Roads and Maritime Services/Sydney Airport Corporation Limited

Sydney Gateway Road Project

Environmental Impact Statement/ Preliminary Draft Major Development Plan

Technical Working Paper 3

Airport Operations

November 2019

Roads and Maritime Services

Sydney Gateway Road Project

Technical Working Paper 3 - Airport Operations

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Glossary

Alignment	The geometric layout (eg of a road or railway) in plan (horizontal) and elevation (vertical).
Airport Lessee Company	A company that holds a lease for a Commonwealth-owned airport. The airport lessee company's sole business is to run the airport. The airport lessee for Sydney Airport is Sydney Airport Corporation.
Airports Act	The Commonwealth *Airports Act 1996* provides the assessment and approval process for development on Commonwealth-owned land for the operation of Sydney Airport.
Airservices Australia	The Commonwealth Government agency providing air traffic control management and related airside services to the aviation industry.
Botany Rail Line	A dedicated freight rail line that forms part of the Sydney Freight Network. The line extends from near Marrickville Station to Port Botany.
Civil Aviation Safety Authority (CASA)	The Civil Aviation Safety Authority is a government body that regulates Australian aviation safety and the safety of Australian aircraft overseas.
Construction	Includes all physical work required to construct the project.
Controlled Activity	Controlled activities are those which include constructing or altering a building, or any other activity that causes a thing attached to or in physical contact with the ground to intrude into the prescribed airspace.
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact assessed on its own.
Detailed design	The stage of design where project elements are designed in detail, suitable for construction.
EIS	Environmental impact statement.
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*.
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.
High intensity approach lighting (HIAL)	A series of lights located on a strip of land in Tempe that provides visual guidance to aircraft approaching Sydney Airport's east–west runway.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Major Development Plan (MDP)	A requirement under the Airports Act 1996 for airport lessee-companies to provide information to the Commonwealth Government and the public about significant planned development on leased federal airport sites.
Manoeuvring area	That part of the aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.
Manual of Standards (MOS)	The Manual of Standards is a document promulgated by CASA under the civil Aviation Safety Regulations 1998 which documents the specifications to ensure for safety of air navigation.
Movement area	That part of the aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the apron(s).

National Airports Safeguarding Framework (NASF)	The National Airports Safeguarding Framework is a national land use planning framework which aims to: improve community amenity by minimising aircraft noise-sensitive developments near airports and improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions.
Navigation aids	Any aircraft surveillance equipment, control towers, radars, visual and non-visual navigation aids and the like.
Obstacle limitation surface (OLS)	An invisible surface that defines the airspace surrounding an airport that must be protected from obstacles to ensure that aircraft flying in good weather during the initial and final stages of flight, or in the vicinity of the airport, can do so safely.
Prescribed airspace	The airspace above any part of either the OLS or the PANS-OPS surfaces of an airport. The prescribed airspace is regulated under the Commonwealth Airports Act 1996.
Procedures for Air Navigational Services – Aircraft Operations (PANS-OPS)	The PANS-OPS surface protects aircraft flying into and out of the airport when the flight is guided solely by instruments in conditions of poor visibility. The PANS-OPS surface is generally situated above the OLS.
Project	The construction and operation of the Sydney Gateway road project.
Project site	The area that would be directly impacted by construction and operation of the project.
Risk	Chance of something happening that will potentially have an undesirable effect. It is measured in terms of consequence and likelihood.
Street furniture	A general term covering all signs, street lights, protective devices for the control, guidance and safety of traffic and convenience of road users.
SEARs	Secretary's Environmental Assessment Requirements.
Sydney Gateway road project	A major transport project, to be delivered by Roads and Maritime Services, to provide a high capacity road link between the Sydney motorway network at St Peters interchange, Sydney Airport and Port Botany.
Turbulence	Short term, 'natural' variations in wind speed or direction due to air flow over the ground. Mechanical turbulence refers to changes in air flow caused by flow over irregular terrain and man-made obstacles eg buildings, causing eddies and therefore turbulence.
Windshear	A sudden change of horizontal wind direction and/or speed with height.

1. Introduction

1.1 Overview

1.1.1 Sydney Gateway and the project

Sydney Kingsford Smith Airport (Sydney Airport) and Port Botany are two of Australia's most important infrastructure assets, providing essential domestic and international connectivity for people and goods. Together they form a strategic centre, which is set to grow significantly over the next 20 years. To support this growth, employees, residents, visitors and businesses need reliable access to the airport and port, and efficient connections to Sydney's other strategic centres.

The NSW and Australian governments are making major investments in the transport network to achieve this vision. New road and freight rail options are being investigated to cater for the forecast growth in passengers and freight through Sydney Airport and Port Botany. Part of this solution is Sydney Gateway, which comprises the following road and rail projects:

- Sydney Gateway road project (the subject of this assessment)
- Botany Rail Duplication.

Sydney Gateway will expand and improve the road and freight rail networks to Sydney Airport and Port Botany to keep Sydney moving and growing. The Sydney Gateway road project forms part of the NSW Government's long-term strategy to invest in an integrated transport network and make journeys easier, safer and faster.

Roads and Maritime Services and Sydney Airport Corporation propose the Sydney Gateway road project (the project). The project comprises new direct high capacity road connections linking the Sydney motorway network at St Peters interchange with Sydney Airport's terminals and beyond. It involves constructing and operating new and upgraded sections of road connecting to the airport terminals, four new bridges over Alexandra Canal and other operational infrastructure and road connections. The project and its location is shown on Figure 1-1.

1.1.2 Overview of approval requirements

The project is subject to approval under NSW and Commonwealth legislation. Parts of the project located on Commonwealth-owned land leased to Sydney Airport (Commonwealth land) are subject to the Commonwealth *Airports Act 1996* (the Airports Act). In accordance with this Act, these parts of the project are deemed major airport development. A major development plan (MDP), approved by the Australian Minister for Infrastructure, Transport and Regional Development, is required before a major airport development can be undertaken at a leased airport.

Parts of the project located on other land are designated State significant infrastructure in accordance with the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). As State significant infrastructure, these parts of the project require approval from the NSW Minister for Planning and Public Spaces. An environmental impact statement (EIS) is required to support the application for approval for State significant infrastructure under the EP&A Act.

A combined EIS and preliminary draft MDP is being prepared to:

- Support the application for approval of the project in accordance with NSW and Commonwealth legislative requirements
- Address the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs), issued on 15 February 2019
- Address the MDP requirements defined by section 91 of the Airports Act.

This report was prepared on behalf of Roads and Maritime and Sydney Airport Corporation to support the combined EIS/preliminary draft MDP.

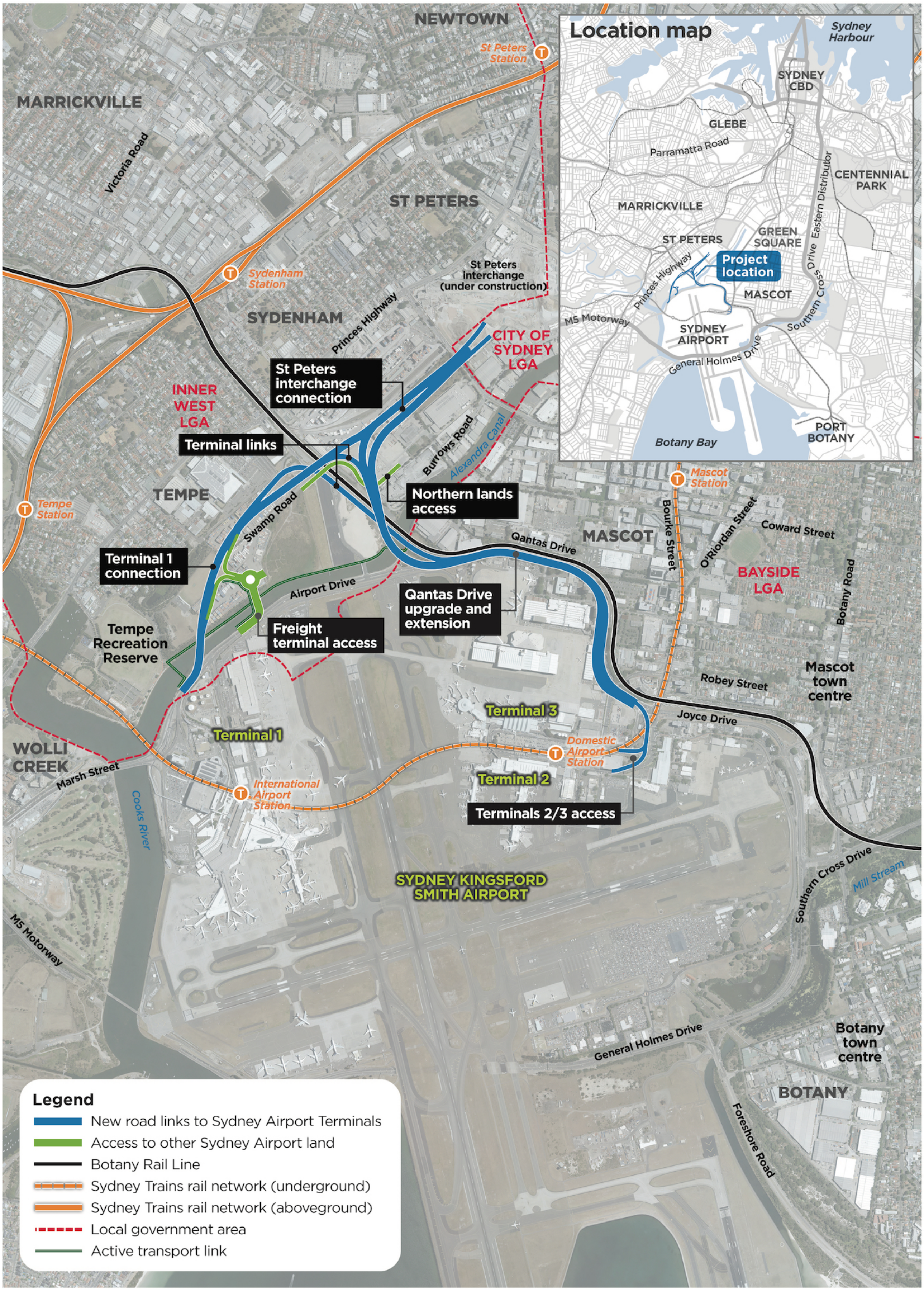

Figure 1-1 The project

1.2 Purpose and scope of this report

This report has been prepared to assess the potential impacts on airport operations at Sydney Airport from constructing and operating the project. The report:

- Describes the existing environment with respect to airport operations
- Assesses the impacts of constructing and operating the project on airport operations, including aviation hazards
- Recommends measures to mitigate the impacts identified, where necessary.

This assessment addresses the relevant SEARs as outlined in Table 1-1. MDP requirements according to section 91 of the Airports Act 1996 as relevant to airport operations are also addressed in this report and outlined in Table 1-2.

Table 1-1 SEARs relevant to this assessment

Requirements	Where addressed in this report
16 Hazards and Risks 16.2. The EIS must outline the process for assessing the risks of the proposal on airport operations, including encroachment into the prescribed airspace, potential impacts on airport Communication, Navigation and Surveillance Systems, light spill and landscaping associated with the construction and operation of the proposal.	Section 3.2 Risk screening, Section 3.3 Methodology Section 5 Assessment of construction impacts Section 6 Assessment of operational impacts

Table 1-2 MDP requirements relevant to this assessment

Requirements	Where addressed in this report
91(1)(d) if a final master plan for the airport is in force—whether or not the development is consistent with the final master plan	Section 2.2.3, Section 9 Conclusion
91(1)(e) if the development could affect flight paths at the airport – the effect that the development would be likely to have on those flight paths	Section 5.2 Prescribed airspace intrusion (construction) Section 6.2 Prescribed airspace intrusion (operation)
91(1)(h) the airport-lessee company's assessment of the environmental impacts that might reasonably be expected to be associated with the development; and	This report
91(1)(j) the airport-lessee company's plans for dealing with the environmental impacts mentioned in paragraph (h) (including plans for ameliorating or preventing environmental impacts); and	Section 8 Recommended mitigation measures

1.3 The project

1.3.1 Location

The project is located about eight kilometres south of Sydney's central business district and to the north of Sydney Airport on both sides of Alexandra Canal. The northern extent of the project is located at St Peters interchange, which is currently being constructed to the north of Canal Road in St Peters. The western extent of the project is located near the entrance to Sydney Airport Terminal 1 on Airport Drive, to the north of the Giovanni Brunetti Bridge and south-west of Link Road. The eastern extent of the project is located near the intersection of Joyce Drive, Qantas Drive, O'Riordan Street and Sir Reginald Ansett Drive.

The project is located mainly on government owned land in the suburbs of Tempe, St Peters and Mascot, in the Inner West, City of Sydney and Bayside local government areas.

1.3.2 Key design features

The project provides a number of linked road connections to facilitate the movement of traffic between the Sydney motorway network, Sydney Airport Terminal 1 (Terminal 1) and Sydney Airport Terminals 2 and 3 (Terminals 2/3). The project would connect Terminal 1 and Terminals 2/3 with each other and with the Sydney motorway network. The project would also facilitate the movement of traffic towards Port Botany via General Holmes Drive. It would provide three main routes for traffic:

- Between the Sydney motorway network and Terminal 1, and towards M5 motorway and Princes Highway
- Between the Sydney motorway network and Terminals 2/3, and towards General Holmes Drive, Port Botany and Southern Cross Drive
- Between Terminal 1 and Terminals 2/3.

The key features of the project include:

- Road links to provide access between the Sydney motorway network and Sydney Airport's terminals, consisting of the following components:
  - St Peters interchange connection – a new elevated section of road extending from St Peters interchange to the Botany Rail Line, including an overpass over Canal Road
    - → Terminal 1 connection – a new section of road connecting Terminal 1 with the St Peters interchange connection, including a bridge over Alexandra Canal and an overpass over the Botany Rail Line
    - → Qantas Drive upgrade and extension – widening and upgrading Qantas Drive to connect Terminals 2/3 with the St Peters interchange connection, including a high-level bridge over Alexandra Canal
    - → Terminal links – two new sections of road connecting Terminal 1 and Terminals 2/3, including a bridge over Alexandra Canal
    - → Terminals 2/3 access – a new elevated viaduct and overpass connecting Terminals 2/3 with the upgraded Qantas Drive
- Road links to provide access to Sydney Airport land:
  - A new section of road and an overpass connecting Sydney Airport's northern lands either side of the Botany Rail line (the northern lands access)
  - A new section of road, including a signalised intersection with the Terminal 1 connection and a bridge connecting Sydney Airport's existing and proposed freight facility either side of Alexandra Canal (the freight terminal access)
- An active transport link approximately 1.3 kilometres in length along the western side of Alexandra Canal to maintain connections between Sydney Airport, Mascot and the Sydney central business district
- Intersection upgrades or modifications

- Provision of operational ancillary infrastructure including maintenance bays, new and upgraded drainage infrastructure, signage and lighting, retaining walls, noise barriers, flood mitigation basin, utility works and landscaping.

1.3.3 Construction overview

A conceptual construction methodology has been developed based on the preliminary project design to be used as a basis for the environmental assessment process. Detailed construction planning, including programming, work methodologies, staging and work sequencing would be undertaken once construction contractors have been engaged.

1.3.3.1 Timing and work phases

Construction of the project would involve four main phases of work. The indicative construction activities within each phase are outlined below.

Table 1-3 Construction work phases

Phase	Indicative construction activities
Enabling works	▪ Construction of the temporary active transport link ▪ Modification of various road intersections to facilitate main construction works.
Site establishment	▪ Installing site fencing, hoarding and signage ▪ Establishing construction compounds, work areas and site access routes.
Main construction works	▪ Clearing/trimming of vegetation ▪ Removal (or partial removal) of a number of buildings and other existing infrastructure eg concrete hardstand areas, drainage infrastructure, sheds, advertising structures, containers ▪ Roadworks, including bridge and viaduct construction and drainage works ▪ Utility works.
Finishing works	▪ Erecting lighting, signage and street furniture, landscaping works and site demobilisation and rehabilitation in all areas.

Specific construction issues which will require careful planning and management as well as close coordination with relevant stakeholders include:

- Works within the prescribed airspace of Sydney Airport
- Works interfacing with the Botany Rail Line
- Piling in the vicinity of the T8 Airport and South line underground rail tunnels
- Works within the former Tempe Tip site and Alexandra Canal which are subject to remediation orders and specific management plans
- Excavation, storage and handling of contaminated soils generally within the project site and contaminated groundwater from the Botany Sands aquifer.

Construction is planned to start in mid 2020, subject to approval of the project, and is expected to take about three and a half years to complete. Further information on construction is provided in Chapter 8 (Construction) of the EIS.

The project would include work undertaken during recommended standard hours as defined by the *Interim Construction Noise Guideline* (DECC, 2009):

- Monday to Friday: 7am to 6pm
- Saturday: 8am to 1pm
- Sundays and public holidays: no work.

It would also include work outside these hours (out-of-hours work) to minimise the potential for aviation and rail safety hazards.

1.3.3.2 Construction footprint

The land required to construct the project (the construction footprint) is shown on Figure 1-2. The construction footprint includes the land needed to construct the proposed roadways, bridges and ancillary infrastructure and land required for the proposed construction compounds. Utility works to support the project would generally occur within the construction footprint, however, some works (such as connections to existing infrastructure) may be required outside the footprint.

1.3.3.3 Compounds, access and resources

Construction would be supported by five construction compounds located to support the main construction works (shown on Figure 1-2). Construction compounds would include site offices, staff amenities, storage and laydown areas, workshops and workforce parking areas.

Materials would be transported to and from work areas via construction haul routes, which have been selected to convey vehicles directly to the nearest arterial road.

The construction workforce requirements would vary over the construction period based on the activities underway and the number of active work areas. The workforce is expected to peak at about 1,000 workers for a period of about 13 months, starting from the fourth quarter of 2021. Either side of this peak, workforce numbers are expected to reduce to about two thirds.

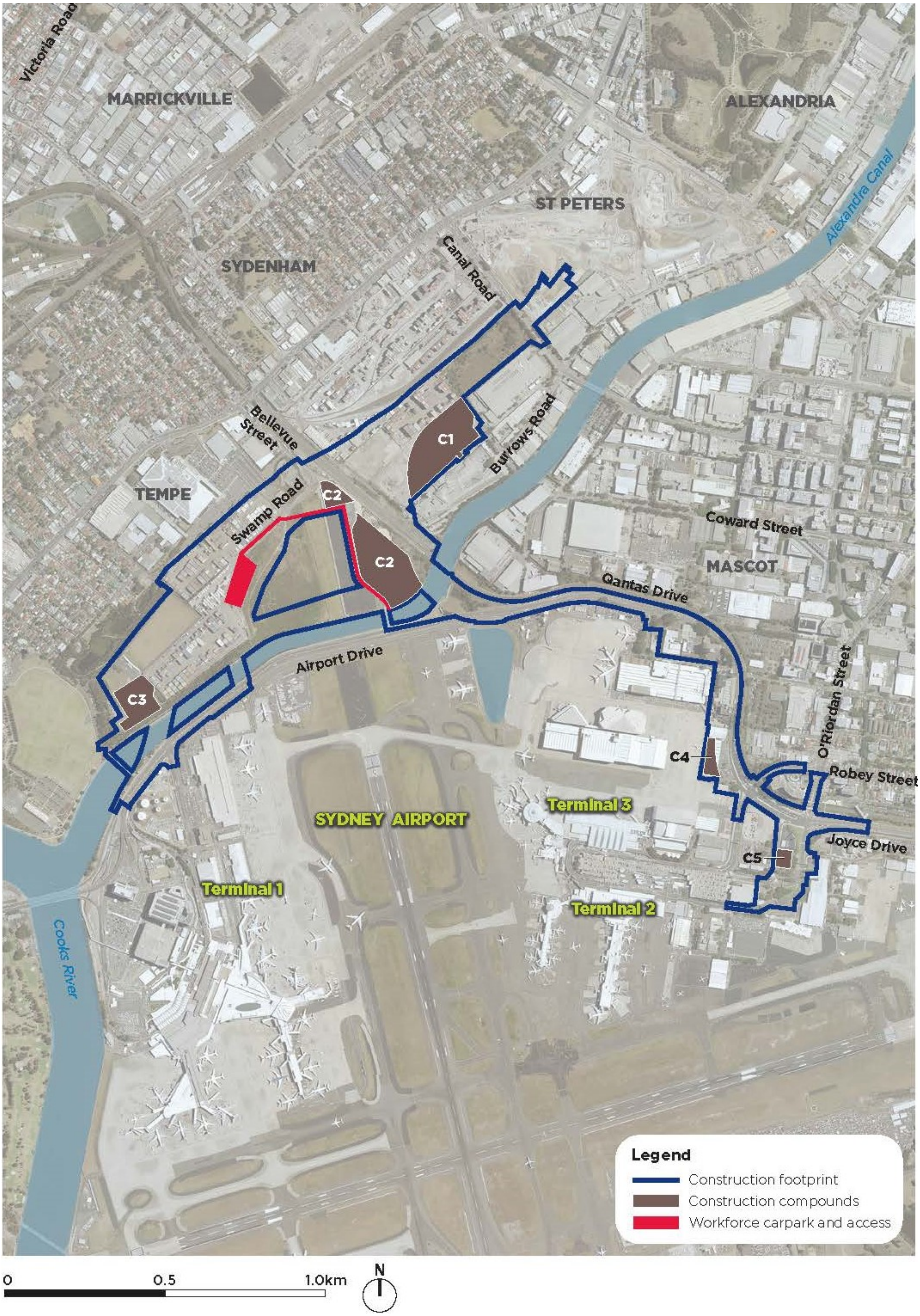

Figure 1-2 Construction footprint and facilities

1.4 Structure of this report

The structure of the report is outlined below.

- **Section 1 – Introduction** – Provides an introduction to the report
- **Section 2 – Legislative and policy context** – Describes the legislative and policy context for the assessment and relevant guidelines
- **Section 3 – Methodology** – Describes the methodology for the assessment
- **Section 4 – Existing environment** – Describes the existing environment and current operations at the airport
- **Section 5 – Assessment of construction impacts** – Describes the potential construction impacts on aviation activities and airport operations
- **Section 6 – Assessment of operational impacts** – Describes the potential operational impacts on aviation activities and airport operations
- **Section 7 – Cumulative impacts** – Describes the cumulative impacts on aviation activities and airport operations
- **Section 8 – Recommended mitigation measures** – Describes the recommended mitigation measures
- **Section 9 – Conclusion** – Provides the conclusions of the assessment.

2. Legislative and policy context

2.1 Commonwealth legislation

2.1.1 Airports Act 1996 and regulations

The project site includes areas of Commonwealth-owned land leased by Sydney Airport. The *Airports Act 1996* (the Airports Act) and associated regulations provide the assessment and approval process for development on Commonwealth-owned land for the operation of Sydney Airport.

Section 89 of the Airports Act specifies types of development that constitute 'major airport development'. A major development plan (MDP) approved by the Australian Minister for Infrastructure, Transport and Regional Development is required before major airport development can be undertaken at a leased airport.

The Airports Act and regulations are the statutory controls for ongoing regulation of development activities on Commonwealth land leased from the Australian Government for the operation of Sydney Airport. Section 70 of the Airports Act requires there to be a final master plan for the airport that has been approved by the Australian Minister for Infrastructure, Transport and Regional Development.

Part 5 of the Act also requires that each airport develop an environment strategy which is included in its master plan. Once approved, Sydney Airport and all persons who carry out activities at the airport are obliged to take all reasonable steps to ensure compliance with the environment strategy.

Part 12, Division 4 of the Airports Act defines controlled activities as:

(a) constructing a building, or other structure, that intrudes into the prescribed airspace;

(b) altering a building or other structure so as to cause the building or structure to intrude into the prescribed airspace;

(c) any other activity that causes a thing attached to, or in physical contact with, the ground to intrude into the prescribed airspace;

(d) operating a source of artificial light, where:
(i) the intensity of the light emitted exceeds the level ascertained in accordance with the regulations; and
(ii) the light is capable of blinding or confusing pilots of aircraft operating in the prescribed airspace;

(e) operating prescribed plant, or a prescribed facility, that reflects sunlight, where:
(i) the intensity of the reflected sunlight exceeds the level ascertained in accordance with the regulations; and
(ii) the reflected sunlight is capable of blinding pilots of aircraft operating in the prescribed airspace;

(f) an activity that results in air turbulence, where:
(i) the level of the turbulence exceeds the level ascertained in accordance with the regulations; and
(ii) the turbulence is capable of affecting the normal flight of aircraft operating in the prescribed airspace;

(g) an activity that results in the emission of smoke, dust or other particulate matter, where:(i) the emission exceeds the level ascertained in accordance with the regulations; and
(ii) the smoke, dust or particulate matter is capable of affecting the ability of aircraft to operate in the prescribed airspace in accordance with Visual Flight Rules;

(h) an activity that results in the emission of steam or other gas, where:
(i) the emission exceeds the level ascertained in accordance with the regulations; and
(ii) the steam or gas is capable of affecting the ability of aircraft to operate in the prescribed airspace in accordance with Visual Flight Rules.

The Airports (Protection of Airspace) Regulations 1996 differentiate between short-term (less than 3 months) and other controlled activities. The Regulations provide for the airport operator to approve, approve with conditions or refuse short-term controlled activities, excluding Procedures for Air Navigational Services – Aircraft Operations (PANS-OPS) infringements, and for the Department of Infrastructure, Transport, Cities and Regional Development to approve other controlled activities, or short-term controlled activities referred to it by the airport operator, including short-term infringements of the PANS-OPS surface. However, long term intrusions of the PANS-OPS surface are prohibited.

2.1.2 Airports (Protection of Airspace) Regulations 1996

Under the Airports (Protection of Airspace) Regulations 1996 (Airports (Protection of Airspace) Regulations), a system has been established for the protection of airspace at and around regulated airports in the interests of the safety, efficiency or regularity of existing or future air transport operations. The regulations define prescribed airspace for an airport. Clause 6(1) provides that the prescribed airspace consists of:

(a) the airspace above any part of either an OLS or a PANS-OPS surface for the airport; and

(b) airspace declared in a declaration, under regulation 5, relating to the airport.

The prescribed airspace for Sydney Airport was declared, pursuant to the Airports (Protection of Airspace) Regulations, on 20 March 2015. It consists of:

- The obstacle limitation surface (OLS), which defines the lower limits of an airport's airspace and should be kept free of obstacles during the initial and final stages of flight or manoeuvring
- The PANS-OPS, which protects aircraft flying into and out of the airport when the flight is guided solely by instruments in conditions of poor visibility (generally situated above the OLS)
- Navigation aids protected surfaces
- High intensity lights protected surfaces
- Radar terrain clearance chart surfaces
- Combined radar departure assessment surfaces
- Precision approach path indicator system protection surfaces.

Controlled activities are those which include constructing or altering a building, or any other activity that causes a thing attached to or in physical contact with the ground to intrude into the prescribed airspace. This includes cranes and other temporary structures. The regulations stipulate that for controlled activities, specific approval is required from the Secretary of the Department of Infrastructure, Transport, Cities and Regional Development.

The regulations require that proponents of proposed controlled activities provide the airport lessee company with the details of the proposal, which are then assessed against the OLS and PANS-OPS protection criteria. Where it is assessed to affect the safety, efficiency or regularity of air transport at the airport, the airport lessee company will oppose the infringement of the OLS and PANS-OPS surfaces.

OLS and PANS-OPS are further described in section 4.

2.1.3 Airports (Building Control) Regulations 1996

Clause 2.02 of the Airports (Building Control) Regulations 1996 states that building approval applications are required for the following:

- Construction or alteration of a building (a building permit)
- Construction or alteration of works (a works permit)
- Demolition, destruction, dismantling or removal of a building, or works (a demolition authorisation).

The project involves building activities that satisfy the meaning in the Airports Act and therefore necessitate building activities approval by the Airport Building Controller. A building activities approval cannot be provided until consent from Sydney Airport Corporation is granted.

In determining its response to a building approval application, Sydney Airport Corporation will have regard to the safety and security of persons at the airport and the impacts of the activity on airport services and the efficient operation of the airport.

2.1.4 Civil Aviation Act 1988 and regulations

The *Civil Aviation Act 1988* is one of two primary pieces of aviation safety legislation in Australia (the other being the *Airspace Act 2007*). The main object of the act is to establish a regulatory framework for maintaining, enhancing and promoting the safety of civil aviation, with particular emphasis on preventing aviation accidents and incidents. The act also has the purpose of establishing the Civil Aviation Safety Authority (CASA) with the functions of regulating:

- Civil air operations inside Australian territory
- The operation of Australian aircraft outside Australian territory.

Section 9A of the Act emphases that, in exercising its powers and performing its functions, CASA must regard the safety of air navigation as its most important consideration.

While safety regulation of civil aviation is its primary role, CASA also provides safety education and training programs and has responsibility for airspace regulation.

2.1.5 Civil Aviation Safety Regulations 1998

The Civil Aviation Regulations 1988 and the Civil Aviation Safety Regulations 1998 are administered by CASA. They provide regulatory controls over civil aviation safety. They set out in detail the safety standards that are required in relation to airworthiness of aircraft, licences and ratings of flight crew and maintenance personnel, air traffic control, rules of the air, dangerous goods and many other safety issues.

The Civil Aviation Regulations and Civil Aviation Safety Regulations also authorise CASA to prepare and implement technical material and requirements (such as a Manual of Standards (refer to section 2.2.2), Civil Aviation Orders and other advisory material and publications) to document the standards and specifications necessary for the safety of air navigation and provide recommendations and guidance for methods of attaining compliance.

Regulation 94 of the Civil Aviation Safety Regulations also provides CASA the authority to require lights that may cause confusion, distraction, or glare to pilots in the air to be extinguished or modified.

2.2 Other relevant guidelines and requirements

2.2.1 National Airports Safeguarding Framework

The National Airports Safeguarding Framework (NASF) is a national land use planning framework that aims to:

- Improve community amenity by minimising aircraft noise-sensitive developments near airports
- Improve safety outcomes by ensuring aviation safety requirements are recognised in land use planning decisions through guidelines being adopted by jurisdictions on various safety-related issues.

The NASF provides guidance to state, local and territory governments on assessment and approvals for land use and development on and around airports, including those that might penetrate operational airspace or affect navigational procedures for aircraft. The NASF applies at all airports in Australia.

The NASF was developed by the National Airports Safeguarding Advisory Group, which includes representatives from Commonwealth Infrastructure and Defence departments, aviation agencies, state and territory planning and transport departments, and the Australian Local Government Association.

It is understood that Sydney Airport has been working with NSW Government and local councils to ensure planning decisions in areas outside of Sydney Airport have regard to or comply with the Framework guidelines. A state-wide approach to implementation of the NASF is under development by NSW Department of Planning and Industry.

The NASF Guidelines are shown in Figure 2-1.

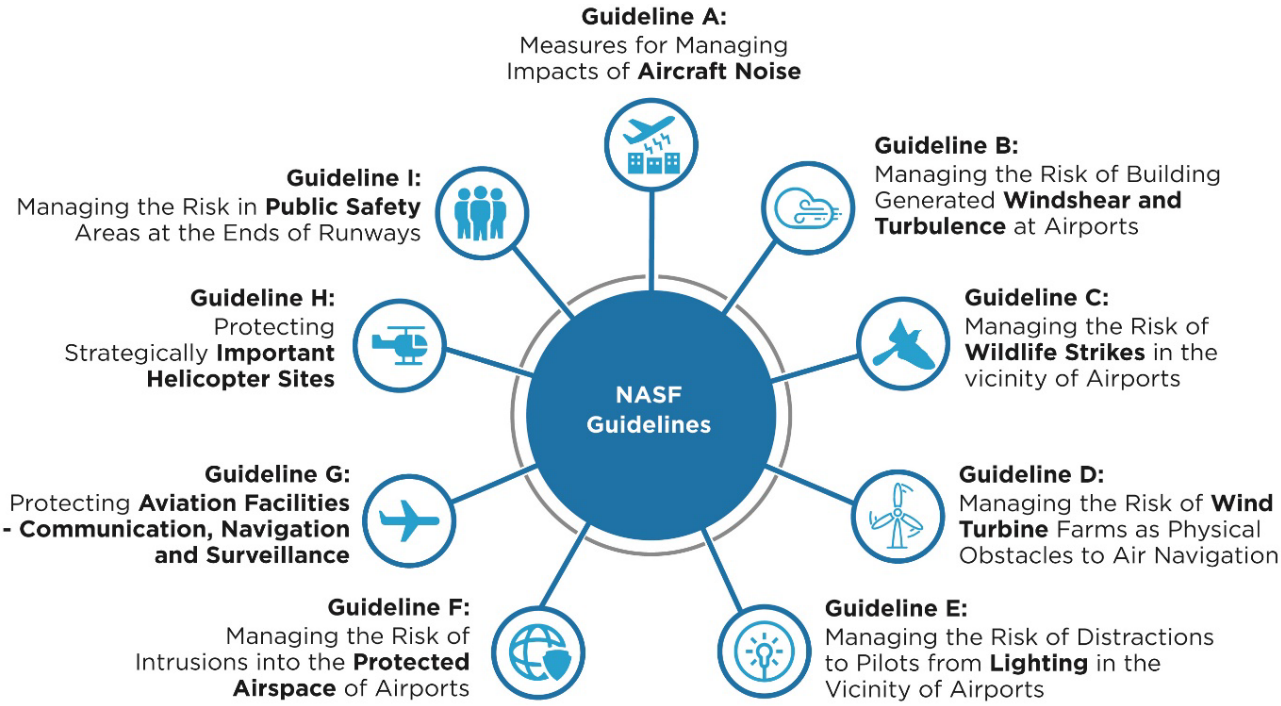

Figure 2-1 NASF guidelines

2.2.2 CASA Manual of Standards

CASA has primary responsibility for the safety regulation of civilian aircraft operations in Australia. The Civil Aviation Regulations 1988 and the Civil Aviation Safety Regulations 1998 provide the general regulatory controls for the safety of air navigation. The regulations enable CASA to issue Manuals of Standards (MOS) with detailed technical material, which support the regulations. The following Manuals of Standards are relevant to the project:

- Manual of Standards Part 139 – Aerodromes
- Manual of Standards Part 172 – Air Traffic Services.

2.2.3 Sydney Airport Master Plan 2039

As part of the planning framework established by the Airports Act, airport operators are required to prepare a master plan for the coordinated development of their airport. Sydney Airport Master Plan 2039 (Sydney Airport Corporation 2019) (Master Plan 2039) outlines the strategic direction for Sydney Airport's operations and development over the next 20 years. It acknowledges that the continued growth of Sydney Airport is vital to achieving local, state and national employment, tourism and development objectives. In accordance with the requirements of the Airports Act, Master Plan 2039:

- Establishes the strategic direction for efficient and economic development at Sydney Airport over the planning period
- Provides for the development of additional uses of the Sydney Airport site
- Indicates to the public the intended uses of the Sydney Airport site
- Reduces potential conflicts between uses of the Sydney Airport site to ensure that uses of the site are compatible with the areas surrounding the airport
- Ensures that operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards
- Establishes a framework for assessing compliance with relevant environmental legislation and standards
- Promotes continual improvement of environmental management at Sydney Airport.

Chapter 16 of Master Plan 2039 provides for the safeguarding of operations at Sydney Airport. This chapter notes that "the capacity of an airport to operate and its ability to respond to growing demand for aviation services can be directly impacted by what occurs on the land surrounding it. For example, the construction of buildings or other structures that physically intrude into the airspace around existing flight paths can clearly limit or prevent use of a particular runway at the airport."

Master Plan 2039 also notes that large structures that generate wind turbulence or wind shear can be a risk to aircraft in flight.

Land uses or activities that may attract wildlife (eg birds, bats or flying foxes) which may constitute a hazard to aircraft in flight should also be assessed and controlled.

