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The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement /
Commonwealth Draft Environmental Impact Statement

Volume 1: Main Report

June 2017

Roads and Maritime Services

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8.4.8 Residual impacts

Residual impacts are defined as those impacts that remain following the implementation of mitigation measures.

Residual impacts as a result of construction of the project are expected to be limited to heritage items that would be directly impacted by the works being Miss Lawson's guesthouse site and Lawson's Inn site, as well as impacts to the natural heritage values of the Orchard Hills Cumberland Plain Woodlands site.

Although the proposed salvage excavation for Miss Lawson's Guesthouse and Lawson's Inn sites would recover data which would contribute to our knowledge and understanding of these two site, the impacted areas would be removed (within the limits of the project approval). This would result in moderate non-Aboriginal heritage impacts as a result of construction of the project.

Minor residual impacts would also occur in relation to the natural heritage values of the Orchard Hills Cumberland Plain Woodlands site due to the clearing of around 9.68 ha of native vegetation, minor hydrological changes, minor (or negligible) weed and pathogen impacts, and minor light impacts. These impacts would be minimised through the implementation of relevant mitigation measures and are not expected to be significant.

8.5 Urban design and visual impact

This chapter provides an assessment of the urban design, landscape character and visual amenity implications associated with the project. The technical working paper Urban Design and Visual Impact Assessment (Appendix O) has been used to inform this chapter

Table 8-31 sets out the Secretary's Environmental Assessment Requirements (SEARs) and Commonwealth EIS guidelines as they relate to urban design, landscape character and visual amenity and states where in this EIS these have been addressed.

Table 8-31 NSW and Commonwealth Environmental Assessment Requirements

Environmental assessment requirements	Where addressed in EIS
Secretary's Environmental Assessment requirement (SEARs)	
During the preparation of the EIS, you must assess project impacts to urban design and visual amenity.	Section 8.5
This includes: • a consideration of the urban design and visual amenity implications of the proposal, including supporting infrastructure, during construction and operation; • a consideration of impacts on views and vistas (including impacts on extant views to the eastern escarpment of the Blue Mountains), streetscapes, existing significant vegetation, key sites and buildings; • measures to ameliorate visual impacts during construction and operation; and • measures to manage lighting impacts during construction and operation.	Consideration of urban design and visual amenity impacts during construction is described in Section 8.5.4, and impacts during operation are described in Section 8.5.5. Environmental management measures are outlined in Section 8.5.6.

Environmental assessment requirements	Where addressed in EIS
Commonwealth EIS Guidelines	
The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: • A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: • The qualities and characteristics of locations, places and areas.	A description of the existing environment is provided in Section 8.5.2.
Impacts to the environment (as defined in section 528) should include but not be limited to the following: • Lighting impacts on everyday activities and on sensitive environmental receptors (all sensitive receptors within the community and natural environment).	Consideration of urban design and visual amenity social and economic impacts during construction is described in Section 8.5.48-2, and impacts during operation are described in Section 8.5.5.

8.5.1 Assessment methodology

The undertaking of the impact assessment and the finalisation of the concept design has been an iterative process which has enabled the concepts to be refined as they were developed, thereby reducing and mitigating the potential visual impact wherever possible. The approach to the assessment follows the Roads and Maritime Services *Guideline for Landscape Character and Visual Impact Assessment EIA-N04* (RMS, 2013) and involved the following sequence of activities:

- Reviewing relevant literature, analysing aerial photographs and topographic maps to understand the study area
- Undertaking an initial site visit and field investigation, to verify assumptions made through literature/photography review and gain a better understanding of site conditions
- Reviewing the initial engineering concept design and supporting material to gain an appreciation of the project
- Defining landscape character through a contextual analysis. The contextual analysis has been used to set the overall baseline for the visual impact assessment.
- Identifying and describing landscape character zones and evaluating the project's impact on them
- Identifying the visual catchment of the proposed works
- Selecting viewpoints within the visual catchment representing a range of different land uses
- Evaluating the project's visual impact by comparing the sensitivity of viewpoints and the magnitude of the impact of the upgrade upon them
- Identifying urban design and landscape opportunities and methods of mitigating adverse visual impacts for consideration during future design phases.

The method used to assess the impact of the proposed upgrade is described in the following sections for both the landscape character impacts and visual impacts.

Figure 8-17 illustrates how the level of sensitivity and magnitude are combined to achieve an overall level of impact for both the landscape character impact and the visual impact.

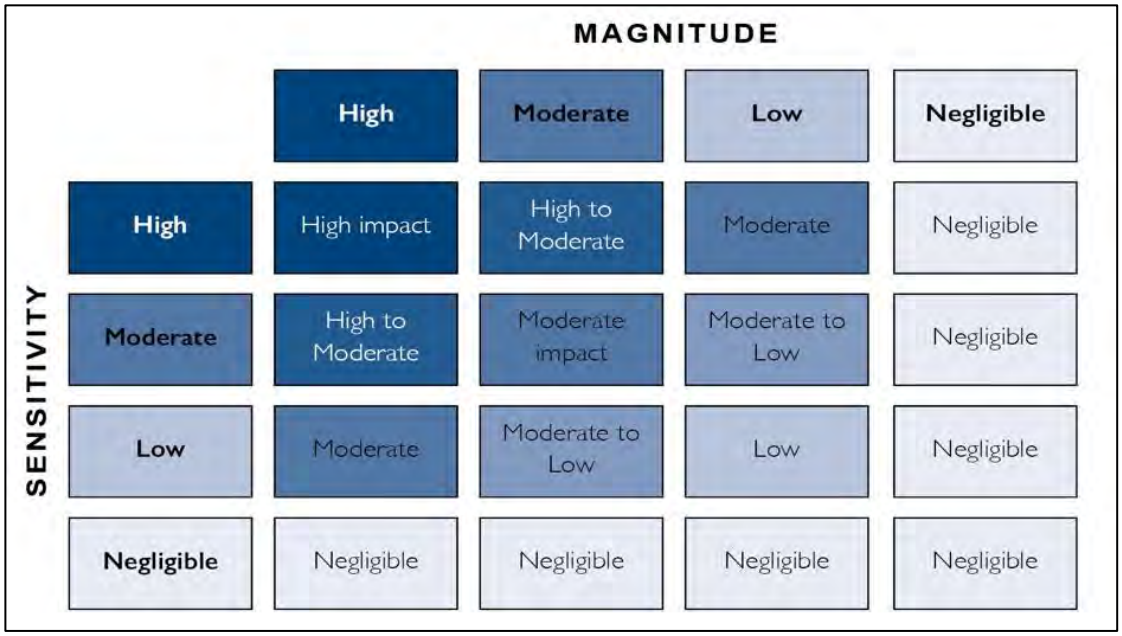


Figure 8-17 Landscape character and visual impact grading matrix

Landscape character impact assessment

A total of five Landscape Character Zones (LCZ) were identified during the contextual analysis. They are generally based on the study area's surrounding land use, vegetation cover and topography. The purpose of dividing the study area into character zones is to make the assessment process easier to undertake and understand. The location and extent of each of the five LCZs is shown in Figure 8-18.

The impact of the proposed upgrade on each LCZ is based on the sensitivity of the zone, and the magnitude of the proposed upgrade in that zone:

- Sensitivity refers to how sensitive the existing character of the setting is to the proposed change, or its inherent capacity to absorb change. For example, a pristine natural environment would be more sensitive to change than an industrial area
- Magnitude refers to the physical size and scale of the project. For example, a large intersection would have a greater magnitude than a localised road widening, and therefore have a greater impact on the landscape character.

The combination of sensitivity and magnitude provides the rating of the landscape character impact (refer to

Figure 8-17).

Visual impact assessment

The extent of the area from which the project would be able to be seen is referred to as the visual catchment. It is largely defined by the landform of the study area. Direction of travel or of the view is another factor influencing visibility of the project. Factors such as built structures or vegetation need to be considered where they limit or obscure views. However, vegetation, whilst often blocking potential views, is not considered as a permanent obstruction as it can be removed. The visual catchment for the project is shown in Figure 8-19.

As distance is an important factor in how the works are perceived, large visual catchments are typically defined by zones of proximity from the proposed works are described, for example zones of 100 m, 300 m and beyond.

Within the LCZs, a number of viewpoints and groups of viewpoints are identified at varying locations and view directions. The visual impact of the project has been assessed by considering both the sensitivity of the view and the magnitude of the proposed works within that view:

- Sensitivity refers to the quality of the view and how it would be affected by the proposed works. It is measured by assessing the chosen view's composition, its inherent capacity to absorb change and the type and number of viewers such as road users and local residents
- Magnitude refers to the physical character, size and scale of the proposed works and their proximity relative to the viewer. For example, a development situated one kilometre from the viewpoint would have a much reduced visual impact relative to one 100 m away.

The combination of sensitivity and magnitude provides the rating of the visual impact (refer to Figure 8-17).

