Data Explorer', Climate Change in Australia, [website], accessed 1 August 2016, http:// www.climatechangeinaustralia.gov.au

Commonwealth Science and Industrial Research Organisation 2016d, NRM_fire_proj_summary.xls (unpublished).

Dineley, J. 2013, On this day: A mighty dust storm rolls into Melbourne, Australian Geographic web blog, accessed 24 August 2016, http://www.australiangeographic. com.au/blogs/on-this-day/2013/02/on-this-day-melbourne%E2%80%99s-monster-dust-storm

Grose, M. et al. 2015, Southern Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, Canberra, Aust. Govt. Pub. Service.

Klemm, O. and N.H. Lin 2016, 'What Causes Observed Fog Trends: Air Quality or Climate Change?' Aerosol and Air Quality Research, vol. 16, no. 5, 2016, pp. 1131-1142.

Lucas, C. et al. 2007, Bushfire Weather in Southeast Australia: Recent Trends and Projected Climate Change Impacts, Climate Institute, Melbourne.

Post, D.A. et al. 2012, 'Projected Changes in Climate and Runoff for South-eastern Australia under 1 °C and 2 °C of Global Warming Phase 2 Special Report', South Eastern Australian Climate Initiative.

Roles and Responsibilities for Climate Change Adaptation in Australia, [website] 2013, accessed 27 August 2016, https://www.coag.gov.au/sites/default/files/Roles%20 and%20Responsibilities%20for%20Climate%20 Change%20 Adaptation.pdf

Standards Australia/Standards New Zealand Standard Committee 2009, AS/NZS ISO 31000:2009 Risk Management- Principles and Guidelines, http://www.standards.org.au

Steele, W. K. 2001, 'Factors Influencing the Incidence of Bird-strikes at Melbourne Airport', 1986-2000 Bird Strike Committee-USA/Canada, Third Joint Annual Meeting, Calgary, AB, 2001, Paper 24.

Steele, W. K. 2015, Wildlife Hazard Management Program – draft progress report, (unpublished).

Victorian Government Department of Environment, Land, Water and Planning 2015, Climate-ready Victoria: Greater Melbourne: How Climate Change Will Affect the Greater Melbourne Region and How You Can Be Climate Ready, Victorian Govt. Pub. Service, Melbourne.

Victorian Government Department of Environment, Land, Water and Planning 2021, Victoria's Climate Change Strategy, Victorian Govt. Public Service, Melbourne.

Wilder, M et al 2015, 'Independent review of the Climate Change Act 2010', Climate Change, accessed 24 July 2016, http://www.delwp.vic.gov.au/__data/assets/ pdf_file/0008/333971/VictorianGovernmentResponse_IndependentReviewofClimateChangeAct2010.pdf

APPENDIX B13.A
CLIMATE CHANGE AND NATURAL HAZARD PHYSICAL RISK REGISTER

Table B13.26
Climate change and natural hazard physical risk register

Risk event	Impacts	Consequence type	Thresholds or previous events	Current risk (2020)		
				Consequence	Likelihood	Risk level
Construction						
Grassfire inside airport boundary	Fire affects construction or access to construction site, meaning construction staff can't work.	Financial Safety Environmental	N/A	Moderate	Almost Certainly Not	Low
Bushfires result in smoke, diminishing air quality for workers.	Without mitigation and management measures and controls, smoke impacts worker health, particularly those with asthma or other chronic respiratory condition(s).	Safety	N/A	Major	Almost Certainly Not	Medium
Drying / changing soils affect tree stability	Tree fall risk on construction roads affect access to construction site.	Environmental Regulatory	N/A	Limited	Probably Not	Very Low
High temperatures and heat waves	Without mitigation and management measures and controls, worker comfort compromised affecting wellbeing and productivity. Outdoor working temperature rules exceeded leading to inefficiencies and project delays.	Regulatory	N/A	Minor	Chances About Even	Low
Localised surface water flooding	Without mitigation and management measures and controls, localised surface water flooding leads to inundation of laydown areas, construction site or access road(s) and consequent disruption to construction schedule.	Financial Safety Environmental	100-year rainfall event	Moderate	Probably Not	Medium
Surface water run-off mobilises contaminants from construction area	Polluted run-off affects local/ downstream water quality of local waterways. Water quality limits breached. Potential for impact on aquatic and riparian flora and fauna.	Environmental Regulatory	Two-year rainfall event	Moderate	Chances About Even	Medium
Sustained periods of rainfall saturate and soften the ground	Over time the structural integrity of detention basins / sediment basins is compromised leading to collapse.	Financial Safety Environmental	Temporary ponds / basins for construction are more prone to collapse	Minor	Probably Not	Low
Strong E/W winds during the period of construction when the east-west runway is closed after M3R construction	Runway 09/27 (existing) will be temporarily closed for modification as part of M3R. When this east-west runway is closed there may be disruptions due to crosswind conditions, which favour operations on the closed runway.	Financial Safety Reputation	Weather conditions necessitating operations on runway 09/27 are rare.	Minor	Probable	Medium