Master Plan 2039 has been developed by Sydney Airport to identify development plans to accommodate the forecast increase in passenger numbers over the next 20 years. Section 13.3.4 (AD3 – Airport Logistics and Support) of Master Plan 2039 details the land use of the Northern Lands Sector of Sydney Airport, which has been identified as a zone encompassing the Sydney Gateway road project.

2.2.4 Sydney Airport Environment Strategy 2019–2024

The Airports Act requires that airport operators provide an assessment of the environmental issues associated with implementing the airport master plan and the plan for dealing with those issues. This is documented in an environment strategy that forms part of the airport's master plan. The Sydney Airport Environment Strategy 2019–2024, which forms part of Master Plan 2039, provides strategic direction for the environmental performance and management of Sydney Airport for the five year period between 2019 and 2024. The purpose of the environment strategy is to:

- Establish a framework for assessing compliance and ensuring that all operations at Sydney Airport are undertaken in accordance with relevant environmental legislation and standards
- Promote the continual improvement of environmental management and performance at Sydney Airport and build on the achievements and goals of previous strategies
- Realise improvements in environmental sustainability, by minimising Sydney Airport's environmental footprint and working towards a more efficient and resilient airport.

2.2.5 Sydney Airport Wildlife Management Plan

Chapter 10, Section 10.2 of MOS Part 139 requires that routine inspections are undertaken to identify "….birds and animals on, or in the vicinity of, the movement area" and that "bird hazard mitigation procedures are incorporated in the environmental management procedures for the aerodrome".

Sydney Airport Corporation has implemented a Wildlife Management Plan which provides guidance to minimise the hazard to aircraft operations created by the presence of wildlife on or in the vicinity of the airport. The plan includes regular fauna monitoring and population counts of birds as well as maintenance of a bird and animal species list to assist in identifying different species. Information on bird counts and bird strike information is collected from airport management staff, airlines and air traffic controllers and distributed to relevant parties.

Management actions include a number of passive to direct controls (i.e. culling) which is triggered by the hazard potential and conducted on an 'as required' basis. The plan also includes a landscaping policy to reduce vegetation which will attract birds that may increase the number of bird strikes.

3. Methodology

3.1 Approach

The methodology for undertaking the assessment of impacts on airport operations comprised the following tasks:

- Review of relevant project documents
- Research using relevant public documents
- Risk screening of potential airport operations issues
- Design checking based on 3D OLS model provided by Sydney Airport
- Conducting a windshear and turbulence assessment
- Preparation of this technical working paper summarising the results.

While the risks to airport operations were broadly considered in the risk screening process, the focus of the assessment centred on potential impacts on aviation safety resulting from the project.

3.2 Risk screening

A risk screening of potential impacts on airport operations was undertaken to identify and set the scope of investigations to be completed. Table 3-1 provides a summary of the risks identified along with the relevant criteria or guideline documents.

Table 3-1 Summary of risk screening outcomes

Risk	Relevant standards/ guidelines	Assessed in this report?
Airspace risks		
Wildlife attraction/ strike	MOS Part 139, Chapter 10.2 NASF Guideline C	Yes, possible during construction and operation. Refer to section 5.1 and 6.1
Prescribed airspace intrusion	Airports (Protection of Airspace) Regulations 1996 MOS Part 139, Chapter 7 NASF Guideline F	Yes, possible during construction and operation. Refer to section 3.3.1.
High velocity air discharge (plume rise)	Civil Aviation Safety Regulations 1998	N/A. Any release of landfill gas resulting from excavation into the former Tempe Tip would be gradual and diffuse and not result in an impact on aviation safety.
Distraction of pilots from lighting	Civil Aviation Regulations 1988 MOS Part 139, Chapter 9.21 NASF Guideline E	Yes, possible during construction and operation. Refer to section 3.3.2.
Windshear and turbulence	NASF Guideline B	Yes, possible during operation. The area of roadway north of runways 16R/34L and 07/25 thresholds are within the assessment zones. A detailed study has been undertaken as part of this report for runway 16R/34L. Sydney Airport Corporation has advised that an assessment is not required for proposed infrastructure in the vicinity of runway 07/25. Refer to section 3.3.3.

Risk	Relevant standards/ guidelines	Assessed in this report?
Smoke or dust reducing visibility	Airports Act Part 12, Division 4	Yes, possible during construction.
Ground-based risks		
Air pollution	Airports (Environment Protection) Regulations 1997 Part 2 and Schedule 1	N/A. This has been addressed through a detailed study – refer to Technical Working Paper 4 – Air Quality. No further assessment has been conducted in this report.
Offensive noise (ground-based)	Airports (Environment Protection) Regulations 1997 Part 2 and Schedule 4	N/A. This has been addressed through a detailed study – refer to Technical Working Paper 2 – Noise and Vibration. No further assessment has been conducted in this report.
Effect on emergency services operations in runway end areas	NASF Guideline I	No, no construction or development in runway end safety areas is proposed.
Public safety at the end of runways	NASF Guideline I	Yes, possible during construction and operation. Refer to section 3.3.6.
Flooding	Performance-based and through discussion with Sydney Airport Corporation	Yes, possible during construction and operation. This has been addressed through a detailed study – refer to Technical Working Paper 6 – Flooding. No further assessment has been conducted in this report.
Interference with communications or navigation equipment	NASF Guideline G	Yes, possible during construction and operation. Refer to section 3.3.5.
Security of the airside area	Aviation Transport Security Act 2004, Part 3	Yes, possible during construction.
Obstruction of the airport movement area	MOS 139	Yes, possible during construction at the Qantas Jet Base area.
Airport ground transport operations/ facilities	Performance-based and through discussion with Sydney Airport Corporation	N/A. This has been addressed through a detailed study – refer to Technical Working Paper 1 – Traffic and Transport. No further assessment has been conducted in this report.
Airport freight/cargo operations/facilities	Performance-based and through discussion with Sydney Airport Corporation	A small area of land adjacent to Airport Drive east of Link Road would be acquired for the construction and operation of the project. Refer to Technical Working Paper 12 – Business impact assessment. No further assessment has been conducted in this report.
Obstruction of air traffic control line of sight	MOS Part 172 – Air Traffic Services, Chapter 3.1	No, the road project would not impact the line of sight of the Air Traffic Control tower to any part of Sydney Airport aircraft movement areas during construction or operation.
Obstruction of the High Intensity Approach Lighting	MOS Part 139 – Aerodromes, Chapter 9.7	Sydney Airport Corporation will undertake necessary adjustments to the HIAL prior to construction of Sydney Gateway road project. This work would be carried out by Sydney Airport Corporation and approvals sought separately from this combined EIS/preliminary draft MDP. No further assessment has been conducted in this report.

For those risks which were confirmed relevant for the project, Table 3-2 provides a summary of the assessment approach. Further details of the methodology conducted are presented below the table for key items.

Table 3-2 Summary of assessment approach for identified risks

Risk	Project elements or activities which may result in an impact	Assessment approach
Wildlife attraction/strike	▪ Construction within the former Tempe Tip could expose waste which may be malodourous and may attract birds ▪ General construction activities may result in litter which may attract birds if not effectively managed ▪ The project would include temporary sedimentation ponds and a permanent flood mitigation basin ▪ Future landscaping and tree replacement (plant species) may attract birds.	▪ A desktop review of the proposed activities has been undertaken ▪ The scale of these issues are unlikely to result in an increase to risks to aviation safety, however, safeguards and other general recommendations have been made as part of this technical working paper which would reduce these risks. This includes an appropriate construction environment management plan, use of non-bird attracting plant species and design of basins to be 'dry'.
Prescribed airspace intrusion	▪ Various construction activities and equipment close to the 16R runway and required to build Sydney Gateway road project may penetrate prescribed airspace at times ▪ Permanent infrastructure including the roadway, signage, street lights, etc. may be located close to or penetrate prescribed airspace.	▪ Prescribed airspace at an airport is defined by the OLS and PANS-OPS surfaces, which are defined in the CASA MOS. Further details of these surfaces and the assessment methodology are provided below ▪ Temporary intrusions into the airspace are currently managed via a controlled activities permitting process. These activities and equipment are outlined in Chapter 8 of the combined EIS/preliminary draft MDP.
Pilot distraction by lighting (glare)	▪ Glare from traffic headlights on elevated infrastructure may present a risk of distraction to pilots in relation to runway 16R/34L.	▪ A desktop headlight glare assessment has been undertaken by modelling the headlight extents as vehicles travel along the roads. Further details of the approach are provided below.
Windshear and turbulence	▪ Parts of the project lie within the windshear assessment zones of runway 16R/34L and 07/25 defined by the NASF guideline.	▪ An initial assessment of potential windshear and turbulence has been undertaken using wind tunnel modelling for runway 16R/34L. The results are reported in this paper. Further details of the approach are provided below.
Interference with navigation, communications or surveillance equipment	▪ Physical impact during construction or operation ▪ Indirect impact via disruption of services or utilities supply eg electricity.	▪ A desktop assessment has been undertaken ▪ Referral required via determining authority to Airservices Australia to allow them to undertake a detailed assessment.
Public safety at the ends of runways	▪ The project may be partly located in the public safety area for runway 16R/34L.	▪ A desktop assessment in line with the advice in NASF Guideline I.

3.3 Detailed methodology

3.3.1 Prescribed airspace intrusion

As noted in section 2.1.2, clause 6(1) of the Airports (Protection of Airspace) Regulations provides that the prescribed airspace consists of:

(a) the airspace above any part of either an OLS or a PANS-OPS surface for the airport; and

(b) airspace declared in a declaration, under regulation 5, relating to the airport.

The prescribed airspace for Sydney Airport was declared, pursuant to the Airports (Protection of Airspace) Regulations, on 20 March 2015. It consists of:

- The OLS, which defines the lower limits of an airport's airspace and should be kept free of obstacles during the initial and final stages of flight or manoeuvring
- The PANS-OPS, which protects aircraft flying into and out of the airports when the flight is guided solely by instruments in conditions of poor visibility (generally situated above the OLS)
- Navigation aids protected surfaces
- High intensity approach lighting (HIAL) protected surfaces
- Radar terrain clearance chart surfaces
- Combined radar departure assessment surfaces
- Precision approach path indicator system protection surfaces.

A 3D model of the OLS and HIAL protected surfaces was received from Sydney Airport Corporation and was used to check against all permanent project infrastructure. The same surfaces were also used to identify locations where temporary intrusion by construction plant could occur. Details of these surfaces are outlined below. Design drawings showing clearance to the OLS are provided in Appendix B. The prescribed airspace intrusion information used for this assessment was current at the time the draft MDP was being prepared.

Protection for other critical operational infrastructure eg navigations and communications systems is described in section 3.3.5.

3.3.1.1 Obstacle limitation surface

The OLS is a series of planes associated with each runway at an airport that defines the desirable limits to which objects may project into the airspace around the airport so that aircraft operations at the airport may be conducted safely. The OLS is primarily related to operations where pilots are flying in good visibility and using visual cues. Figure 3-1 shows a typical relationship of some of the surfaces that make up the OLS. This OLS is the basis of the assessment of construction and operation impacts in section 5 and 6 of this report.

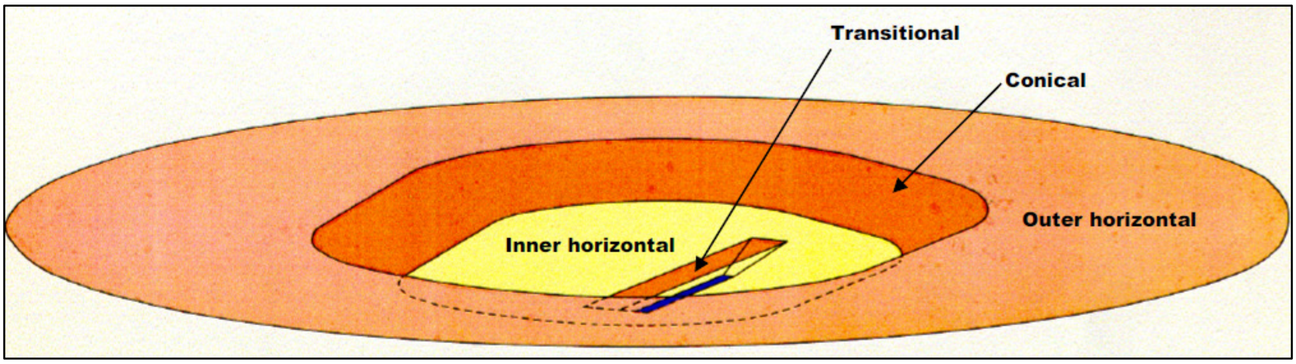

Figure 3-1 Relationship of outer horizontal, conical, inner horizontal and transitional surfaces

3.3.1.2 Procedures for Air Navigational Services – Aircraft Operations (PANS-OPS)

The PANS-OPS surface is designed to avoid collisions between aircraft and obstacles when the aircraft are flying in low visibility conditions and guided primarily by instruments. Such instruments include the instrument landing systems which comprise ground based transmitters that provide guidance to aircraft for approach bearing (localiser systems) and approach angles (glidepath systems).

Short-term intrusions into the PANS-OPS surface may disrupt airport operations, while long term intrusions of the PANS-OPS surface are prohibited. PANS-OPS surface intrusions are referred by the airport operator to the Department of Infrastructure, Transport, Cities and Regional Development for a final decision.

3.3.2 Distraction of pilots from lighting

Section 9.21 of Civil Aviation Safety Authority Manual of Standards Part 139 provides advice regarding lighting systems for use at or in the vicinity of an aerodrome. Lights may cause confusion or distraction by reason of their colour, position, pattern, or intensity of light emission above the horizontal plane within six kilometres of an airport.

The Civil Aviation Safety Authority Manual of Standards Part 139 Figure 9.21-1: Maximum lighting intensities defines zones where glare may cause distraction of pilots and limits the allowed intensity, as shown in Figure 3-2.

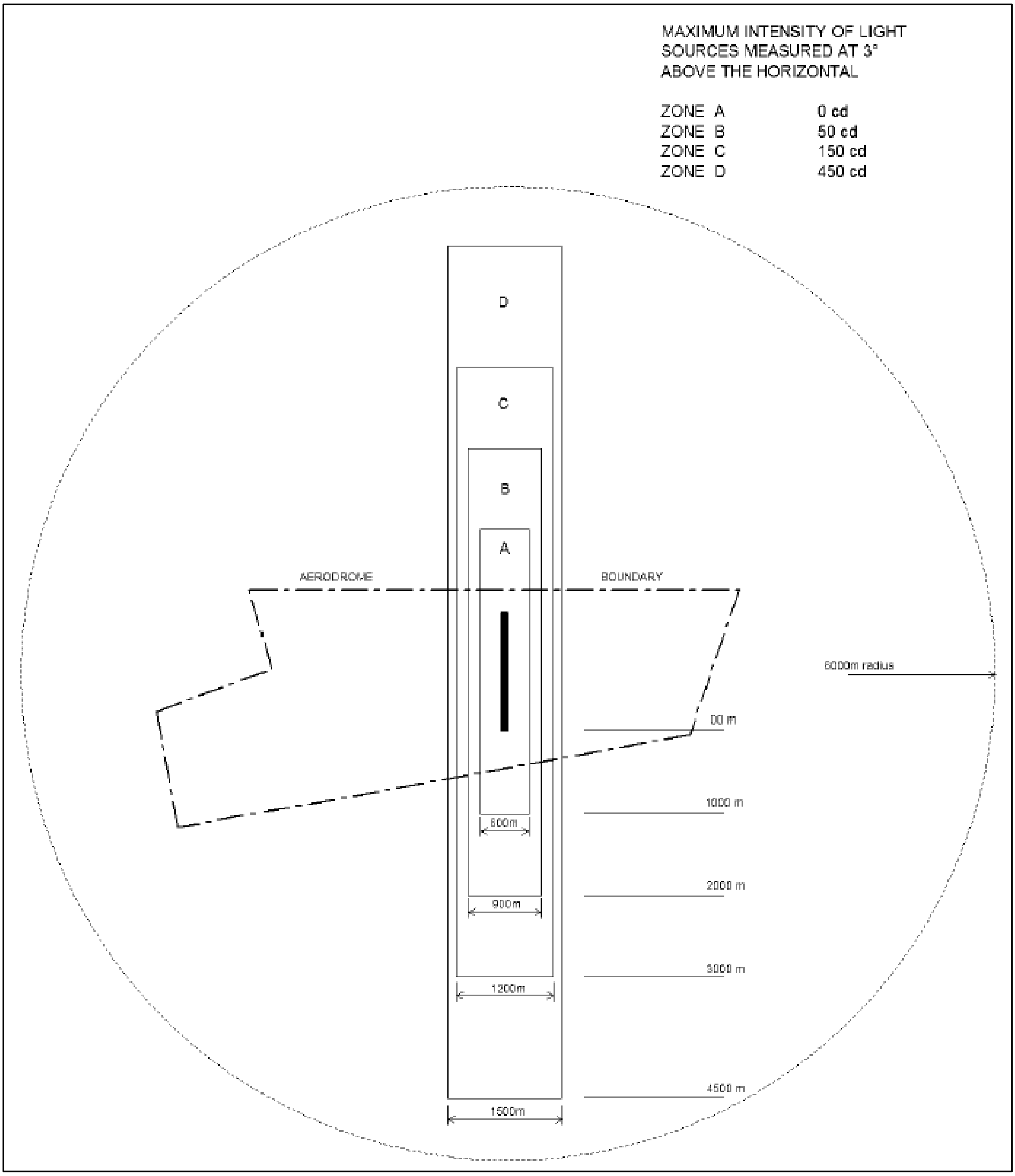

Figure 3-2 Maximum lighting intensities defined by CASA Manual of Standards

The project design has been superimposed onto the maximum light intensity zones prescribed by Section 139 of the MOS. As shown in Figure 3-3, parts of the project fall within zones A, B, C and D where interference to pilots is likely above the specified levels when measured at 3 degrees above the horizontal. Further assessment is therefore required and mitigation as necessary.

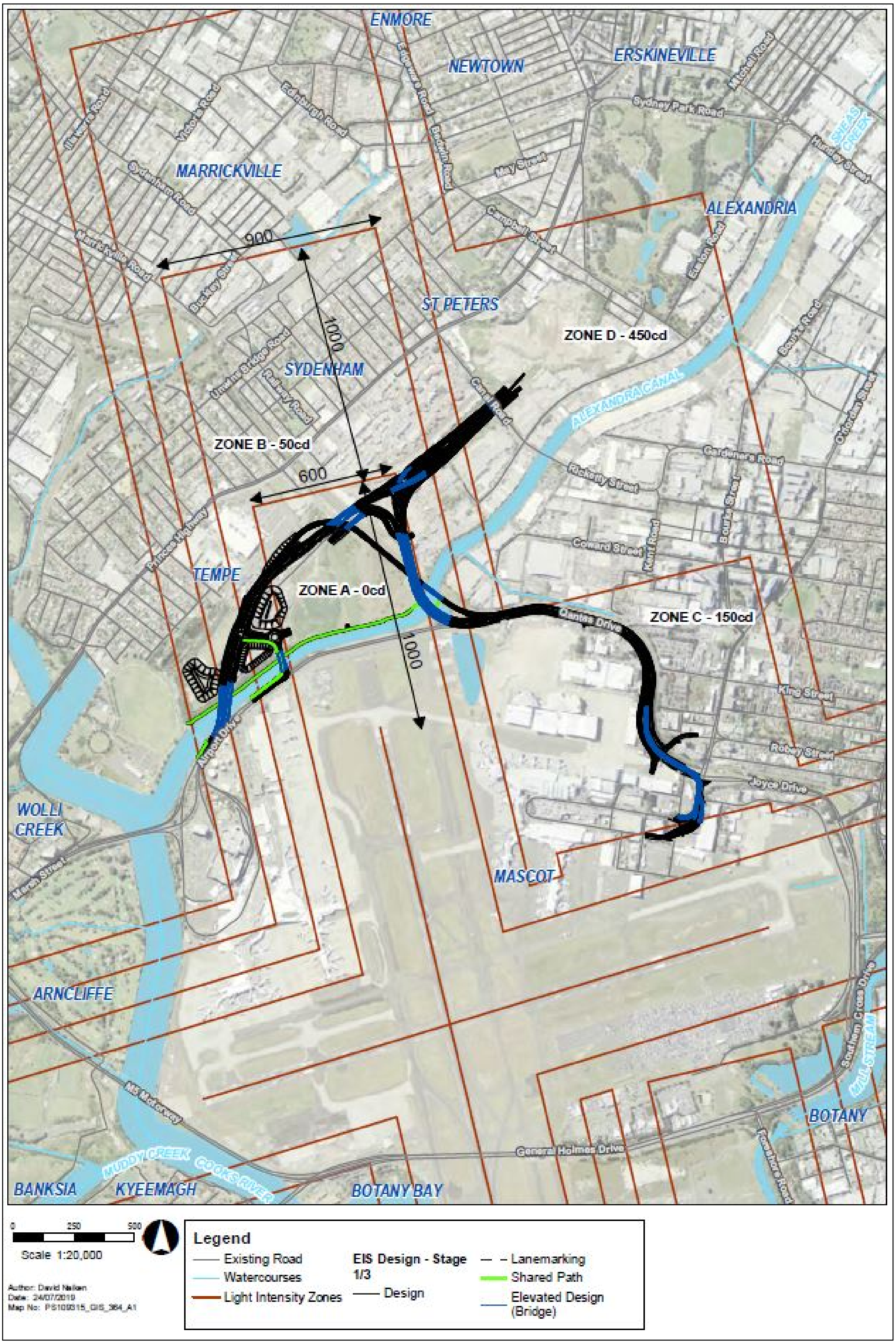

Figure 3-3 Lighting intensity zones for Sydney Gateway

3.3.2.1 Headlight glare

As vehicles travel along the road there is the possibility that their headlights would shine upwards towards incoming aircraft. The headlight illumination in front of the vehicles has been measured as per Austroads Guide to Road Design Part 3: Geometric Design, section 5.9, figures 5.6 and 5.7 (Austroads, 2016). The headlights were assessed at 150 metres in front of the vehicle, with a 3 degree horizontal spread, and 1 degree upward spread, as shown in Figure 3-4 and Figure 3-5.

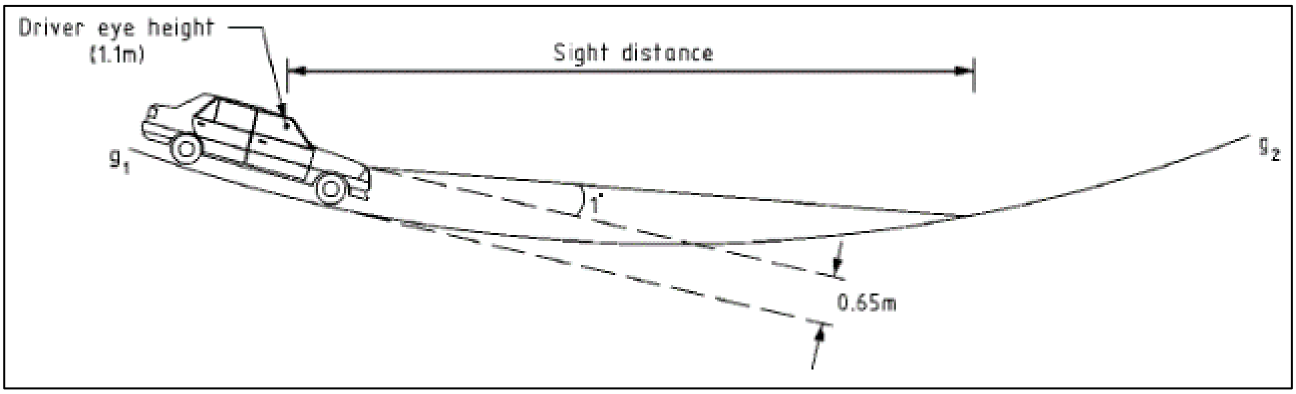

Figure 3-4 Car headlight illumination on a vertical curve

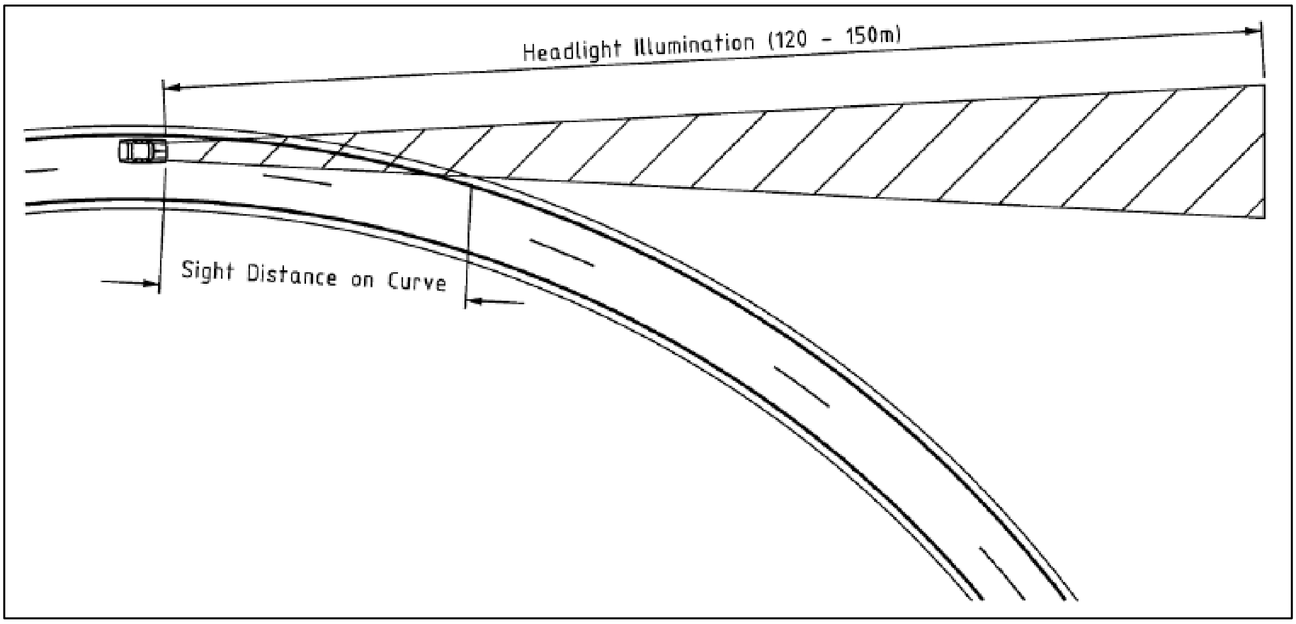

Figure 3-5 Car headlight illumination on a horizontal curve

Headlights that shine upwards either in the vicinity of, or parallel to the HIAL for runway 16R/34L may cause confusion for approaching pilots. Headlights may also cause dazzling and distraction of pilots if the glare is excessive.

3.3.3 Windshear and turbulence

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

Windshear is defined as a change of horizontal wind direction or speed with height. Rapid changes in wind velocity encountered during the landing and take-off phases of flight can be extremely hazardous to aircraft.

In accordance with NASF Guideline B, where any developments are proposed in proximity to runways, they should be assessed for potential to create windshear and turbulence that could affect the safety of aircraft. For on-airport developments, CASA provides advice to the Minister regarding windshear risk so that this can be considered in the approval of an MDP. Where developments are not located on federally-leased airports, CASA can provide safety advice, however the approval decision rests with the local planning/approval authority.

In accordance with NASF Guideline B, buildings or structures that could pose a safety risk from windshear and turbulence are those located within a rectangular ‘assessment trigger area’ around the runway ends defined as:

- 1200 metres or closer perpendicular from the runway centreline (or extended runway centreline)
- 900 metres or closer in front of runway threshold (towards the landside of the airport)
- 500 metres or closer from the runway threshold along the runway.

For structures that fall within these zones and penetrate a surface that slopes upwards and perpendicular away from the runway centreline at 1:35, a detailed study is required.

Figure 3-6 shows the windshear assessment zones in relation to runway 16R/34L and runway 07/25 and indicates the elements of the project which lie within the 900 metres assessment zones. As the section of road infrastructure to the north of runway 16R/34L is also above the runway level, a detailed assessment is required and is provided in Appendix A. It was confirmed with Sydney Airport Corporation that a windshear and turbulence assessment for the road infrastructure lying within the runway 07/25 assessment zone was not required.

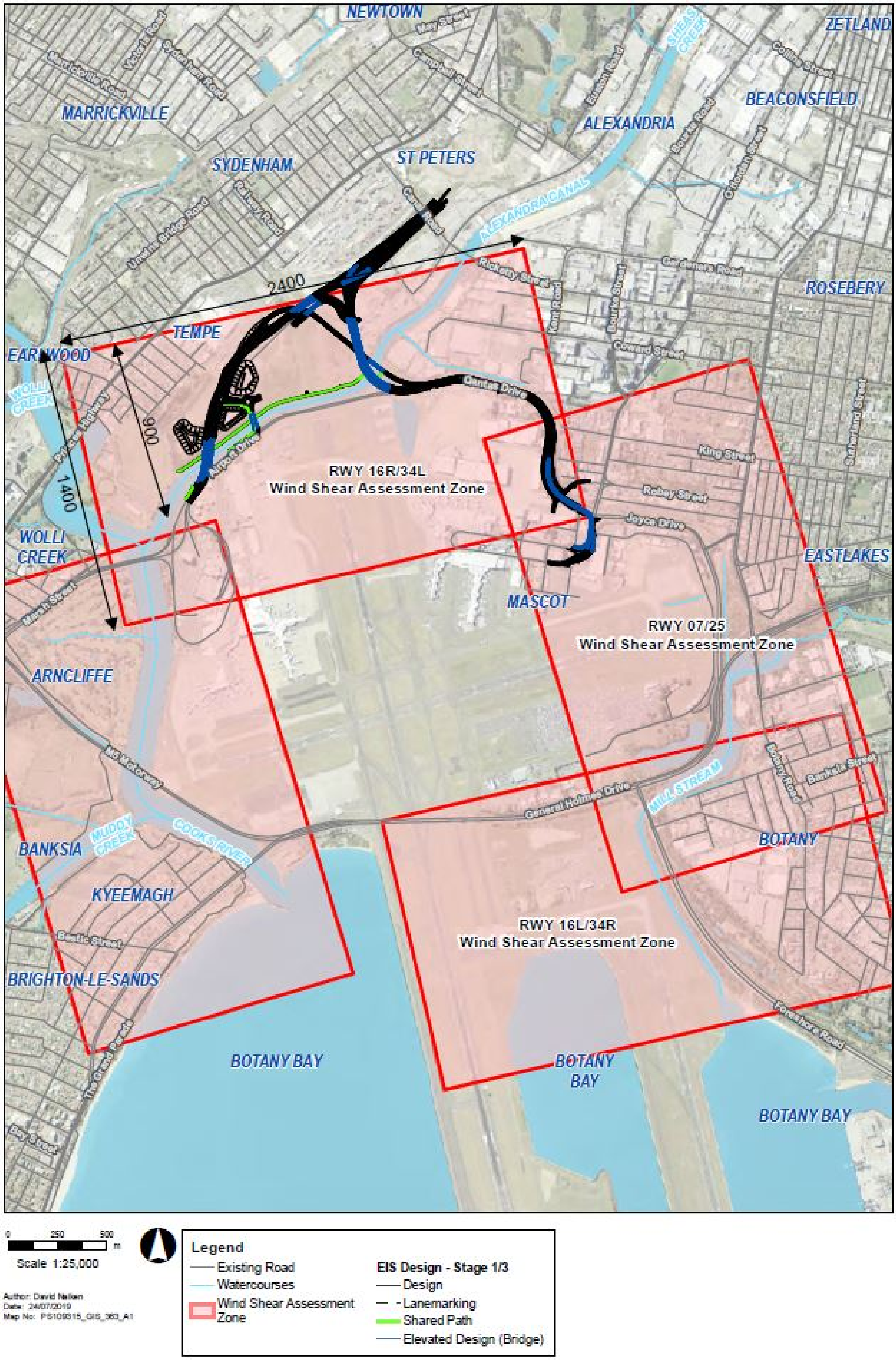

Figure 3-6 Windshear assessment zones for runways 16R/34L and 07/25 at Sydney Airport

A model of the runway approach and surrounds were constructed to a scale of 1:750 and placed in a wind tunnel test machine. A number of scenarios were modelled for the Sydney Gateway road project, including pre- and post-construction, as well as two preliminary mound options. A representative layout of shipping containers stacked up to six high in the storage area west of the runway approach and north of the roadway (the Cooks River Intermodal Terminal) was also included in the wind tunnel model.

The wind tunnel testing was performed in the natural boundary layer wind tunnel of Cermak Peterka Petersen Pty Ltd. Appropriate approach boundary layer conditions representative of a built-up environment were established in the test section of the wind tunnel.

NASF Guideline B requires testing for all relevant wind directions that intersect the structure and the runway centreline at chainages between -900 metres and 500 metres, in increments of 22.5 degrees. To rationalise the extent of testing, the area directly downstream of the proposed roadway was tested for critical wind directions.

The primary critical wind directions for runway 16R/34L were considered to be 90 degrees and 247.5 degrees, which are closest to a pure crosswind and have a slight headwind component for approaching aircraft, hence most likely to affect aircraft operations. The testing for the secondary wind directions of 270 degrees and 67.5 degrees, including a slight downwind component, was conducted for a similar range of locations directly downwind of the proposed roadway.

These wind directions were selected as they are the ones most likely to cause mechanical turbulence and corner vortices generated by the project which could impact aircraft operations. Other wind directions intersecting the proposed roadway and the runway centreline either have a significantly larger distance between the elevated roadways and runway centreline or have a significant tailwind component and landing would therefore be conducted in the opposite direction. Wind directions of 67.5 degrees and 90 degrees were only tested once for preliminary mound option 2, as the earth mounds are located west of the runway approach, that is downwind of the extended runway centreline for these wind directions.

Test locations were spaced 100 metres apart horizontally and five metres vertically for ease of comparison with the criteria.

Available literature on windshear and turbulence suggests that aircraft are much more vulnerable to wind velocities and eddies during the final stage of the approach than during take-off. Therefore, only the effects on approaching aircraft were considered. Further details of the approach and methodology are provided in Appendix A.

3.3.4 High intensity approach lighting

The HIAL associated with runway 16R/34L approach would need to be adjusted due to the proximity of the road. This would require shortening the length of the existing light array, adjusting spacings as well as raising the height of the lighting masts to meet relevant legislative and other requirements. This work will be carried out by Sydney Airport Corporation and approvals sought separately from this combined EIS/preliminary draft MDP. No further assessment has therefore been conducted, although dialogue between Roads and Maritime and Sydney Airport Corporation has ensured that the revised lighting array is able to co-exist with the proposed infrastructure. Design drawings showing clearance of the design to the HIAL are provided in Appendix B.

3.3.5 Communication, navigational and surveillance clearances

Currently, there are no CASA requirements for protecting navigation aids, however MOS 139 sets out rules for the protection of various navigation aids. Sydney Airport Corporation has developed Navigation Aid protected surfaces for reference purposes that aim to ensure off-airport obstacles do not interfere with signals from ground-based navigation equipment or obscure airport safety lights. This guarantees pilots are receiving the correct information about their aircraft in relation to the airport.

NASF Guideline G relates to required clearances from specific communications, navigation and surveillance systems associated with air transport. This includes civilian and defence facilities. The communications, navigation and surveillance infrastructure and facilities enable pilot navigation, instrument approach procedures, communication between pilots and air traffic control and monitoring of aircraft locations by air traffic control.

Project elements that may impact on this infrastructure include bridges and motorway overpasses as well as construction equipment such as cranes and concrete pumps.

Sydney Airport Corporation has published the 'Sydney Airport Navigational Aids Protection Surfaces' drawing (FSS 6934). As this is a large scale document, it has only been possible to estimate that there may be slight infringements into this surface by the project.

Airservices Australia and the Australian Department of Defence provide coordinates of their facilities to planning agencies in all states and territories. Airservices Australia also provides assistance as required in assessing impacts of projects on communications, navigation and surveillance equipment.