8.5.2 Existing Environment

The following sections outline the contextual analysis of the project site and surrounding area. This is considered to provide a baseline of existing conditions from which potential impacts from the project have been assessed. A number of LCZs are identified through the contextual analysis. They are generally based on the study area's surrounding land use, vegetation cover and topography to identify areas of distinct characteristics identified in the following sections.

Local context

The project is located within a rural setting around the periphery of the Western Sydney Airport, partly within the Western Sydney Priority Growth Area (WSPGA). The Northern Road is an important urban arterial road skirting the west of the Sydney metropolitan area. It would function as the main north–south connecting route between Camden and Campbelltown, and Penrith and Windsor.

South of Glenmore Parkway, the project area is surrounded by rural residential zoned land as well as pastures and grasslands. Land to the east of The Northern Road in this section is occupied by the DEOH. Further south, The Northern Road passes through the town centre of Luddenham (which includes a small number of residential and commercial properties), before continuing through agricultural grasslands to its junction with Mersey Road at the southern end of the project.

Luddenham is a rural village that services the surrounding area featuring shops and services as well as schools, churches and a number of historic buildings. The relatively tight clustering of buildings clearly distinguishes it from the remainder of the study area including Bringelly village, south of the study area.

The DEOH, while representing a different land use, nevertheless is consistent in character with surrounding land uses, containing a similar mix of open and vegetated areas.

It is noted that the development of the Western Sydney Airport at Badgerys Creek, the WSPGA and the South West Priority Growth Area (SWPGA) would result in substantial changes to the existing land use and settlement pattern. This would transform the character of the landscape in turn as rural areas would become urbanised.

Landform and views

The landscape of the study area is typical of the Cumberland Plain and defined by its situation along a well-defined ridge that constitutes the watershed between the South Creek and Nepean River catchment. For the most part of the study area the existing alignment of The Northern Road closely follows this ridge as it gradually descends in elevation from a high point south of Luddenham to Glenmore Park.

In terms of the views available to the motorist, there are three distinct sections within the study area. In the southern section between Mersey Road and Cosgroves Creek, the route is characterised by occasional glimpses of the Blue Mountains to the west and generally open mid to long distance views over rolling paddocks to the east.

The section of The Northern Road between Cosgroves Creek and the WaterNSW supply pipelines is the most open section of the study area. The Blue Mountains are an almost constant feature in the west. North and south of Luddenham town centre motorists enjoy panoramic views from the road corridor, ranging from the Blue Mountains in the west to the prominent ridge line that defines the Western Sydney Parklands to the east. The exception is Luddenham town centre where built structures limit views from the road corridor.

The northern section of the study area between the WaterNSW Supply Pipelines and Glenmore Parkway in contrast is much more enclosed. There are only occasional brief glimpses of the Blue Mountains. Views to the east are contained by a ridge line running in close proximity to the road corridor, limiting views from the road corridor or to short-distance views into immediately adjoining lands.

Ecology and vegetation cover

The native vegetation within the study area generally consists of Cumberland Plain Woodland. It is highly modified as a result of past and current land uses, including agricultural uses which have resulted in significant clearing of the original vegetation. A detailed assessment of impacts to native vegetation is provided in Section 7.3.

Remnant vegetation is found throughout the study area. It generally occurs in scattered clumps of trees and as individual specimen along the edges of the road corridor, or in private properties adjoining the road corridor. A number of private properties retain larger stands of remnant vegetation. Larger stands are also typically associated with creeks.

The vegetation of the study area is important as it is a key feature in defining the landscape of the area. Together with the topography it influences the character of the landscape, as well as the views and vistas.

There are a number of creeks and tributaries surrounding the study area, all part of the wider Hawkesbury-Nepean Catchment. Within the study area a number of creeks and farm dams are found. They are often associated with vegetation remnants. Farm dams make an important contribution to the landscape character and the experience of the drive along The Northern Road, including its visual values. Additionally a number of waterways crossed by the project have been identified as Key Fish Habitat (refer to Section 7.3 Biodiversity).

Landscape character

The landform and vegetation, views and vistas, settlement pattern and built structures within and adjoining the study area combine to define the landscape character of the study area. Within the study area, five different LCZ can be defined based on the interplay of natural and built features. The LCZs are shown on Figure 8-18 and summarised in Table 8-32.

Visual catchment

The extent from which The Northern Road is visible from adjoining areas varies along the length of the study area. It is influenced by topography, vegetation, buildings and land use patterns. A detailed field and desktop assessment was undertaken to determine the area from where The Northern Road is visible. This is defined as the visual catchment or visual envelope and is illustrated on Figure 8-19. A number of key viewpoints and groups of viewpoints within the visual envelope of the study area have been selected for the visual impact assessment presented in Section 8.5.7.

Table 8-32 Summary of landscape character zones

Landscape Character Zone (LCZ)	Existing landscape character	Sensitivity	Photo of typical landscape within LCZ
LCZ 1 - Bringelly	LCZ 1 is generally an open and expansive rural landscape, interspersed with remnant vegetation, farm dams and buildings.	High. The rural nature of LCZ 1 is essential to its character and is highly sensitive to change, as it has a limited capacity to absorb a major new piece of infrastructure.	
LCZ 2 - Duncans Creek	The Duncans Creek catchment around Willowdene Avenue. LCZ 2 is characterised by a diverse pattern of large and small rural holdings, woodland remnants, pastures, food production, creek corridors and farm dams. They combined to produce an attractive and visually interesting character.	High. LCZ 2 has a scenic, undulating landscape character with extensive areas of Cumberland Plain Woodland. The landscape is largely viewed by local residents and visitors but would have a low capacity to absorb major new infrastructure.	

Landscape Character Zone (LCZ)	Existing landscape character	Sensitivity	Photo of typical landscape within LCZ
LCZ 3 - Luddenham Plateau	The Luddenham Plateau LCZ is characterised by a broad ridge with scenic panoramic views over a gently sloping pastoral landscape.	High. LCZ 3 attracts a larger number of potential viewers including residents and visitors to Luddenham and motorists and tourists along The Northern Road. Due to its open and exposed ridge top location LCZ 3 has a low capacity to absorb major changes. The elevated plateau provides a spectacular setting for views over an attractive rural landscape to the Blue Mountains.	
LCZ 4 - Cosgrove Creek	The landscape of LCZ 4 is comprised of a rural valley surrounded by steep slopes leading up to the ridges of the surrounding Luddenham Plateau.	High. The generally open and attractive rural valley has a low capacity to absorb major infrastructure, but has a potentially large number of viewers including residents and visitors to Luddenham.	

Landscape Character Zone (LCZ)	Existing landscape character	Sensitivity	Photo of typical landscape within LCZ
LCZ 5 – Mulgoa – Orchard Hills	LCZ 5 is a diverse undulating landscape with pockets of remnant woodlands, open paddocks and rural residential clusters.	Moderate. LCZ 5 is a largely linear zone along the existing road corridor. Due to the variable topography and tree cover, proposed changes would be more easily absorbed and not widely visible beyond the road corridor. However, the areas has been identified as possessing significant scenic landscape values	