Current controls and future mitigation measures	Target Risk			Effect of climate change on risk	Med-term risk (2030 RCP4.5)			Long-term risk (2070 RCP8.5)		
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level	Consequence	Likelihood	Risk level
Construction (cont.)										
Aircraft Rescue and Firefighting Service provides fire response and protection services within the airport boundary. Additionally, the airport ensures there is adequate fire water supply, fire break management, vegetation management (regular grass slashing and woodland thinning) and Municipal Fire Management Plan strategies are in place.	Moderate	Almost Certainly Not	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Melbourne Airport will encourage the contractor to include specific procedures in its Occupational Health & Safety Management Plan to ensure safety in smoky conditions.	Moderate	Almost Certainly Not	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tree and vegetation removal undertaken during early works with project footprint. Trees to be retained are flagged off 'no-go areas' and regularly monitored.	Limited	Probably Not	Very Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Melbourne Airport will encourage the contractor to include specific procedures in its Occupational Health & Safety Management Plan to ensure comfort in high temperatures. In addition, the contract timetable will have an allowance for inclement weather which leads to delays.	Minor	Chances About Even	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In the final design phase, a best practice IECA Sediment and Erosion Control Plan will be developed as part of the CEMP.	Minor	Probably Not	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
In the final design phase, a best practice IECA Sediment and Erosion Control Plan will be developed as part of the CEMP.	Moderate	Almost Certainly Not	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Regular inspections of airport drainage system including sediment and detention basins. Increased inspections during times of high rainfall or when destabilisation or piping is apparent.	Minor	Almost Certainly Not	Very Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wherever possible, existing runways will remain open during M3R construction. Necessary closures for works will be optimised to reduce risk of unavailability due to weather conditions.	Minor	Probable	Medium	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Risk event (cont.)	Impacts (cont.)	Consequence type (cont.)	Thresholds or previous events (cont.)	Current risk (2020) (cont.)		
				Consequence	Likelihood	Risk level
Operation						
Grassfire inside airport boundary	People can't access airport, health impacts (particulate matter), airside staff can't work - this will affect plane landings and take-offs, could result in reduced passenger numbers.	Financial Safety Environmental	N/A	Moderate	Almost Certainly Not	Low
Regional bushfires outside of airport boundary	Regional bushfires or grassfires lead to smoke and particles in the airshed. This results in poor visibility affecting plane landings and take-offs, could result in reduced passenger numbers, reduced landside staff as they can't access airport and may be looking after their homes and / or volunteering.	Financial Safety	Hazy conditions reducing visibility and potentially affecting flight operations and air traffic movement flows. In February 2014, bushfires in the Kilmore area meant that the air traffic control tower was evacuated briefly due to smoke penetration, causing some flights to undergo emergency landings and half-hour delays for outbound flights. Bushfires in January 2020 also resulted in delays to flights.	Moderate	Probably not	Medium
Changes in behaviour or distribution of wildlife, particularly the foraging/flight patterns of bird species during autumn, as well as the Grey-headed Flying Fox	Bird strike, Injury or death to wildlife (i.e. birds and bats) as a result of aircraft incidents and changes to local habitat dynamics and wildlife foraging/ roosting patterns.	Environmental Safety	N/A	Limited	Probable	Low
On-site vegetation cover reduced due to period of drought and hot weather	Reduction in water quality treatment performance by landscaped features. Regulatory discharge limits with respect to pollutants are exceeded.	Environmental Regulatory	Regulatory water quality requirements (Cth and State)	Minor	Chances About Even	Low
On-site vegetation dies due to period of drought and hot weather	Potential degradation of protected ecological communities or habitat	Environmental	N/A	Moderate	Probably not	Medium
Compacted dry soils lead to increased run-off risk when heavy rain arrives	Run-off overwhelms drainage system resulting in saturation of the subgrade layers. Regular saturation will result in the degradation of the pavement	Financial Safety	Requires volume of run- off above that can be handled	Moderate	Almost Certainly Not	Low