Clauses 26–29 of NASF Guideline G indicate that only specified government agencies, principally land use planning decision makers, have access to communications, navigation and surveillance facilities location data to enable consideration when development applications are received. Where a proposed development or activity is likely to infringe one of these items, details should be referred to Airservices Australia to allow them to undertake an assessment. The referral process ensures awareness of the proposed obstacle and that appropriate mitigation measures are available. Airservices Australia would also assess the cumulative impact of the proposed development or activity along with other obstacles and would provide technical advice about the impact of a proposed development and any necessary mitigation measures.

3.3.6 Public safety areas

The NASF Guideline I states that the way land use is managed beyond airport boundaries, specifically at runway ends, can contribute to mitigating the risk of on-ground fatalities due to aircraft incidents. The guideline does not prescribe how state authorities should implement planning controls. There is flexibility for individual jurisdictions to add policies to planning schemes. However, it is understood that no legislation presently exists in NSW with respect to permissible off-airport land uses with respect to aircraft crash risks.

The NASF Guideline advises that the Public Safety Area (PSA) relate to the statistical chance an accident occurring at a particular location. In general, areas close to the final approach have a higher risk of an aviation incident occurring, and this risk reduces further from the runway, Statistical analysis can be used to model the likelihood of a fatal accident occurring at a set location over a one-year period.

Sydney Airport have adopted the Queensland State Planning Policy PSA model which gives a PSA shape 1000 metres long and 350 metres wide at the runway end, tapering to 250 metres wide. This area is shown on Figure 3-7 and shows that part of the project site traverses this area.

Within the PSA's, developments that increase the numbers of people living, working or congregating are discouraged as this increases the risk of fatal accidents.

The NASF Guideline includes considerations for transport infrastructure in this zone. It notes that particular sections of roads are only used by individuals for short periods of time, however at any one point in time, there may be a large number of people in the area. The density of occupation throughout a day could therefore be similar to a residential development. As such, the average density of people should be assessed for exposure to the risk. Calculations can therefore be used to predict the average density of people over a one-year period. Inputs would include numbers of vehicles using the road, average speeds, and average occupancy of the vehicles.

Clause 39 of NASF Guideline I refers to the risk of a person remaining in the same location for a period of a year being killed as a result of an aircraft accident around an airport. Comparisons between vehicles on a road and a person in a residence (which is an incompatible land use identified in NASF Guideline I) can be approximated based on traffic volumes, average speeds (dwell times) and the surface area of the road within the PSA. As outlined in Clause 49 of NASF, the assessment has estimated the density of occupation (average hours/year/square metre) that vehicles using the Sydney Gateway road project would be present within the PSA and compares that with a person present in a residential dwelling within the same area. Cars on average would be present for about 13 hours/year/square metre compared to a resident being present for about 40 hours/year/square metre. This indicates persons in a vehicle would be at less risk in the PSA than the person in a dwelling (an incompatible land use identified in NASG Guideline I).

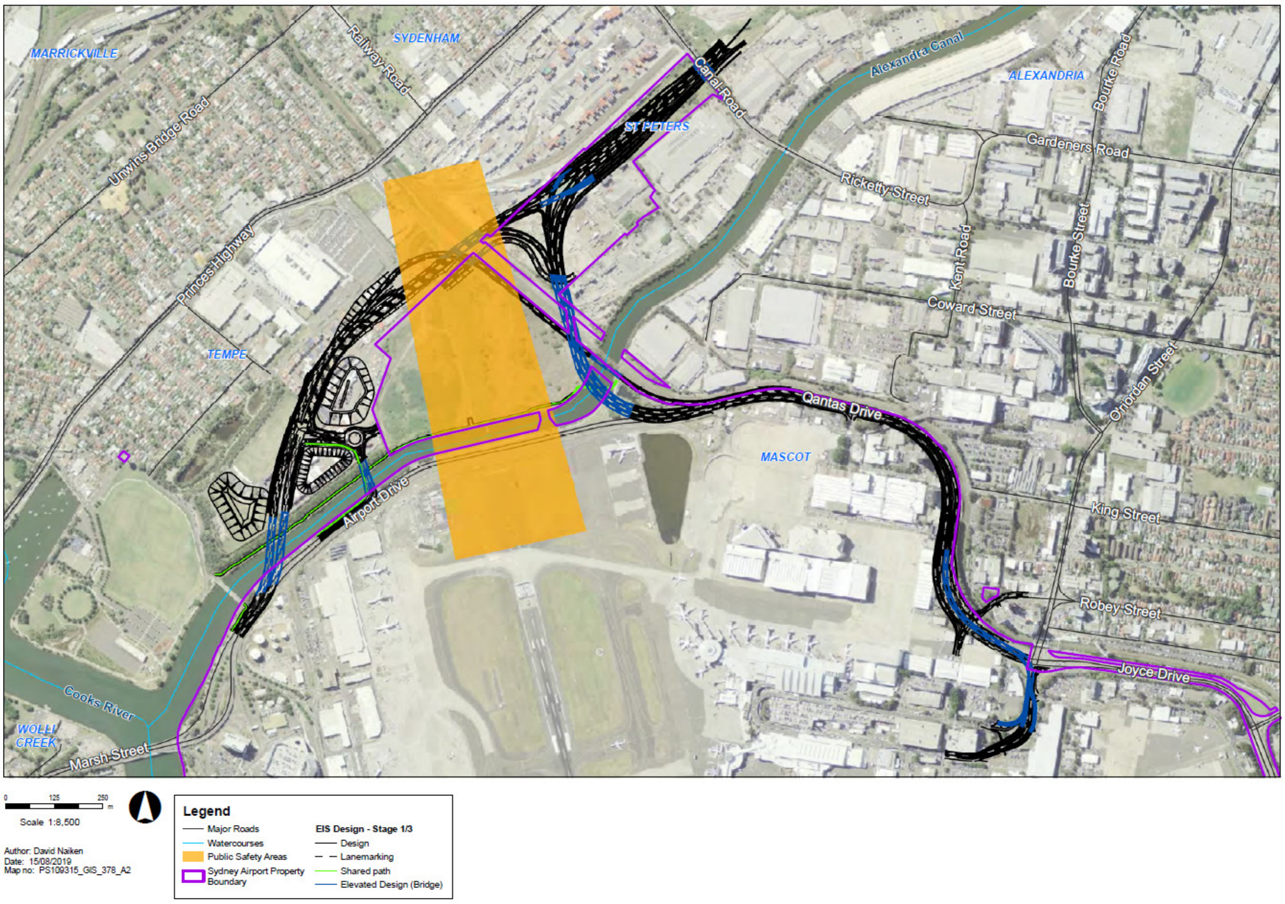

Figure 3-7 Public safety area for Runway 16R/34L at Sydney Airport

4. Existing environment

4.1 Overview of key infrastructure facilities and current operations

Sydney Airport is Australia's largest airport in terms of passengers and freight. It is located on about 907 hectares of land adjoining Botany Bay in Mascot, approximately eight kilometres south of Sydney's Central Business District. Sydney Airport currently caters for around 40 per cent of Australia's international passenger movements, 46 per cent of domestic/regional passenger movements and 50 per cent of air freight. In 2017, there were around 43 million trips to Sydney Airport and the airport also moved about 643,000 tonnes of freight.

There are currently 34 international, six domestic and six regional airlines operating from the airport, together servicing 97 destinations, including 11 international and eight regional destinations not served by any other Australian airport.

Sydney Airport operates three passenger terminals, comprising an international terminal (Terminal 1) located in the north-west sector of the airport and a domestic terminal complex (housing Terminals 2 and 3) in the north-east sector of the airport.

Sydney Airport has three runways, comprising two parallel runways on an approximate north−south alignment and a cross runway on an east−west alignment. The two north−south runways are equipped with HIAL lighting systems and all runways are equipped with Instrument Landing Systems.

Runway 16R/34L is the main runway for the airport and is 3,962 metres in length. It parallels the shorter (2,438 metre) Runway 16L/34R. Runway 07/25 is the cross runway and is approximately 2,530 metres long, on an approximate east−west alignment through the centre of the airport. The runways and their supporting taxiways can accommodate operations of aircraft up to and including the Airbus A380 (currently the world's largest passenger airliner).

Apron areas are provided to facilitate aircraft parking (the parking position is known as an aircraft 'stand' or 'gate'). There are 106 aircraft stands dedicated to supporting international, domestic, regional and freight operations at Sydney Airport. The apron areas also support activities associated with the servicing of aircraft such as baggage handling, movement of freight, refuelling and in-flight catering. A network of airside roads provides for ground support equipment and other vehicle movements.

The general aviation parking area is located in the north-east sector of the airport, east of Terminal 2/3. The area provides aircraft parking for a number of freight, corporate and private aircraft as well as a variety of aviation support facilities such as maintenance hangars, freight handling and administrative buildings.

There are four international cargo terminal operators and two domestic cargo terminal operators operating at Sydney Airport. A helicopter precinct is located in the south-east sector of the airport, which includes a touchdown and lift off area, taxiways, parking pads, storage/maintenance hangars and administrative buildings.

The air traffic control tower, a Commonwealth heritage listed item, is roughly in the centre of the airport adjacent to the General Holmes Drive tunnel under runway 16R/34L.

Figure 4-1 shows the location of key facilities at Sydney Airport.

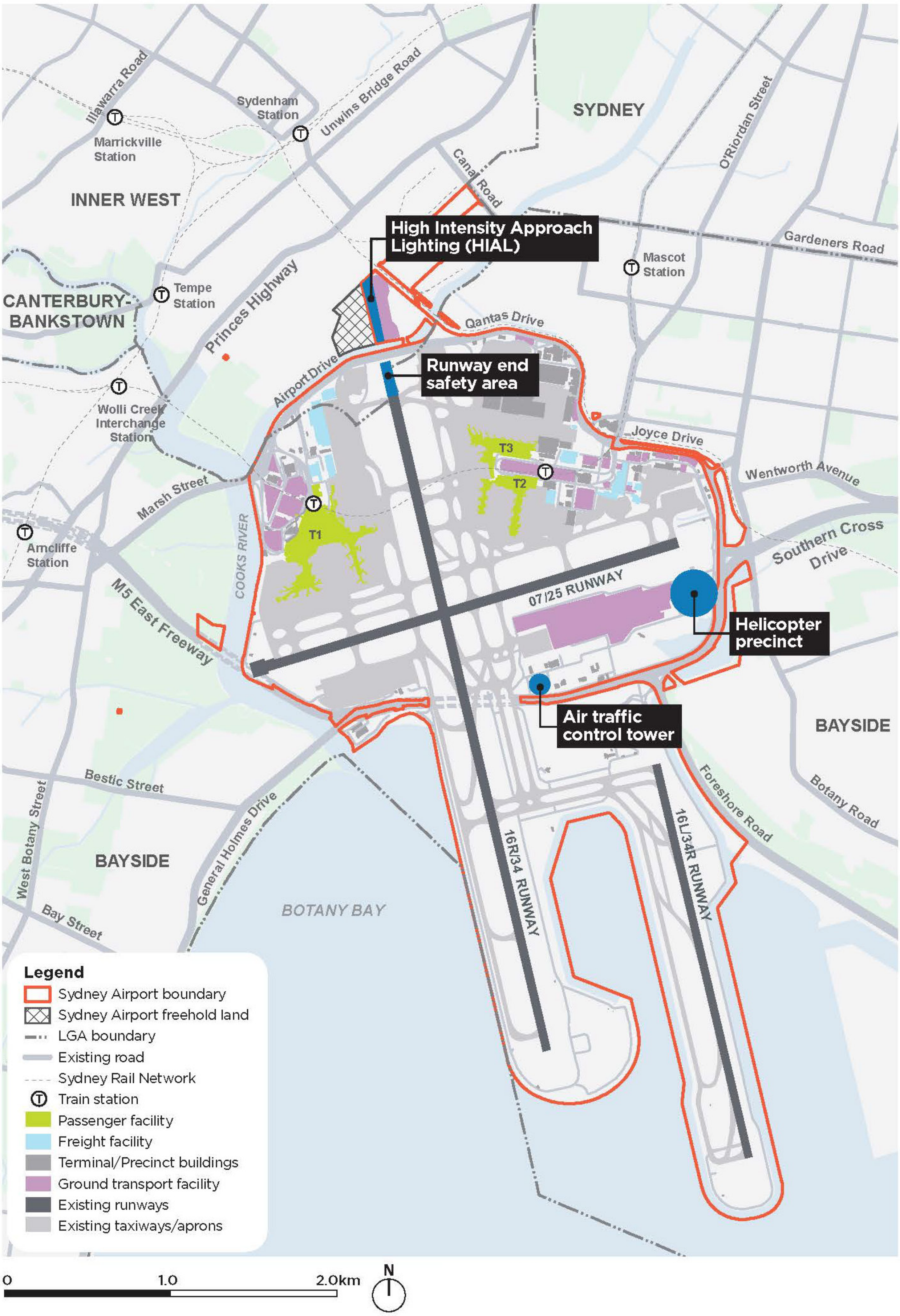

Figure 4-1 Location of key facilities at Sydney Airport

4.2 Aviation safety

The Australian Transport Safety Bureau (ATSB, 2018) reported that in 2017, nearly 200 aircraft were involved in accidents in Australia, with 203 involved in a serious incident (an incident with a high probability of an accident). There were 40 fatalities in the aviation sector in 2017 which was a significant increase from the 21 fatalities in 2016. There were no fatalities associated with either high or low capacity commercial passenger transport operations, which has been the case since 1975 and 2010 respectively.

Almost half of all fatalities that occurred in commercial passenger transport operations over the period 2008–2017 occurred in 2017. During 2017, there were 14 fatalities from 21 accidents in commercial passenger transport operations, 21 fatalities from 93 accidents in general aviation operations, and five fatalities from 53 accidents in recreational aviation operations. This indicates commercial passenger transport operations are one of the safest forms of aviation activity.

Aircraft control, followed by terrain collisions, were the most common accident type for aircraft involved in commercial air transport operations.

Wildlife strikes, including birdstrikes, were the most common type of incident involving both commercial air transport and general aviation operations. Runway events and aircraft control incidents were the most common types of incident reported for recreational aviation.

Aeroplanes remain the most common aircraft type flown, which is reflected in the proportion of accidents they are involved in. In 2017, 15 of the 22 fatal accidents involved aeroplanes—three gliders, two helicopters, and two weight shift aircraft were also involved in fatal accidents.

Figure 4-2 shows the incidence of various types of accidents involving high capacity commercial passenger transport aeroplanes within 50 kilometres of Sydney Airport between 2008 and 2017 (National Transport Safety Bureau National Aviation Occurrence Database). As indicated above, the graph shows there have been no fatal accidents and few serious accidents over a ten year period.

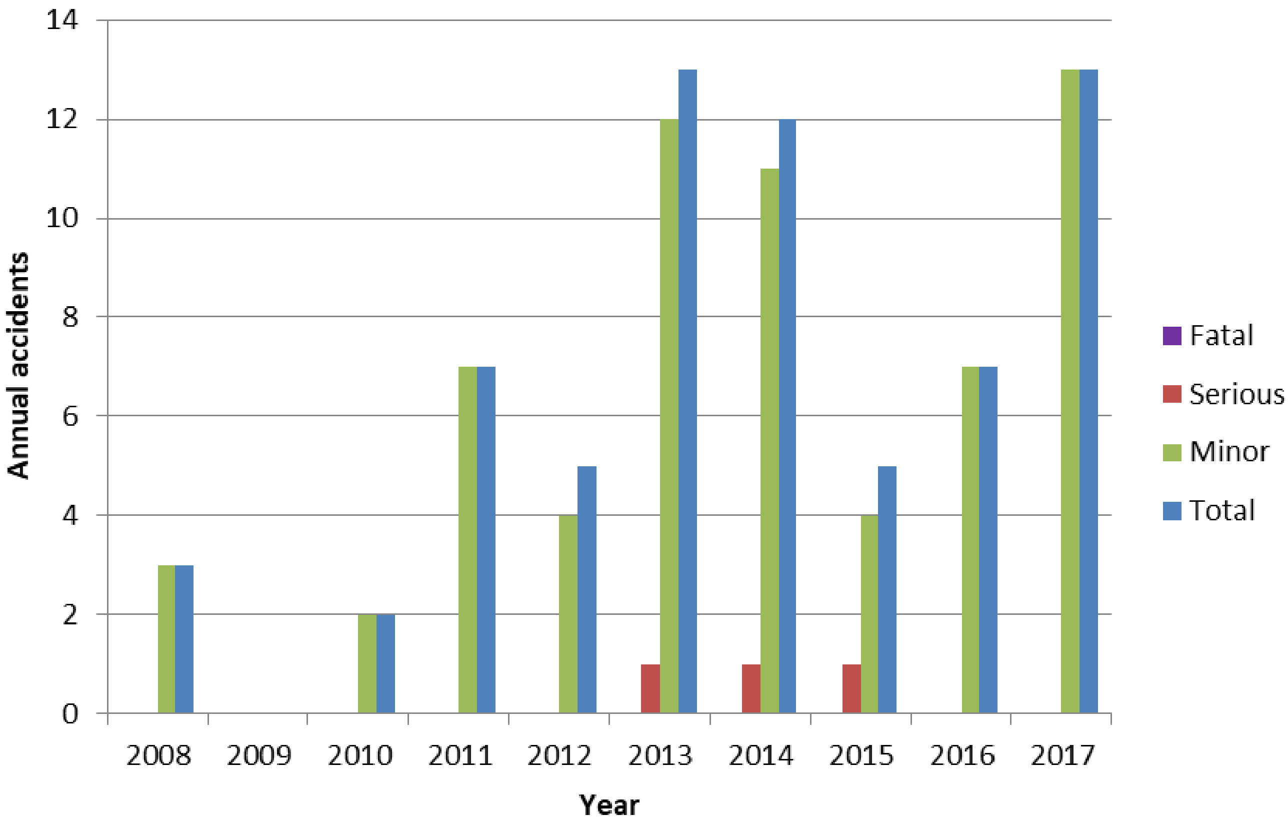

Figure 4-2 Accidents within 50 km of Sydney Airport involving high capacity commercial aeroplanes 2008–2017

4.3 Obstacle limitation surface

The OLS at Sydney Airport spans a radius of about 15 kilometres from the runway ends. Infrastructure and terrain within this area is required to be at a height below the OLS to avoid becoming a hazard to aircraft operations. The portion of the OLS at Sydney Airport to the north of Alexandra Canal is shown in Figure 4-3.

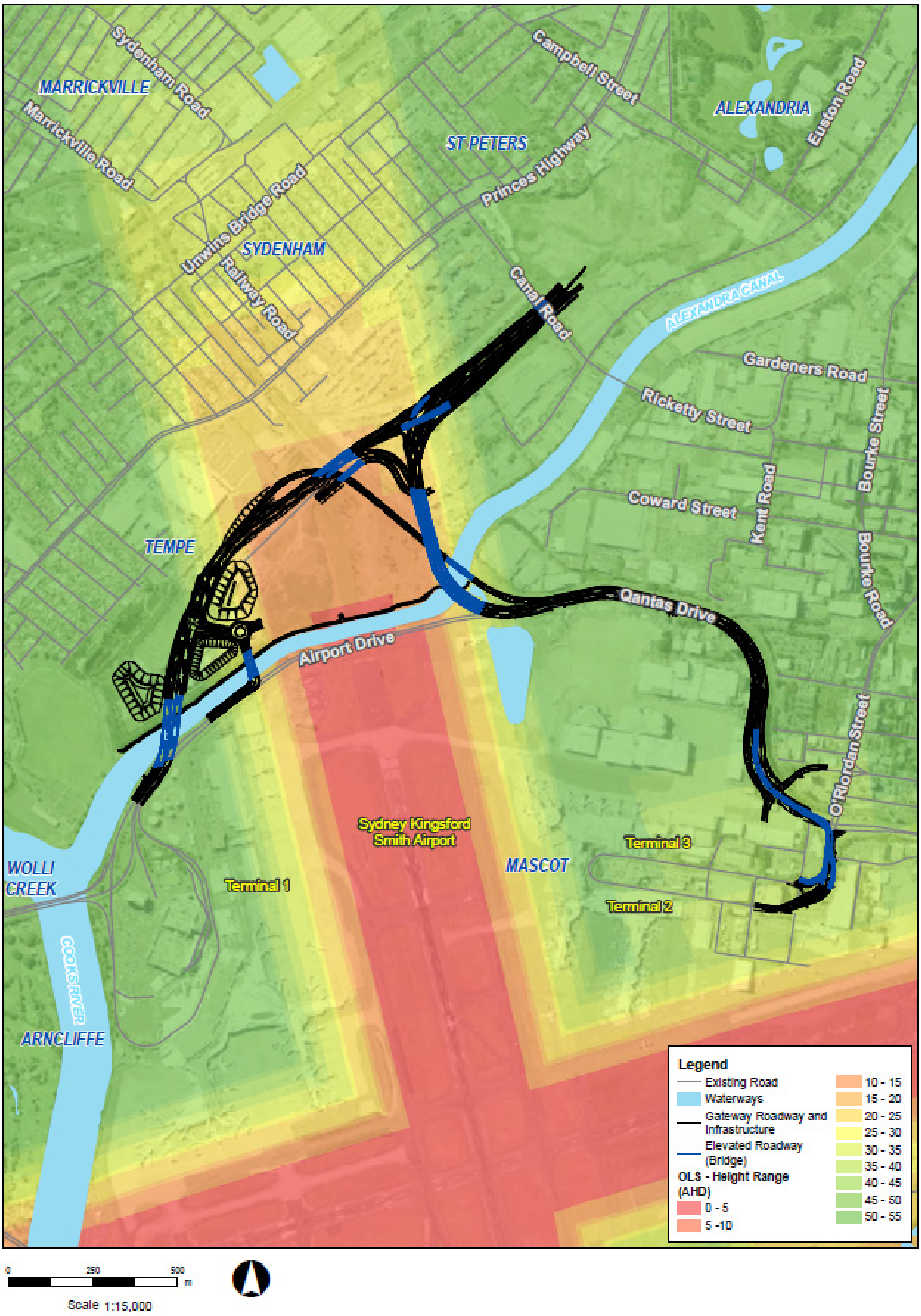

Figure 4-3 OLS surfaces at Sydney Airport

4.4 High intensity approach lighting

The HIAL runs in a straight line beyond the end of runway 16R/34L on the area of land between Alexandra Canal and Swamp Road (shown in Figure 4-4) and provides visual guidance for aircraft landing on the runway at night or in low visibility conditions. It is imperative that these lights are unobstructed to ensure pilots are able to see the lights as they are approaching the runway. It is also important to not have other lights within the vicinity of the HIAL that may cause confusion or a distraction for pilots.

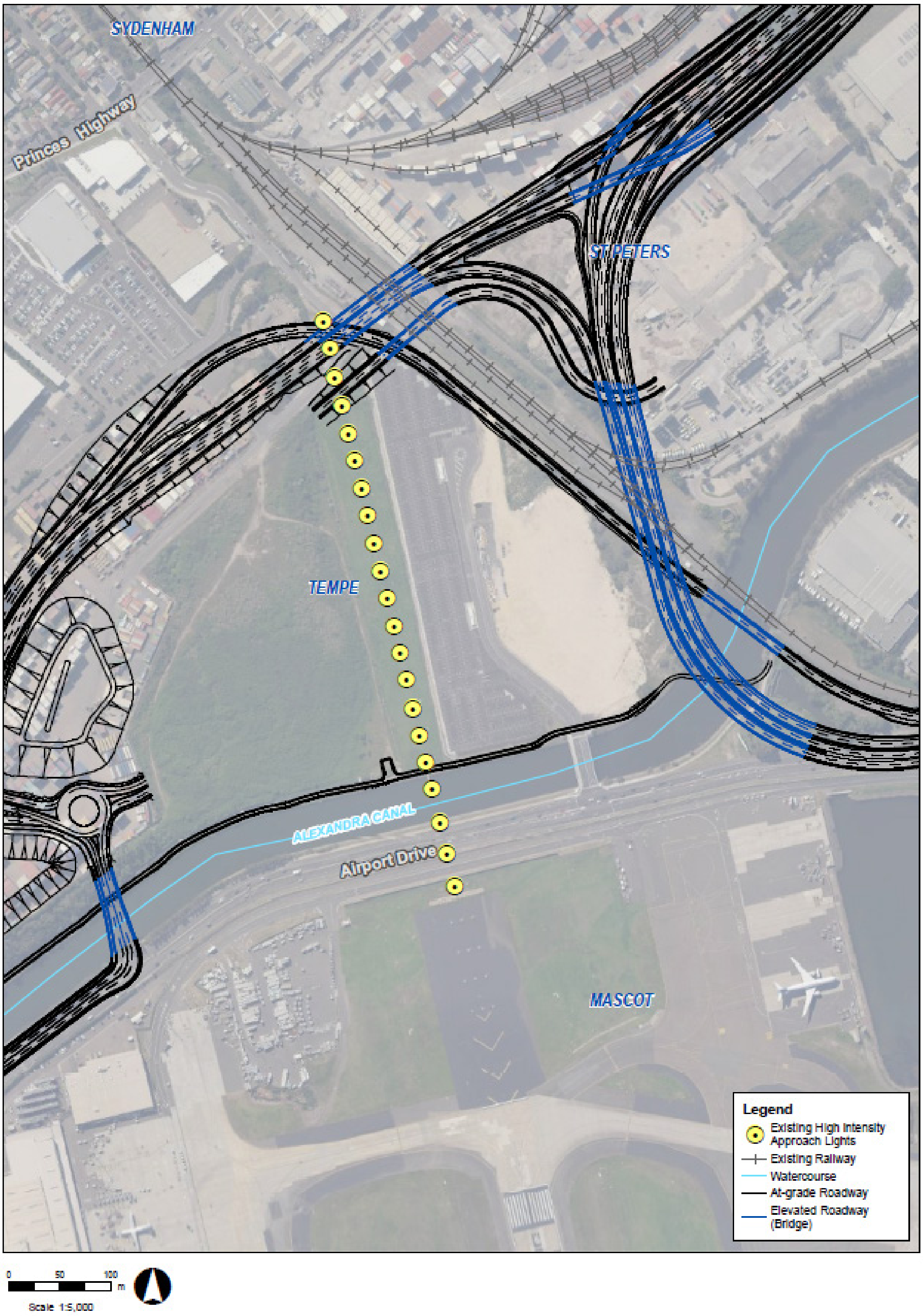

Figure 4-4 HIAL locations at Sydney Airport

As noted in section 3, adjustments to the HIAL are necessitated by the project and Sydney Airport Corporation has confirmed that adjustments will be completed prior to construction commencing. Such adjustments include removal of the last two light masts, and changes to the heights of the remaining masts. The required modifications to the HIAL, including consultation and approvals by CASA, will be undertaken by Sydney Airport Corporation, separate to this combined EIS/preliminary draft MDP.

4.5 Communications, navigational and surveillance facilities

The communications, navigation and surveillance infrastructure and facilities at Sydney Airport enable pilot navigation, instrument approach procedures, communication between pilots and air traffic control and monitoring of aircraft locations by air traffic control.

4.6 Airside security

Sydney Airport's airside (operational) areas are surrounded by security fencing, with access to this area available at designated access gates and by approved staff. Within and close to the project site, airside security fencing is located along the southern edge of Airport Drive and Qantas Drive (west of Lancastrian Road). The Qantas Jet Base is generally located airside with the exception of a few building entrances located outside the airside area. Access to the airside area within the project site is provided via a security checkpoint located at Lancastrian Road.

4.7 Airport movement area

The movement area of an airport, as defined in the Manual of Standards Part 139, is that part of the aerodrome to be used for the take-off, landing and taxiing of aircraft, consisting of the manoeuvring area and the aprons. The manoeuvring area is that part of the aerodrome to be used for the take-off, landing and taxiing of aircraft, excluding aprons.

Sydney Airport contains engineering facilities in the north-east sector to the north of Terminal 3. In this leased area, the Qantas Jet Base provides facilities for the maintenance and servicing of aircraft. It is located adjacent to Qantas Drive on land leased from Sydney Airport Corporation. The Qantas Flight Training Centre is located on the same site, partially on land within the project site.

The Flight Training Centre, which is the largest in the southern hemisphere, supports the training requirements of Qantas pilots and flight crew as well as other airlines. It includes facilities such as flight simulators, aircraft cabin mock-ups, ditching pools, and training rooms and other facilities.

5. Assessment of construction impacts

The assessment of construction impacts follows the chronology of risks identified in section 3 and the methodology outlined therein.

5.1 Wildlife attraction/strike

Sydney Airport is a coastal airport which is subject to visitation and transiting by a variety of coastal and inland bird species. There are currently 140 species of birds on the Bird and Animal Species Database maintained by Sydney Airport Corporation.

Construction would involve development of temporary site drainage measures, including sedimentation ponds. During construction planning, care would need to be taken to ensure that the site is positively drained to avoid creation of intermediate trapped low points and that any site basins do not hold water for periods longer than five days, which could attract birds. The proposed permanent flood mitigation basin would be designed to remain 'dry' to minimise the attraction of birds to the area. Alternatively, similar to other ponds in the vicinity of Sydney Airport, the ponds could be netted if required. Temporary site drainage would also be required to avoid ponding water that could attract birds.

The excavation and re-emplacement of waste from the former Tempe landfill may also lead to accumulation of waste and odours that may attract birds.

The construction environmental management plan should contain measures to avoid this risk through appropriate waste management strategies. In relation to the re-emplacement of waste, this should involve controlling the amount of waste areas exposed at any time and covering the waste as soon as practicable and at least every day. General site management practices would also include food waste being correctly stored and regularly removed from site.

Provided there is no failure to implement such practices, the risk of attracting wildlife is considered small and manageable. A measure should also be implemented to routinely monitor birds visiting these areas and consult with Sydney Airport Corporation regarding any necessary harassment measures to ensure swift management of any issues.

5.2 Prescribed airspace intrusion

Construction plant and activities associated with the project are to remain below the OLS described in section 4.3 wherever practicable. Where the work requires cranes (or other plant) to operate within the OLS, an Airspace Protection Crane Enquiry Form (Application for Approval of Crane Operation) in general accordance with sections 182 and 183 of the Airports Act and regulation 7 of the Airports (Protection of Airspace) Regulations must be completed and submitted to Sydney Airport Corporation prior to the activities occurring.

Due to the location and nature of the project in close proximity to the airport, construction activities would routinely require approvals to work within the prescribed airspace. Any proposed intrusions into the prescribed airspace would be undertaken in accordance with Controlled Activity approvals. Some of these works would need to be undertaken at times when the affected runways are not in operation. Construction works would need to be completed by 5am with consideration for recall periods should the runway be required at any time.

The proposed construction methodology would be reviewed as the detailed design is developed and revised as required. Amending the proposed construction activities and plant (if possible), undertaking works during the airport curfew period, with works completed by 5am, and following the existing approval process (unless specific exemptions are granted by Sydney Airport Corporation), along with any further necessary mitigation is expected to reduce the risk of unacceptable impacts on aviation safety.

Figure 5-1 shows the indicative locations where airspace intrusions during construction are likely to occur. These would be reviewed by the construction contractor(s) following tender award.

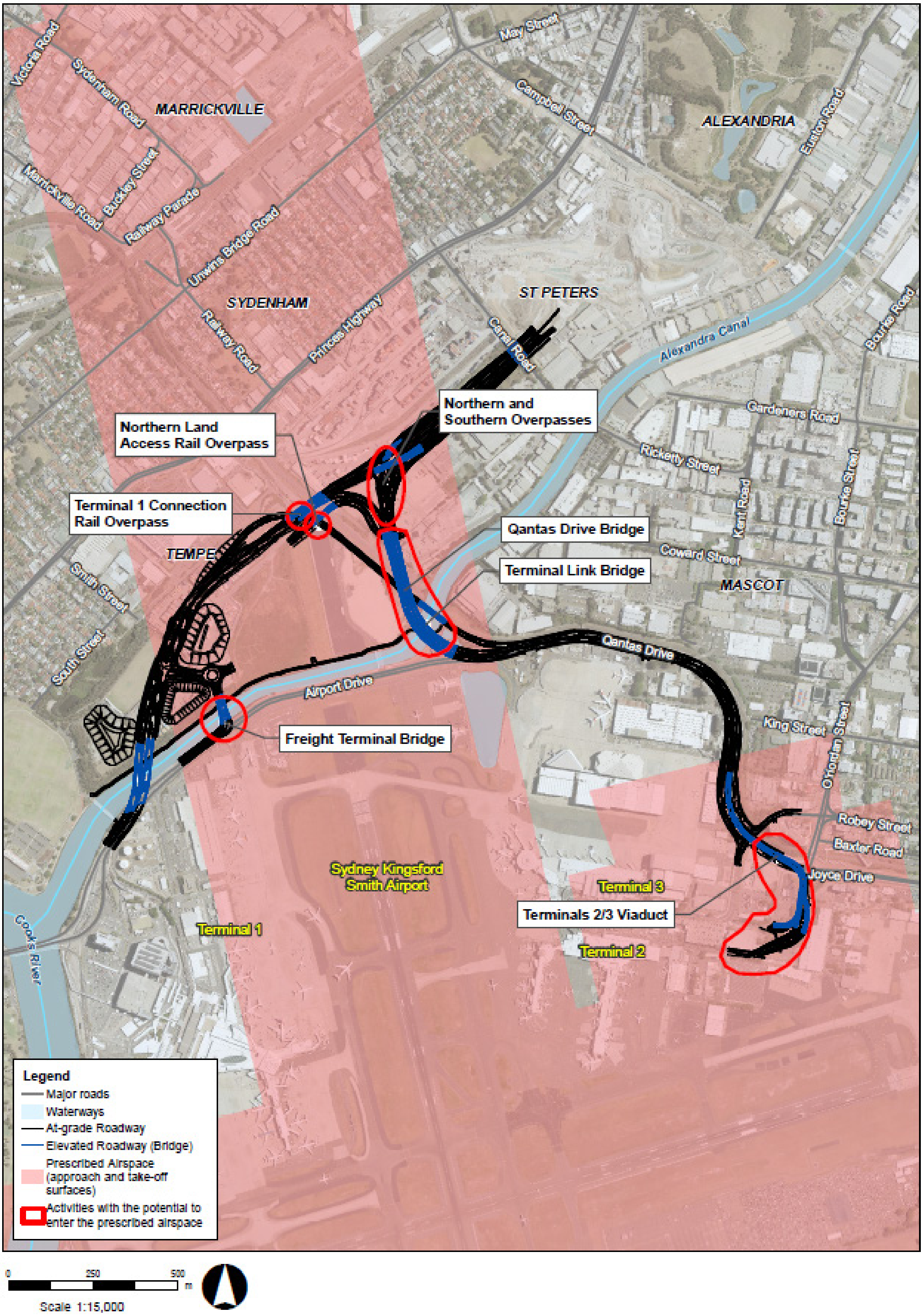

Figure 5-1 Location of activities with the potential to enter Sydney Airport's prescribed airspace

5.3 Distraction of pilots from lighting

Figure 3-3 shows the project areas where restrictions on lighting intensity apply relative to project infrastructure components. A similar figure is shown in the Sydney Airport Master Plan 2039 as Map 32. Night works would be routinely required for the project due to restrictions posed by the operation of Sydney Airport and the need to undertake works on major roads outside of peak hours to minimise congestion and delays. Similarly in relation to aviation operations, penetration of the prescribed airspace would be needed to conduct certain construction operations, with some of these undertaken outside of standard construction hours in the evening and night-time when lights would be needed. Such lighting would be subject to the same controls in relation to pilot distraction.

Restrictions on construction lighting use during the airport curfew period, with their use completed by 5am, may be relaxed with specific exemptions granted by Sydney Airport Corporation.