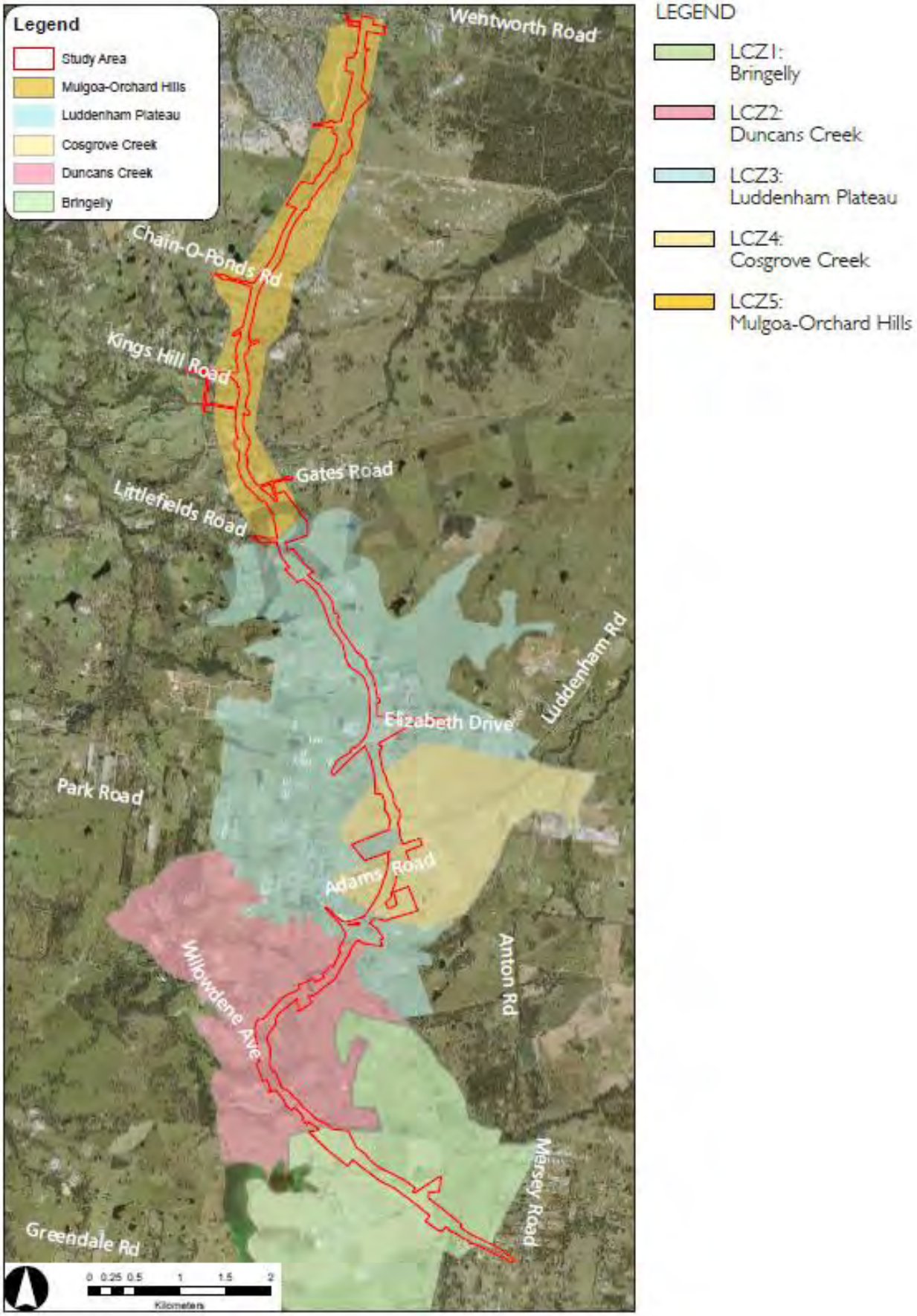


Figure 8-18 Landscape character zones

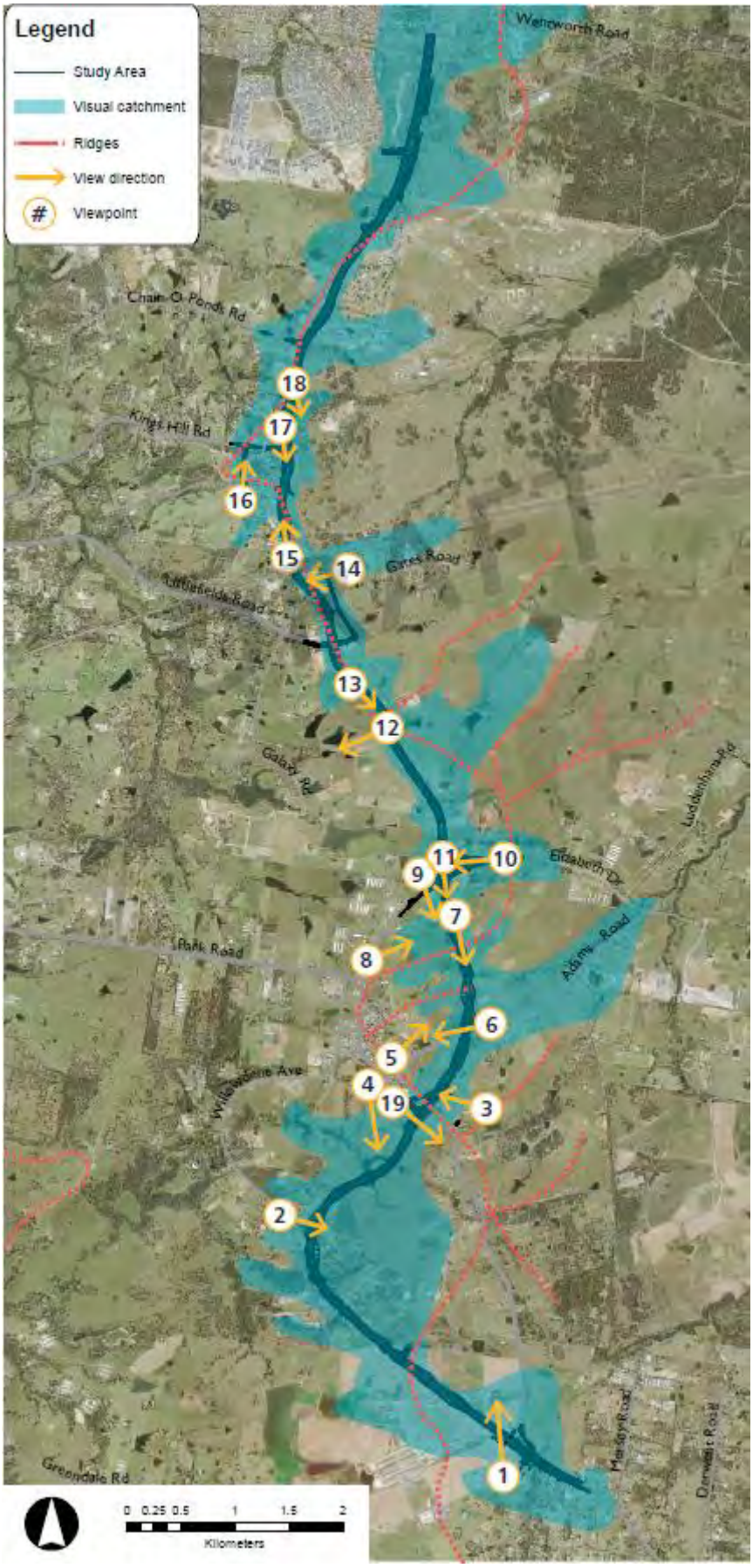


Figure 8-19 Visual catchment for the project

8.5.3 Design rationale and urban design concept

The urban design concept has been developed based on the project objectives and principles, to achieve an integrated concept design for the project. It describes the relationship between the proposed road work, structures, including bridges, and the adjoining areas, based on the current engineering concept design.

The urban design objectives and principles for the proposed upgrade have been developed based on:

- The South Western Sydney Urban Design Strategy (SWSUDS) prepared by Cox et al provides guidance in respect of the desired outcomes for the road network of the area
- The Northern Road Corridor Plan of Management (CPoM) Narellan to Bringelly - Consistent with the corridor approach to the design of the road network promoted by the SWSUDS, the design objectives and principles identified by The Northern Road CPoM for the sections of south of the proposed upgrade are of relevance to achieve a consistent corridor outcome
- The proposed upgrade of The Northern Road between Glenmore Parkway and Jamison Road - Consistent with the corridor approach to the design of the road network promoted by the SWSUDS, the design objectives and principles identified for the Upgrade of The Northern Road north of Glenmore Parkway are of relevance to achieve a consistent corridor outcome
- *Beyond the Pavement* is the overarching Roads and Maritime policy guiding urban design on all its projects. It outlines nine design principles as key to achieving and integrated engineering and urban design outcome for all Roads and Maritime projects.

The following four overarching urban design objectives are proposed:

- Protect and enhance existing views, character and cultural values of the corridor
- Provide a flowing road alignment that is responsive to, and integrated with the natural and built landscape
- Facilitate the provision of good urban design outcomes for areas adjoining the road
- Develop a simple and unified palette of elements and details that are attractive and easily maintained.

Urban design concept

The urban and landscape concept design consists of several components:

1. An urban design strategy outlining the overall approach to the design
2. Recommendations for road design elements including embankments, structures such as bridges and walls, hydrological features and roadside elements and furniture
3. A landscape planting concept including recommended species
4. Urban and landscape design concept plans at 1:5,000 describing main treatments and outcomes
5. A series of cross sections through proposed work illustrating the outcomes and treatments in the third dimension, including interfaces with adjoining areas and the local road network
6. An elevation of the proposed Adams Road bridge to illustrate the relationship with the proposed upgrade and the local road network.

The proposed urban design concept for the project is outlined in detail in Appendix O – Urban Design and Visual Impact Assessment.

8.5.4 Assessment of potential construction impacts

Construction would require some works at night-time which would require installation and use of temporary lighting. If unmanaged, light spill from these activities may impact on the health and wellbeing of some residents and occupants of buildings nearest to construction works at night-time.

Additionally, ecological light pollution as a result of construction lighting impacts would potentially affect nocturnal fauna by interrupting their life cycle. However long-term impact is unlikely (refer to Section 7.4 Biodiversity).

A number of temporary ancillary facilities would be established within each LCZ during construction to facilitate construction activities in nearby areas. These facilities would comprise offices and material laydown areas which would be fenced off and generally covered in hardstand. Offices would generally be prefabricated and material storage areas would include purpose built temporary structures as required. The sites would include activities such as site compounds, stockpile areas for materials, temporary storage of spoil and other construction activities.