Current controls and future mitigation measures (cont.)	Target Risk (cont.)			Effect of climate change on risk (cont.)	Med-term risk (2030 RCP4.5) (cont.)			Long-term risk (2070 RCP8.5) (cont.)		
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level	Consequence	Likelihood	Risk level
Operation (cont.)										
Aircraft Rescue and Firefighting Service provides fire response and protection services within the airport boundary. Additionally, the airport ensures there is adequate fire water supply, fire break management, vegetation management (regular grass slashing) and Municipal Fire Management Plan strategies are in place.	Moderate	Almost Certainly Not	Low	Increase in extreme fire danger days – up to 135% by 2050.	Moderate	Probably Not	Medium	Moderate	Probably Not	Medium
N/A	Moderate	Probably Not	Medium	Increase in extreme fire danger days – up to 135% by 2050.	Moderate	Probably not	Medium	Moderate	Chances About Even	Medium
Daily airside monitoring and Bird Control Plan containing a range of pre-emptive and reactive measures aimed at habitat management, population control, exclusion, removal, active scarring and passive deterrents to reduce wildlife attractants on and within 13 kilometres of the airport boundary (as recommended by ICAO).	Limited	Probable	Low	Various climatic changes lead species' responses.	Limited	Probable	Low	Limited	Probable	Low
Landscaping to specify native, drought-tolerant species.	Minor	Probably not	Low	Increase in drought months – 20% by 2030; 40% by 2070.	Minor	Probably Not	Low	Minor	Chances About Even	Low
Ongoing monitoring to record any changes to protected communities	Moderate	Almost Certainly Not	Low	Increase in drought months – 20% by 2030; 40% by 2070.	Moderate	Probably Not	Medium	Moderate	Chances About Even	Medium
Drainage system designed for the 100-year event based on typical antecedent moisture conditions for grassed areas in South Eastern Australia. As per Australian Rainfall and Runoff guidelines.	Moderate	Probably Not	Low	Increase in drought months – 20% by 2030; 40% by 2070.	Moderate	Probably Not	Medium	Moderate	Probably not	Medium