5.4 Dust or smoke affecting visibility

During construction there is a risk of excessive dust production from spoil handling associated with large scale earthworks. To maintain visibility in the airspace surrounding the airport, dust levels need to be kept at a minimal level, particularly for the St Peters interchange connection works. A crushing and grinding plant is also proposed close to an existing concrete batching plant at St Peters, as shown in Figure 5-2. This location is approximately 500 metres from the extended runway 16R/34L centreline, and is located on the outside edge of the approach segment of the OLS. In the event of adverse flight crew comments with respect to dust and visibility, immediate action would be required to mitigate the issue.

The potential for fugitive dust emissions, both from general construction activities as well as crushing and grinding activities in particular, have been considered as part of a separate detailed study documented in Technical Working Paper 4 – Air Quality. The mitigation measures necessary to control dust to within acceptable levels are described in that document and would be included in the construction environmental management plan. These measures are standard on many major infrastructure projects in Sydney and are expected to be effective in reducing fugitive dust to levels that would not affect aviation safety.

Substantial emissions of smoke are unlikely to be emitted from any construction plant sufficient to give rise to concerns about aviation safety. The only areas containing substantial grass and other vegetation is in the area of the former Tempe landfill. Due to existing landfill gases, there is already a hot works procedure in place in this location as part of the landfill site management plan. This would continue and be included in the construction environmental management plan for the project. Any accidental fires which might occur in this area and might produce smoke sufficient to cause a hazard to aviation would be dealt with as part of a contingency management plan developed for the project. Civil fire brigade units and fire resources at Sydney Airport could be quickly mobilised to respond to such an event, should it occur.

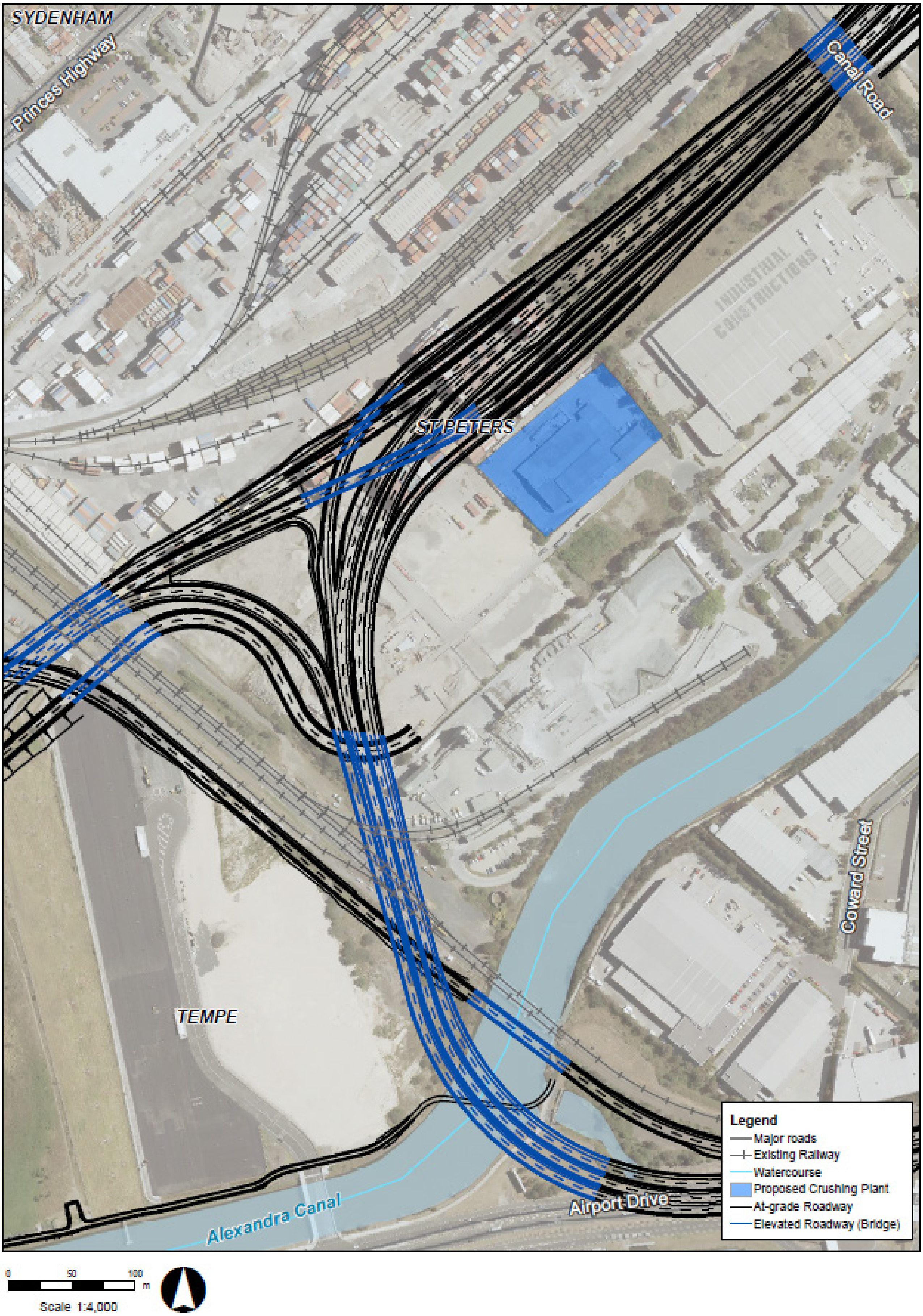

Figure 5-2 Indicative location of crushing and grinding plant

5.5 Interference with communication, navigation and surveillance equipment

There would be limited construction activities occurring within the airside area of Sydney Airport land where most communications, navigation and surveillance equipment is located and therefore no line of sight issues are expected.

Sydney Airport's drawing (FSS 6934) 'Sydney Airport Navigational Aids Protection Surfaces' shows that the surfaces extend over the construction area for the project. It is possible therefore that there would be some infringements of the surfaces during construction.

As part of detailed design and construction planning, detailed checks would be undertaken to assess the potential impacts on navigation aids, communications or surveillance equipment. Assessment by Airservices Australia would be required to confirm extent of infringements. Any requirements for protection of communication, navigation and surveillance equipment during construction or operation will be determined by Airservices during detailed design.

The risk of unexpected utility interruptions occurring during construction of the project is possible. Electricity supply to critical navigation and communications equipment at Sydney Airport has several levels of redundancy in case of contingency events occurring. While unplanned utility disruptions could occur, it is unlikely these would have an impact on airport operations.

5.6 Security of the airside area

The continued security of the airside area will be the responsibility of Sydney Airport Corporation.

Construction works along Airport Drive and Qantas Drive would require sections of the current airside fence to be removed and temporary fences installed securing the airside area.

All adjustments to the airside fence would be coordinated by Sydney Airport Corporation and installed in accordance with the requirements of Sydney Airport, prior to the existing fence sections being removed.

5.7 Construction adjacent to movement area

The project encroaches into the Qantas Jet Base and several buildings are to be removed to accommodate the project. These include administration buildings and Building 167 which was formerly used for air cargo (but is now vacant). No aircraft movement areas would be impacted by the project.

Where any utilities serving the airport are affected, these would need to be protected, augmented or relocated as appropriate to maintain supplies to airport systems.

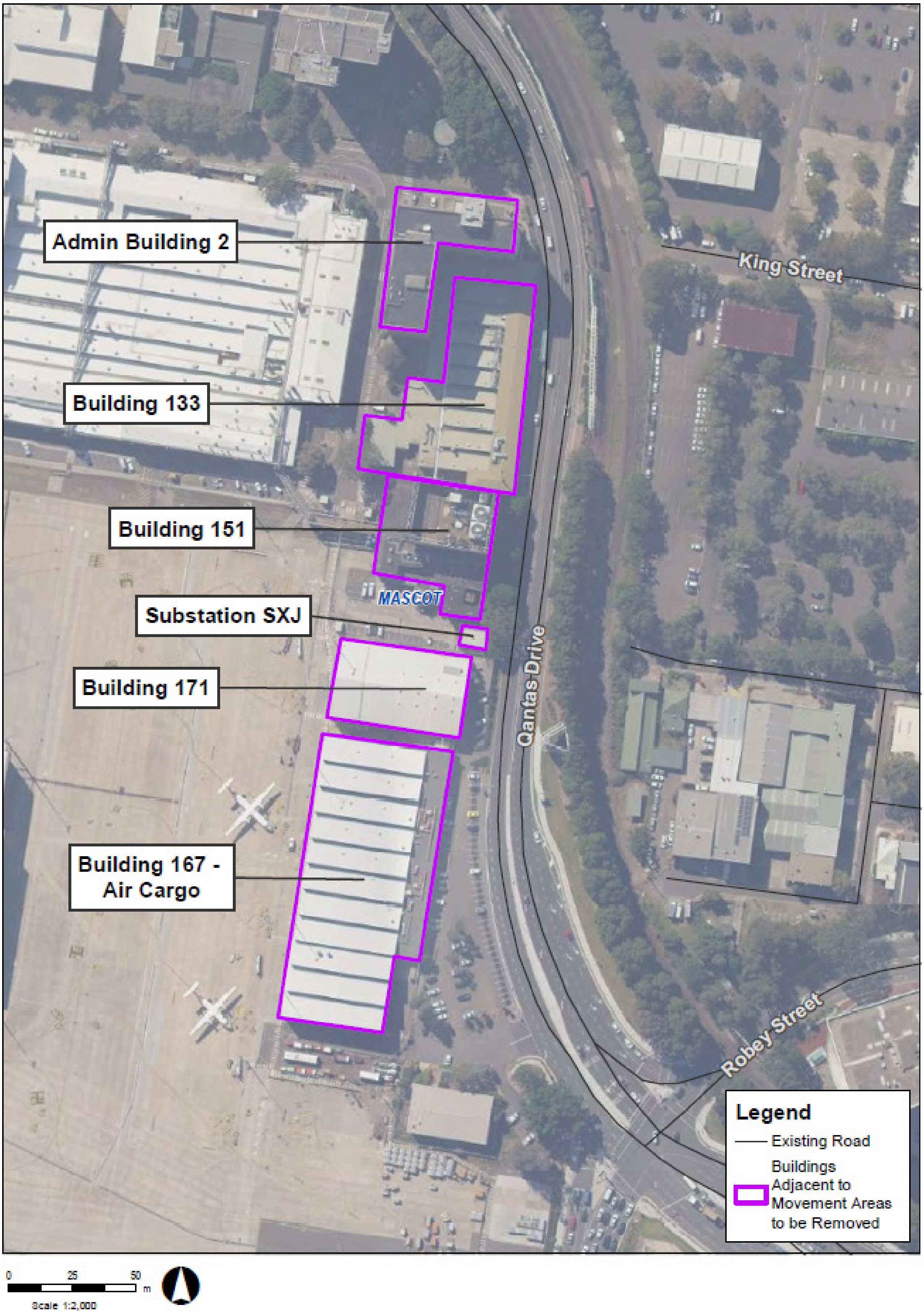

Figure 5-3 Buildings adjacent to aircraft movement areas to be removed

5.8 Summary of construction impacts and management strategies

Table 5-1 presents a summary of the potential construction impacts of the Sydney Gateway road project and relevant mitigation and management actions.

Table 5-1 Summary of potential construction impacts and management

Item	Potential impact and management strategies
Wildlife attraction/strike	Standard construction and waste management strategies should be developed to avoid attracting wildlife. All temporary and permanent drainage and sedimentation basins should be designed to be dry or netted. Routine observations of habituating birds should be undertaken. Coordination with the identification, reporting and management strategies outlined in Sydney Airport's Wildlife Management Plan. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Prescribed airspace intrusion	Construction plant and equipment should be controlled within acceptable height limits to avoid intrusions into airspace. Where intrusions are not possible to avoid, permits must be obtained from the Department of Infrastructure, Transport, Cities and Regional Development or its delegate prior to commencement. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Distraction of pilots from lighting	Evening and night-time works would be unavoidable due to constraints associated with the operation of Sydney Airport and to avoid road works during peak periods on major roadways. Construction lighting must adhere to the maximum intensities stipulated in the Civil Aviation Safety Regulations. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Dust or smoke affecting visibility	Standard dust control measures should be implemented to avoid visibility issues as prescribed in Technical Working Paper 4 – Air Quality. Contingency management plan for contingency events eg grass fires. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Interference with communications, navigations or surveillance equipment	Referral required via determining authority to Airservices Australia to allow them to undertake a detailed assessment as part of detailed design.
Security of the airside area	All adjustments to the airside fence would be undertaken by Sydney Airport Corporation and installed to the required specifications prior to the existing fence sections being removed. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Construction adjacent to movement areas	Several buildings would be removed in the Qantas Jet Base to allow for the increased road reserve. Access to airside/movement areas is to be suitably restricted at all times in consultation with Sydney Airport Corporation.
Impact to existing Sydney Airport utilities	Any Sydney Airport utilities affected by the works should be reprovisioned/relocated.

6. Assessment of operational impacts

The assessment of operation impacts follows the chronology of risks identified in section 3 and the methodology outlined therein.

6.1 Wildlife attraction/strike

Permanent above ground drainage infrastructure and landscaping within the project site has the ability to attract wildlife. Attraction of additional wildlife to the area potentially increases the risk of wildlife strikes with aircraft operating in the airspace near the airport. Artificial and natural lakes are classified as high risk wildlife attractants.

The project's operational infrastructure would include a flood mitigation basin on the western side of Alexandra Canal, immediately south of the Cooks River Intermodal Terminal and approximately 70 metres east of the Botany Rail Line. This basin would continue to be designed to remain dry, except for periods immediately after rainfall. As a result, it is not expected to attract wildlife such that there would be an increased aviation hazard. If this is not practical, netting should be used.

The vegetation species, locations and design of landscaping would be defined in the urban design and landscape plan for the project, which would be prepared in consultation with key stakeholders, including Sydney Airport Corporation. The plan would include consideration of relevant requirements and species lists under Sydney Airport's Wildlife Management Plan and other relevant guidelines, including the *National Airports Safeguarding Framework* and *Recommended Practices No. 1 – Standards for Aerodrome Bird/Wildlife Control* (International Birdstrike Committee 2006). Landscaping would be designed to minimise the potential to attract wildlife at levels likely to pose a hazard to aviation.

Overall, the risk of attracting wildlife during the operational phase of the project, with suitable mitigation such as netting where required, is considered negligible.

6.2 Prescribed airspace intrusion

6.2.1 Road infrastructure and vehicles

The finished height of the road as well as the vehicles using it must be below the OLS. As the road also passes over the Botany Rail Line and maintains minimum clearance to this infrastructure, there is a risk that the design road levels or vehicles using the road may encroach into the OLS.

As part of the design process, these constraints have been fully considered through interrogation of the 3D OLS design model provided by Sydney Airport Corporation. Designs were checked against the OLS as demonstrated in Figure 6-1 and Figure 6-2, remain below the OLS.

No infringement of structures into the OLS prescribed airspace was identified. Checking should also occur through subsequent design phases to ensure any changes made are compliant with the Airports (Protection of Airspace) Regulations.

The largest vehicle expected to travel along the Sydney Gateway road project is a 26 metre B-double. Transport for NSW defines the maximum permitted operation height of vehicles to be 4.6 metres. The concept design has included a clearance of 4.6 metres below the OLS to account for tall vehicles using the road so as not to encroach into the OLS. This would be reviewed and confirmed during detailed design.

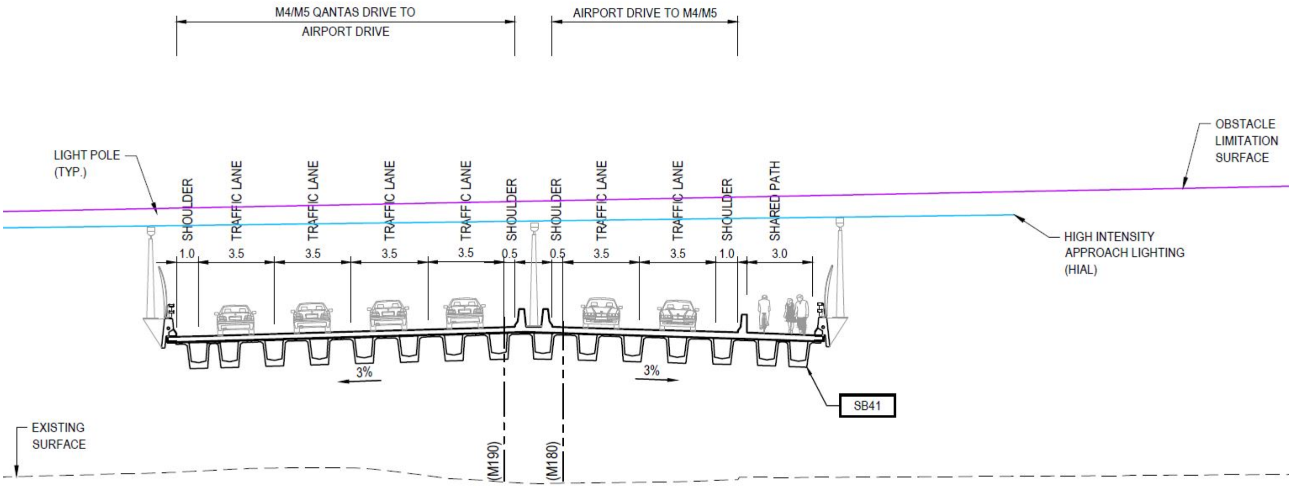

Figure 6-1 Typical elevated roadway section showing clearance to HIAL and OLS

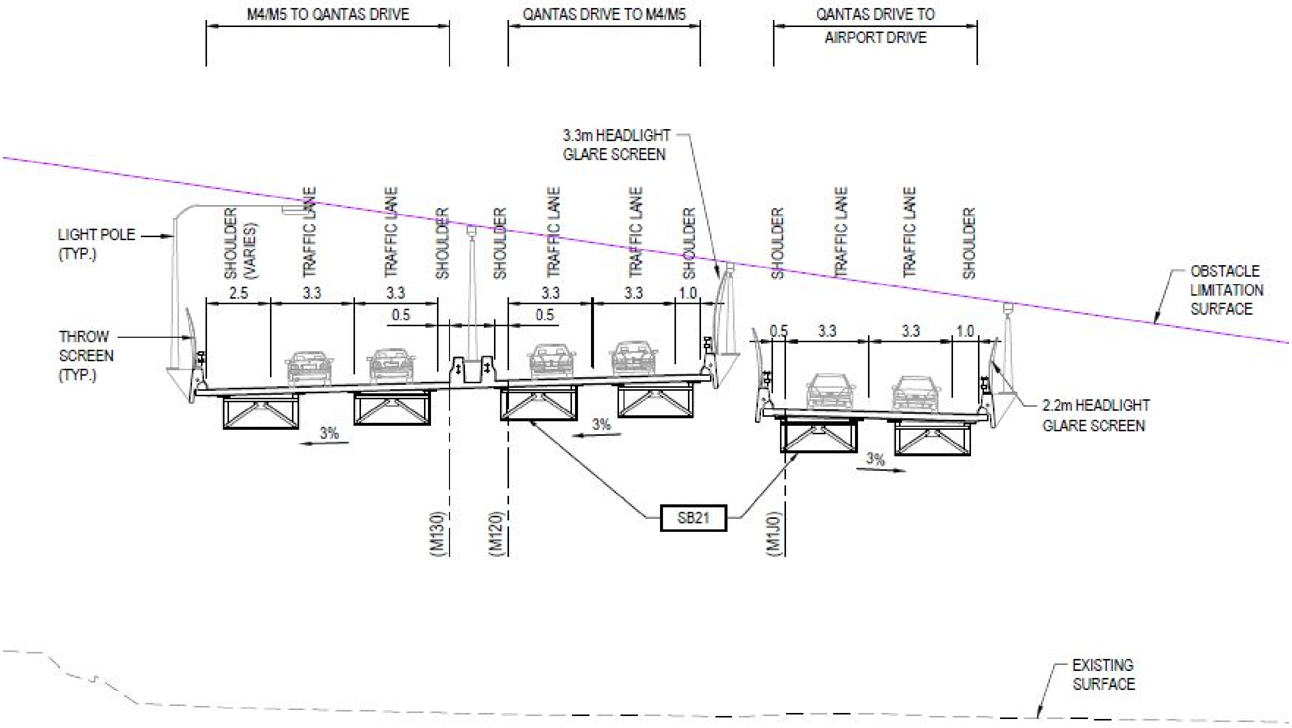

Figure 6-2 Typical section at bridges over Botany Rail Line showing clearance to OLS

6.2.2 Street furniture

The Sydney Gateway road project includes various road infrastructure and objects that are located above the finished road level. These include streetlights, power poles, variable message signs, overhead signage, etc. These objects can also be hazardous for arriving and departing aircraft if they protrude into the OLS.

As indicated above, the design was reviewed against the 3D OLS model provided by Sydney Airport Corporation included consideration of such structures and no infringements were identified. Checking would however need to be undertaken through subsequent design phases to ensure any changes made are compliant with the Airports (Protection of Airspace) Regulations.

6.3 Distraction of pilots by lighting

6.3.1 Headlights

Light glare from vehicle headlights has the potential to distract or confuse pilots as they are arriving at Sydney Airport.

Some sections of the road would require a risk assessment by CASA and Sydney Airport Corporation to determine the required shielding to diffuse the headlight glare. Based on the design checks performed as part of the reference design, shielding may need to be implemented on the following sections of roads indicated in Figure 6-3:

- Qantas Drive extension bridge
- Southern overpass in the St Peters interchange connection – between design chainage 325 to 380
- Northern lands access– between design chainage 530 to 620.

On these sections of road, the headlight glare can be diffused or screened by use of screening barriers combined with safety barriers. Many of these road sections are not in line with the HIAL or the runway alignment, and are therefore considered lower risk than areas where headlights have the potential to be confused with the HIAL.

Headlight glare from vehicles on the Northern lands access is perpendicular to the HIAL, heading in a south-easterly direction. Since the road is a private road on Sydney Airport land, and the traffic volume on the road during the night-time is expected to be minimal, the risk of headlight glare is considered to be minimal risk. It is recommended that Sydney Airport Corporation undertake a separate risk assessment for this section of road.

6.3.2 Streetlights

Glare from streetlights is generally a low risk of impact to aircraft operations. Upwards light spill from streetlights is controlled by *AS/NZS 1158.1.1:2005 Lighting for road and public spaces Vehicular traffic (Category V) lighting – Performance and design requirements* (SAI Global, 2005) and limited to 3 per cent. Adherence to this design standard should be adequate to minimise pilot distraction and should be specified as part of tender documentation for the project.

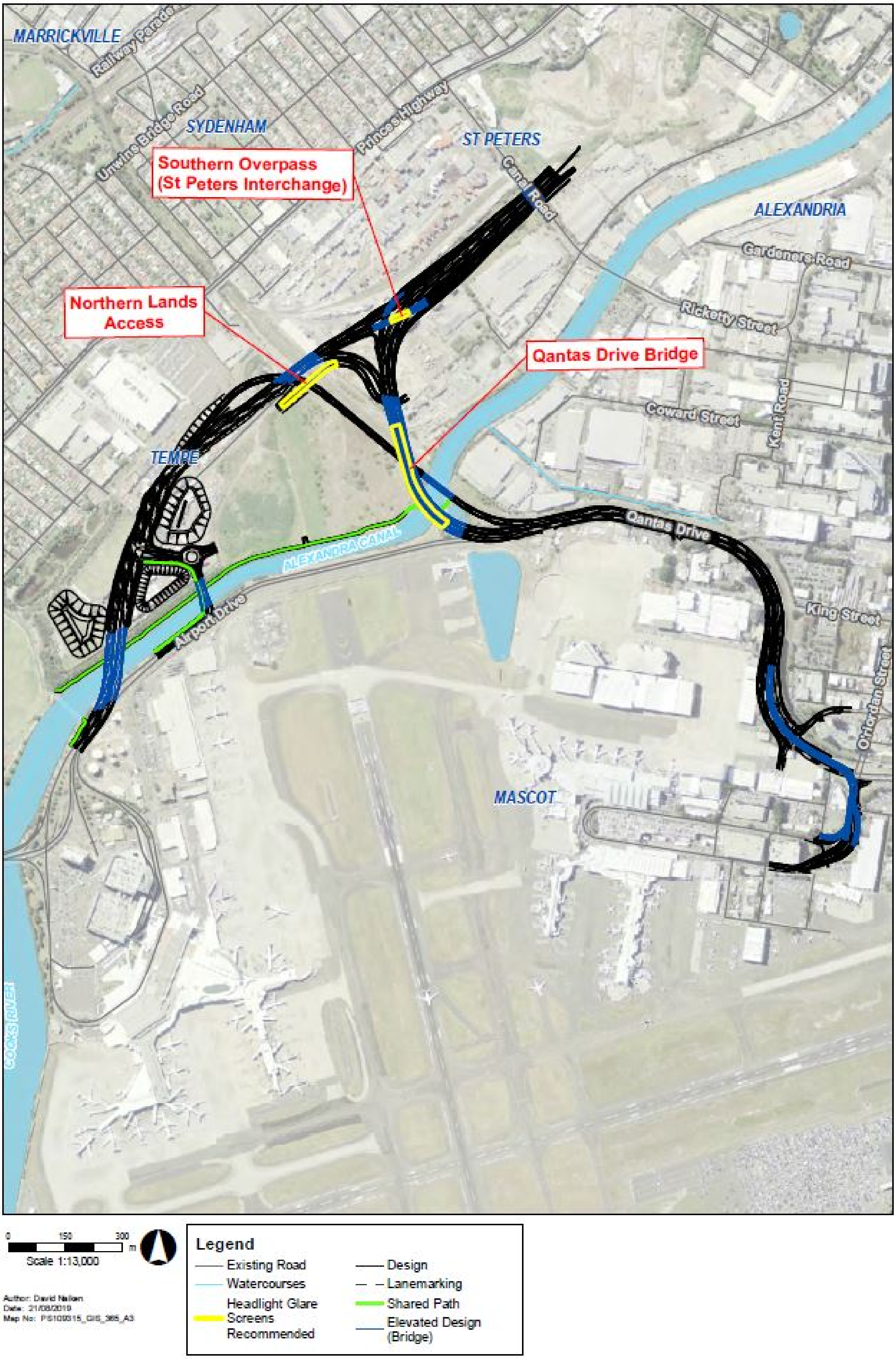

Figure 6-3 Indicative road sections where headlight shielding may be required

6.4 Windshear and turbulence

A detailed assessment of the potential effects of windshear and turbulence resulting from the project is provided in Appendix A.

6.4.1 Windshear

The NASF requires that the variation in mean wind speed over a distance of at least 100 metres, at heights below 61 metres (200 feet) due to wind disturbing structures, must remain below:

- 7 knots (3.6 metres per second) parallel to the runway centreline (the '7 knot along-wind windshear criterion')
- 6 knots (3.1 metres per second) perpendicular to the runway centreline (the '6 knot across-wind windshear criterion').

Wind tunnel testing of the project, including various preliminary emplacement mound options, was carried out for a number of representative wind directions. The results indicated that the 6 knot across-wind windshear criterion is the governing criterion. The lowest gust wind speeds required to exceed the criterion with the project present were between 44 and 47 knots (depending on the emplacement mound option).

Aeronautical Information Package Book, Park 2 – En Route (Airservices Australia, 2016) provides guidance to air traffic control regarding runway nomination based on the cross-wind and tail-wind components. The modelling indicated that the wind speeds required to exceed the 6 knot across-wind windshear criterion are well in excess of the operational cross-wind limits for operating the main north–south runway. In such winds, the use of the east–west runway is likely to be nominated for the landing of aircraft. As a result, the project is not expected to result in any windshear issues that would cause a hazard to landing aircraft.

6.4.2 Turbulence

The NASF criterion for turbulence is that the standard deviation of wind velocity at heights below 61 metres (200 feet) must remain below 4 knots (2.1 metres per second). The results of modelling showed that the gust wind speeds required to exceed the turbulence criterion were generally significantly lower than those required to exceed the windshear criteria.

The wind speeds required to exceed the turbulence criterion at all measured heights and for all tested wind directions were in excess of the cross-wind operational limit wind speed. In such winds, the use of the east–west runway is likely to be nominated for the landing of aircraft, in accordance with the requirements of Aeronautical Information Package Book, Part 2 – En Route (Airservices Australia, 2016).

The impact of the project on wind conditions on the approach to the north-south runway is considered to be minimal, based on the wind directions tested in the initial windshear and turbulence assessment.

The road infrastructure and landforms, including the mound options, were developed as part of the concept design and indicative construction methodology for the project. The road infrastructure and final landforms (including the mounds) would be reviewed and refined during detailed design to:

- Address aviation matters according to the "as low as reasonably practicable" principle
- Minimise the volume of material excavated from the former Tempe landfill
- Avoid disturbance outside the project boundary
- Enable compatible uses for remaining land within the project area.

In order to achieve the above requirements, alternative design for road infrastructure and different mound locations, heights and shapes would be considered. With respect to aviation, any revised road infrastructure and landforms would be assessed in relevant wind directions, in accordance with NASF Guideline B, to identify an optimal design configuration.

The optimisation process would address Sydney Airport operational requirements and occur in consultation with Sydney Airport Corporation, aviation stakeholders, and federal, state and local government agencies.

6.5 Interference with communication, navigation and surveillance equipment

Airservices Australia operates a number of radio navigation aids at Sydney Airport that provide guidance to aircraft operating in poor weather conditions. Airservices Australia also operates a number of surveillance systems that provide surveillance of aircraft in the air, and aircraft and vehicles operating on the ground at Sydney Airport.

To meet the performance requirements, airspace restrictions are established for each item of equipment and procedure. It may be possible under some circumstances (subject to detailed modelling and analysis by Airservices Australia) to permit infringements of the protective surfaces without degradation in system performance.

NASF Guideline G also seeks to protect communications, navigation and surveillance facilities off-airport. As the location of this infrastructure is not publically available, assessment by Airservices Australia would be required during detailed design and construction planning, on referral by the determining authority. This would apply to potentially affected navigation aids, radar departure assessment surfaces and the precision approach path indicator system.

Sydney Airport's prescribed airspace drawing (FSS 6934) 'Sydney Airport Navigational Aids Protection Surfaces' shows that the surfaces extend over the operational area for the project. It is possible there would be some infringements of the surfaces during operation. Assessment by Airservices Australia, as part of the planning approval process, would be required where infringements are unavoidable to determine any impacts on system performance. Infringements, and associated required mitigation measures, can only be confirmed by Airservices Australia.

6.6 Public safety areas

It is understood that no NSW legislation presently exists with respect to permissible off-airport land uses with respect to aircraft crash risk. However, the NASF Guideline I proposes that transport infrastructure be assessed in terms of the average density of people that may be exposed to risk due to an aviation incident.

Based on the traffic forecasts for the Project, during the course of a year, it is estimated that the average density of vehicles that would be present within the PSA (refer to Figure 3-7) would be approximately 13 per hour per square metre. Further work is required during detailed design to refine this calculation and assess in terms of people density. An 'as low as reasonably practicable' (ALARP) public risk assessment will then be undertaken. Additional factors such as the frequency of use runway 16R/34L and reduction of flights during the curfew hours would also be factored into this assessment as appropriate.

6.7 Summary of operational impacts

Table 6-1 presents a summary of the potential operational impacts of the Sydney Gateway road project and relevant mitigation and management actions.

Table 6-1 Summary of potential operational impacts and management

Item	Potential impact and management strategies
Wildlife attraction/strike	The project would add a flood mitigation basin which would be designed to be dry (or netted) to avoid attraction of wildlife. Landscaping to select species which are not bird attractants and coordinated with Sydney Airport Corporation. The potential impact is considered low.
Prescribed airspace intrusion	The concept design has been confirmed to be below the OLS, including consideration of street furniture and vehicles moving along the road. Additional checks should be undertaken during future design stages. Assuming mitigation and management measures are implemented, the potential impact is considered low.
Distraction of pilots from lighting	Headlights on identified sections of road have the potential to cause a distraction to pilots if not appropriately screened. A risk assessment and consultation with CASA and Sydney Airport Corporation should occur for some sections of road, although generally, as these sections of road to not parallel to the HIAL, the risk is considered low. Assuming mitigation and management measures are implemented, the potential impact is considered negligible. Street light glare should be effectively controlled by adopting design specifications within the relevant Australian Standard.
Windshear and turbulence	The results of wind tunnel testing (refer to Appendix A) indicates that the wind speeds required to exceed the 6 knot across-wind windshear criterion are well in excess of the normal operating and discretionary limits for operating the main north–south runway. In such winds, the use of the east–west runway is likely to be nominated for the landing of aircraft. As a result, the project is not expected to result in any windshear issues that would cause a hazard to landing aircraft The wind turbulence modelling indicated the Sydney Gateway road project would not have a significant effect on turbulence compared to existing conditions. The differences in gust wind speeds required to exceed the turbulence criterion between the tested project configurations and the existing situation are not considered to be substantial. Air traffic control has the option to nominate the east–west runway under unfavourable cross-wind conditions. Nonetheless, further windshear and turbulence assessment would be carried out as part of the detailed design in accordance with requirements of Guideline B National Airports Safeguarding Framework and any other relevant guidance. This would include consideration of the final proposed emplacement mounds within the former Tempe landfill site.
Interference with communications, navigations or surveillance equipment	Potential interference identified during checks performed on the design. Further checks to be performed during detailed design with detailed assessment to be undertaken by Airservices Australia on referral by the determining authority.
Public safety areas	The project passes through the public safety area associated with the runway. Detailed risk assessment to be undertaken during detailed design stage.

7. Cumulative impacts

7.1 Botany Rail Duplication

The Botany Rail Duplication includes the following potential impacts on airport operations, in relation to runway 07/25:

- Intrusion into prescribed airspace (both operation and construction phases)
- Potential lighting glare during construction and from train headlights during operation.

Similar to the Sydney Gateway road project, these issues are not expected to result in impacts on airport operations or aviation safety, so long as all relevant legislation and other guidelines are followed and close liaison with Sydney Airport Corporation and existing permitting processes are followed.

7.2 New M5 and M4–M5 Link

The New M5 comprises twin motorway tunnels between the M5 East Motorway (east of King Georges Road, Beverly Hills and Bexley Road, Bexley) and St Peters, including a new road interchange and upgrade of local roads, connecting to Campbell Road and Euston Road, St Peters and Gardeners Road, Mascot. The northern extent of the project would tie-in to the St Peters interchange. The New M5 is due for completion in 2020.

The M4–M5 Link comprises a new, multi-lane road link between the M4 East at Haberfield and the New M5. Construction of the M4–M5 Link is expected to be completed in 2023.

As any ventilation shafts associated with these projects have been assessed and approved by the Department of Infrastructure, Transport, Cities and Regional Development, and as there are no such plume rise concerns associated with the project, it is not considered that these developments would result in a material cumulative adverse impact on airport operations or aviation safety. There are no other elements of these projects which may present a cumulative impact with the project.

7.3 Other proposed major developments

An MDP was approved for the development of Ground Transport Solutions and a hotel at Sydney Airport in 2015. The MDP included assessment of the following potential impacts on aviation activities:

- Wind shear and turbulence
- Dust generation
- Plume rise
- Airport navigational aids and radar, including OLS.

No impacts on airport operations or aviation activities were identified.

Master Plan 2039 identifies a number of proposed developments for the Northern Land sector of Sydney Airport including:

- Airside aviation support activities, such as
  - Freight
  - Catering
  - Ground support equipment maintenance
  - Truck staging
  - Vehicle storage
- Landside and airside access connections
- New air freight facilities.

Sydney Airport Corporation will be responsible for developing these facilities in accordance with relevant legislation, including the NASF guidelines.

However, based on the expected nature of the above facilities and information available at this stage, it is not considered that these developments would result in a cumulative adverse impact on airport operations or aviation safety.

The Sydney Gateway road project is referenced in Master Plan 2039 as a key part of the development of ground transport and other facilities proposed at the airport over the next 20 years.