Establishment and use of these sites during construction would temporarily alter the landscape character of the area and would be visible by road users along the existing road alignment. In areas where these sites would be situated in prominent locations, for example on the ridge tops and slopes adjoining existing road corridors, such facilities would be highly visible from surrounding areas and would temporarily alter the character of the landscape. In areas where mature vegetation is required to be cleared to allow establishment of these sites, the impact from the loss of established vegetation would persist following removal of the compound resulting in potential long-term impacts. However wherever possible compound site locations have been limited to areas that would not require vegetation clearing beyond that already required for the project. Additionally impacted areas that would not be directly impacted by the new or upgraded road would be restored on completion of the construction works.

Potential impacts to each of the LCZs as a result of the establishment and use of ancillary facilities during construction is outlined in Appendix O and summarised below:

- LCZ 1: The use of the areas within this LCZ would temporarily alter its character, with the exception of the site around the proposed new intersection to the Western Sydney Airport which would be located adjacent to The Northern Road and would be highly visible by the large numbers of people travelling along that route. Ancillary facilities would have a temporary impact on the landscape character of LCZ 1
- LCZ 2: The majority of the area within this LCZ proposed for use as a compound site is currently cleared. While use of the site as a construction compound would temporarily alter the character of the landscape, the site is not readily visible from surrounding areas. It would have little impact on the landscape character of LCZ 2
- LCZ 3: The sites identified for ancillary facilities within this LCZ are generally cleared areas, with the exception of the Christmas tree farm near the intersection of The Northern Road and Elizabeth Drive. These sites would be situated in prominent locations along existing major road corridors and the use of the site for construction compounds or other ancillary facilities would temporarily alter the character of the landscape
- LCZ 4: The proposed ancillary facilities within this LCZ are extensively cleared areas. However they would be situated in prominent locations on the ridge tops and slopes adjoining existing road corridors and would therefore be highly visible from surrounding areas which would temporarily alter the character of the landscape
- LCZ 5: The proposed ancillary facilities in this LCZ are generally cleared areas, with the exception of the site north of the WaterNSW Supply Pipelines which retains a larger number of scattered remnant trees. These sites would be situated in prominent locations along The Northern Road and would therefore be highly visible to large numbers of potential viewers and which would temporarily alter the character of the landscape.

Construction site establishment would involve the placement of temporary concrete safety barriers and fencing to create a safe work zone. Construction works would generally involve vegetation removal. This would alter the character of each LCZ, in particular vegetation removal around creeks and the road interface with adjoining properties. Impacts as a result of typical construction activities would generally be temporary short-term, direct and indirect impacts. As above the removal of vegetation during construction would result in long-term impacts, which would be reduced in some areas during operation of the project as vegetation becomes established.

8.5.5 Assessment of potential operational impacts

Landscape character impacts

A qualitative assessment of landscape character impacts across the five identified LCZs for the project is detailed in the Urban Design and Visual Impact Assessment (Appendix O of this EIS). The result of these assessments ranges from moderate to high, and is summarised in Table 8-33.

While The Northern Road is already an arterial road, it retains a rural quality along the route that easily integrates with the surrounding landscape. The project would fundamentally alter the character of the existing road north of Elizabeth Drive, and introduce a new road alignment into greenfield areas south of Elizabeth Drive. The change in road character, in particular the width of the road, combined with extensive earthworks and removal of vegetation and farm dams would have a considerable impact on the existing rural landscape along the route. The project would impact on all LCZs, due to the scale of the proposed works and the high sensitivity of surrounding areas.

It is noted that substantial land use changes are planned for areas along the project south of Elizabeth Drive and east of the new road alignment. They include the development of employment lands within the WSPGA, the Western Sydney Airport and the development of urban centres and residential areas within the SWPGA.

The project seeks to support these planned changes that would themselves lead to a transformation of the landscape character of the area to meet identified community needs over the next 20 to 25 years. Nevertheless the project represents one of the first steps in this transformation and the identified impacts would be highly noticeable in an area that as yet retains its rural character.

Further, there are no current plans that indicate major changes to land uses around Luddenham and west of the existing alignment of The Northern Road. These areas are identified as part of the Metropolitan Rural Area in *A Plan for Growing Sydney* (DPE, 2014), which is part of the Sydney Metropolitan Area generally located outside established urban areas, and are unlikely to change in the foreseeable future.

Table 8-33 Summary of landscape character impacts

Landscape Character Zone	Sensitivity	Magnitude	Landscape Character Impact
LCZ 1 - Bringelly	High. The rural nature of LCZ 1 is essential to its character and is highly sensitive to change, as it has a limited capacity to absorb a major new piece of infrastructure.	High. Features of the project within this LCZ would include the widening of about 700 m of existing road and the introduction of a new road alignment through a greenfield site, with a total width of over 110 m in some sections. It represents a major new road and built infrastructure in a setting with currently low levels of development.	High

Landscape Character Zone	Sensitivity	Magnitude	Landscape Character Impact
LCZ 2 - Duncans Creek	High. LCZ 2 has a scenic, undulating landscape character with extensive areas of Cumberland Plain Woodland. The landscape is largely viewed by local residents and visitors but would have a low capacity to absorb major new infrastructure.	High. The project within this LCZ would introduce a new road alignment through a greenfield site, with a total width of about 130 m in some sections and requiring substantial earthworks and embankments. It represents a major new road and built infrastructure in a setting with currently low levels of development.	High
LCZ 3 - Luddenham Plateau	High. LCZ 3 attracts a larger number of potential viewers including residents and visitors to Luddenham and motorists and tourists along The Northern Road. Due to its open and exposed ridge top location LCZ 3 has a low capacity to absorb major changes. The elevated plateau provides a spectacular setting for views over an attractive rural landscape to the Blue Mountains.	Moderate. The upgrade would introduce a major new road corridor into a rural setting in the south, and increase the width of the existing road north of Elizabeth Drive more than fourfold. This would represent a large new built form in a visually exposed area. However, the upgrade would deliver some benefit to the character and amenity of Luddenham town centre.	High to Moderate
LCZ 4 - Cosgrove Creek	High. The generally open and attractive rural valley has a low capacity to absorb major infrastructure, but has a potentially large number of viewers including residents and visitors to Luddenham.	High. The project would introduce a major new piece of infrastructure into a greenfield site that is a rural valley with currently low levels of development. It would include a large new bridge structure and associated earthworks located in the centre of the valley floor where it would be highly visible.	High
LCZ 5 – Mulgoa – Orchard Hills	Moderate. LCZ 5 is a largely linear zone along the existing road corridor. Due to the variable topography and tree cover, proposed changes would be more easily absorbed and not widely visible beyond the road corridor. However, the areas has been identified as possessing significant scenic landscape values.	Moderate. The project would increase in road width about fourfold, representing a very larger increase. This would fundamentally change the currently relatively small road from a low key country road to a major arterial that would be more typical of an urban context. Relative to other LCZs the project would integrate more readily with the landscape, requiring less earthworks to meet the geometric requirements.	Moderate

Visual impacts

The extent from which The Northern Road is visible from adjoining areas varies along the length of the project. It is influenced by topography, vegetation, buildings and land use patterns. The potential visual impact of the project has been assessed in relation to a number of key viewpoints and groups of viewpoints as shown in Figure 8-19.

Table 8-34 provides a summary of the visual impact at each viewpoint and each group of viewpoints. A total of 19 viewpoints form the basis of the visual impact assessment. The viewpoints are generally focused on locations that would be commonly viewed by the local community. The assessment indicates that the proposed upgrade of The Northern Road would have a high visual impact on two thirds of the assessed views. Remaining visual impacts would be in the high to moderate and moderate range, indicating that the project would notably affect the views and visual qualities within the study area.

Table 8-34 Summary of visual impacts

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 1 – Leppington Pastoral Company, Greendale, view from private access road looking north-east.	Moderate. The open rural landscape with undulating topography and limited tree cover has a relatively low capacity to absorb a major new road. The sensitivity of the view is reduced by the oblique angle and the distance between the viewer and the project.	Moderate. The new road alignment would be elevated, introducing a highly unnatural landform out of scale with the existing landscape. The culvert and associated headwall and road would introduce further new built form. A number of mature trees would be removed.	Moderate
Viewpoint 2 – Willowdene Avenue, Luddenham, looking south-east	High. The picturesque view of a diverse rural landscape interspersed with remnant vegetation has a low capacity to absorb a major new piece of infrastructure	High. This view would undergo a major change as a result of extensive vegetation removal and the introduction of a major new road and associated large cut and fill embankments.	High Note – the impact is likely to reduce somewhat over time as vegetation becomes established.
Viewpoint 3 – Eaton Road, Luddenham, at the intersection with the proposed new alignment of The Northern Road, looking west	High. The view is along a small unsealed lane, in a rural residential setting along the outskirts of Luddenham. Located along a ridge line, the landscape is open with long-distance views to the Blue Mountains and interspersed with tree cover. It has a relatively low capacity to absorb a major new road and large vertical structures.	Moderate. Much of the proposed new road alignment would be in cut, reducing the extent to which the road itself would be visible. However, the cutting would alter the topography in the view. Tree removal in Eaton Road would result in notable changes to the view, creating a more open vista until proposed vegetation establishes and matures.	High to moderate