Risk event (cont.)	Impacts (cont.)	Consequence type (cont.)	Thresholds or previous events (cont.)	Current risk (2020) (cont.) Consequence	Likelihood	Risk level
Operation (cont.)						
Compacted dry soils lead to increased run-off risk when heavy rain arrives	Inundation of airfield areas and aircraft manoeuvring surfaces could cause ponding in operational areas which could result in flight delays and possible cancellations, en route diversions and loss of revenue.	Financial Safety	Requires volume of run- off above that can be handled	Minor	Probably Not	Low
An increase in variation of wet and dry spells	An increase in variation of wet and dry spells causes subsidence or heave, damaging the runway foundations, taxiways and surfaces.	Financial Safety Reputation	N/A	Moderate	Probably Not	Medium
Spillage or release of contaminants such as fire retardant at a time when heavy rain has completely inundated the drainage and treatment network.	Mobilisation of contaminants in stormwater run-off affecting downstream water quality. Water quality limits breached. Potential for impact aquatic and riparian flora and fauna.	Environmental Regulatory Reputational	Water quality treatment system will be designed for up to the two-year design storm.	Moderate	Probably Not	Medium
Localised surface water flooding	Localised surface flooding can overwhelm drainage capacity causing delays and disruptions including on access roads and car parks. Inundation of airfield areas and aircraft manoeuvring surfaces reduces surface friction, causing hazardous conditions for landing and taxiing aircraft and related ground operations including ground support equipment and airside vehicles. This can result in flight delays and possible cancellations, and loss of revenue. Flooding may additionally damage aircraft navigation systems, buildings, and runways (which could impact take-off and landings).	Financial Safety	Run-off water depth of >3mm over more than 25% of the runway surface will be hazardous to safe landing and take-off operations leading to temporary closure of the runway. September 2011 – nearly 50 millimetres of rain in one hour led to flight disruption over two days.	Minor	Chances About Even	Low
Heavy rain leads to reduction in visibility	More frequent or more intense rainfall causing reduced visibility for aircraft and ground support equipment, resulting in delays.	Financial Safety	Increased separation distance between aircraft leading to delays.	Limited	Probably Not	Very Low
Heatwave	Heat damage to airfield pavements (i.e. runways, taxiways, aprons and airside roads) and underground services (i.e. fuel hydrant system). Asphalt bindings in airfield pavements/asphalt sub-layers weaken when exposed to sustained periods of excessive hot weather (i.e. >38°C days) and heat absorption. This results in the asphalt oxidising, stiffening and cracking. Heavy static aircraft loads, ground taxiing and landing/take-off operations will progressively soften/deform the asphalt and in extreme circumstances trap or immobilise aircraft in ruts/runway grooves. Fuel residues from underground hydrant system leaks can bubble up to the surface through soft sub-layers. Immobilised aircraft will require towing for airworthiness inspections, creating system delays.	Financial Safety	Excessive hot weather (e.g. higher than 38°C) that can weaken asphalt bindings in airfield pavements leading to cracking and deformation, especially when subject to the structural loading from aircraft parking and ground manoeuvres	Moderate	Almost Certainly Not	Low

Current controls and future mitigation measures (cont.)	Target Risk (cont.)			Effect of climate change on risk (cont.)	Med-term risk (2030 RCP4.5) (cont.)			Long-term risk (2070 RCP8.5) (cont.)		
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level	Consequence	Likelihood	Risk level
Operation (cont.)										
Various surface water controls such as bio-retention storage will manage peak flow rates and are designed to effectively drain airfield	Minor	Almost Certainly Not	Very Low	Increase in drought months – 20% by 2030; 40% by 2070.	Minor	Almost Certainly Not	Very Low	Minor	Probably Not	Low
The runway pavement has been designed to take account of variations in subgrade moisture condition.	Moderate	Almost Certainly Not	Low	Increase in drought months – 20% by 2030; 40% by 2070.	Moderate	Probably Not	Medium	Moderate	Probably Not	Medium
Stormwater Management Plan, regular inspections of airport drainage system including outfalls, retarding basins and water sensitive urban design.	Moderate	Almost Certainly Not	Low	An increase in the intensity of extreme rainfall events is projected with high confidence; the RCP4.5 medium emissions scenario predicts a 7% increase by 2070.	Moderate	Almost Certainly Not	Low	Moderate	Probably Not	Medium
The drainage culverts across the airport (including M3R) will be designed to handle a rainfall event with a 100- year Average Recurrence Interval (ARI). To allow for increases in rainfall intensity due to climate change the design will be sensitivity tested for rainfall with a 200-year ARI. Maintain runway in optimum condition, grooved runway surface, runway condition assessments/inspections, airport drainage system, runway end safety areas.	Minor	Probably Not	Low	An increase in the intensity of extreme rainfall events is projected with high confidence; the RCP4.5 medium emissions scenario predicts a 7% increase by 2070.	Minor	Probably Not	Low	Minor	Chances About Even	Low
	Limited	Probably Not	Very Low	Increased extreme rainfall events projected with high confidence; RCP4.5 medium emissions scenario predicts 7% increase by 2070.	Limited	Chances About Even	Low	Minor	Chances About Even	Low
The airport carries out various procedures that will help mitigate this risk, involving regular airside inspections, pavement rehabilitation, rapid resurfacing and slab replacement works, etc, based on applicable design standards and best practice.	Moderate	Almost Certainly Not	Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Moderate	Probably Not	Medium	Moderate	Chances About Even	Medium