Cumulative impacts on communications, navigations or surveillance equipment would be considered by Airservices Australia as and when any additional developments are submitted for approval.

8. Recommended mitigation measures

The following table details how the potential impacts or risks discussed in this report would be addressed during construction and operation of the Sydney Gateway road project.

Table 8-1 Recommended mitigation measures

Issue/impact	Mitigation measure
Construction	
Wildlife strikes due to increased wildlife activity in the vicinity of the airport	Temporary and permanent drainage design should be designed to avoid ponding water that could attract birds. Landscaping design should not create high risk environments for attracting additional wildlife. The construction environmental management plan should include relevant waste management strategies to avoid the accumulation of litter and waste Routine bird monitoring should be undertaken in the Northern Lands area and coordination with Sydney Airport Corporation should occur regarding any necessary harassment measures and reporting for management of any issues. Working protocols and design should comply with NASF Guideline C.
Prescribed airspace intrusion	Detailed construction planning should consider alternative working proposals to avoid potential intrusion and ensure plant proposed is appropriate for working near the airport. Necessary approvals should be obtained as required by the Airports Act and Regulations, particularly for the use of cranes. Use of cranes must comply with NASF Guideline F.
Distraction of pilots from lighting	Detailed construction planning should ensure temporary lighting is appropriate for working near the airport. Construction lighting should comply with CASA MOS 139 section 9.21, and NASF Guideline E.
Dust/smoke affecting visibility	Standard dust control measures should be implemented during construction (refer to Technical Working Paper 4 – Air Quality) Standard dust control measures should be implemented during constructions (refer to Technical Working Paper 4 – Air Quality). Fugitive dust emissions from the proposed crushing and grinding plant should be controlled to within acceptable levels. A hot works permitting process should be adopted for work in the Airport Northern Lands in the former Tempe landfill area.
Interference with communication, navigation and surveillance equipment	A review of the detailed design should be undertaken to confirm extent of impacts on navigations aids, communications or surveillance equipment. Detailed assessment should be referred to Airservices Australia. A contingency management plan should be prepared containing procedures for responding to unplanned outages of services, particularly for critical airport infrastructure. NASF Guideline G requirements must be implemented.
Security of the airside area	Any adjustments to the airside fence should be planned and implemented in conjunction with the requirements of Sydney Airport Corporation. Generally, a new section of fence should be installed before any existing sections of fence are dismantled.

Issue/impact	Mitigation measure
Operation	
Wildlife strikes due to increased wildlife activity in the vicinity of the airport	Drainage and landscaping design should not create high risk environments for attracting additional wildlife.
Road infrastructure and vehicles infringing prescribed airspace	The road should be designed so as not to intrude into the prescribed airspace and in accordance with the OLS surface model provided by Sydney Airport Corporation. This should consider any street furniture such as street lights, signage, etc. Checks should be undertaken during detailed design to ensure all road infrastructure and vehicle heights are below the OLS and do not become hazardous for aircraft operating in the airspace.
Distraction of pilots from lighting	The vertical alignment of the roadway should be designed to minimise the amount of headlight upwards glare from vehicles. A risk assessment should be carried out for several road sections. Appropriate methods to diffuse and screen headlights from the view of arriving aircraft should be developed as required. Relevant approvals should be obtained from CASA and Sydney Airport Corporation as required. Street lights should be designed in accordance with AS/NZS 1158.1.1:2005 and vertical light spill limited to limits detailed in section 3.3.2 measured at 3° above the horizontal. Lighting should comply with CASA MOS 139 Section 9.21, and NASF Guideline E.
Windshear and turbulence	The road infrastructure and final landforms (including the mounds) will be reviewed and refined during detailed design to: ▪ Address aviation matters ▪ Minimise the volume of material excavated from the former Tempe landfill ▪ Maximise open space and community use opportunities ▪ Avoid disturbance outside the project boundary. In order to achieve the above requirements, alternative mound locations, heights and shapes will be considered. With respect to aviation, any revised mound options will be assessed in relevant wind directions, in accordance with NASF Guideline B, to identify an optimal mound configuration. The optimisation process will address Sydney Airport operational requirements and will occur in consultation with Sydney Airport Corporation, aviation stakeholders, and federal, state and local government agencies.
Interference with communication, navigation and surveillance equipment	A review of the detailed design should be undertaken to confirm whether impacts on navigations aids, communications or surveillance equipment would occur and what mitigation may be necessary. Referral to Airservices Australia for assessment should occur. NASF Guideline G requirements should be implemented.
Public safety areas	Review of density of occupation calculation and relevant factors in NASF Guideline I to be undertaken during detailed design.

9. Conclusion

Roads and Maritime proposes to construct and operate the Sydney Gateway road project, which is foreshadowed in the Sydney Airport Master Plan 2039. The project comprises new, direct high capacity road connections linking the Sydney motorway network at St Peters interchange with Sydney Airport's terminals and beyond. The new connections and increased road capacity would help improve traffic flow to Sydney Airport, towards Port Botany and beyond, making the movement of people and goods easier, safer and faster.

Various activities and infrastructure proposed as part of the project have the potential to impact operations at Sydney Airport (particularly the safety of aviation operations). Parts of the project are located on Commonwealth-owned land that is leased to Sydney Airport Corporation.

The potential impacts on airport operations and aviation safety have been investigated and analysed in this report. This has included a risk screening process and reference to relevant legislation and guidelines, including the NASF guidelines. Some of the identified risks and issues relating to the project, such as increases in dust that could affect visibility, impacts on ground transport operations, are addressed in other technical working papers for the combined EIS/preliminary draft MDP technical studies and were not considered by this assessment.

The assessment has concluded that with implementation of the recommended mitigation measures, including following existing approval processes for works in and around Sydney Airport, the potential risks would be low and readily manageable.

Construction of the project is identified in Master Plan 2039 and has been factored into planning for the airport's future development. In particular, the project is consistent with Chapter 16 on airport safeguarding procedures.

Adjustments to the HIAL are required and this work will be carried out by Sydney Airport Corporation and approval will be sought separately.

There are potential infringements into the communications, navigations and surveillance surfaces of the prescribed airspace that require detailed assessment by Airservices Australia.

Further analysis of the public safety area is required during detailed design.

10. References

Airservices Australia 2019, Aeronautical Information Package Book, Part 2 – EnRoute, May 2019.

Australian Transport Safety Bureau 2018, Aviation Occurrence Statistics – 2008-2017, AR2018-030, 21 December 2018.

Austroads, 2016, Guide to Road Design Part 3: Geometric Design, September 2016.

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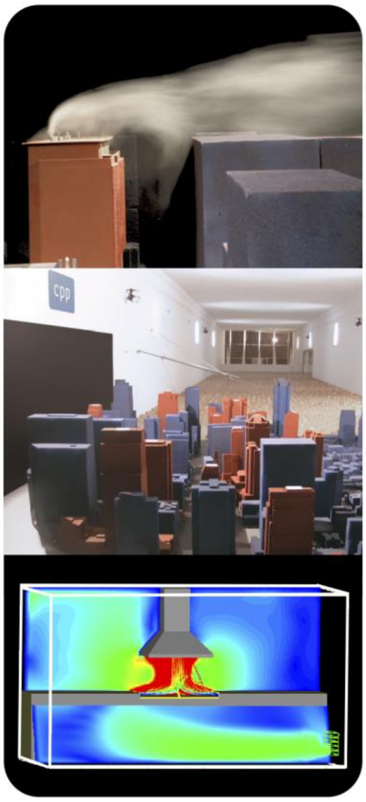
Appendix A
Results of wind tunnel testing for Sydney Gateway

CERMAK
PETERKA
PETERSEN

WIND ENGINEERING AND AIR QUALITY CONSULTANTS

Final Report



Wind Tunnel Tests for:

Sydney Gateway

NSW, Australia

Prepared for:

Roads and Maritime Services

101 Miller Street

North Sydney, NSW 2060

Australia

May 2019

CPP Project: 13049

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EXECUTIVE SUMMARY

A wind tunnel study was conducted to determine the effect of the proposed Sydney Gateway roads on wind conditions along the approach flight path to the existing Runway 16R at Sydney Airport. The threshold of the runway is close to the proposed roadway which is located within the assessment trigger area for this runway and penetrates the 1:35 surface. Therefore, a detailed assessment with regard to the potential of the proposed roadway to generate wind shear and wake turbulence affecting approaching aircraft was required.

A model of the runway approach was fabricated to a length scale of 1:750 with the runway approach approximately centred on the turntable in the wind tunnel. Replicas of the surrounding structures within an 1060 m radius were constructed and placed on the turntable. Testing was conducted for two configurations of the planned earth mounds to the west of the runway approach.

The wind tunnel testing was performed in the natural boundary layer wind tunnel of Cermak Peterka Petersen Pty. Ltd., St Peters. Appropriate approach boundary layer conditions representative of a suburban environment were established in the test section of the wind tunnel. The approach wind flow had appropriate turbulence characteristics as defined in Standards Australia (2011).

Measurements of wind conditions at various locations up to 60 m above ground level along the glide slope to the threshold of Runway 16R were made with hot-film anemometers at various heights and locations for critical wind directions. These measurements were used to predict the wind conditions caused by the proposed roadway, and to compare the level of wind shear and turbulence with design criteria. Measurements were also taken and assessed with the proposed roadway absent from the turntable to assess the specific impact of the proposed roadway on the wind conditions.

This report finds that the wind conditions along the approach to Runway 16R meet the DIRDC (2018) requirements for wind shear and turbulence at all times during Sydney Airport standard operational procedures, as defined in the AIP en route documentation (AirServices Australia, 2016) and excluding the local discretionary operational limit. Both the proposed and existing configurations exceed the turbulence criterion in individual locations when considering the local discretionary operational limit at Sydney Airport.

DOCUMENT VERIFICATION

Date	Revision	Prepared by	Checked by	Approved by
08/05/19	Initial release	JP	AVD	AVD

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1 INTRODUCTION

In the vicinity of areas of aircraft operations such as airports, a combination of strong runway cross winds and large structures near runways can create wind effects in the form of wind shear and turbulence that could affect aviation safety. Assessment of the acceptability of the wind environment near an airport is determined against the National Airports Safeguarding Framework (NASF) Guideline B (DIRDC, 2018), which outlines the maximum influence that a particular structure can have on the wind characteristics in the vicinity of operating aircraft.

CPP has been commissioned by Roads and Maritime Services to determine the influence of the proposed Sydney Gateway road project located close to the approach of the existing Runway 16R, Figure 1, on the wind characteristics in the vicinity of operating aircraft.

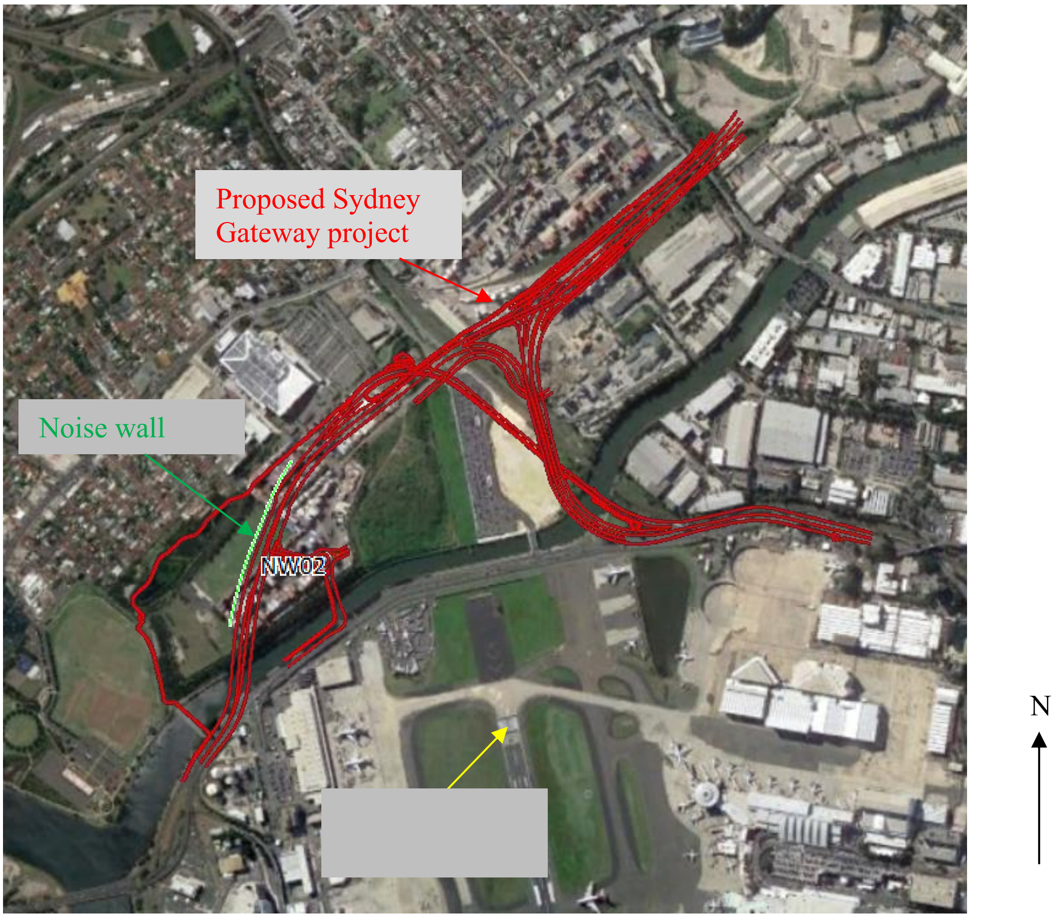

Figure 1: Aerial view with proposed roadway highlighted (Google Earth, 2018).

The proposed roadway is located north of the threshold to Runway 16R at Sydney Airport, Figure 1. The proposed roadway is elevated above ground level and comprises various bridges across Alexandria Canal and existing trainlines, as well as a 5 m high noise wall over a length of 400 m to the north-west, thereby the development penetrates the NASF 1:35 surface for Runway 16R, and hence a more detailed assessment is required to determine their impact on wind shear and turbulence for aircraft approaching this runway. The proposed development also includes two earth mounds west of the runway approach near Alexandria canal with heights of up to 13.5 m above existing ground level. Two options of these mounds were assessed in the wind tunnel testing, Figure 2.

Figure 2: Earth mounds: Option 2 (L), and Option 3 (R)

Operating requirements at Sydney Airport limit a gust cross-wind component to 10.3 m/s (20 kt), and a downwind component of 2.6 m/s (5 kt) as per the Aeronautical Information Package (AIP) Book, Part 2 – En Route (ENR) (AirServices Australia, 2016) with a local (Sydney Airport) discretionary limit of 12.9 m/s (25 kt), and a downwind component of 2.6 m/s (5 kt). The standard averaging time period for the wind gust speed provided by the Bureau of Meteorology and from AirServices Australia is a *"3-second average"*. The sampling frequency of the data is unknown, which could have a slight impact on the results presented herein.

There are six anemometers located around the airport near the threshold to each runway. When the measured gust wind speed is higher than the aforementioned cross-wind limit, the operating runway may be changed. For this study, it has been assumed that only one anemometer is used for the assessment of the wind speed, and that this is located in a similar turbulent environment to the landing aircraft. The typical approach speed of aircraft is between about 36 and 77 m/s (70 and 150 kt), which is significantly higher than normal operational wind speeds.

2 THE WIND TUNNEL TEST

Wind tunnel modelling requires special consideration of flow conditions to obtain similitude between the model and the prototype. A detailed discussion of the similarity requirements and their wind tunnel implementation can be found in Cermak (1971, 1975, 1976). In general, the requirements are that the model and prototype be geometrically similar, that the approach wind speed and turbulence profiles at the model have a similar profile shape to the full-scale flow, and that the Reynolds number for the model and prototype be equal. Due to modelling constraints the Reynolds number cannot be made equal and all testing was conducted to the requirements of Australasian Wind Engineering Society Quality Assurance Manual (2001). For this project, modelling the Reynolds number is not critical as the flow characteristics are considered to be Reynolds number independent and it is the wind profiles and spectral content of the flow that is paramount to model.

The testing was performed in the boundary layer wind tunnel shown in Figure 3. This wind tunnel has a 16 m long, 3.0 m wide, by 2.4 m high test section, with a porous slatted roof for passive blockage correction. The floor of the test section is covered with roughness elements, preceded by a vorticity generating fence and spires to reproduce at model scale the atmospheric wind characteristics required for the model test. The spires, barrier, and roughness were designed to provide a modelled atmospheric boundary layer approximately 0.6 m thick with a mean velocity and turbulence intensity profile, and distribution of turbulent energy similar to that expected to occur in the region approaching the modelled area. The approach wind characteristics used for the model test are shown in Figure 4. As the mean wind speed and turbulence characteristics in the wind tunnel have been scaled to model full-scale conditions, and assuming these conditions are independent of wind speed, the results presented are valid for all wind speeds.

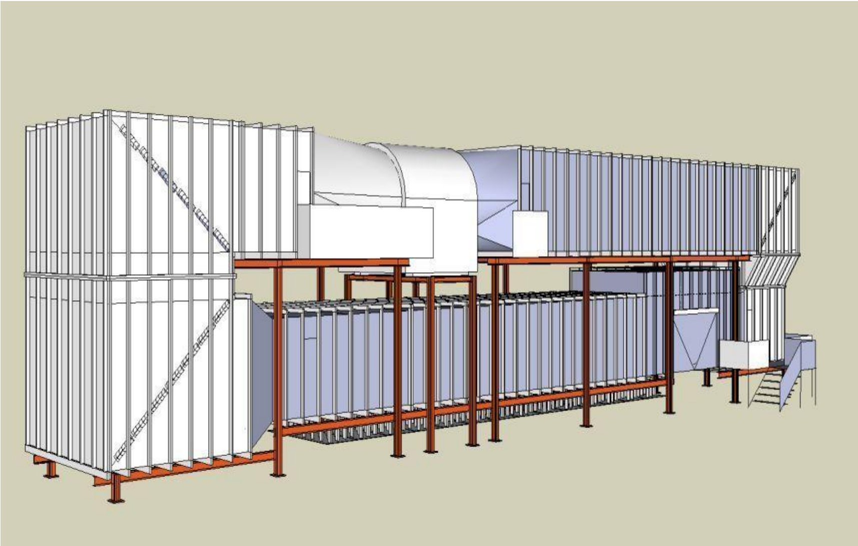

Figure 3: Schematic of the closed-circuit wind tunnel.

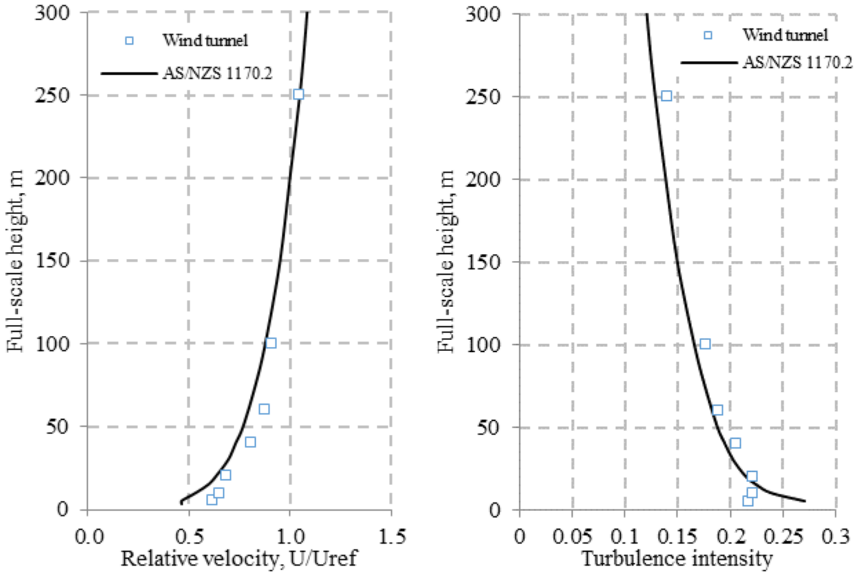

Figure 4: Mean velocity and turbulence profiles approaching the model.

Wind velocity and turbulence profiles are developed from the ground up with changing roughness. The distance required to fully develop a boundary layer after a change in roughness is considerable. Hence, for winds moving across the relatively flat open areas of the airport precinct, a transition boundary layer profile will be developed with reduced levels of near ground turbulence, but unchanged at higher altitudes. In the context of the current study, it is important to note that in the wake region of the relatively isolated modelled building structures, the measured turbulence levels will be dominated by the turbulence generated from wind flow over these structures. It should be noted that these profiles are for extreme wind events and at lower wind speeds, the turbulence characteristics can increase or decrease depending on the meteorological wind event.

For analysis purposes, it is important to appreciate the difference between wind shear and mechanical turbulence to enable a reasonable interpretation of the wind tunnel testing results conducted on the proposed configurations. A brief discussion is included in Appendix 3.

A model of the runway approach and surrounds were constructed to a length scale of 1:750, which was consistent with the modelled atmospheric flow, permitted a reasonable test model size with an adequate portion of the adjoining environment to be included in a proximity model, and was within wind tunnel blockage limitations. The turntable layout and tested wind directions are presented in Figure 5, with further details and the results of all testing presented in Appendix 2. A representative layout of shipping containers stacked up to 6 containers high in the storage area east of the runway approach, north of the proposed roads was included in the wind tunnel model as requested by Roads and Maritime Services.

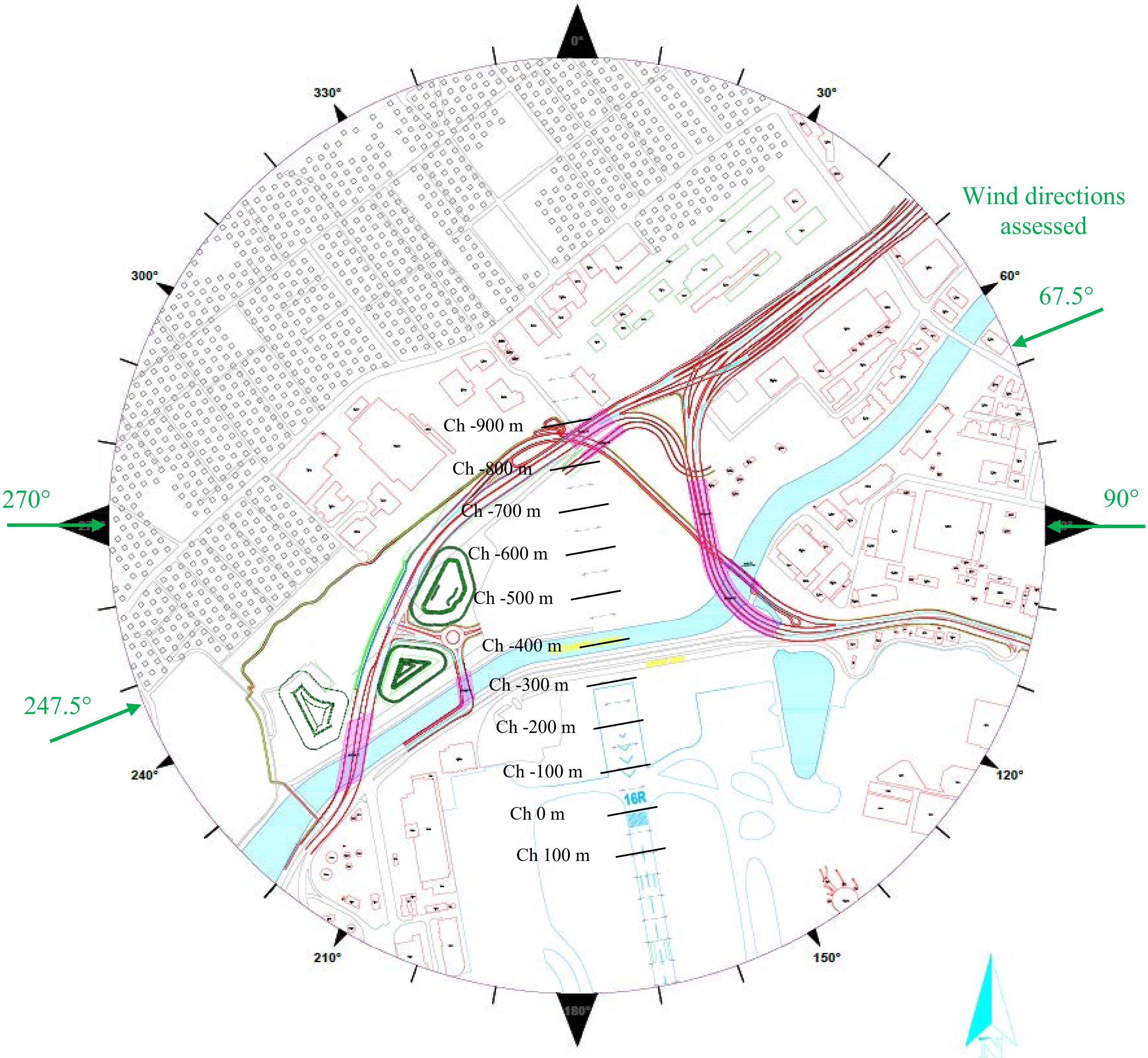

Figure 5: Wind tunnel model with proposed Sydney Gateway (both mound options shown)

The model was mounted on a turntable located near the downstream end of the wind tunnel test section, Figure 6. Additional photos of the model are shown in Appendix 1. The turntable permitted rotation of the modelled areas for examination of wind speeds from any approach wind direction.

Figure 6: Sydney Airport model including the proposed Sydney Gateway in the wind tunnel.

3 DATA ACQUISITION

3.1 Velocity measurements

Wind speed profile measurements were taken to verify that appropriate boundary layer flow approaching the site was established. All wind speed measurements were made with hot-film anemometers, which were calibrated against a Pitot-static tube in the wind tunnel. The calibration data were described by a King's Law relationship (King, 1914).

Mean wind speed and turbulence intensity profiles for the boundary layer flow approaching the model are shown in Figure 4, as measured at the centre of the turntable. Turbulence intensities are related to the local mean wind speed.

The velocity signals were sampled for a period corresponding to about 4 hours in prototype (but representative of a self-stationary random data set of 1 hour duration within the micrometeorological peak) to obtain the mean and standard deviation of wind speed for comparison with the available wind shear and turbulence criteria.

It is evident from the body of research into wind flow around bluff features that the local wind flow pattern will change considerably up to about 5 times the height of the feature downstream of the downstream edge of the structure. Further downstream, the turbulence generated by the structure is dissipated through viscous effects and the far field flow pattern is expected to be relatively constant.

NASF Guideline B (DIRDC, 2018) requires testing for all relevant wind directions, in increments of 22.5°, that intersect the structure and the runway centreline at chainages between -900 m and 500 m. To rationalise the extent of testing, the area directly downstream of the proposed roadway was tested for critical wind directions for Runway 16R, as discussed below.

The primary critical wind directions for Runway 16R are considered to be 90° and 247.5° for this test, which are closest to a pure crosswind and have a slight headwind component for approaching aircraft, hence most likely to affect aircraft operations. Longitudinal wind speed profiles were measured in a matrix of typical operational locations along and above (up to 60 m above ground level) the 3° glide slope to the threshold of Runway 16R as per the test location plan, Figure 7. Following the glide slope to the threshold rather than the touchdown point would include testing slightly underneath the usual flight path of landing aircraft, and would hence cover an area that may occasionally be used for lower than usual approaches. The testing for the secondary wind directions of 67.5° and 270° with a slight downwind component was conducted for a similar range of locations directly downwind of the proposed roadway, Figure 7.

Test locations are 100 m apart horizontally, and 5 m apart vertically, for ease of analysis with the available criteria.

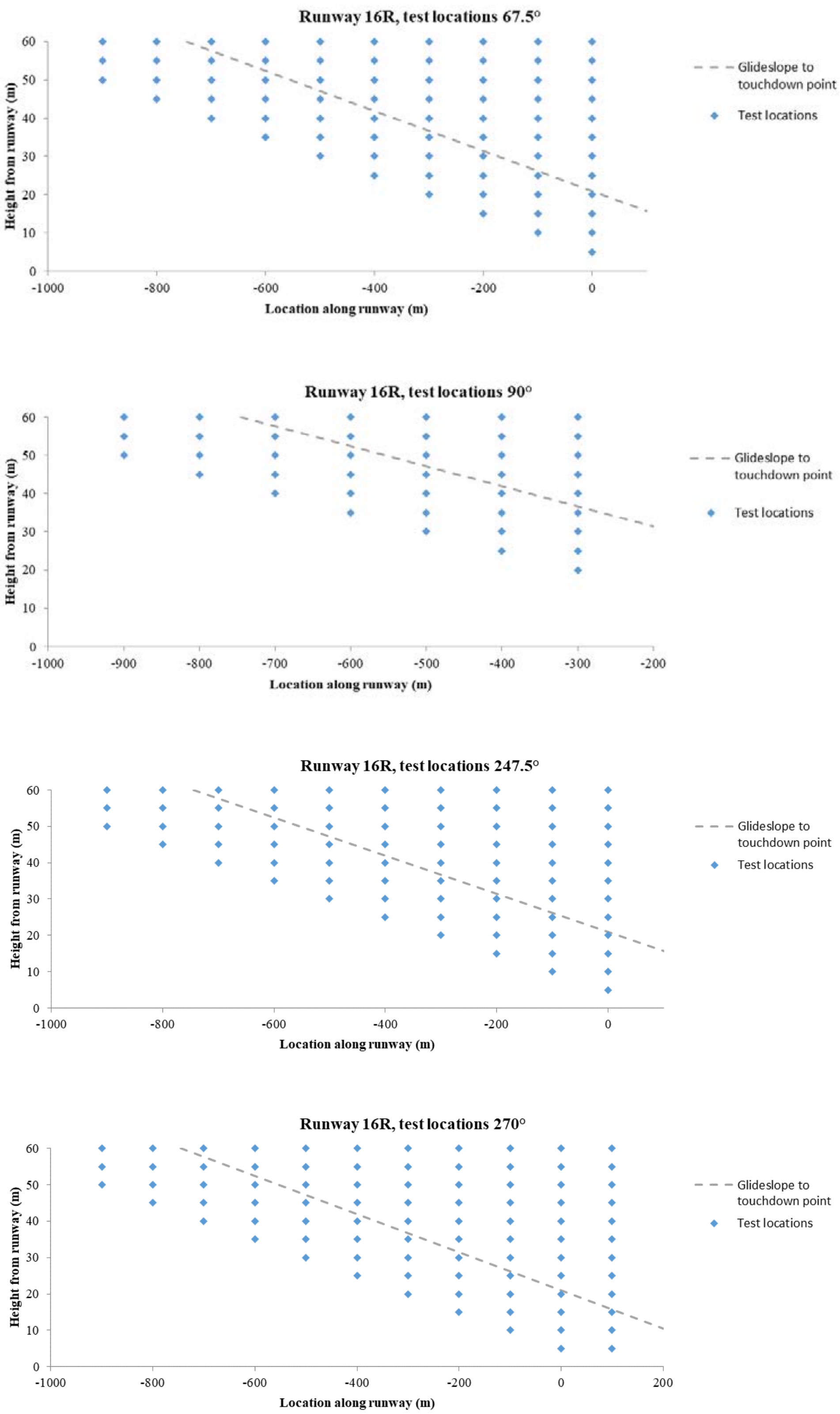

Figure 7: Test locations for Runway 16R at 67.5°, 90°, 247.5°, and 270°.

These wind directions were selected as they are the ones most likely to cause mechanical turbulence and corner vortices generated by the subject structures, which could impact aircraft operations. Other wind directions intersecting the proposed roadway and the runway centreline in the assessment trigger zone either have a significantly larger distance between the elevated roadways and runway centreline or have a significant tailwind component and landing would therefore be conducted in the opposite direction. Wind directions 67.5° and 90° were only tested once for mound option 2, as the earth mounds are located west of the runway approach, that is downwind of the extended runway centreline for these wind directions.

Due to the variability in the wind, the results reported herein for the mean wind speed and turbulence intensity values are considered accurate to within 5% respectively, based on the assumption that the modelled flow matches the theoretical predictions of different storm events. This is considered reasonable as the natural variability in wind characteristics at these lower wind speeds will be greater than these values.

4 WIND SHEAR AND TURBULENCE CRITERIA AND RESULTS

Wind speed profiles at several heights were tested along the runways downwind of the subject structure. The specific locations and chainages tested for the various wind directions are presented in Figure 7. The mean lateral and vertical wind velocities were generally below 10% of the longitudinal wind velocity and therefore will not be discussed further as these would not be expected to cause any significant issues for landing aircraft.

With standard approach profiles for mean wind speed and turbulence, wind conditions in the natural wind have the potential to cause wind shear and turbulence issues for landing aircraft. The 3 s gust wind speed in knots, measured at an anemometer location at a height of 10 m in similar approach conditions, required to create wind conditions that would exceed the DIRDC (2018) wind shear and turbulence criteria are presented in Figure 8. The criteria allow a maximum wind shear of 3.1 m/s (6 kt) in the cross-wind direction, and 3.6 m/s (7 kt) in the along-wind direction over a distance of 100 m, and a maximum standard deviation of wind speed of 2.06 m/s (4 kt). It is evident that the natural turbulence in the wind is more important than wind shear for aircraft operations with regard to these criteria.

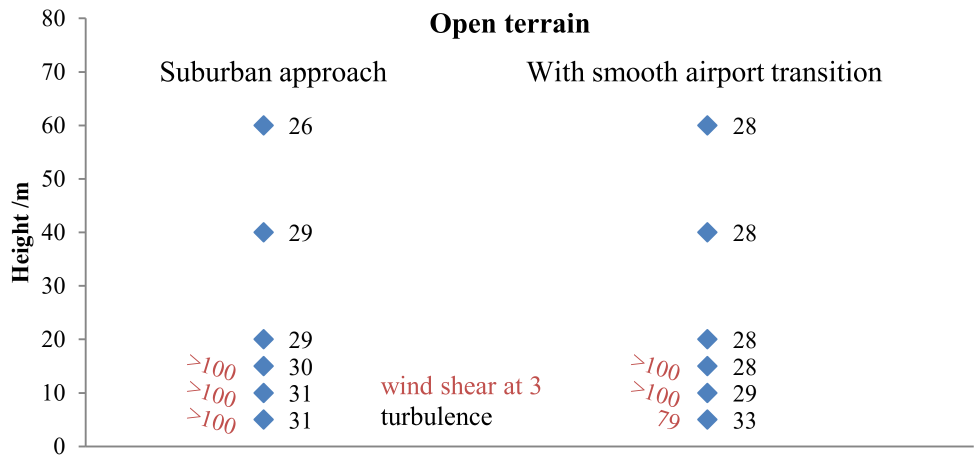

Figure 8: Results for standard approach roughness conditions.

4.1 Background of the criteria

The criteria contained within the recent update of the NASF Guideline B (DIRDC, 2018) are based on research conducted by the Dutch NLR Air Transport Safety Institute and is detailed in Nieuwpoort (2010). The Dutch NLR Air Transport Safety Institute define a turbulence criterion with the standard deviation of the flow velocity limited to 2.1 m/s (4 kt) as well as wind shear criteria of 3.6 m/s (7 kt) and 3.1 m/s (6 kt) in the along-flight and cross-flight directions respectively. These criteria are based on a range of studies including observation of pilots in flight simulators and were found to be appropriate for a wide range of jet aircraft sizes bounded by the Boeing 747 and Fokker 100. The criteria have not been developed for General Aircraft. The Dutch guidelines for turbulence and wind shear are primarily for landing aircraft; “Because aircraft are much more vulnerable to disturbed wind velocity profiles during the final stage of the approach than during take-off only the effects on approaching aircraft have been considered.”. Private communication with staff who were involved with the research into the turbulence criteria developed at the Dutch NLR Air Transport Safety Institute have indicated that the effect of turbulence on departing aircraft is not well quantified, but from experience “that during take-off an aircraft may be able to cope with around 30% higher wind disturbances than during landing.”, Geest (2012). Thus, for departing aircraft, if this advice were to be adopted, a limiting standard deviation of wind speed of 2.7 m/s (5.2 kt) would be appropriate.