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 4 – St James Anglican Church Cemetery, looking south	High. The picturesque outlook over the diverse rural landscape would be highly sensitive to change. The view is taken from a cemetery where viewers would be highly sensitive to change in the setting.	Low. The new road alignment would introduce a major new built form into a greenfield site with some sections requiring large cut and fill embankments. The oblique angle of view and the distance between the proposed new alignment and the view would reduce the extent to which it would be able to be perceived in the view. The rural landscape would continue to comprise the vast majority of the view.	Moderate Note – the impact is likely to reduce somewhat over time as vegetation becomes established.
Viewpoint 5 – Wilmington Reserve on Jamison Street, Luddenham, looking north-east into Cosgrove Valley	High. The rural landscape has a low capacity to absorb the proposed introduction of a major new road. There are a large number of viewers in Luddenham that overlook the valley, including sensitive residential and recreation users.	Moderate. The new bridge over Adams Road and associated embankments would introduce a large new built form in the rural landscape. These features would interrupt the open view along the valley. The cutting through the hillside would visibly alter the existing topography. The distance between the viewer and the proposed new alignment reduces the scale of the upgrade in the view.	High to moderate
Viewpoint 6 – Adams Road, looking west	High. This view would have low capacity to absorb the proposed changes. It is situated in a rural environment on the outskirts of Luddenham where viewers would be sensitive to change. It is characterised by the rural landscape outlook, including a series of cascading farm dams along Cosgrove Creek.	High. The bridge over Adams Road and associated tall embankments would constitute a major new built form, out of scale and character with the existing landscape. It would block the existing open vista along the valley floor. The introduction of the new road infrastructure would substantially alter the existing view.	High

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 7 – Private property driveway at 2,901 The Northern Road, Luddenham, looking south	High. The elevated outlook over the picturesque rural landscape would be highly sensitive to the introduction of a major new arterial road. Rural residents would be highly sensitive to change in their surroundings	High. The new road alignment would introduce a major new built form into a greenfield site, requiring large cut and fill embankments, modifications to farm dams and bisecting the property.	High
Viewpoint 8 – The Northern Road, Luddenham, opposite the Park Road intersection, looking east	High. The elevated outlook over the picturesque rural landscape would be highly sensitive to change as it has limited capacity to absorb a major new arterial road. Rural residents would be highly sensitive to change in their surroundings.	Low. The new road alignment would introduce a major new built form into a greenfield site, requiring large embankments of about 6 m in height, as well as modifications to farm dams and watercourses. The scale of the changes is moderated by the distance of over 800 m between the view and the proposed upgrade. Long-distance views would not be affected and the landscape would continue to the major feature in the view.	Moderate
Viewpoint 9 - Private property driveway at 2,901 The Northern Road, Luddenham, looking west	High. The view is characterised by a rural setting of pastures, remnant trees and rural dwellings. It has limited capacity to absorb the proposed changes. Rural residents would be highly sensitive to change in their surroundings.	High. The new road alignment and incident response facility would introduce a large amount of new built form into a greenfield site. The view would change fundamentally.	High
Viewpoint 10 – Local and regional motorists. Residents on rural properties	Moderate. The view is along the existing Elizabeth Drive which currently remains a two lane rural road. While motorists may be accepting of a certain amount of change within the road corridor, the road passes through a rural landscape. Remnant and planted trees as well as glimpses into adjoining farmland are important visual elements that contribute to the driver experience.	High. There would be notable increase in road infrastructure in this view due to road widening and re-alignment. This would change the scale and scenic quality currently experienced along the drive. In addition, large amounts of mature trees lining the road would be removed changing the outlook and spatial qualities.	High to moderate Note – the impact is likely to reduce somewhat over time as vegetation becomes established.

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 11 – The Northern Road, roundabout at the existing Elizabeth Drive intersection, looking south	High. The view is characterised by a pleasant outlook over the open rural landscape. Exposed on the high plateau, the view would have a low capacity to absorb the proposed changes.	High. The view would undergo major change as a result of road widening, re-alignment, levelling, tree removal, and earthworks. The outlook would change from a view into rural areas to one overlooking major road infrastructure.	High
Viewpoint 12 – no. 2,788 The Northern Road, Luddenham, looking west	High. The view is located along one of the most scenic sections of The Northern Road. It affords long-distance views over farmland and dams towards the Blue Mountains. These views are shared by residents in adjoining rural properties. They would be sensitive to changes in the outlook	Moderate. The upgrade would fundamentally alter the existing scale and character of The Northern Road. It would result in a large increase in road infrastructure, more than doubling the existing road width, thereby increasing the prominence of the road infrastructure in the view. The panoramic outlook and background would not be affected.	High to moderate
Viewpoint 13 – 2,787 The Northern Road, Luddenham, looking south	High. The view is located along one of the most scenic sections of The Northern Road. The road is currently a two lane rural road along pastures separated from the road by a line of trees. The view has relatively little capacity to absorb the proposed changes and residents in adjoining rural properties would be sensitive to changes in the visual environment.	High. The upgrade would fundamentally alter the existing scale and character of The Northern Road in this view. It would result in a large increase in road infrastructure, more than doubling the existing road width into areas of existing pasture. It would replace the outlook over pastures with a major arterial road. New variable message sign would be a large built structure that would be inconsistent with the surrounding rural environment.	High

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 14 – Residents in the rural residential cluster along Gates Road	High. The view is along the existing small rural road. It would be seen by residents in the rural living cluster along Gates Road. These residents are likely to be sensitive to changes in their visual environment. The adjoining rural landscape including tree cover framing the road are important visual elements and have a low capacity to absorb major changes.	High. The construction of the new link road through a greenfield site, widening and regrading of Gates Road and associated tree and shrub removal would result in notable changes to the view. Place a greater focus on the road infrastructure in the view. It would change the existing character of Gates Road, increase road infrastructure and remove a large amount of vegetation.	High Note – the impact is likely to reduce somewhat over time as vegetation becomes established.
Viewpoint 15 – 2,567 The Northern Road, Mulgoa, looking north	High. The view is characterised by the mix of rural dwelling, remnant vegetation and glimpses of the Blue Mountains. The Northern Road itself is a two-lane rural road that is subservient to the larger landscape setting. The view has relatively little capacity to absorb the proposed changes and residents in adjoining rural properties would be sensitive to changes in the visual environment.	High. The upgrade would fundamentally alter the existing scale and character of The Northern Road in this view. It would result in a large increase in road infrastructure, more than doubling the existing road width. Large fill batters would extend into areas of small rural holdings. The variable message sign would be a large built structure that would be inconsistent with the surrounding rural environment.	High
Viewpoint 16 – Corner of Longview and Vineyard Roads, looking north	High. The natural vegetated setting of the unmade road reserve has a low capacity to absorb new road infrastructure. Rural residents are likely to be sensitive to changes in the visual environment.	High. The extension of the road would change the view from a setting dominated by pasture and remnant vegetation to looking along a new road. Removal of mature trees along the boundary with 23-33 Longview Road would further change the outlook and open up views into the private property.	High

Viewpoint ID	Sensitivity	Magnitude	Visual Impact
Viewpoint 17 – Grover Crescent, Mulgoa, looking south	High. The view is characterised by an existing informal road providing access to a small rural residential cluster. Remnant and planted trees provide important elements in the view. Residents are likely to be sensitive to changes in the visual environment	High. The extent and scale of formal road infrastructure would increase notably in this view. Widening of The Northern Road itself would be difficult to perceive due to the angle of the view. However, associated earthworks and removal of trees currently framing and terminating the view would be highly noticeable changes.	High Note – the impact is likely to reduce somewhat over time as vegetation becomes established.
Viewpoint 18 – Defence Establishment Orchard Hills, opposite 2,359-2,365 The Northern Road, Mulgoa, looking south	High. The view is characterised by a mix of woodland remnants and open pasture at the interface to the DEOH, and small rural holdings to the west. The Northern Road itself is a two-lane rural road that is subservient to the larger landscape setting. The view is generally open and has little capacity to absorb the proposed changes. Residents in adjoining rural properties would be sensitive to changes in the visual environment.	High. The upgrade would fundamentally alter the existing scale and character of The Northern Road in this view. It would result in a large increase in road infrastructure, more than doubling the existing road width. The variable message sign would be a large built structure that would be inconsistent with the surrounding rural environment.	High
Viewpoint 19 – The Northern Road, Luddenham, opposite the IGA supermarket, looking south	High. The view is characterised by gentle rural valley comprised of a mix of woodland remnants and open pasture, west of the existing The Northern Road. The foreground of the view is open. As a result it has little capacity to absorb the proposed changes. Residents in Luddenham Town Centre and from adjoining rural properties would be sensitive to changes in the visual environment.	High. The re-alignment of Eaton Road and the existing The Northern Road with road widening, the introduction of the new road alignment through the centre of the valley at the southern perimeter of Luddenham Town Centre combine to fundamentally alter this view, replacing the rural outlook and introducing large built infrastructure.	High