Risk event (cont.)	Impacts (cont.)	Consequence type (cont.)	Thresholds or previous events (cont.)	Current risk (2020) (cont.) Consequence	Likelihood	Risk level
Operation (cont.)						
High temperatures	Increased build-up of rubber on runway leading to an increase in contaminant build up and rubber removal resources and costs.	Financial Environmental	N/A	Minor	Probably not	Low
Heatwave	Thermal expansion of building infrastructure, such as concrete and steel, which over time can lead to failures and reduced longevity.	Financial	N/A	Moderate	Almost Certainly Not	Low
High temperatures	Sustained high temperatures will impact the health and wellbeing of outside workers, especially airside staff such as ground handlers, refuellers, flight dispatchers, etc.	Safety Financial	Sustained temperatures in excess of 25°C to 30°C will require appropriate workplace precautions to be taken regarding sun protection / hydration and a possible reorganisation of shift patterns and certain outdoor activities on the airside.	Minor	Probable	Medium
High temperatures	Flashpoint of aviation Jet A-1 fuel exceeded leading to risk of fuel ignition and therefore increased fire hazard risk for apron and ramp areas.	Safety	Material Safety Data Sheet for Jet A-1 kerosene-grade fuel indicates a flashpoint minimum of 38°C.	Minor	Probably Not	Low
High temperatures leading to lower air density air	Prolonged heatwaves lead to increased take-off disruptions. Noting that high temperatures lead to lower air density (which reduces aerodynamic lift and jet engine power output). This can lead to restrictions in take-off weight (meaning plane weights may need to be reduced), or service disruptions if runways are not long enough.	Financial Reputation Safety		Moderate	Probably Not	Medium
High temperatures	Overheating of aircraft during block turnarounds	Financial	During prolonged periods of hot weather with temperatures >25°C to 35°C, airlines (subject to their respective procedures and agreements) will use APUs to keep the aircraft cabin comfortable. APU use can result in unnecessary fuel burn, emissions and ground noise.	Minor	Almost Certainly Not	Very Low

Current controls and future mitigation measures (cont.)	Target Risk (cont.)			Effect of climate change on risk (cont.)	Med-term risk (2030 RCP4.5) (cont.)			Long-term risk (2070 RCP8.5) (cont.)		
	Consequence	**Likelihood**	**Risk level**		**Consequence**	**Likelihood**	**Risk level**	**Consequence**	**Likelihood**	**Risk level**
Operation (cont.)										
Maintenance of runway surface will include regular removal of waste rubber at appropriate intervals.	Minor	Almost Certainly Not	Very Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Minor	Almost Certainly Not	Very Low	Minor	Probably Not	Low
The airport carries out various procedures that will help mitigate this risk, involving regular building structural inspections and rehabilitation.	Moderate	Almost Certainly Not	Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Moderate	Probably Not	Medium	Moderate	Probably Not	Medium
Sun protection, first aid kits, medical facilities, hydration stations and cool zones are provided for all staff, ground handlers and contractors. Airport guidelines include safety procedures for working in hot conditions.	Minor	Chances About Even	Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Minor	Probable	Medium	Minor	Almost Certain	Medium
Emergency spill response and clean-up procedures implemented in accordance with APAM's certified ISO 14001:2015 EMS and Airport Environment Strategy.	Minor	Almost Certainly Not	Very Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Minor	Almost Certainly Not	Very Low	Minor	Almost Certainly Not	Very Low
Ensure runway lengths are fit for purpose at various climate change scenarios. This will be determined in planning based on appropriate assumptions about future temperatures and aircraft capabilities.	Moderate	Almost Certainly Not	Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Moderate	Almost Certainly Not	Low	Moderate	Probably Not	Medium
Airline agreements, installation of 400Hz (90kVA) FEGP and PCA systems on some contact stands, mobile GPU use and aircraft APU running.	Minor	Almost Certainly Not	Very Low	Increase in days >35°C from nine days to 11 days by 2030 and 20 days by 2070.	Minor	Almost Certainly Not	Very Low	Minor	Almost Certainly Not	Very Low