4.2 Wind shear

The NASF Guideline B (DIRDC, 2018) wind shear criteria state that the mean wind speed difference in the cross-flight direction between two locations 100 m apart should be less than 3.1 m/s (6 kt), and 3.6 m/s (7 kt) in the along-flight direction. This matches the wind shear criteria specified in the Dutch criteria. The minimum gust wind speed at the anemometer location, in knots, required to exceed these criteria are presented in Figure 13 to Figure 22 in Appendix 2. The gust wind speed causing exceedance of the wind shear criterion between two locations along the glideslope are noted in orange and between two horizonal locations in green. The results shown are the minimum gust wind speeds required to exceed the cross-flight and along-flight criteria. The cross-flight criterion was dominant for all test locations and wind directions, with the wind speeds causing an exceedance of the along-flight criterion being higher than the reported cross-flight values.

The reported 3 s gust at the anemometer is in the direction of the mean wind speed and has not been converted into an along-flight, or cross-flight component. The conversion from the measurements to the anemometer location assumes the control anemometer is sited in the same turbulence conditions as the approach flow for that wind direction, and that the operational criterion is based on a gust wind speed of 3 s duration, as provided by the Bureau of Meteorology, and Airservices Australia.

All anemometer gust wind speeds presented in Figure 13 to Figure 22 for wind shear are higher than the standard operational wind speed at the airport of 20 kt in the cross-flight direction, and the local discretionary limit of 25 kt, and thus represents no impact to standard aircraft operations. A pure cross-wind direction would be 78° or 258° for Runway 16R, so the equivalent operational limits would be wind speeds of approximately 20-21 knots for the tested wind directions of 67.5°, 90° 247.5°, and 270° (25-26 knots including the discretionary limit). From the wind tunnel testing the lowest gust wind speed required at the anemometer to exceed the NASF wind shear criterion with the proposed roadway present in the wind tunnel model was found to be 44 kt for mound option 2 and 47 kt for mound option 3. With the roadway absent, the lowest gust wind speed required to exceed the NASF wind shear criterion was found to be 50 kt.

In terms of compliance with NASF Guideline B wind shear criteria, both the configurations with and without the proposed roadway and mounds pass, and as such the roadway and earth mounds would notbe expected to produce any operational issues to aircraft from a wind shear perspective.

4.3 Turbulence

The recent update of the NASF Guideline B incorporated the turbulence criterion as defined in the Dutch criteria. The landing criterion has been used for all wind directions. The relationship between the criterion level and the required wind speed to exceed the criterion is linear; therefore, if the criterion were raised to 5.2 kt for departing aircraft, in line with the advice from Geest (2012), then the required wind speed to exceed the criterion would be the values presented in Appendix 2 multiplied by 1.3.

The 3 s gust wind speed in knots, at an anemometer height of 10 m located in similar approach turbulence conditions, required to generate a turbulence level in the horizontal plane of 2.1 m/s (4 kt) at all relevant locations are presented in the black font in Figure 13 to Figure 22 of Appendix 2. The 3 s gust is in the direction of the mean wind speed and has not been converted into an along-flight, or cross-flight component.

The gust wind speeds required to exceed the turbulence criterion are generally significantly lower than those required to exceed the mean wind shear criteria, though are higher than the standard 20 kt cross-wind operational limit wind speed at all heights and for all tested wind directions. Both the proposed and existing configurations exceed the discretionary limit in individual points with the lowest gust wind speeds required to exceed the turbulence criterion being 24 kt (mound option 2) and 25 kt (mound option 3) for the proposed configuration and 24 kt for the existing configuration. The differences in the anemometer gust wind speeds required to exceed the NASF turbulence criterion between proposed and existing configurations are considered insignificant.

5 CONCLUSIONS

Wind tunnel model tests of the proposed Sydney Gateway roads and bridges at Sydney Airport were conducted to determine the wind characteristics in the vicinity of operating aircraft on the approach to the runway at Sydney Airport. Tests were conducted for aircraft operating along Runway 16R in areas considered most likely to be affected by the presence of the proposed roadway for the critical wind directions. Based on standard operating procedures at the airport as per AIP Book (AirServices Australia, 2016), wind conditions would not exceed the NASF Guideline B (DIRDC, 2018) wind shear or turbulence criteria. Both test configurations are slightly exceeding the turbulence criteria when taking into account the local discretionary operational limit at Sydney Airport. The impact of the proposed roadway on wind conditions on the approach to Runway 16R is considered to be minimal from an aircraft safety perspective.

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Appendix 1: Additional photograph of the CPP wind tunnel model

Figure 9: Existing Sydney Airport model without proposed roadway in the wind tunnel viewed from the east.

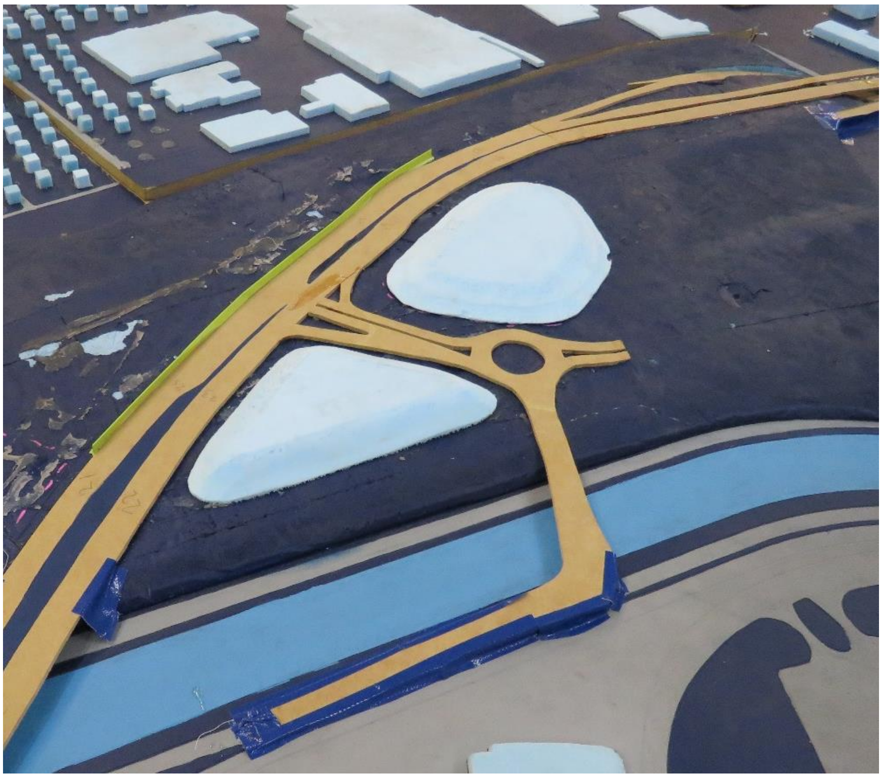


Figure 10: Close up photograph of the wind tunnel model – mound option 2.

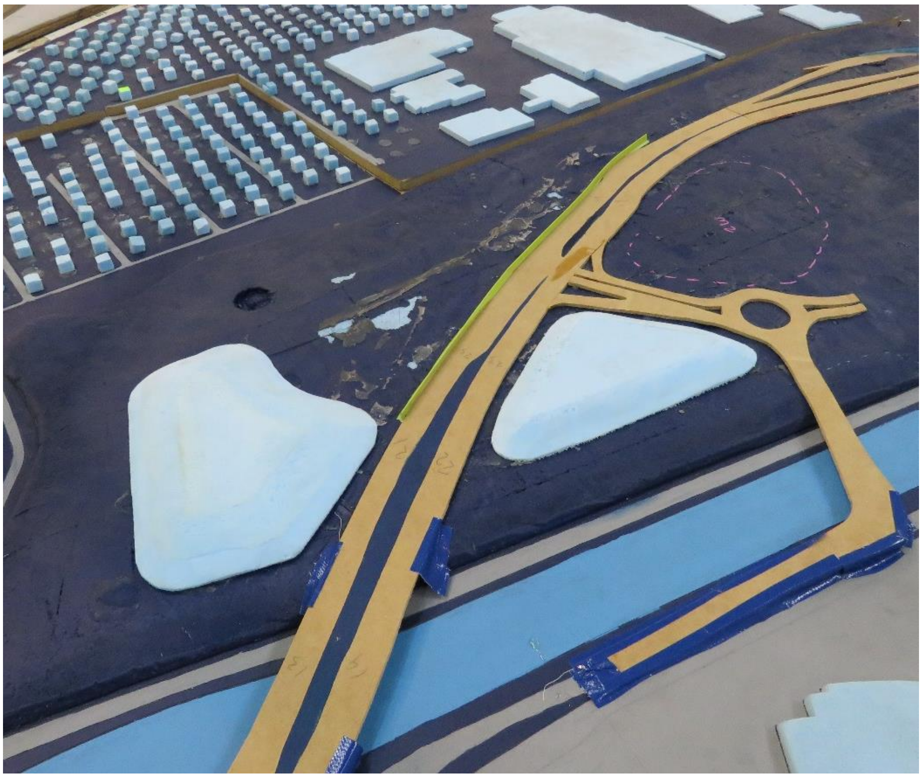


Figure 11: Close up photograph of the wind tunnel model – mound option 3.

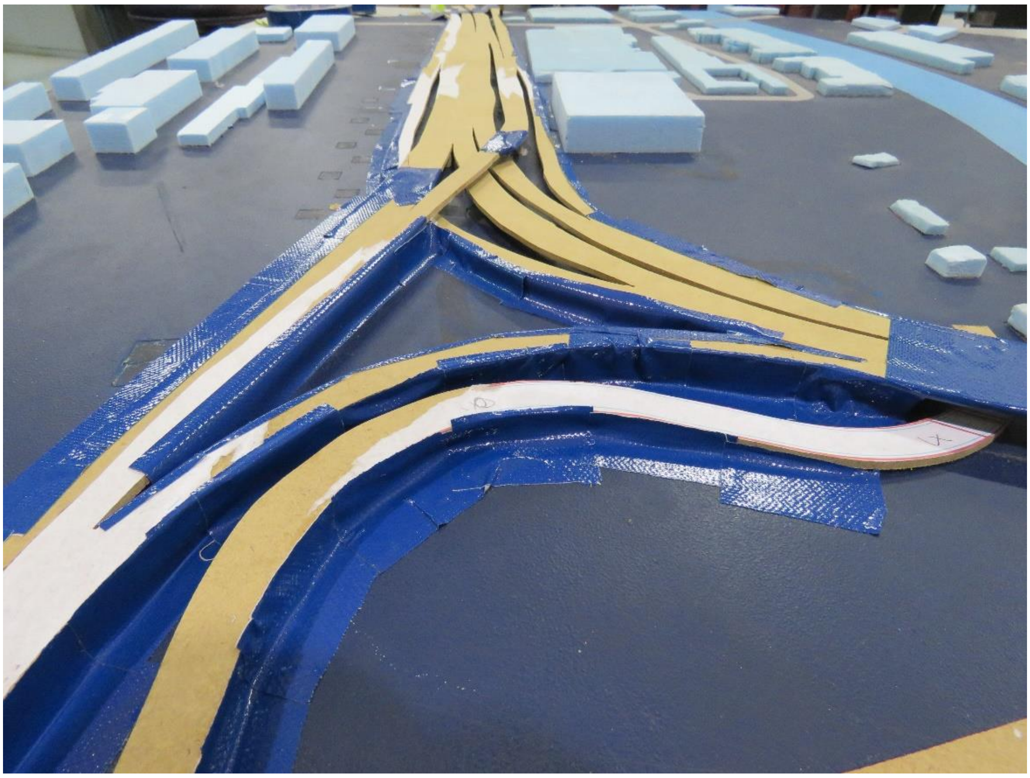
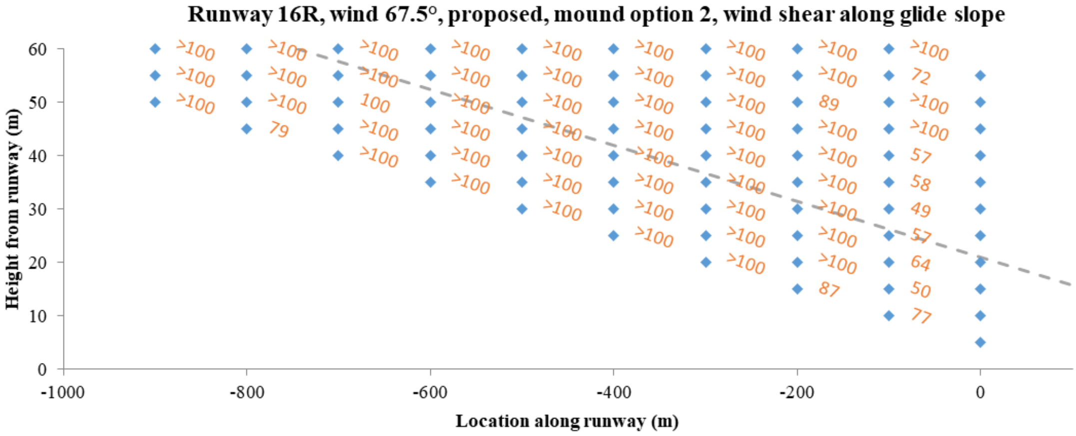
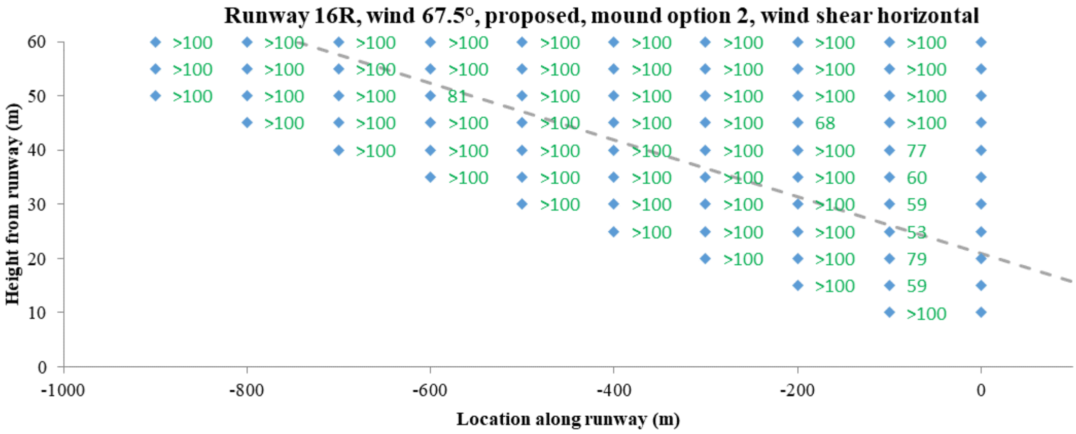


Figure 12: Close up photograph of the wind tunnel model.

Appendix 2: Test configurations and results





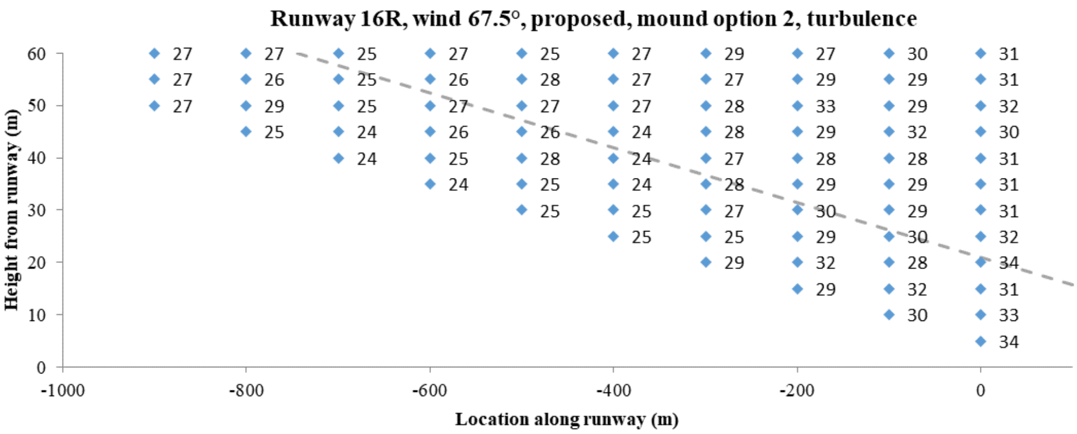


Figure 13: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 67.5° wind direction, proposed configuration (mound option 2).

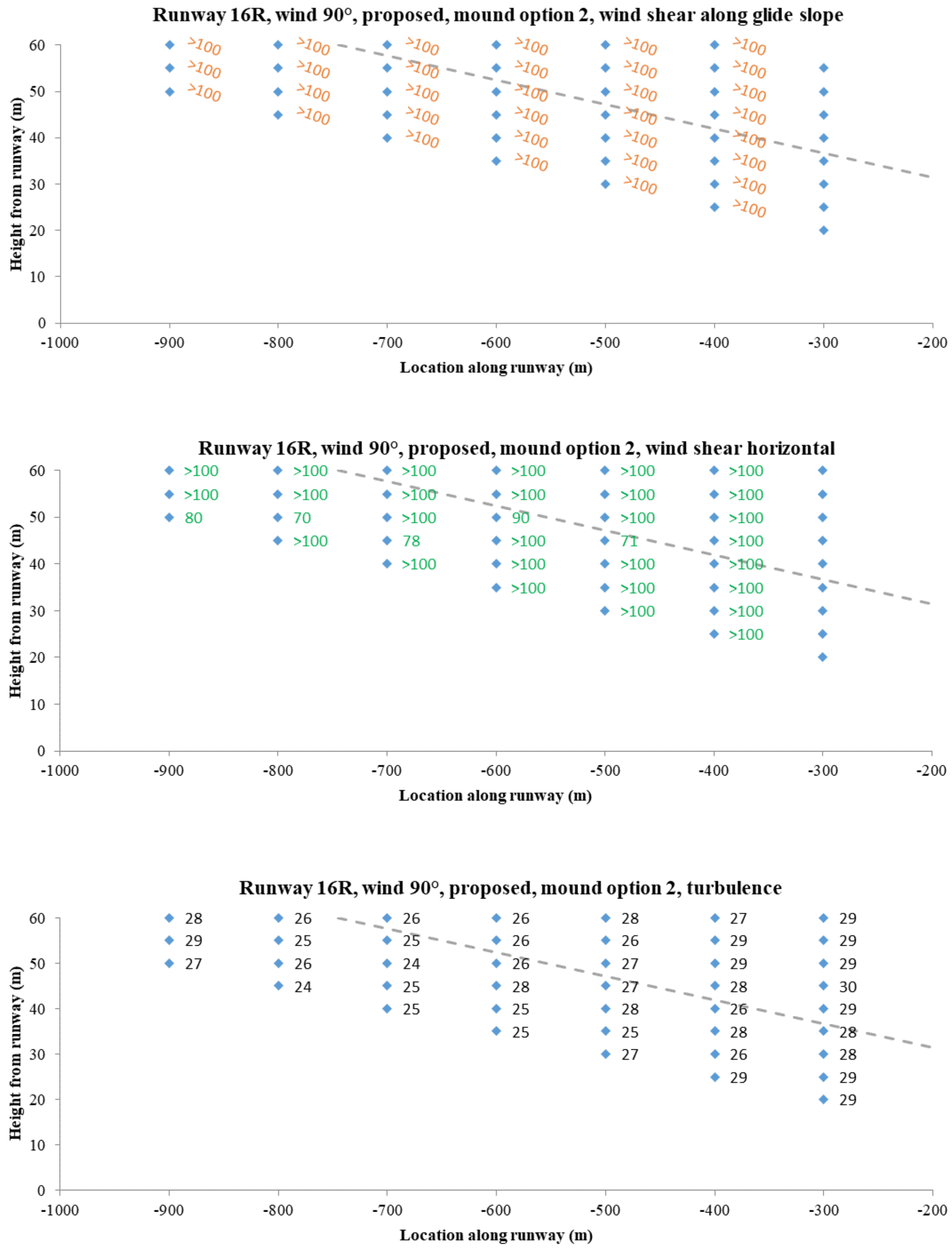
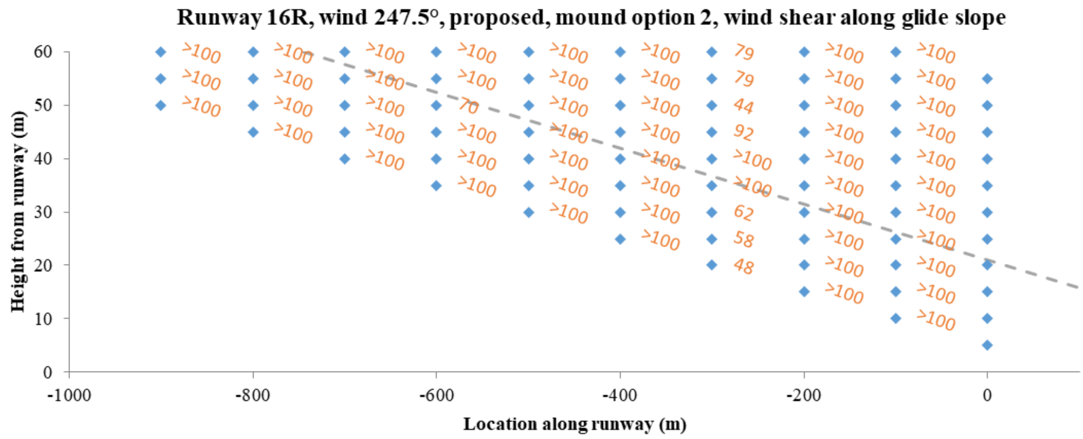
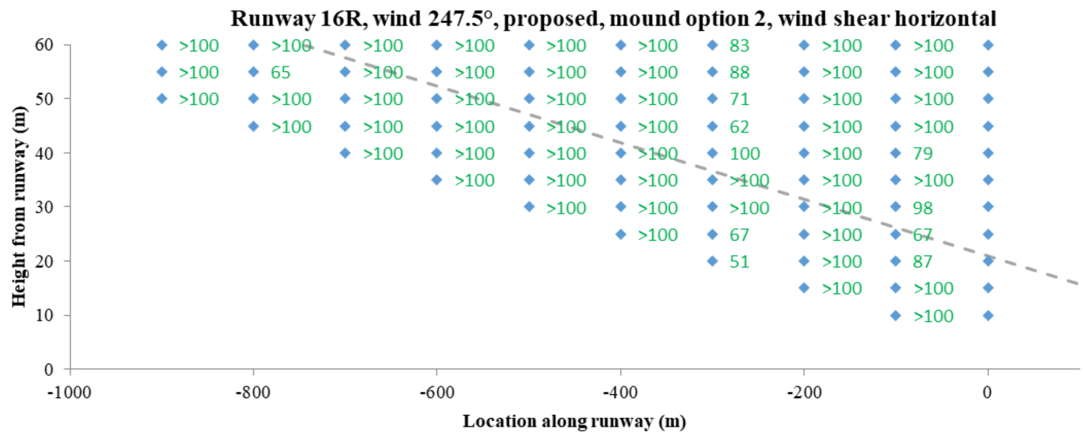


Figure 14: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 90° wind direction, proposed configuration (mound option 2).





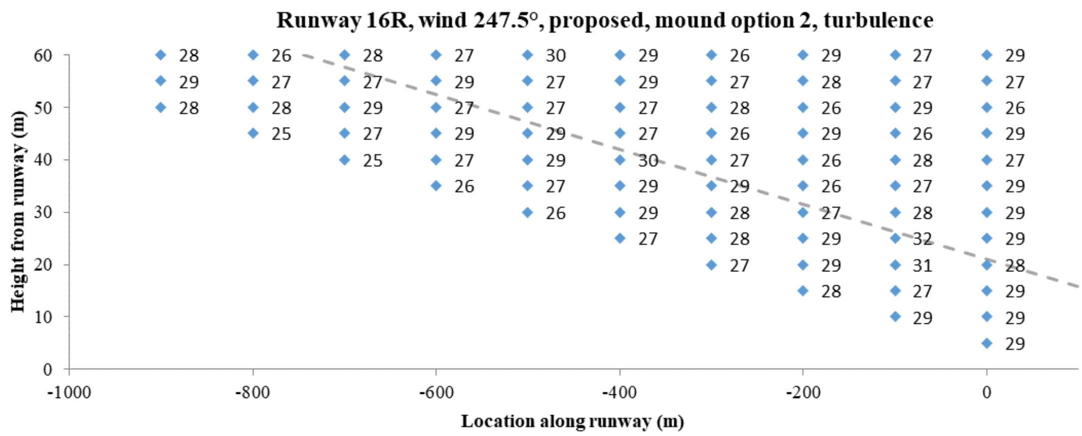


Figure 15: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 247.5° wind direction, proposed configuration (mound option 2).

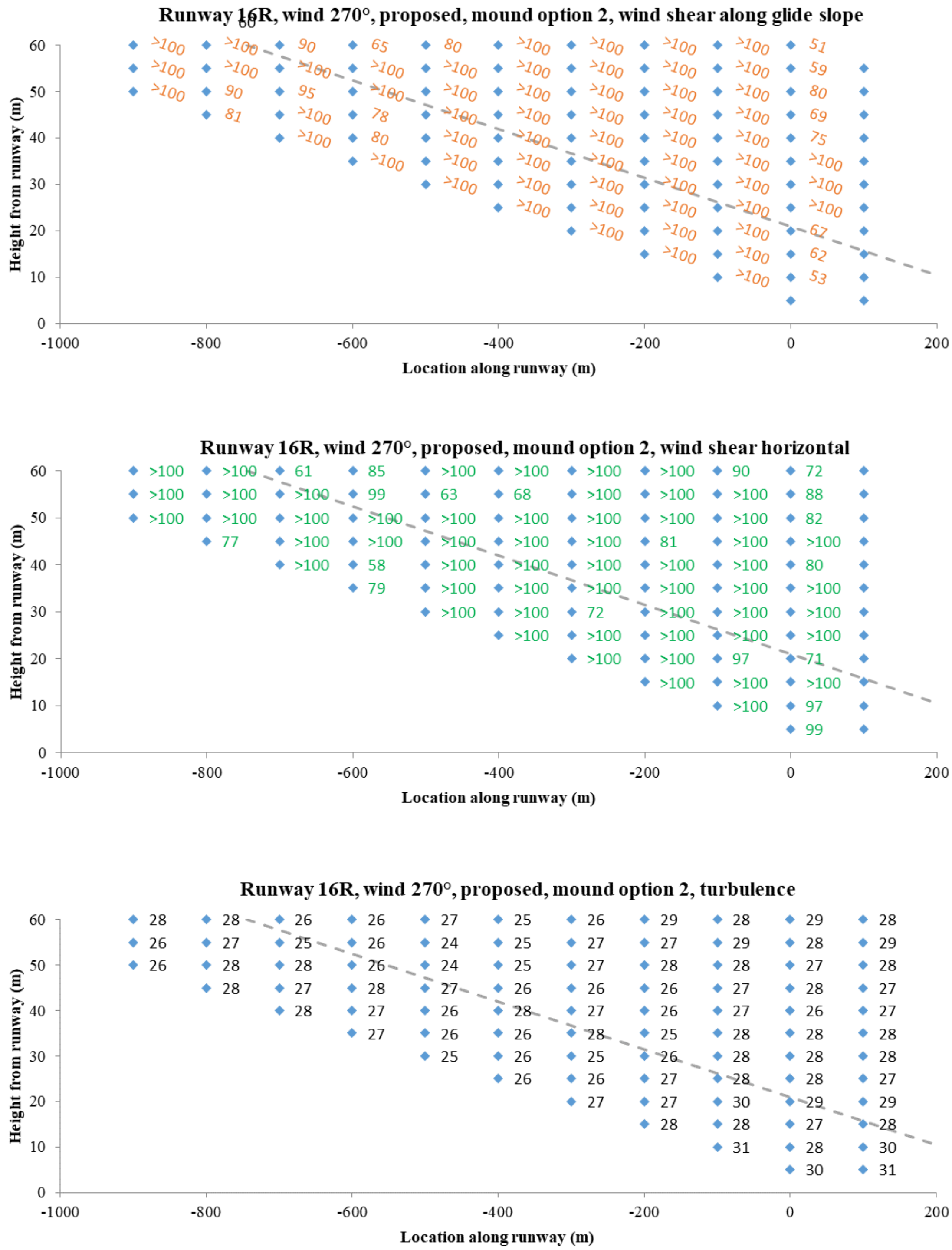


Figure 16: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 270° wind direction, proposed configuration (mound option 2).

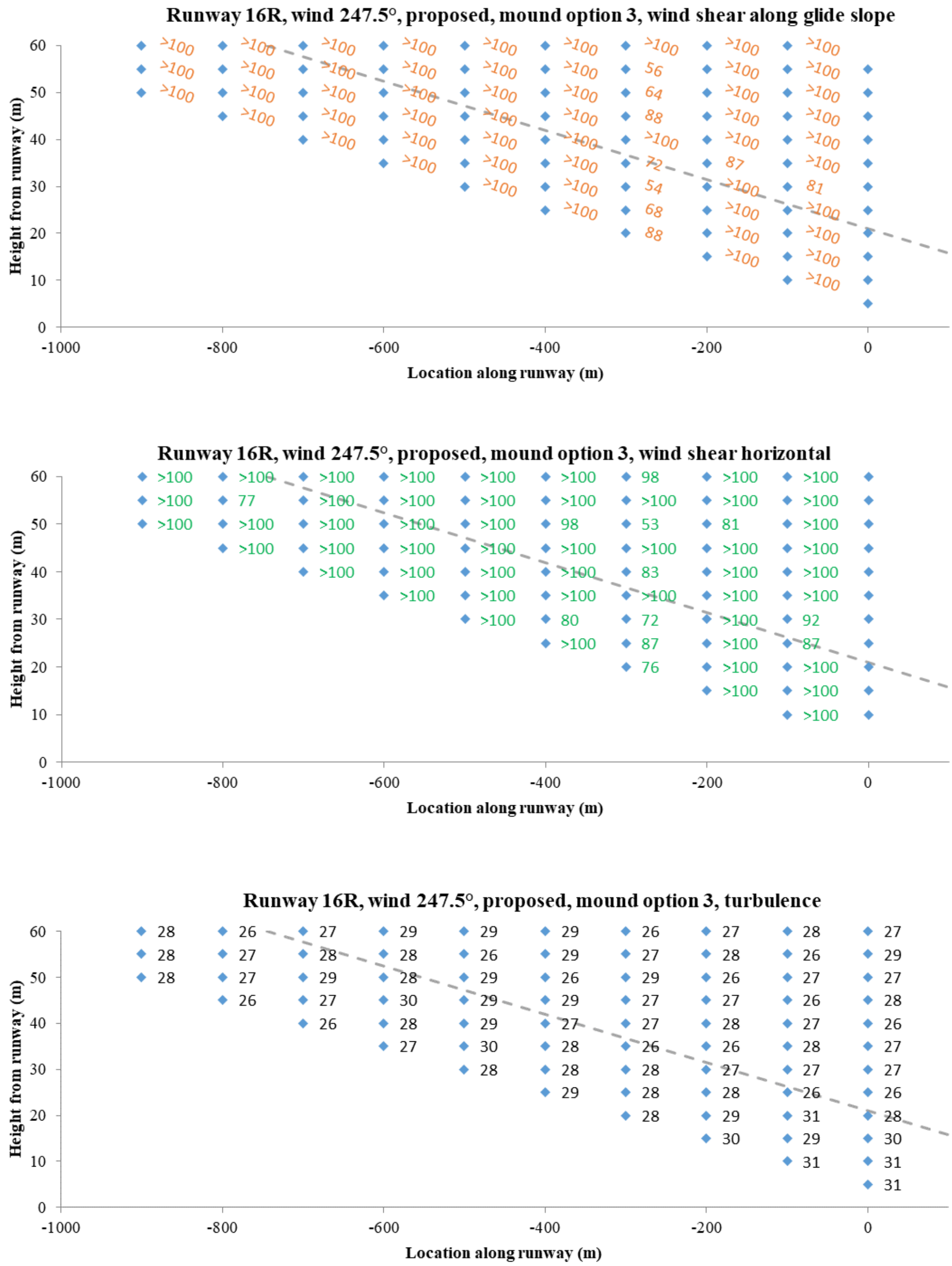


Figure 17: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 247.5° wind direction, proposed configuration (mound option 3).

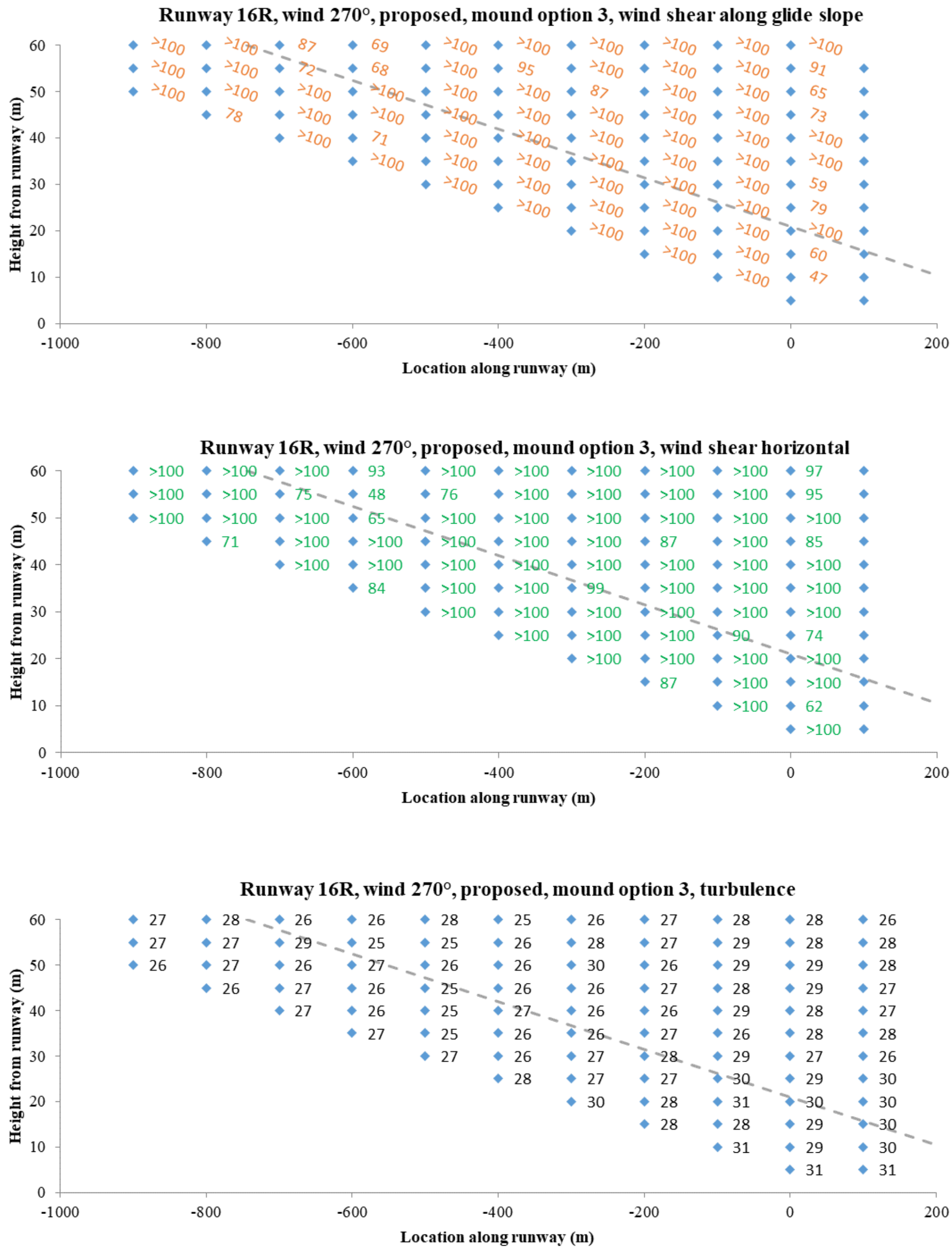


Figure 18: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 270° wind direction, proposed configuration (mound option 3).