Viewpoint 1: Leppington Pastoral Company, Greendale, view from private access road looking north-east – existing

Viewpoint 1: Leppington Pastoral Company, Greendale, view from private access road looking north-east – proposed

Viewpoint 2: Willowdene Avenue, Luddenham, looking south-east – existing

Viewpoint 2: Willowdene Avenue, Luddenham, looking south-east – proposed

Viewpoint 3: Eaton Road, Luddenham, at the intersection with the proposed new alignment of The Northern Road, looking west – existing

Viewpoint 3: Eaton Road, Luddenham, at the intersection with the proposed new alignment of The Northern Road, looking west – proposed

Viewpoint 4: St James Anglican Church Cemetery, looking south – existing

Viewpoint 4: St James Anglican Church Cemetery, looking south – proposed

Viewpoint 5: Wilmington Reserve on Jamison Street, Luddenham, looking north-east into Cosgrove Valley – existing

Viewpoint 5: Wilmington Reserve on Jamison Street, Luddenham, looking north-east into Cosgrove Valley – proposed

Viewpoint 6: Adams Road, looking west – existing

Viewpoint 6: Adams Road, looking west – proposed

Viewpoint 7: Private property driveway at 2,901 The Northern Road, Luddenham, looking south – existing

Viewpoint 7: Private property driveway at 2,901 The Northern Road, Luddenham, looking south – proposed

Viewpoint 8: The Northern Road, Luddenham, opposite the Park Road intersection, looking east – existing

Viewpoint 8: The Northern Road, Luddenham, opposite the Park Road intersection, looking east – proposed

Viewpoint 9: Private property driveway at 2,901 The Northern Road, Luddenham, looking west – existing

Viewpoint 9: Private property driveway at 2,901 The Northern Road, Luddenham, looking west – proposed

Viewpoint 10: Elizabeth Drive, looking west – existing

Viewpoint 10: Elizabeth Drive, looking west – proposed

Viewpoint 11: The Northern Road, roundabout at the existing Elizabeth Drive intersection, looking south – existing

Viewpoint 11: The Northern Road, roundabout at the existing Elizabeth Drive intersection, looking south – proposed

Viewpoint 12: no. 2,788 The Northern Road, Luddenham, looking west – existing

Viewpoint 12: no. 2,788 The Northern Road, Luddenham, looking west – proposed

Viewpoint 13: no. 2,787 The Northern Road, Luddenham, looking south – existing

Viewpoint 13: no. 2,787 The Northern Road, Luddenham, looking south – proposed

Viewpoint 14: Gates Road, Luddenham, looking west – existing

Viewpoint 14: Gates Road, Luddenham, looking west – proposed

Viewpoint 15: no. 2,567 The Northern Road, Mulgoa, looking north – existing

Viewpoint 15: no. 2,567 The Northern Road, Mulgoa, looking north – proposed

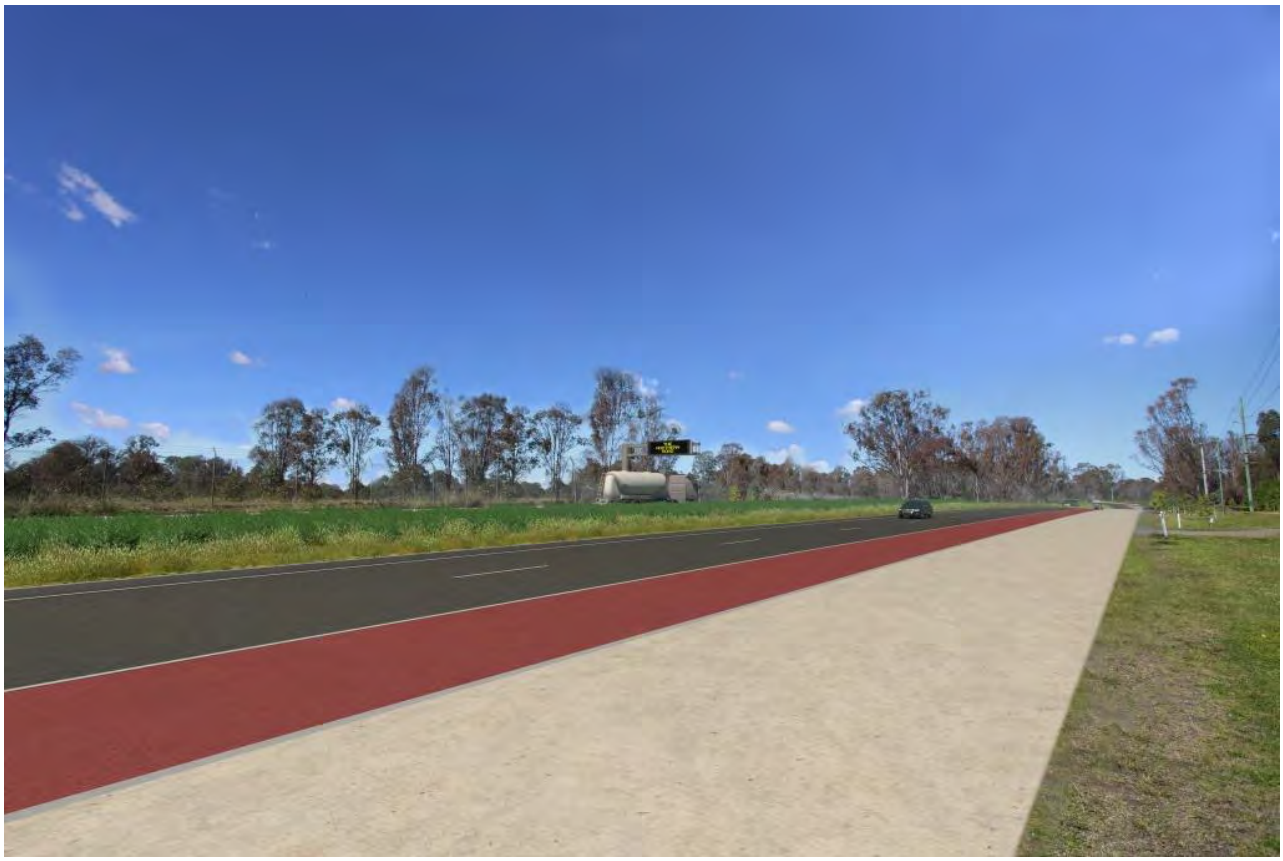
Viewpoint 16: Corner of Longview and Vineyard Roads, looking north – existing

Viewpoint 16: Corner of Longview and Vineyard Roads, looking north – proposed

Viewpoint 17: Grover Crescent, Mulgoa, looking south – existing

Viewpoint 17: Grover Crescent, Mulgoa, looking south – proposed

Viewpoint 18: Defence Establishment Orchard Hills, opposite 2,359-2,365 The Northern Road, Mulgoa, looking south – existing



Viewpoint 18: Defence Establishment Orchard Hills, opposite 2,359-2,365 The Northern Road, Mulgoa, looking south – proposed

Viewpoint 19: The Northern Road, Luddenham, opposite the IGA supermarket, looking south – existing

Viewpoint 19: the existing The Northern Road, Luddenham, opposite the IGA supermarket, looking south-east – proposed

8.5.6 Summary of impacts to the environment of Commonwealth land

A summary of potential impacts to the environment of Commonwealth land as a result of construction and operation of the project is provided in this section.

The majority of potential landscape character and visual impacts to Commonwealth land would occur as a result of proposed works within LCZ 1 and LCZ 2 within or immediately adjacent to the Western Sydney Airport, works within LCZ 2 with regards some parcels of Commonwealth land at Willowdene Avenue, and LCZ 5 in relation to works within or immediately adjacent to the DEOH.

Potential construction related landscape character and visual impacts are outlined in Section 8.5.4. Generally construction related impacts would occur as a result of proposed construction sites and ancillary facilities. For the most part, the proposed compound sites for the project would not be located directly on Commonwealth land, with the exception of site C7 on lands associated with the Western Sydney Airport in LCZ 2, and site C17 on lands at the DEOH within LCZ 5. Any potential impacts would be temporary and mitigated through the measures outlined in Section 8.5.7.

Potential landscape character and visual impacts during operation of the project are outlined in Section 8.5.5. These generally relate to changes in the landscape and impacts to views. Impacts to Commonwealth land would include the following:

- New cut and fill embankments would stand out as unnatural landforms in the gently undulating landscape
- Natural creek lines such as Badgerys Creek within LCZ 1 at the southern end of the project would be altered which would change the extent to which these creeks can be perceived and appreciated as natural landscape features
- Removal of native roadside vegetation
- Drainage channels including open drains and swales would be highly visible and would be inconsistent in character with the rural landscape
- In the case of LCZ 1 and LCZ 2, the new road alignment would introduce a major new built form in the landscape, including some areas directly on or immediately adjacent to Commonwealth land associated with the Western Sydney Airport
- At the DEOH within LCZ 5, the Chaffey Brothers Irrigation Scheme Canal heritage item would be directly impacted which would impact on the landscape character of the area
- Within LCZ 5 works would require modifications to the existing golf course layout on Commonwealth land to accommodate the project
- Visual impacts as identified for viewpoint 18 (assessed as being of high impact) would have the potential to impact views to and from the adjacent DEOH
- Visual impacts identified for viewpoints 1 and 2 (assessed as being of moderate to high impact) would have the potential to impact views to and from the Western Sydney Airport
- Visual impacts identified for viewpoint 2 (assessed as being of high impact) would also potentially impact views in relation to the parcels of Commonwealth land at Willowdene Avenue.