Risk event (cont.)	Impacts (cont.)	Consequence type (cont.)	Thresholds or previous events (cont.)	Current risk (2020) (cont.) Consequence	Likelihood	Risk level
Operation (cont.)						
High winds	An increase in the frequency of high winds can result in damage to high intensity approach lighting (HIAL) structure.	Financial Safety	HIAL structures designed for 100-year return interval for wind	Moderate	Probably Not	Medium
High wind during a prolonged drought leads to dust storms generated in arid inland areas.	Dust clouds driven by high winds can results in a loss of visibility, causing flight and ground disruptions and leading to delays and cancellations. In addition, dust clouds can block sensors resulting in unreliable airspeed indicators, corrode the airframe, reduce thrust and lead to engine surging/flame-outs which can cause flight issues.	Financial Safety Reputation	N/A	Moderate	Chances About Even	Medium
High winds	Damage to assets, standing aircraft, vehicles and injuries to staff.	Financial Safety	N/A	Minor	Probably not	Low
Increased incidence of tropical disease outbreaks and epidemics results in reduced travel or altered tourism patterns	Warmer temperatures have an impact on the spread of tropical diseases. Modern transportation and air travel play a part, but the potential range for many diseases expands as regions farther and farther poleward get warmer. This means there are more and more places where a disease like Zika can take root. When the Zika outbreak occurred, it was reported that travel and tourism patterns altered causing significant economic damage to areas affected by the epidemic	Financial	N/A	Limited	Almost Certainly Not	Very Low

Current controls and future mitigation measures (cont.)	Target Risk (cont.)			Effect of climate change on risk (cont.)	Med-term risk (2030 RCP4.5) (cont.)			Long-term risk (2070 RCP8.5) (cont.)		
	Consequence	Likelihood	Risk level		Consequence	Likelihood	Risk level	Consequence	Likelihood	Risk level
Operation (cont.)										
HIAL structures will be built to the Australian Standard for structural design actions (AS1170.2) and designed to withstand, without collapse, wind of a magnitude of up to and including that with a 100-year ARI.	Moderate	Almost Certainly Not	Low	Potential for wind speeds to increase in winter by up to 13% by 2070 (may also decrease).	Moderate	Almost Certainly Not	Low	Moderate	Probably Not	Medium
The airport has numerous controls in place, including tie-down procedures to follow when high wind alerts are issued. This means that all loose objects within the airfield and construction sites are tied down and/or covered. In addition, there are other external controls, such as "Notice to Airmen" (NOTAM) notifications which alert pilots to any potential safety hazards in their journey.	Moderate	Probably Not	Medium	Increase in drought months – 20% by 2030; 40% by 2070.	Moderate	Chances About Even	Medium	Moderate	Chances About Even	Medium
The airport has numerous controls in place, including tie-down procedures to follow when high wind alerts are issued. This means that all loose objects within the airfield and construction sites are tied down and/or covered. In addition, there are other external controls, such as "Notice to Airmen" (NOTAM) notifications which alert pilots to any potential safety hazards in their journey.	Minor	Probably not	Low	Potential for wind speeds to increase in winter by up to 13% by 2070 (may also decrease).	Minor	Probably Not	Low	Minor	Probably Not	Low
N/A	Limited	Almost Certainly Not	Very Low	N/A	Limited	Almost Certainly Not	Very Low	Limited	Almost Certainly Not	Very Low

Table B13.27
Climate change and natural hazard transitional risk register for M3R