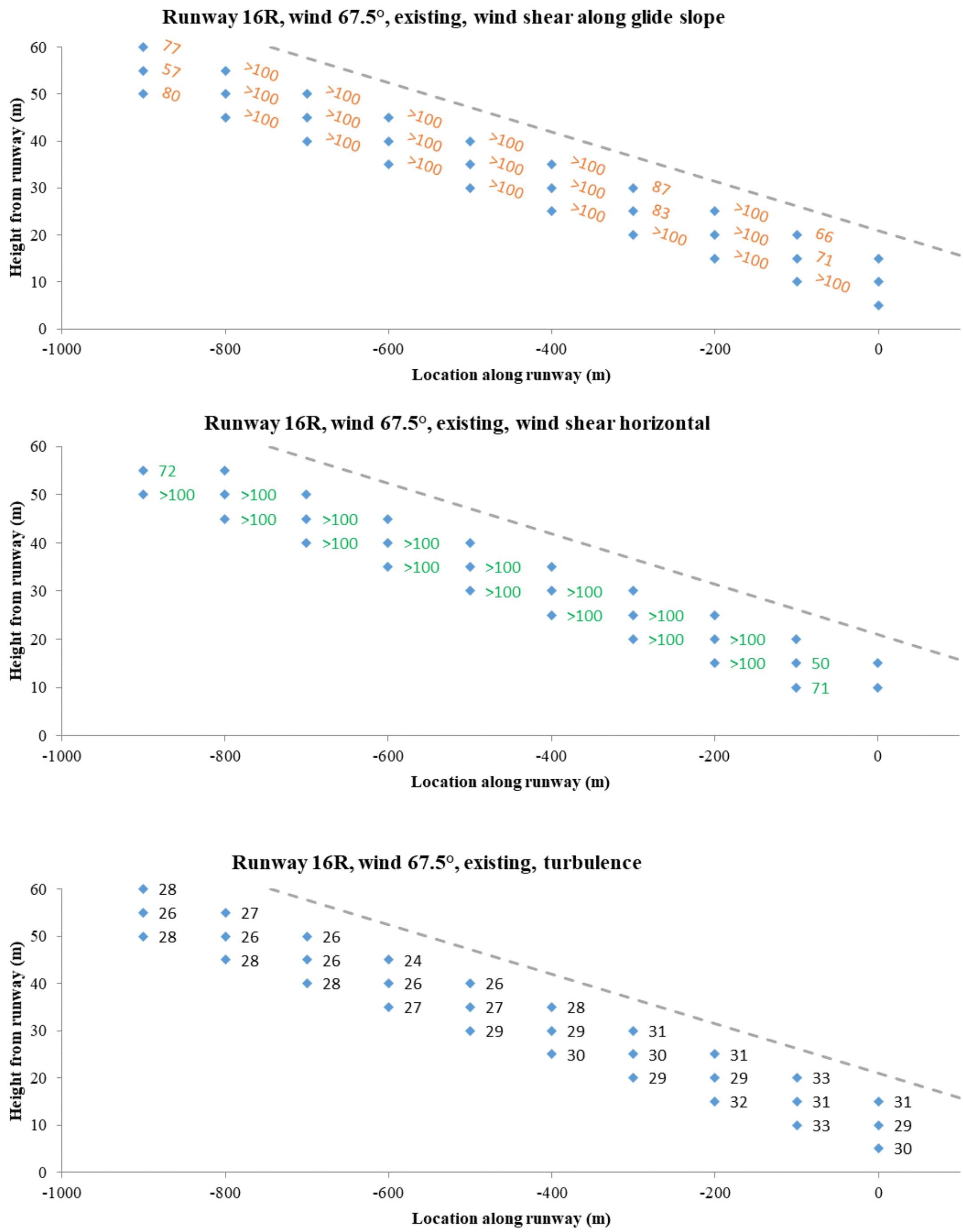


Figure 19: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 67.5° wind direction, existing configuration.

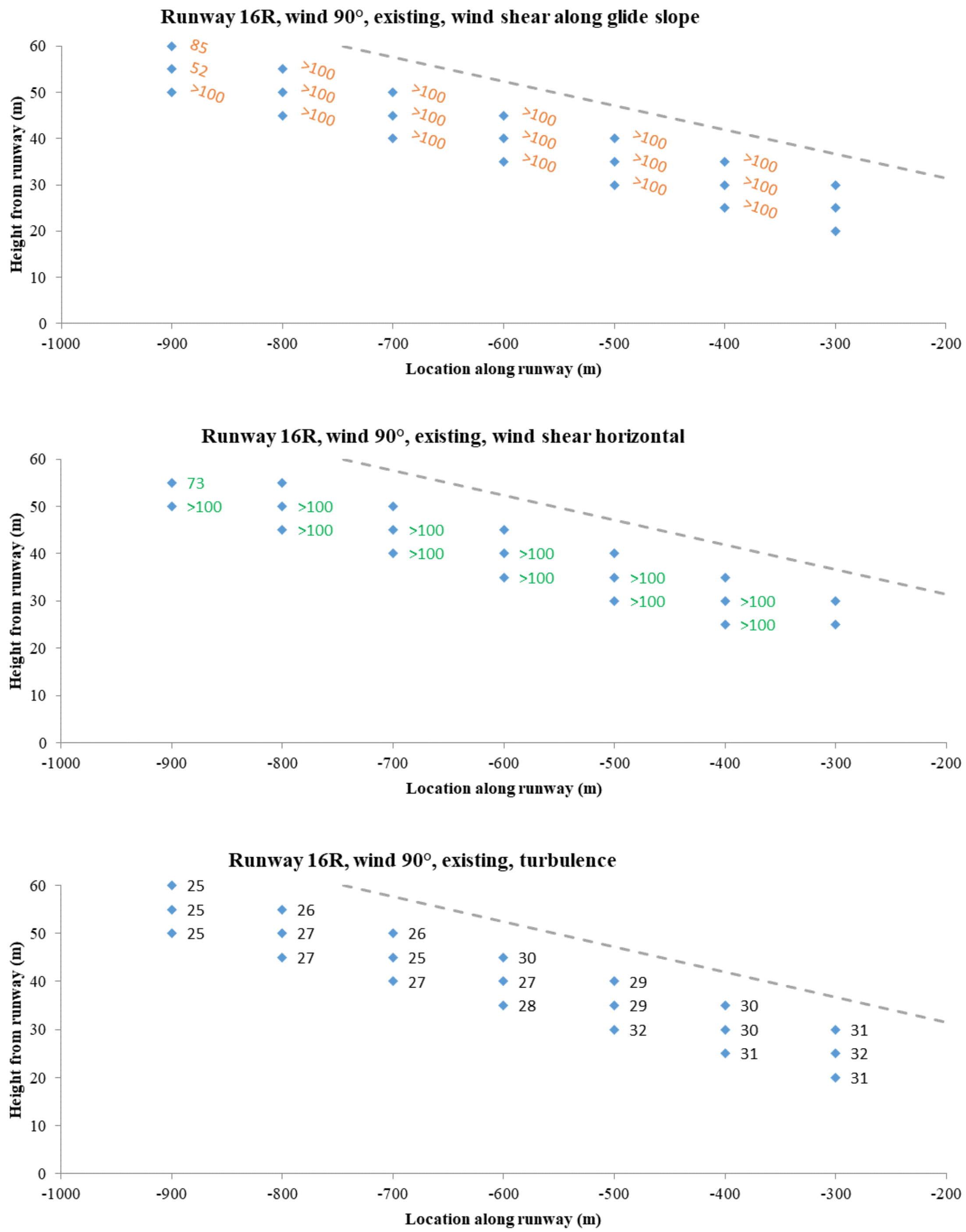


Figure 20: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 90° wind direction, existing configuration.

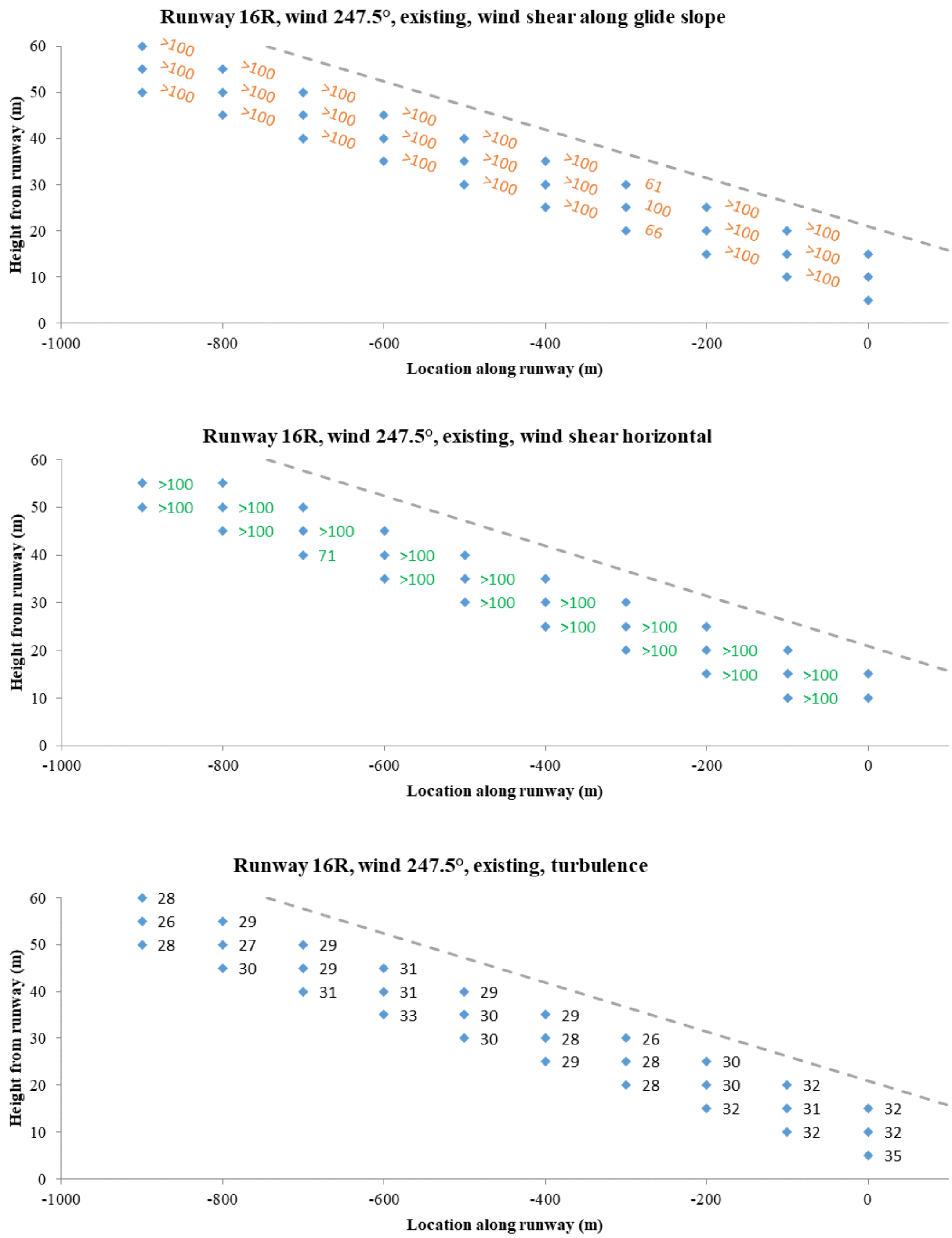


Figure 21: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 247.5° wind direction, existing configuration.

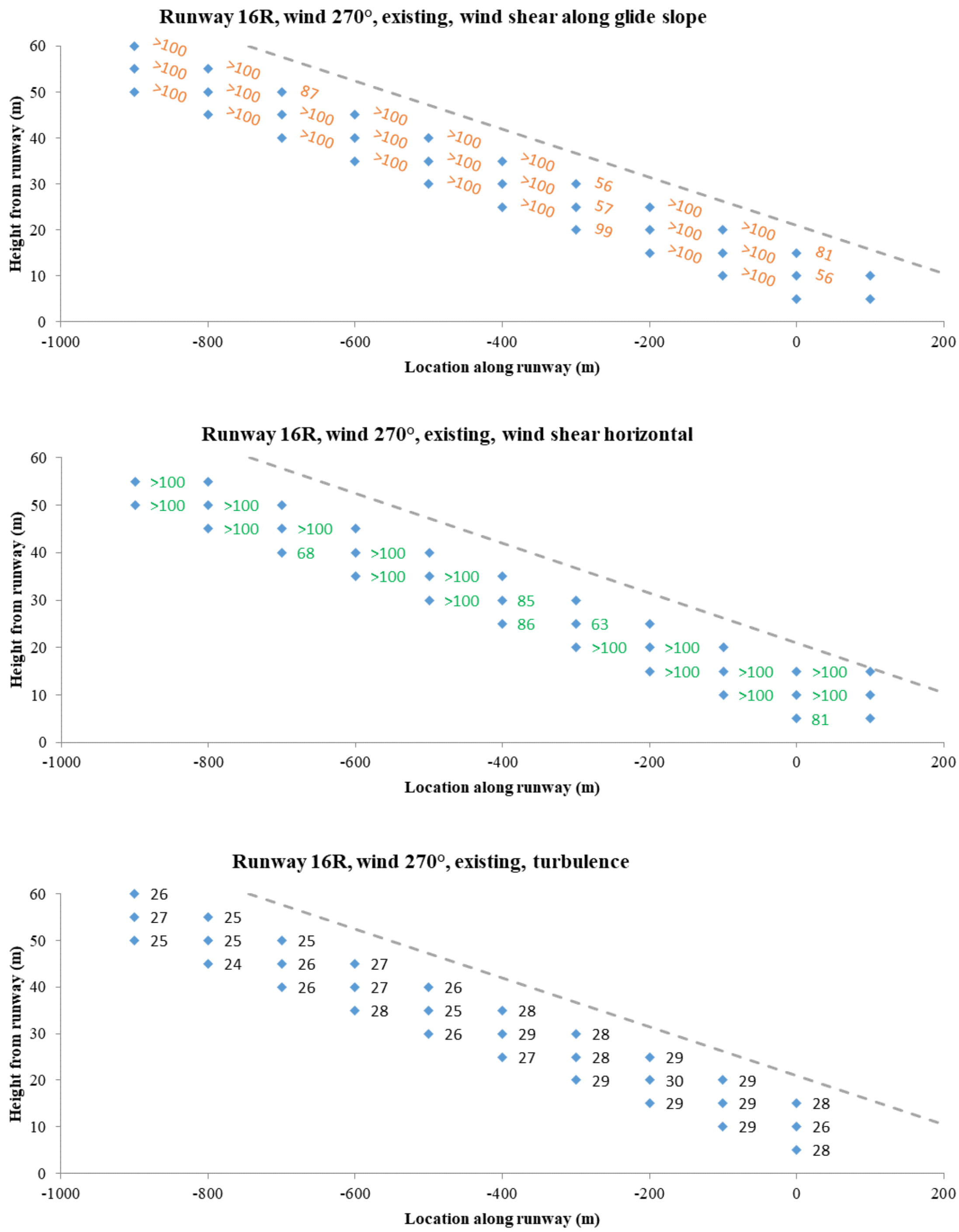


Figure 22: Runway 16R test results: 3 s gust wind speeds in knots required for exceedance of specified criteria, 270° wind direction, existing configuration.

Appendix 3: Discussion on wind shear and turbulence

Paragraph 2.2.1 from ICAO (2005) states:

'In the explanation of wind shear given in Chapter 1, the changes in wind speed and/or direction concern changes in the mean (or prevailing) wind from one reference point in space to another. Short-term fluctuations of the wind about a mean direction and/or speed are normally referred to as "variations" from the prevailing wind. Such variations of the wind, individually at least, are temporary, like eddies; while eddies clearly involve wind shear; because they are on a much smaller scale than an aircraft, they tend to affect the aircraft as bumpiness or turbulence. The scale on which the wind shear operates, in relation to the overall size of the aircraft concerned, is therefore of fundamental importance.'

From the above, it can be appreciated that wind shear is based on a difference in mean wind speed between two locations, whereas turbulence is the natural variation in the wind speed and direction due to the flow over the ground.

The "variations" mentioned above are generally called turbulence in the wind engineering community and will be used in this document. Turbulence intensity is a term used to quantify turbulence and is calculated as the standard deviation of wind speed divided by the mean wind speed. This does not give an indication of the size of, or energy level associated with the gusts. A spectral analysis would be required to extract the frequency structure of the gusts from which a measure of the size could be inferred. This is beyond the scope of the current discussion, and would be impractical to monitor full-scale.

To emphasise the difference between wind shear and turbulence, a brief discussion on the driving mechanisms involved in generating turbulence and low level wind shear in the form of a thunderstorm downburst is included. "Low level" in wind engineering terms is defined as below about 500 m.

The typical atmospheric boundary layer created by synoptic wind events is created by friction at the ground surface, and therefore changes from the ground up. The boundary layer typically extends about 500 to 1000 m above ground level. Increasing friction caused by ground objects causes a decrease in the near-ground mean wind speed and an increase in turbulence intensity. The ratio of mean wind speed at 500 m to that at 10 m is typically about 1.6 for winds over open terrain (scattered trees and uncut grass), and 2.1 times for winds over suburbia. The mean wind speed at 500 m over open terrain is about 10% higher than that over suburbia. Turbulence intensity ratios between 500 m and 10 m are typically about 0.4, with winds over suburbia having about 1.3 times the turbulence intensity of those created over open country terrain.

To develop ICAO (2005) defined moderate and strong wind shear in open country terrain from 40 m to 10 m above ground level, the mean wind speed at 10 m would have to be in excess of 18 m/s (36 kt), and 33 m/s (66 kt) respectively. However, paragraph 5.2.8 of ICAO (2005) indicates that an aircraft could withstand a wind shear of 1.67 m/s per s (3 kt/s); for an aircraft landing in open country terrain with a ground speed of 55 m/s on a 3° glide slope, this would relate to a mean wind speed at a height of 10 m of approximately 75 m/s (150 kt), which would evidently never occur.

Turbulence intensity is wind speed dependent and the lower the mean wind speed, the higher the turbulence intensity. However, once the mean wind speed exceeds about 10 m/s (20 kt), the turbulence statistics become relatively less sensitive to wind speed. At the lower wind speeds, turbulence intensity is not considered a significant issue to aircraft safety, as the change in relative air speed between the aircraft and the wind is negligible. Turbulence is also a function of the meteorological event; local pressure driven winds such as a summer onshore wind will contain much smoother flow than winds associated with a large frontal system, even if they come from the same direction. This report only deals with developed atmospheric boundary layer flows and does not deal with meteorological events such as frontal systems and thunderstorm events, which cannot be practically modelled.

It is evident from the above, and an appreciation of the different surrounding terrain roughness that the existing wind conditions at the Airport are diverse depending on wind speed and direction. Determining the cause of any turbulence-related pilot complaints based on isolated Bureau of Meteorology data would be exceptionally difficult; especially if it could be proven there were a lack of complaints during similar wind event days. It would be considered necessary to investigate the number of similar meteorological events and determine whether similar complaints were received on those days. Discussions with pilots would also be considered important to determine the frequency and severity of turbulent events.

The most likely cause of low level wind shear at the Airport is caused by a frontal system, thunderstorm downdraft, or some form of temperature inversion. One mechanism for generating low level wind shear in thunderstorms is created by a descending column of generally cold air reaching the ground, then being turned by the ground plane, Figure 23. These events are called thunderstorm downbursts. Thunderstorm microbursts have a central diameter of between 400 m and 4 km. The dashed white line starting on the left of Figure 23 at an elevation 1 k ft (300 m) is a typical glide slope for a landing aircraft. The concern for aviation is that a landing aircraft initially experiences a significant headwind in excess of 20 m/s (40 kt), which changes into a tailwind after passing through the impingement point, at the centre of the descending column of air where the wind is coming vertically downward. The headwind causes the aircraft to rise, whereby the pilot will lower the throttle causing the aircraft to descend back to the glide slope, but then tailwind causes a reduction in lift causing the aircraft to land short of the runway. Thunderstorm downburst events typically last for only a few minutes and therefore have the spatial and temporal size to create localised wind shear.

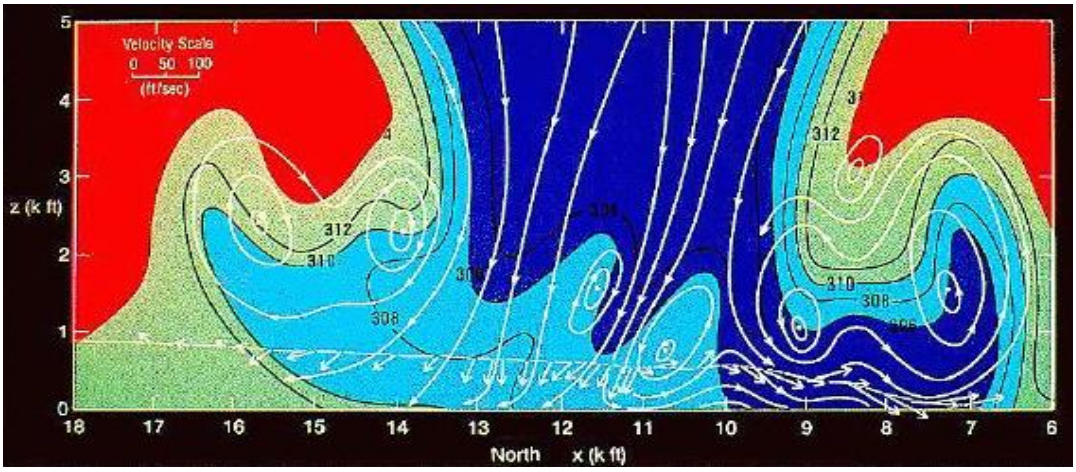


Figure 23: Radar image of a thunderstorm downburst.

The wind flow patterns over a building, Figure 24, are completely different in that there will be recirculation zones near the windward wall and roof edge, and in the immediate lee of the building. The typical extent of these recirculation zones relative to the height of the structure, h, is illustrated conservatively in Figure 24; for instance Peterka et al. (1985) describe the downstream recirculation zone extending 2 to 6 times the height of the structure. These regions are not fixed but fluctuate in time thereby increasing downstream turbulence, but wind shear would only be experienced in the recirculation zones. As the distance increases from the structure, the flow pattern will resort to the undisturbed state. This distance is a function of the geometry of the building, and the roughness of the surrounding terrain, but the mean velocity and turbulence intensity at roof height would be expected to be within 10% of the free stream conditions at 10 times the height of the structure downwind from the building. The building will influence the wind pattern to a distance larger than this, but the magnitude of any change is expected to be slight. The frequency of turbulence shed from the building would be expected to be fairly high and the spatial extend of a similar size to a large aircraft, therefore any effect would be expected to be of short duration.

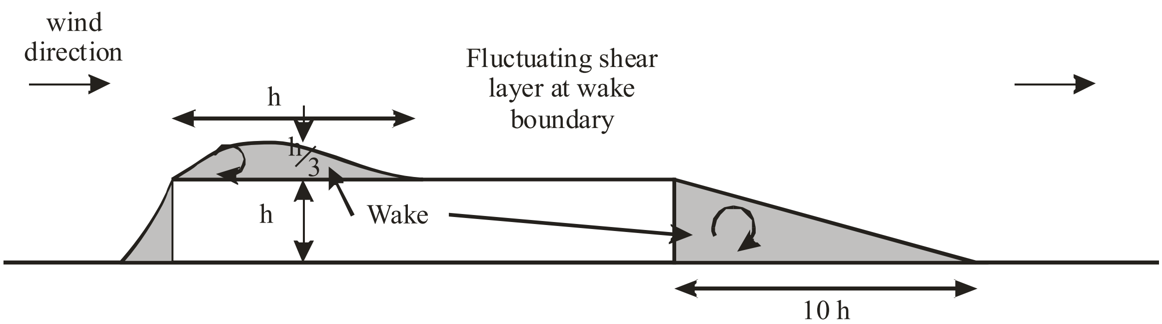


Figure 24: Sketch of the flow pattern over a structure.

It is evident from the above that the wind shear situation for flow over a structure is completely different to that for a thunderstorm. Unless the aircraft were to fly directly through one of the small wake regions, which are probably smaller in spatial extent than the aircraft itself, it would not experience any wind shear. The only concern would be if a large building were constructed right next to the runway and there were no provisions for using another runway during strong cross-wind events.

This discussion is in agreement with the ICAO Manual which in section 3.2.2 states:

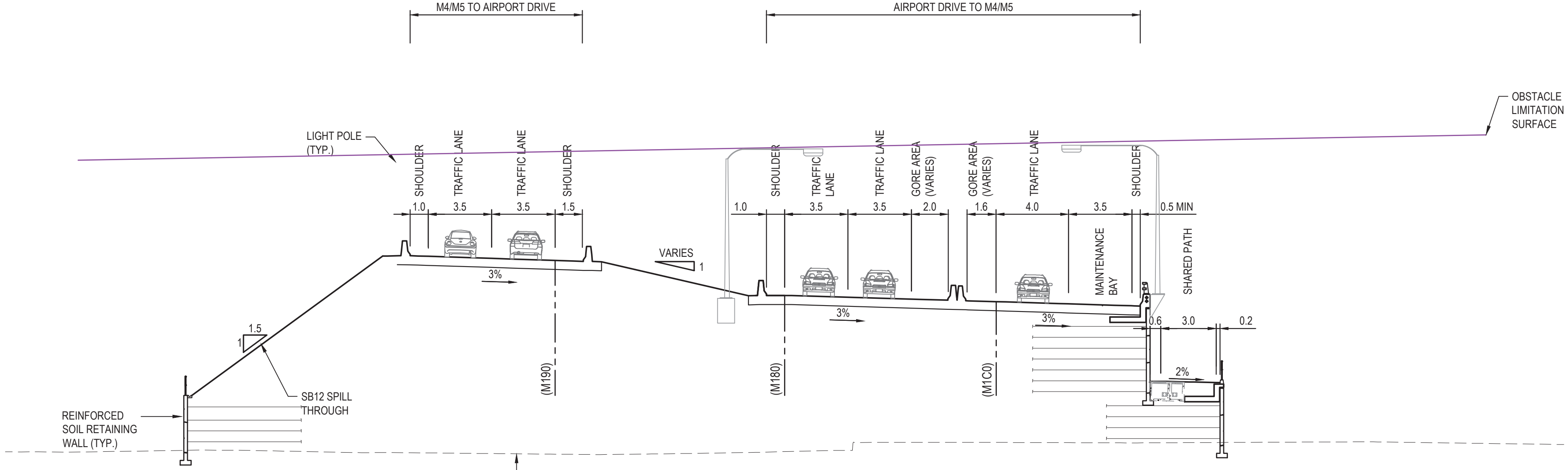
'…This means that while the buildings are comparatively low, they present a wide and solid barrier to the prevailing surface wind flow. The wind flow is diverted around and over the buildings causing the surface wind to vary along the runway. Such horizontal wind shear, which is normally very localised, shallow and turbulent, is of particular concern to light aircraft operating into smaller aerodromes, but has also been known to affect larger aircraft.'

Before the discussion on the specific development site, it should be appreciated that only strong wind events (gusting to over 10 m/s, 20 kt) are considered here, because wind events with a lower wind speed would not be expected to appreciably influence the lift characteristics of a landing aircraft moving at a minimum of 36 m/s (70 kt).

Appendix B
Bridge drawings showing clearance to OLS

NOTES

1. FOR ROAD PLANS REFER TO RD-0101 TO RD-0125.



TYPICAL SECTION ON AIRPORT DRIVE
(M180 @ CH 250)
SCALE 1:250

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HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

PLOT DATE / TIME: 1 March 2019 - 1:34:25 PM

PLOT BY: Trevor-Wilson, Andrew

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DESIGN	M. JAMES	19.10.18
DESIGN CHECK	M. SABA	19.10.18
DESIGN MNGR	J.P. BARRETT	19.10.18
PROJECT MNGR	P.LETTS	19.10.18

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PREPARED FOR: SYDNEY GATEWAY

CITY OF SYDNEY - INNER WEST & BAYSIDE COUNCILS
SYDNEY GATEWAY - NEW AIRPORT DRIVE AND QANTAS DRIVE
STAGE 1 - SYDNEY GATEWAY MOTORWAY
ROAD ALIGNMENT AND GEOMETRY
TYPICAL CROSS SECTION
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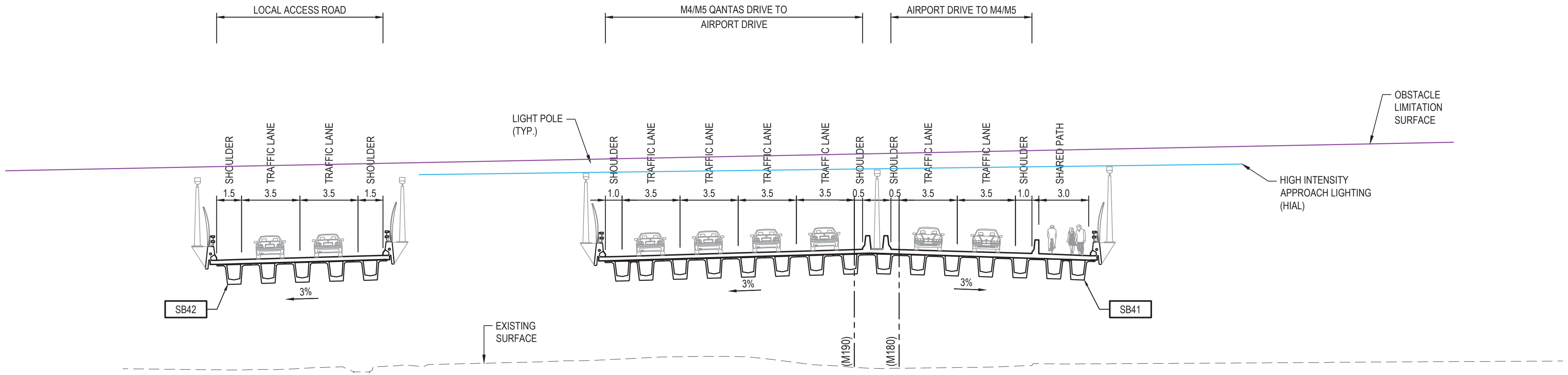

TYPICAL SECTION @ BRIDGE OVER PORT BOTANY RAIL LINE ON AIRPORT DRIVE (M180 @ CH 475)

SCALE 1:250

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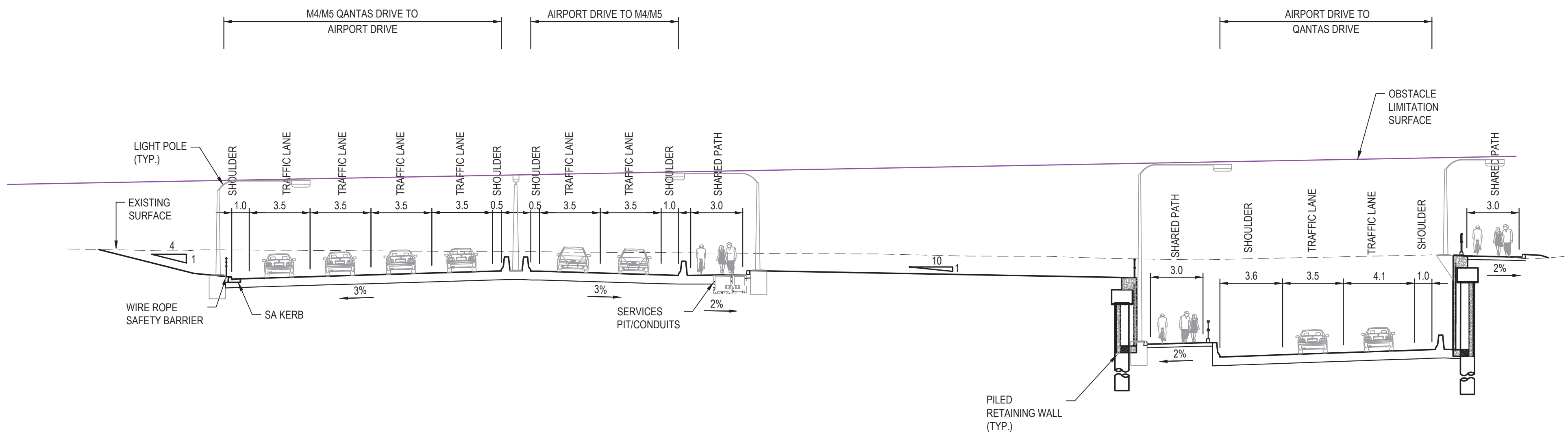

TYPICAL SECTION ON AIRPORT DRIVE
(M180 @ CH 600)
SCALE 1:250

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PROJECT MNGR	P.LETTS	19.10.18

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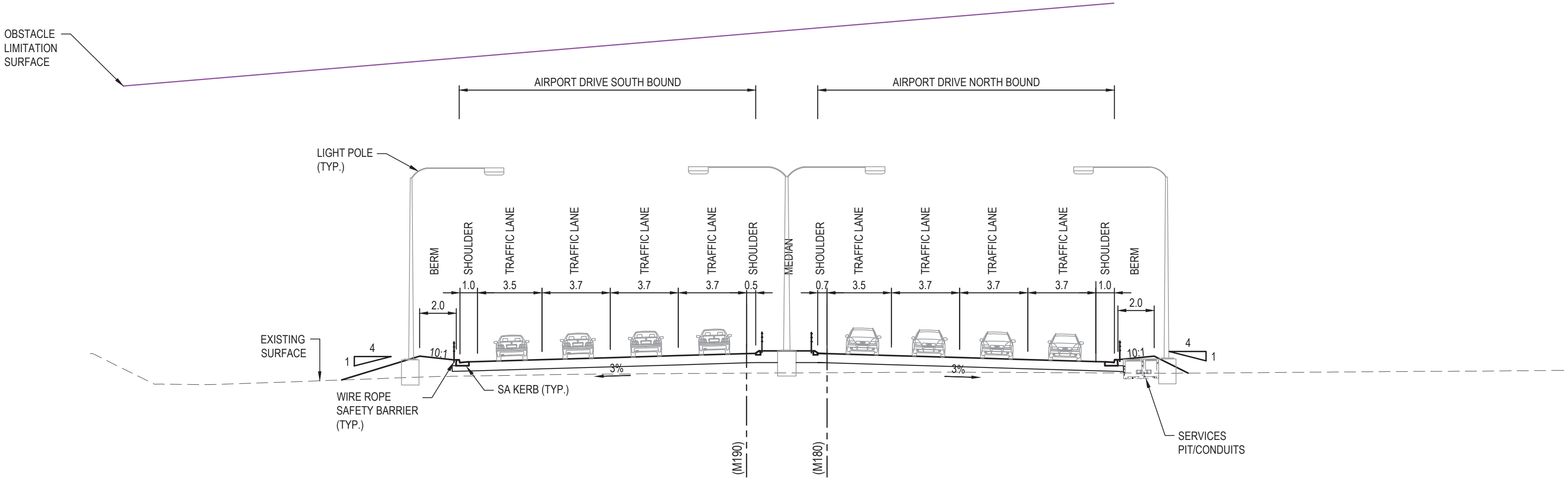

TYPICAL SECTION ON AIRPORT DRIVE
(M180 @ CH 925)