This would result in long-term impacts to Commonwealth land during operation of the project. Impacts would be minimised through the implementation of the management measures outlined in Section 8.5.7

In summary, the potential landscape character and visual impacts to the environment of Commonwealth land during both construction and operation are not anticipated to be greater or different to those outlined above for the project, and the residual impacts are considered to be consistent with those outlined in Section 8.5.8.

8.5.7 Environmental management measures

Expected environmental outcomes

Project specific environmental management measures identified in Table 8-35 have been developed with the aim of minimising or mitigating, as far as practical, the potential impacts described in this chapter.

An urban design strategy and concept plan is outlined in Appendix O as summarised in this chapter. This is based on the urban design and objectives and principles established for the project, which can be summarised as follows:

- Protect and enhance existing views, character and cultural values of the corridor
- Provide a flowing road alignment that is responsive to, and integrated with the natural and built landscape
- Facilitate the provision of good urban design outcomes for areas adjoining the road
- Develop a simple and unified palette of elements and details that are attractive and easily maintained.

Together with the mitigation measures identified below, the concept design provides guidance towards the future detailed design and construction environmental management.

General outcomes that would be achieved through the implementation of the mitigation strategy for the project as outlined in Appendix O would include:

- Identification and implementation of primary mitigation measures that intrinsically comprise part of the identification of proposed works through an iterative process
- Identification and implementation of secondary mitigation measures designed to specifically address the remaining (residual) adverse effects arising from the proposed works.

Specific outcomes that would be achieved through the implementation of environmental management measures include:

- Mitigation of landscape character and visual impacts through detailed design including treatment of built elements
- Minimisation of vegetation loss as a result of the project
- Rehabilitation of disturbed areas in keeping with the local landscape character and setting
- Conservation and enhancement of existing views and vistas where possible
- Compliance with the relevant legislative requirements and project conditions of approval.

Expected effectiveness

Roads and Maritime have experience in managing potential urban design, landscape character and visual impacts as a result of road developments of a similar scale and scope to this project.

Urban design outcomes have been incorporated into concept design and would be further refined during detailed design of the project. The urban design outcomes have been guided by existing Roads and Maritime policies and procedures (such as *Beyond the Pavement*), which commit Roads and Maritime to providing excellent outcomes for the people of NSW, governed by over-arching urban design principles that include both physical outcomes and performance based principles.

The aim of the mitigation measures is to realise the engineering and performance objectives of the proposed upgrade while producing a design outcome that produces good urban design outcomes and has a high visual quality. Therefore a range of mitigation measures are recommended for incorporation into the project. These measures combine with the urban concept design to develop a solution that maximises the protection of the existing visual values and landscape character of

The Northern Road and adjoining areas. Mitigation measures may be considered under two categories:

- Primary mitigation measures are embedded in the design of the proposed works through an iterative process between the engineering and urban design teams. This form of mitigation is generally the most effective
- Secondary mitigation measures are designed to specifically address the remaining (residual) adverse effects arising from the proposed works.

Together with the mitigation measures proposed, the concept design provides guidance towards the future detailed design and construction documentation. The mitigation measures are a series of opportunities to maximise integration of the project into the study area and as such, are expected to be effective.

An urban design plan would be prepared during detailed design to incorporate the urban design strategy and concept plan outlined in Appendix O of the EIS. This would include urban design treatments to reduce visual impacts during operation of the project. Additionally construction management measures are proposed to reduce visual and landscape character impacts during construction of the project as result of general construction activities, ancillary facilities and vegetation loss.

Audits and reporting of the effectiveness of environmental management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP prepared for the project. Procedures would also be developed for monitoring and maintaining landscaped areas to be implemented during operation of the project to ensure planting becomes established and ensure the effectiveness of these treatments are appropriately implemented and maintained.

Table 8-35 outlines environmental management measures that have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works.

Project-specific management measures have been developed with the aim of minimising or mitigating, as far as practical, landscape character and visual impacts as described above. The management and mitigation measures draw on best management practice, government standards and guidelines, and specialist knowledge.

Further detail regarding the management outcomes to be implemented in accordance with the management procedures for the project is provided in Appendix O.

Table 8-35 Urban design and visual environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Urban design	UD-1	The urban design and landscape concept developed for the project would be adopted during detailed design. This would include design treatments for: • location and identification of existing vegetation and proposed landscaped areas, including species to be used • built elements including retaining walls and Adams Road Bridge • design treatments for stormwater quality measures and infrastructure • pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas.	Contractor	Detailed Design / Construction / Operation	Expected to be effective. Urban design outcomes have been incorporated into concept design and would be further refined during detailed design of the project in consultation with a range of stakeholders including State Government agencies, Penrith City Council, Liverpool City Council and the local community.
Lighting impacts	UD-2	The design of temporary lighting must avoid unnecessary light spill on adjacent residents or sensitive receivers and be designed in accordance with AS 1158.1-1986.	Contractor	Detailed Design / Construction	Proven effective if carried out in accordance with AS 1158.1-1986.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Visual impacts from construction sites	UD-3	Consider the provision of barriers to screen views from visually sensitive nearby areas such as rural dwellings, residential and recreational areas.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts from construction sites	UD-4	Contain construction activities within the construction works zone boundary and occupy the minimum area practicable for limiting impacts on adjoining areas, including the extent of native vegetation clearing.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-5	Construction programming must show how progressive rehabilitation of disturbed areas would be undertaken to minimise the duration and extent of temporary visual and landscape character impacts and to minimise soils exposure and the potential for erosion and dust generation.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-6	Existing trees to be retained within construction areas are to be identified, protected and maintained in accordance with AS4970 Trees on Development Sites, or as otherwise directed by a qualified ecologist or arborist.	Contractor	Construction	Proven effective if carried out in accordance with AS4970 Trees on Development Sites.

8.5.8 Residual Impacts

Residual impacts are defined as those impacts that remain following the implementation of mitigation measures.

Residual impacts during construction of the project are expected to be minor, with the exception of vegetation removal which is discussed below. Minor short-term residual impacts would be associated with the establishment and operation of construction sites and ancillary facilities which would be visible from the road and by surrounding land users. For the most part the proposed temporary ancillary facilities during construction would be established on cleared areas, and where vegetation removal is required for the purpose of establishing ancillary facilities this would be limited to that already required for the project. Sites would be progressively restored on completion of construction works. Therefore residual impacts during construction (with the exception of vegetation removal) are expected to be minor and short-term.

Vegetation removal would be undertaken during construction, resulting in associated residual landscape character and visual impacts during both construction and operation of the project. While some of the impacts would appear less severe over time during operation of the project as the proposed vegetation establishes and matures, the project would result in the following long-term irreversible residual impacts during operation:

- Alterations to the topography as a result of the required earthworks
- Filling in of farm dams and disruptions to creeks as ecological corridors through the introduction of culverts which would alter the rural outlook and natural systems long-term
- The loss of views as a result of earthworks and other structures associated with the proposed upgrade (it is noted that the project would also create opportunities for new views not currently available to the general public)
- The scale of the proposed upgrade itself as a major arterial through a rural landscape
- The introduction of lighting along the proposed upgrade would persist long-term and is required to support the safe functioning of the road.

Based on the above, the identified landscape character and visual impacts would not substantially reduce over time. That is they would remain:

- In the moderate to high range for landscape character impacts
- In the moderate to high range for visual impacts.

The mitigation measures proposed in Section 8.5.7 seek to integrate the proposed upgrade with the existing landscape while taking into account the planned changes to maximise the long-term fit of the project within its natural and built setting.

While the impacts themselves would not reduce over time, it is likely that the perception of the severity of the impacts may reduce, as people gradually adjust to the changes in their visual environment.

Additionally it is noted that the upgrade is proposed in the context of substantial land use changes planned for the area, including the area south of Elizabeth Drive and east of the upgraded The Northern Road which would become progressively urbanised for employment purposes and the Western Sydney Airport.

In the context of an urbanising landscape, it is therefore anticipated that the long-term landscape character changes brought about by the project would be consistent with the future character and use of the area. Therefore long-term landscape character and visual impacts as a result of the project are not expected to be significant.

8.6 Air quality

This chapter provides an assessment of potential impacts on air quality at a local and regional scale from construction and operation of the project and recommends environmental management measures to reduce these impacts.