Transition risk type	Context	Events	Consequence type	Inherent risk rating: 2020 Consequence	Inherent risk rating: 2020 Likelihood	Inherent risk rating: 2020 Risk level	Med-term risk: 2030 Consequence	Med-term risk: 2030 Likelihood	Med-term risk: 2030 Risk level	Long-term risk: 2070 Consequence	Long-term risk: 2070 Likelihood	Long-term risk: 2070 Risk level
Policy / legal												
Emissions reporting obligations – net zero / carbon neutrality targets	In June 2019 ACI Europe announced a resolution for its 500 members to reach net zero carbon emissions by 2050. In November 2019, Qantas Group pledged to reach net zero carbon emissions by 2050. There are currently 50 airports across the world that have achieved carbon neutrality under the ACA program. In February 2022 the APAC ESG Strategy was published which applies to Melbourne Airport. This strategy commits Melbourne Airport to achieving net-zero Scope 1 and 2 carbon emissions by 2025. Melbourne airport has committed to achieving Level 3 ACA accreditation in the future. This could include Level3+ Neutrality which would require the airport to offset residual emissions under its control.	Early retirement of existing assets (natural gas tri-generation system) in order to meet target emission levels, leading to sunk costs. Carbon offset expenses (potentially required to meet net zero commitment), leading to increased operational costs.	Regulatory Reputation Financial	Moderate	Almost Certainly Not	Low	Moderate	Chances About Even	Medium	Major	Probable	Significant
Price on carbon	Australia already has an Australia Carbon Credit Unit market with a spot price of approximately $16.10/ unit in October 2019. 29 national jurisdictions currently have an implemented carbon tax or emissions trading scheme (ETS). Australia had an ETS between 2012 – 2014 before it was revoked. CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) is a UN deal designed to help the aviation industry reach its "aspirational goal" to make all growth in international flights after 2020 "carbon neutral". Under this scheme, airlines will have to buy emissions reduction offsets from other sectors to compensate for any increase in their own emissions. Alternatively, they can use lower carbon "CORSIA eligible" fuels.	Increased ticket prices results in lower passenger demand. Ticket prices may increase as a result of: Higher operational costs throughout supply chain. Increased insurance premiums.	Financial	Moderate	Almost Certainly Not	Low	Moderate	Probably Not	Medium	Major	Probable	Significant

Transition risk type (cont.)	Context (cont.)	Events (cont.)	Consequence type (cont.)	Inherent risk rating (cont.) 2020: Consequence	Inherent risk rating (cont.) 2020: Likelihood	Inherent risk rating (cont.) 2020: Risk level	Med-term risk (cont.) Med-term: 2030: Consequence	Med-term risk (cont.) Med-term: 2030: Likelihood	Med-term risk (cont.) Med-term: 2030: Risk level	Long-term risk (cont.) Long-term: 2070: Consequence	Long-term risk (cont.) Long-term: 2070: Likelihood	Long-term risk (cont.) Long-term: 2070: Risk level
Policy / legal (cont.)												
TCFD reporting becomes mandatory	"in the future, to achieve a carbon-neutral economy, disclosure must clearly become mandatory." - Mark Carney, Governor of the Bank of England The US has proposed The Climate Risk Disclosure Act of 2019 ASIC are investigating large companies' climate change risk management To date, the transport sector has demonstrated a high level of reporting quality, relative to the TCFD recommendations.	Additional resources (staff hours, budget, etc) required to meet new reporting obligations, will increase operating costs.	Regulatory Financial Reputational	Limited	Almost Certainly Not	Very Low	Limited	Chances About Even	Low	Limited	Chances About Even	Low
Climate-related regulation	The Heathrow airports third runway expansion was found to be illegal by the United Kingdom's Court of Appeal in February 2020. In making the judgement, the court made the ruling on the grounds that the policy to expand the airport is incompatible with commitments made by the government in the Paris climate agreement. In NSW, the Planning and Environment court affirmed the NSW government's decision to refuse approval for a new coal mine in the Gloucester Valley. Australia's obligations under the Paris Agreement, and the impact of burning coal upon the world's climate were reasons which the Court said were, on their own, sufficient to justify the government's decision not to approve the project.	Fines and judgments may result in increased costs and/or reduced demand for products and services Delay or cancellations of expansions may restrict the growth in passenger numbers, limiting revenue growth.	Regulatory Financial Reputational	Major	Probably Not	Medium	Major	Chances About Even	Significant	Major	Chances About Even	Significant