SCALE 1:250

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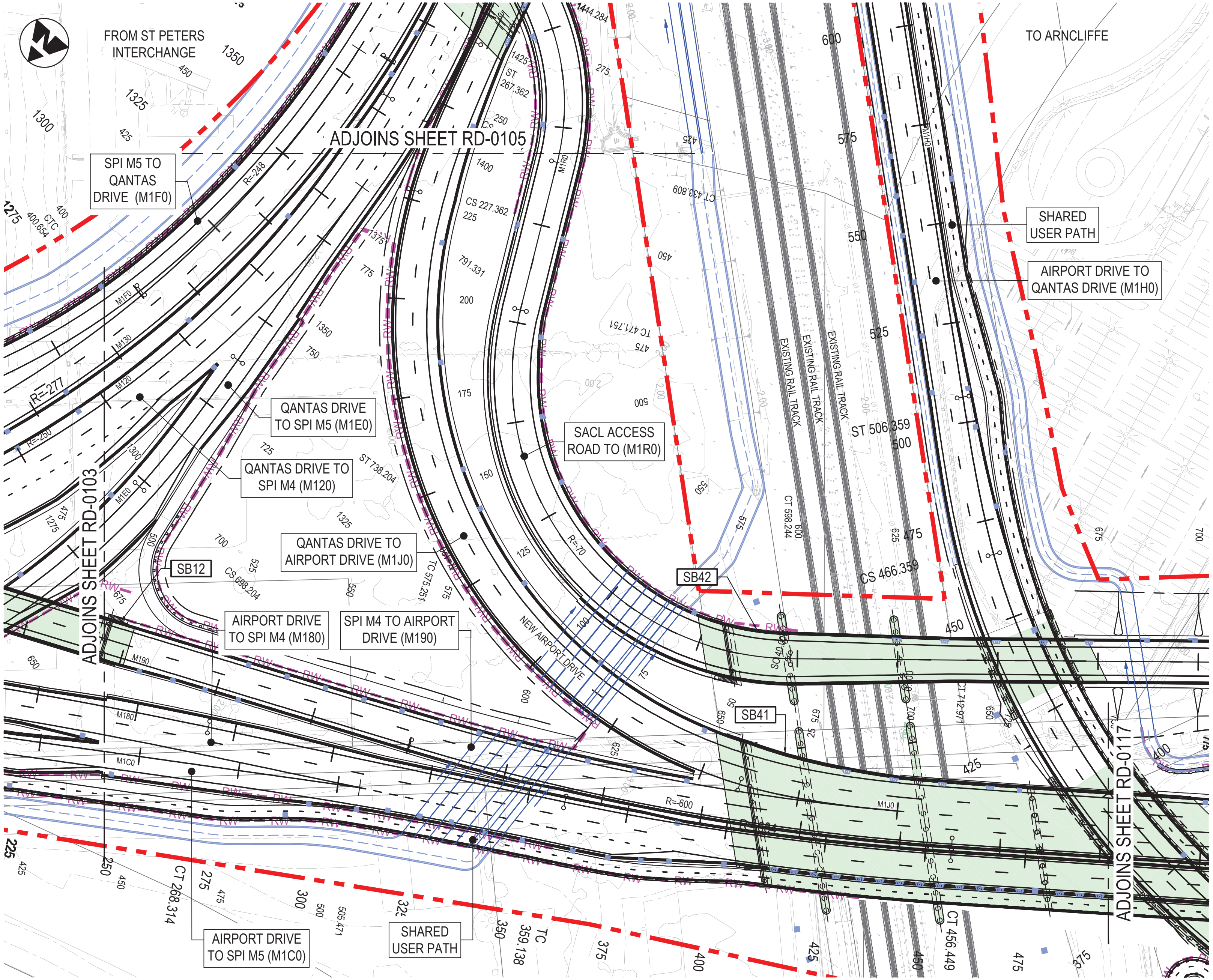

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- BRIDGE
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- SB01 BRIDGE STRUCTURE NUMBER
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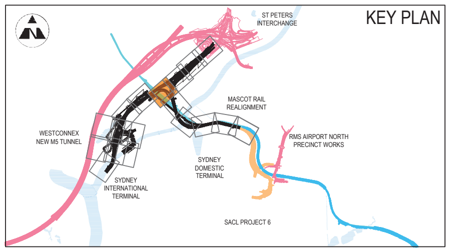

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PROJECT MNGR	P.LETTS	01.03.19

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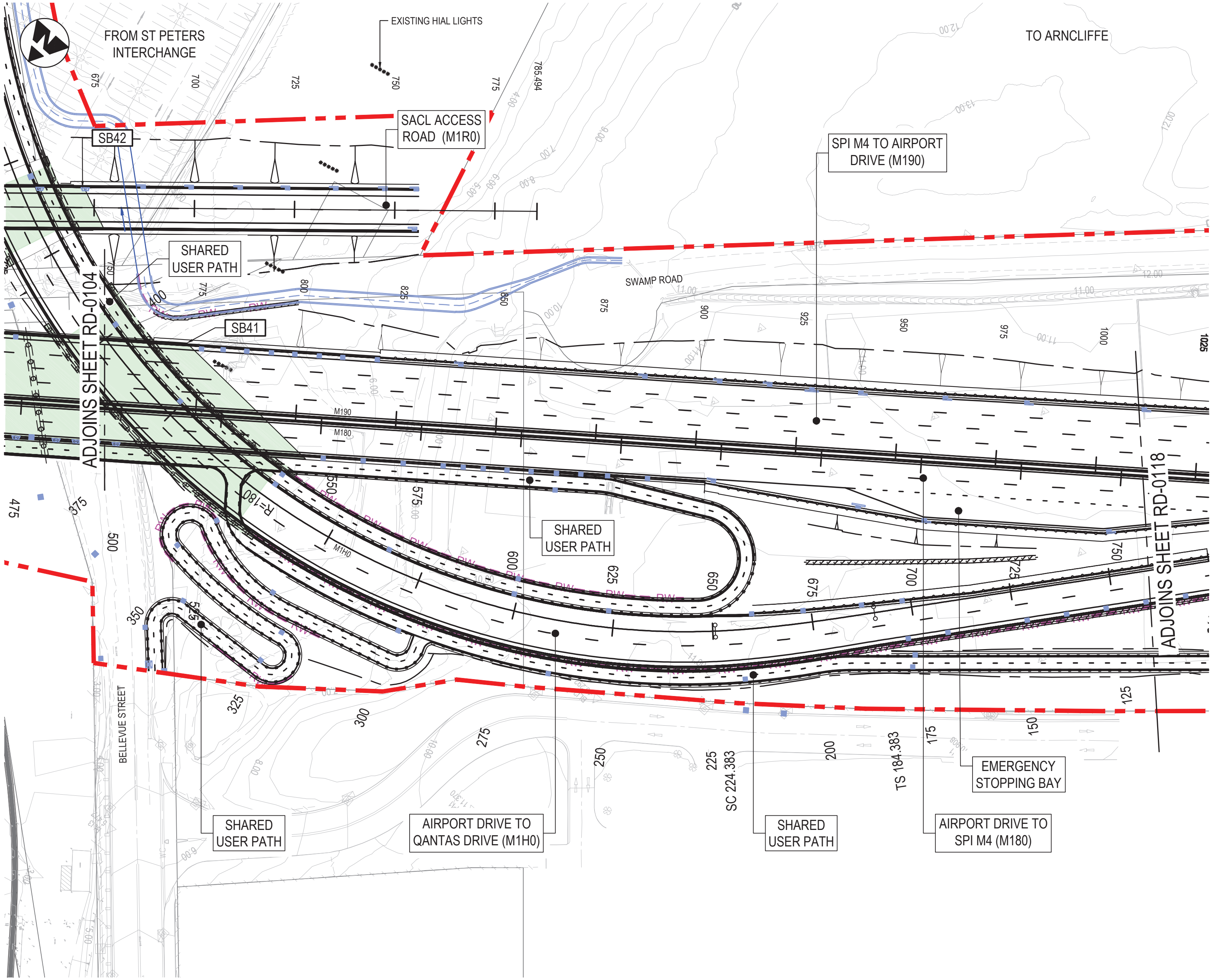

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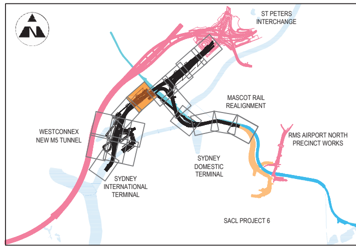

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DESIGN MNGR	J.P. BARRETT	01.03.19
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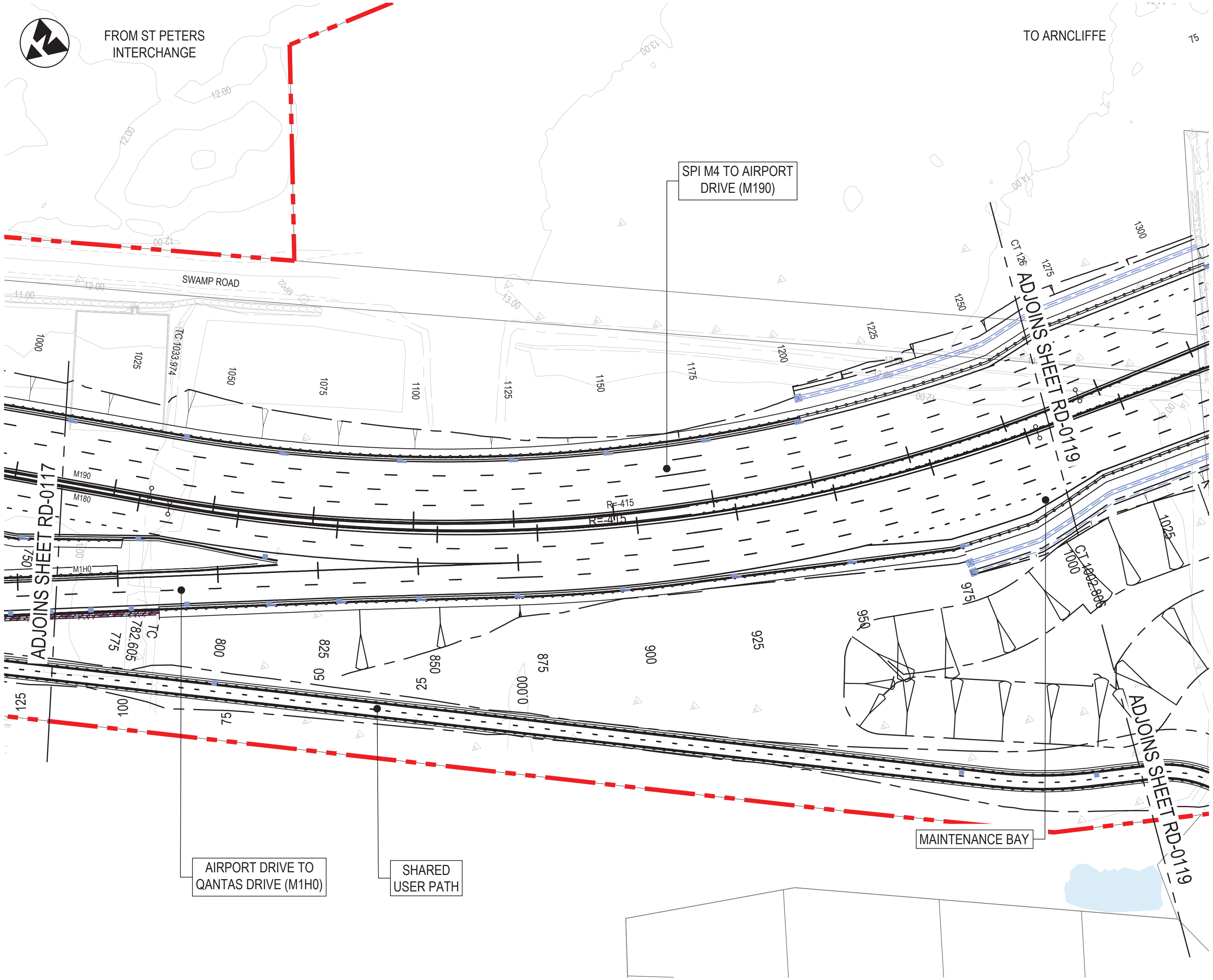

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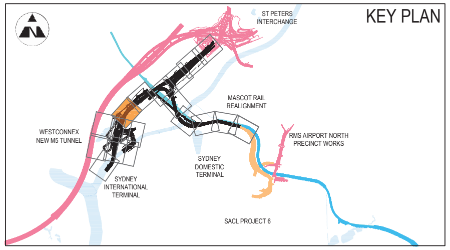
- EXISTING TREE

NOTES

1. FOR TYPICAL CROSS SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0021 TO 0036.
2. FOR ROAD LONGITUDINAL SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0201 TO 0404.
3. FOR ROAD CROSS SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0501 TO RD-0661.

KEY PLAN



FOR INFORMATION ONLY

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

50mm ON A3 SIZE ORIGINAL

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DOCUMENT NUMBER / NAME: SG01-G2S-RD-DRG-0118

DESIGN LOT CODE

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: SG01-G2S-RD-MOD-0001-03

EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
0	24.05.18	ISSUED FOR CONCEPT DESIGN		E.O.
01	15.06.18	REISSUED FOR CONCEPT DESIGN		E.O.
02	19.10.18	REISSUED FOR CONCEPT DESIGN		P.L.
03	01.03.19	REISSUED FOR CONCEPT DESIGN		P.L.

SCALES ON A3 SIZE DRAWING: 0 10 20 30 40 50 SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

PLOT DATE / TIME: 1 March 2019 - 1:41:07 PM

PLOT BY: Trevor-Wilson, Andrew

TITLE	NAME	DATE
DRAWN	R. USI	01.03.19
DRG CHECK	A. TREVOR-WILSON	01.03.19
DESIGN	M. JAMES	01.03.19
DESIGN CHECK	M. SABA	01.03.19
DESIGN MNGR	J.P. BARRETT	01.03.19
PROJECT MNGR	P.LETTS	01.03.19

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: SYDNEY GATEWAY

CITY OF SYDNEY - INNER WEST & BAYSIDE COUNCILS
SYDNEY GATEWAY - NEW AIRPORT DRIVE AND QANTAS DRIVE
STAGE 1 - SYDNEY GATEWAY MOTORWAY
ROAD ALIGNMENT AND GEOMETRY
GENERAL ARRANGEMENT PLAN
SHEET 11

A3

SHEET No. 11 OF 18

RMS REGISTRATION No. DS2016/001353

PART 1

ISSUE STATUS: CONCEPT DESIGN

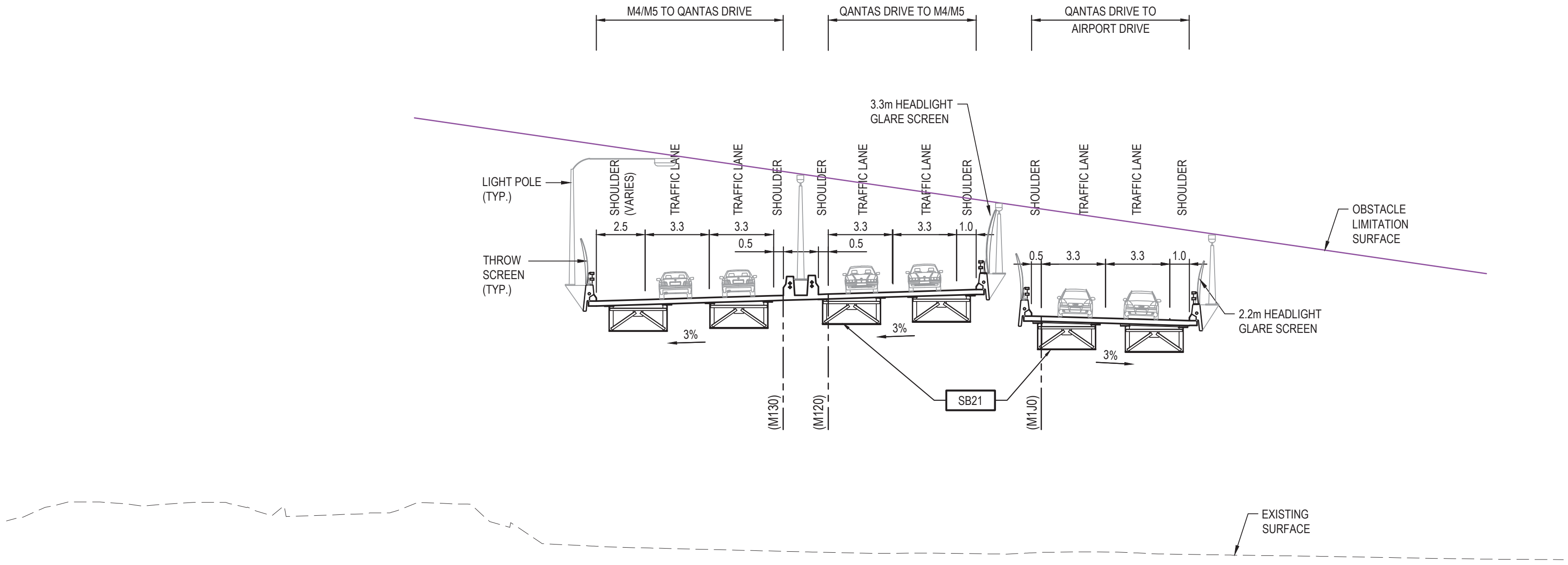
EDMS No.: TBC

SHEET No.: RD-0118

ISSUE: 03

NOTES

1. FOR ROAD PLANS REFER TO RD-0101 TO RD-0125.



TYPICAL SECTION AT BRIDGES OVER PORT BOTANY RAIL ON QANTAS DRIVE (M130 @ CH 1550)

SCALE 1:250

FOR INFORMATION ONLY

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

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50mm ON A3 SIZE ORIGINAL

DOCUMENT NUMBER / NAME: SG01-G2S-RD-DRG-0025

DESIGN LOT CODE

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING

PLOT DATE / TIME: 1 March 2019 - 1:33:48 PM

PLOT BY: Trevor-Wilson, Andrew

EXTERNAL REFERENCE FILES

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01	15.06.18	REISSUED FOR CONCEPT DESIGN		E.O.
02	19.10.18	REISSUED FOR CONCEPT DESIGN		P.L.
03	01.03.19	REISSUED FOR CONCEPT DESIGN		P.L.

SCALES ON A3 SIZE DRAWING: 0 2.5 5 7.5 10 12.5 SCALE 1:250m

CO-ORDINATE SYSTEM: MGA ZONE 56

HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

TITLE	NAME	DATE
DRAWN	R. USI	01.03.19
DRG CHECK	A. TREVOR-WILSON	01.03.19
DESIGN	M. JAMES	01.03.19
DESIGN CHECK	M. SABA	01.03.19
DESIGN MNGR	J.P. BARRETT	01.03.19
PROJECT MNGR	P.LETTS	01.03.19

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: SYDNEY GATEWAY

CITY OF SYDNEY - INNER WEST & BAYSIDE COUNCILS
SYDNEY GATEWAY - NEW AIRPORT DRIVE AND QANTAS DRIVE
STAGE 1 - SYDNEY GATEWAY MOTORWAY
ROAD ALIGNMENT AND GEOMETRY
TYPICAL CROSS SECTION
SHEET 5

A3

SHEET No. 5 OF 16

RMS REGISTRATION No. DS2016/001353

PART 1

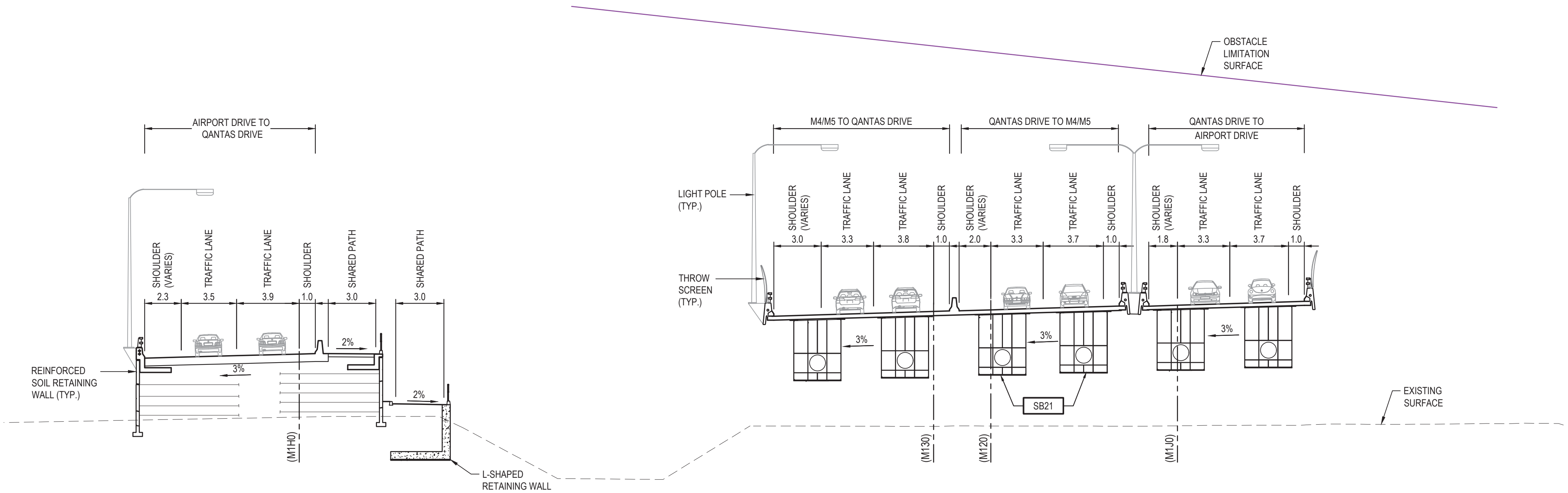
ISSUE STATUS: CONCEPT DESIGN

EDMS No. TBC

SHEET No. RD-0025

ISSUE 03

NOTES
1. FOR ROAD PLANS REFER TO RD-0101 TO RD-0125.



TYPICAL SECTION AT TWIN BRIDGES OVER ALEXANDRA CANAL ON QANTAS DRIVE (M130 @ CH 1800)

SCALE 1:250

FOR INFORMATION ONLY

DOCUMENT NUMBER / NAME	SG01-G2S-RD-DRG-0026			DESIGN LOT CODE	DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING
EXTERNAL REFERENCE FILES	REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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	01	15.06.18	REISSUED FOR CONCEPT DESIGN		E.O.
	02	19.10.18	REISSUED FOR CONCEPT DESIGN		P.L.
	03	01.03.19	REISSUED FOR CONCEPT DESIGN		P.L.

SCALES ON A3 SIZE DRAWING: 0 2.5 5 7.5 10 12.5 SCALE 1:250m

CO-ORDINATE SYSTEM: MGA ZONE 56 | HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

PLOT DATE / TIME: 1 March 2019 - 1:33:57 PM | PLOT BY: Trevor-Wilson, Andrew

TITLE	NAME	DATE
DRAWN	R. USI	01.03.19
DRG CHECK	A. TREVOR-WILSON	01.03.19
DESIGN	M. JAMES	01.03.19
DESIGN CHECK	M. SABA	01.03.19
DESIGN MNGR	J.P. BARRETT	01.03.19
PROJECT MNGR	P.LETTS	01.03.19

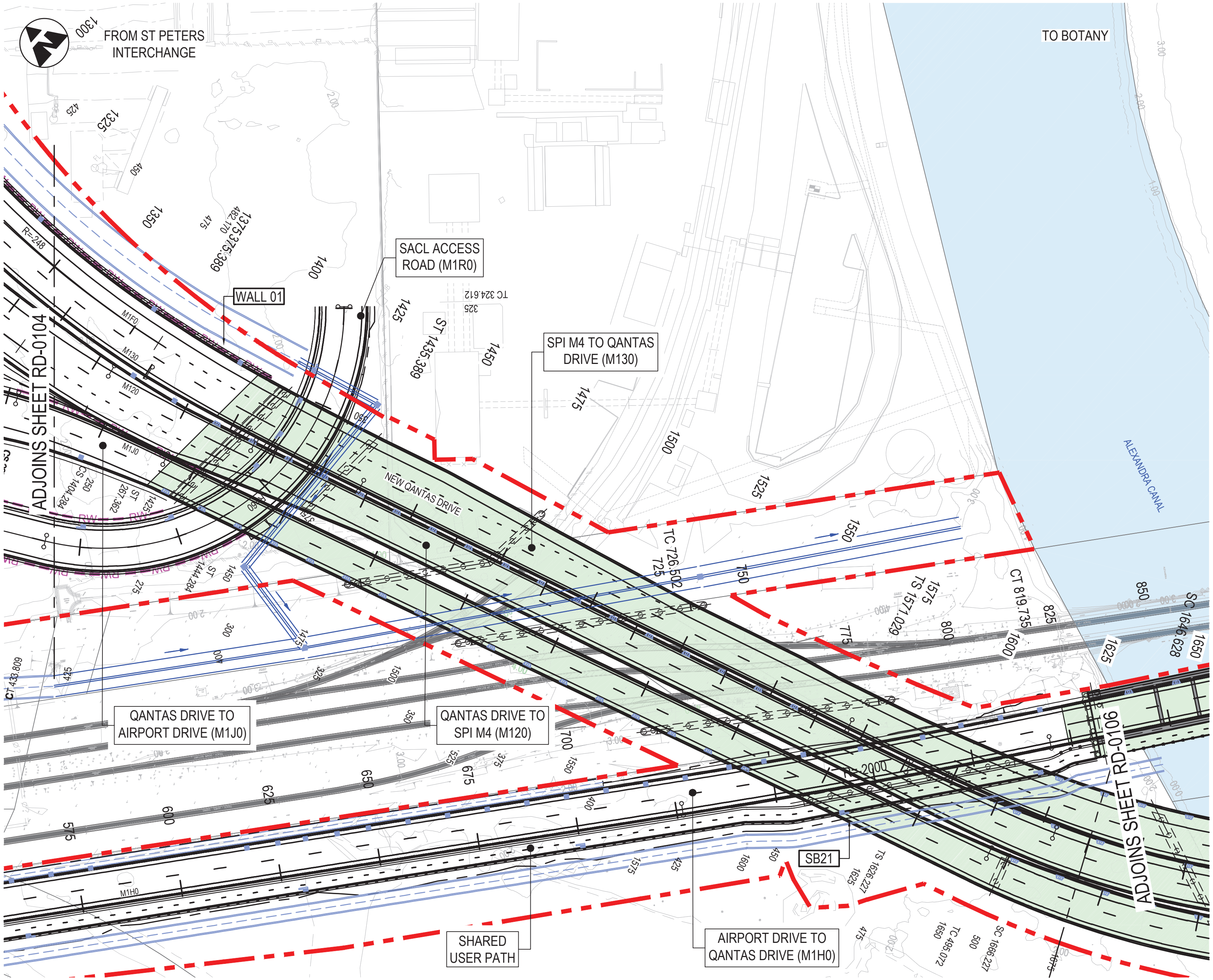
CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

PREPARED FOR: SYDNEY GATEWAY

CITY OF SYDNEY - INNER WEST & BAYSIDE COUNCILS
SYDNEY GATEWAY - NEW AIRPORT DRIVE AND QANTAS DRIVE
STAGE 1 - SYDNEY GATEWAY MOTORWAY
ROAD ALIGNMENT AND GEOMETRY
TYPICAL CROSS SECTION
SHEET 6 | SHEET No. 6 OF 16 | A3

RMS REGISTRATION No. DS2016/001353 | PART 1

ISSUE STATUS: CONCEPT DESIGN | EDMS No. TBC | SHEET No. RD-0026 | ISSUE 03



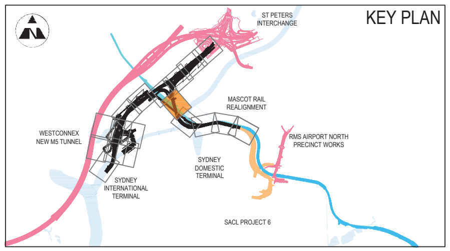
LEGEND

- PROPOSED PROJECT ROAD BOUNDARY
- CADASTRAL BOUNDARY
- WORKS BY OTHER PACKAGES / PROJECTS
- RW RW — PROPOSED RETAINING WALL
- TYPE F SAFETY BARRIER
- BRIDGE
- EXISTING CANAL
- EXISTING RAIL
- SB01 — BRIDGE STRUCTURE NUMBER
- PROPOSED DRAINAGE PIT
- PROPOSED DRAINAGE CHANNEL
- EXISTING FENCE
- 5571 77.438 — SURVEY MARK (ID, RL)
- EXISTING TREE

NOTES

1. FOR TYPICAL CROSS SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0021 TO 0036.
2. FOR ROAD LONGITUDINAL SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0201 TO 0404.
3. FOR ROAD CROSS SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0501 TO RD-0661.

KEY PLAN



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50mm ON A3 SIZE ORIGINAL

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DOCUMENT NUMBER / NAME: SG01-G2S-RD-DRG-0105

DESIGN LOT CODE

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: SG01-G2S-RD-MOD-0001-03

PLOT DATE / TIME: 1 March 2019 - 1:37:56 PM — PLOT BY: Trevor-Wilson, Andrew

EXTERNAL REFERENCE FILES

REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
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01	15.06.18	REISSUED FOR CONCEPT DESIGN		E.O.
02	19.10.18	REISSUED FOR CONCEPT DESIGN		P.L.
03	01.03.19	REISSUED FOR CONCEPT DESIGN		P.L.

SCALES ON A3 SIZE DRAWING: 0 10 20 30 40 50 SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

TITLE	NAME	DATE
DRAWN	R. USI	01.03.19
DRG CHECK	A. TREVOR-WILSON	01.03.19
DESIGN	M. JAMES	01.03.19
DESIGN CHECK	M. SABA	01.03.19
DESIGN MNGR	J.P. BARRETT	01.03.19
PROJECT MNGR	P.LETTS	01.03.19

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

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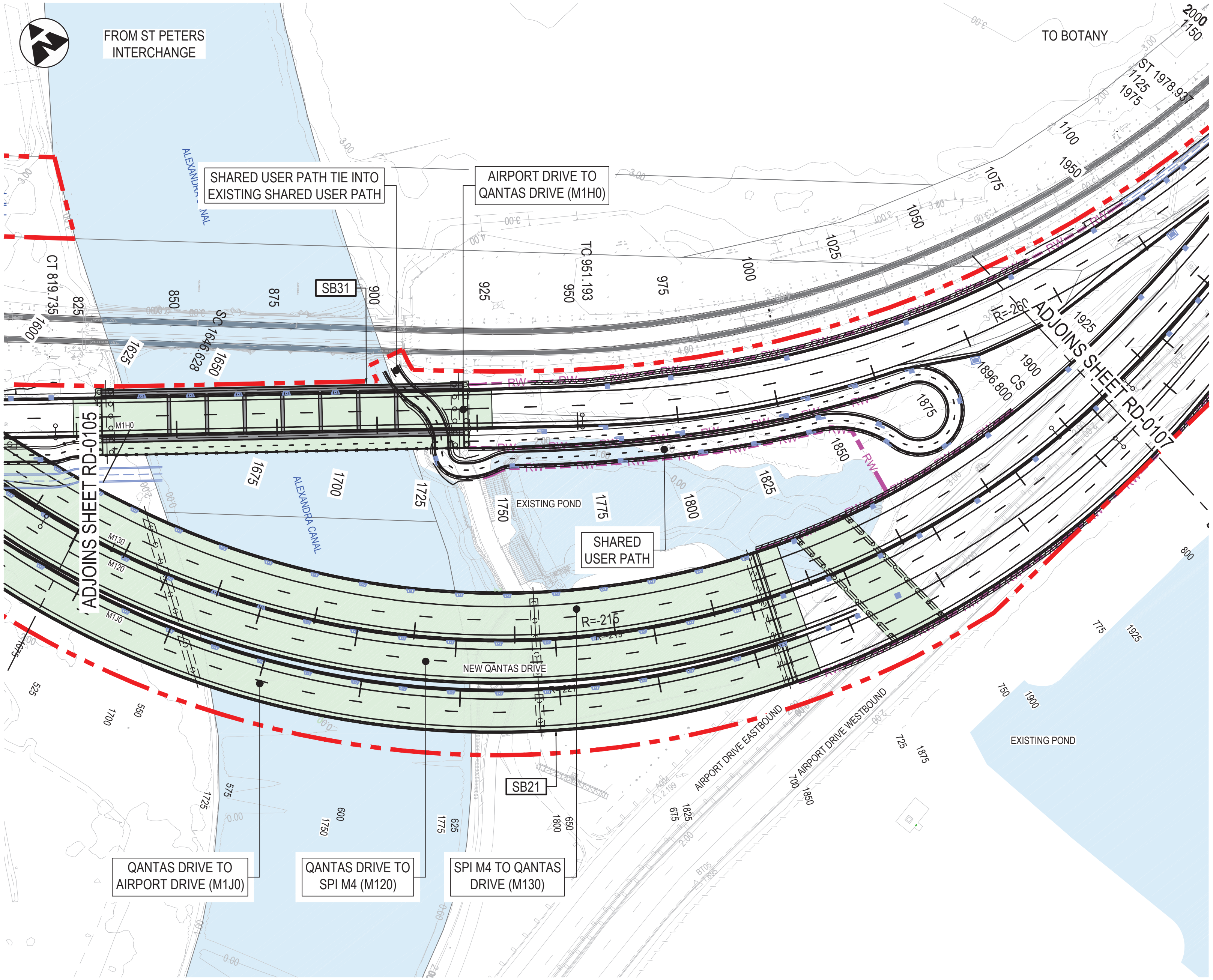
ROAD ALIGNMENT AND GEOMETRY
GENERAL ARRANGEMENT PLAN
SHEET 5

A3

SHEET No. 5 OF 18

RMS REGISTRATION No. DS2016/001353 — PART 1

ISSUE STATUS: CONCEPT DESIGN — EDMS No. TBC — SHEET No. RD-0105 — ISSUE 03



LEGEND

- PROPOSED PROJECT ROAD BOUNDARY
- CADASTRAL BOUNDARY
- WORKS BY OTHER PACKAGES / PROJECTS
- RW — PROPOSED RETAINING WALL
- TYPE F SAFETY BARRIER
- BRIDGE
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3. FOR ROAD CROSS SECTIONS REFER TO DRG. No's SG01-G2S-RD-DRG-0501 TO RD-0661.

KEY PLAN

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50mm ON A3 SIZE ORIGINAL

C:\PRINT-s1\SG01-G2S-RD-DRG-0106.dwg

DOCUMENT NUMBER / NAME: SG01-G2S-RD-DRG-0106

DESIGN LOT CODE

DESIGN MODEL FILE(S) USED FOR DOCUMENTATION OF THIS DRAWING: SG01-G2S-RD-MOD-0001-03

PLOT DATE / TIME: 1 March 2019 - 1:38:29 PM — PLOT BY: Trevor-Wilson, Andrew

REV	DATE	AMENDMENT / REVISION DESCRIPTION	WVR No.	APPROVAL
0	24.05.18	ISSUED FOR CONCEPT DESIGN		E.O.
01	15.06.18	REISSUED FOR CONCEPT DESIGN		E.O.
02	19.10.18	REISSUED FOR CONCEPT DESIGN		P.L.
03	01.03.19	REISSUED FOR CONCEPT DESIGN		P.L.

EXTERNAL REFERENCE FILES

SCALES ON A3 SIZE DRAWING: 0 10 20 30 40 50 — SCALE 1:1000m

CO-ORDINATE SYSTEM: MGA ZONE 56 — HEIGHT DATUM: A.H.D.

DRAWINGS / DESIGN PREPARED BY: WSP GHD

TITLE	NAME	DATE
DRAWN	R. USI	01.03.19
DRG CHECK	A. TREVOR-WILSON	01.03.19
DESIGN	M. JAMES	01.03.19
DESIGN CHECK	M. SABA	01.03.19
DESIGN MNGR	J.P. BARRETT	01.03.19
PROJECT MNGR	P.LETTS	01.03.19

CLIENT: NSW GOVERNMENT Transport Roads & Maritime Services

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GENERAL ARRANGEMENT PLAN
SHEET 6

A3

SHEET No. 6 OF 16

RMS REGISTRATION No. DS2016/001353 — PART 1

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