Transition risk type (cont.)	Context (cont.)	Events (cont.)	Consequence type (cont.)	Inherent risk rating (cont.) – 2020: Consequence	2020: Likelihood	2020: Risk level	Med-term risk (cont.) – Med-term: 2030: Consequence	2030: Likelihood	2030: Risk level	Long-term risk (cont.) – Long-term: 2070: Consequence	2070: Likelihood	2070: Risk level
Technology												
All-electric aircraft	In July 2019, Israeli firm Eviation launched the world's first commercial all-electric passenger aircraft.	Existing equipment becomes redundant, resulting in sunk costs Unsuccessful investment in new technologies leads to losses	Financial	Minor	Almost Certainly Not	Very Low	Minor	Almost Certainly Not	Very Low	Minor	Probably Not	Low
Renewable energy advances	Renewable energy is now most frequently the cheapest energy source and the price continues to fall	Transition to renewable energy will require investment costs Transition to electrified ground operations will require investment costs Redundancy of existing infrastructure leads to sunk costs	Financial Reputational	Beneficial	Chances About Even	Very Low	Beneficial	Probable	Very Low	Beneficial	Almost certain	Very Low
Alternative fuels i.e. hydrogen, biofuel, Sustainable Aviation Fuel (SAF)	Alternative fuels can be blended with fossil fuels for lower-emission fuelling options Bergen, Brisbane, LA, Oslo and Stockholm airports have regular biofuel distribution - only five in world. The Wayne County Airport Authority in Michigan, USA is piloting producing biofuels on-site Biofuels are expected to provide 10% of aviation fuel by 2030 and close to 20% by 2040. An indication of aviation's commitment to growing alternative fuel use is the agreement of long-term offtake agreements between airlines and biofuel producers. These now cumulatively cover around 6 billion litres of fuel. Meeting this demand will require further production facilities, and some airlines have directly invested in aviation biofuel refinery projects.	Biofuel is likely only a transitional fuel and may become redundant before it delivers an overall return on investment Unsuccessful investment in new technology, leading to sunk costs Alternative fuels are currently more expensive than standard jet fuel	Financial Reputational	Minor	Almost Certainly Not	Very Low	Minor	Probably Not	Low	Minor	Chances About Even	Low

Transition risk type (cont.)	Context (cont.)	Events (cont.)	Consequence type (cont.)	Inherent risk rating (cont.) 2020: Consequence	2020: Likelihood	2020: Risk level	Med-term risk (cont.) Med-term: 2030: Consequence	Med-term: 2030: Likelihood	Med-term: 2030: Risk level	Long-term risk (cont.) Long-term: 2070: Consequence	Long-term: 2070: Likelihood	Long-term: 2070: Risk level
Markets												
Changing customer behaviour – less travel via conventional aircraft	There is a new global movement that wants to reduce the amount people fly which may affect customer behaviour and willingness to use the airport. Sustainability is a primary concern for the millennial population. Swiss bank UBS survey found that 1/5 people had cut their flights because of climate impact - There may be a shift in tourism patterns, which may impact the number of tourists coming in and out of Melbourne and timing of their travel.	Shift in consumer preferences e.g. advancements in teleconference software may result in less business travel (reduced demand for flights) Reduced demand for flights due to a shift in consumer preferences	Reputation Financial	Moderate	Almost Certainly Not	Low	Moderate	Probably Not	Medium	Major	Chances About Even	Significant
Abrupt/ unexpected shifts in energy costs	Costs of jet fuels have been rising and are projected to continue to rise. If there is a global jet fuel crisis again this would have significant impacts on ticket prices. APAC's operating costs increased 10.3% over FY17/18, with the increases attributable to costs to service the increased passenger traffic and electricity price changes.	Increased operating costs and debt Difficulty in managing budgets and controlling costs may result in budget challenges	Financial	Moderate	Probably Not	Medium	Moderate	Probably Not	Medium	Minor	Chances About Even	Low

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