Table 8-36 sets out the Secretary's Environmental Assessment Requirements (SEARs) and Commonwealth EIS guidelines as they relate to air quality and states where in this EIS these have been addressed.

Table 8-36 NSW and Commonwealth Environmental Assessment Requirements

Requirements	Where addressed in this EIS
Secretary's Environmental Assessment Requirements	
During the preparation of the EIS, you must assess project impacts to air quality.	
This includes: • potential for impacts on local and regional air quality, including sensitive receivers; and • details of the proposed mitigation measures to prevent the generation and emission of dust.	Section 8.6.5, Section 8.6.6, Section 8.6.7 and 8.6.9. Appendix P
Commonwealth EIS Guideline	
The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: • description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: Natural and physical resources, including air.	Section 8.6.4 Appendix P
Impacts to the environment (as defined in section 528) should include but not be limited to the following: • changes to air quality during construction and operation (including consideration of seasonal and meteorological variations that influence local air quality).	Section 8.6.5, Section 8.6.6 Appendix P

8.6.1 Assessment methodology

The information sources used in carrying out the assessment are identified below, where applicable, and comprise Government databases, existing meteorology data, and previous assessments. Publically available imagery was reviewed to determine the location of nearby receivers in relation to the project study area.

A complete list of information sources used in the assessment is provided in the working paper. Air quality monitoring was not carried out to verify the accuracy of the sourced data.

Construction air quality

To identify and appropriately manage the generation of dust emissions during construction, a risk-based qualitative assessment method was applied and included:

- Identification of local receivers, prevailing meteorological and ambient air quality conditions through data collected from the nearest monitoring station operated by the Bureau of Meteorology (BoM) at Penrith Lakes (station number 67113). The monitoring station is located about 8.5 km north-west of the northern end of the project
- Background air quality conditions around the project were estimated from data collected at the nearest NSW Office of Environment and Heritage (OEH) ambient air quality monitoring stations located at St Marys, Bringelly, Prospect and Liverpool
- Potential air quality impacts were qualitatively assessed for each phase of construction associated with the project. The likelihood (probability) and consequence (severity) of activities resulting in air quality impacts were evaluated to develop initial risk ratings
- Factors including the intensity and duration of activities, relative location in relation to surrounding sensitive receivers, existing air quality and prevailing meteorological conditions were considered to develop likelihood and consequence ratings, and resulting initial risk ratings for each phase of construction
- Following the initial assessment, air quality mitigation measures were recommended, where necessary, to minimise and mitigate phases of construction where 'moderate risks' or higher were estimated. Residual risk ratings were calculated based on the application of recommended management measures and safeguards
- The extent of residual risks to air quality determined at a local scale was used to inform potential impacts at a broader regional level.

Operational air quality

To evaluate potential operational air quality impacts, a quantitative assessment approach was applied using the Roads and Maritime Tool for Roadside Air Quality (TRAQ) prediction model. TRAQ, which uses the CALINE4 air dispersion model for predicting air pollutant concentrations near roadways, was used to develop models for the following assessment scenarios:

- Scenario 1: Do minimum, year of opening (2021)
- Scenario 2: Proposed upgrade, year of opening (2021)
- Scenario 3: Do minimum, future year (2031)
- Scenario 4: Proposed upgrade, future year (2031).

It is noted that the 'Do minimum' scenarios 1 and 3 relate to a scenario whereby The Northern Road is realigned along the proposed upgrade route, with a single lane in each direction. This alignment has been selected for the assessment as the Western Sydney Airport site is planned to traverse the existing alignment of The Northern Road between Adams Road and Badgerys Creek.

Modelling considered concept upgrade arrangements, measured and forecast traffic data (volumes, composition and speeds), and worst case meteorological conditions (that is, wind speed of 1 m/s, atmospheric stability Class F, and 15 degrees Celsius). Environment Protection Authority (EPA) vehicle fleet exhaust emission factors for 2021 and 2026 were used for the 2021 and 2031 scenarios respectively.

Predicted roadside operational contributions were added to background concentrations and compared to EPA ambient air quality assessment criteria. These criteria are discussed in Appendix P – Air Quality. The relative difference in predicted impacts between each scenario was also assessed. Mitigation measures were recommended, as required, to manage any identified operational impacts.

As for construction, predicted impacts at a local level were used to inform potential operational impacts at a wider regional scale.

8.6.2 Policy setting

In NSW, emissions to air are controlled by the *Protection of the Environment Operations Act 1997* (POEO Act) and the following regulations:

- Protection of the Environment Operations (Clean Air) Regulation 2010
- Protection of the Environment Operations (General) Regulation 2009, Part 5.4 Air pollution.

The Approved Methods for Modelling and Assessment of Air Pollutants in NSW (approved methods), (NSW Environment Protection Authority, 2005) provides methods for modelling and assessing emissions to air in NSW.

8.6.3 Assessment Criteria

Relevant assessment criteria for the project from the approved methods and the recent variation to the National Environment Protection Measure (NEPM) for the primary pollutants associated with the construction and operational phases of the project identified above are presented below in Table 8-37. This includes the original source for criteria adopted in the Approved methods.

Table 8-37 Air quality impact assessment criteria (DEC, 2005)

Pollutant	Averaging time	Criteria	Source
Particulate matter (PM_{10})	24 hours	50 µg/m^3	DoE, 2016
	Annual	30 µg/m^3	DoE, 2016
Particulate matter ($PM_{2.5}$)	24 hours	25 µg/m^3	DoE, 2016
	Annual	8 µg/m^3	DoE, 2016
Total suspended solids (TSP)	Annual	90 µg/m^3	NHMRC, 1996
Deposited dust	Annual (maximum increase)	2 g/m^2/month	NERDDC, 1988
	Annual (maximum total)	4 g/m^2/month	NERDDC, 1988
Carbon monoxide (CO)	15 minutes	100 mg/m^3	WHO, 2000
	1 hour	30 mg/m^3	WHO, 2000
	8 hours	10 mg/m^3	NEPC, 1998
Nitrogen dioxide (NO_2)	1 hour	246 µg/m^3	NEPC, 1998
	Annual	62 µg/m^3	NEPC, 1998
Volatile organic compounds (VOCs) as benzene	1 hour	29 µg/m^3	GoV, 2001

The intent of each of these criteria based on the approved methods are summarised below. Further details are provided in Appendix P – Air Quality:

- Particulate matter (PM10 and PM2.5): the desired outcome of the measure is ambient air quality that allows for the adequate protection of human health and well-being
- Total suspended solids (TSP): at the levels listed in the criterion above, there may still be some people who would experience respiratory symptoms, however the intent of this criteria is the protection of human health for the broader majority of the population
- Carbon monoxide (CO): The criteria for CO are intended to preserve a COHb (Carbon monoxide haemoglobin oxygen carrying capacity of the blood) safe level of 2.5 per cent for a 'normal subject' engaging in light or moderate exercise. Exposures to concentrations above these levels are known to result in adverse health effects

- Nitrogen dioxide (NO2): The objective of this criterion is to provide adequate protection of human health and well-being. Where short-term exposures is greater than 400 µg/m3, there is evidence to suggest possible small effects in function of asthmatics
- Volatile organic compounds (VOCs): This criterion includes a factor of safety of 40, given the high toxicity and potential health effects arising from exposure to such substances.

As such, it can generally be concluded that exposure up to and at the criteria specified in Table 8-37 may result in some health effects for some individuals. Exposures above these criteria broadly results in an increase in frequency of adverse health effects amongst a population, though the extent of this relationship varies between pollutants and exposures times.

These criteria relate to the 100th percentile (99.9th percentile for benzene), total cumulative concentration of pollutants in the air and not just contributions from project-specific sources. As such, ambient pollutant concentrations determined in Table 8-38 must also be considered when evaluating against these criteria.

8.6.4 Existing environment

The following sections outline the existing environmental conditions relevant to local and regional air quality. This is considered to provide a baseline of existing conditions from which potential impacts from the project have been assessed.

Meteorology

Long-term temperature and rainfall averages recorded at Penrith Lakes automatic weather station (located about 8.5 km to the north-west of the project) from its date of commission in 1995 to present are provided in Appendix P – Air Quality and are summarised below:

- Summer is generally warm and wet with mean daily maximum temperature of between 29 and 31 degrees Celsius
- Months through winter and the beginning of spring are the coldest and driest periods of the year with average monthly rainfall from July to September of around 30 mm per month
- Annual and seasonal wind roses are generally consistent from each of the three years, with winds blowing from the south-west most common during all times of the year
- Calm conditions (i.e. wind speeds less than 0.5 m per second) were most common in autumn and winter; occurring around 20 per cent of the time during these seasons.

Ambient air quality

The OEH developed a metric known as the ‘air quality index’ (AQI). The purpose of the AQI is to provide an indication of the overall air quality by considering pollutant data measurements for ozone (O3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and PM10, as well as visibility against criteria presented in the *Variation to the National Environment Protection* (Ambient Air Quality) Measure and OEH standard for visibility.

Statistics generated from daily AQI values calculated at the nearest OEH air quality monitoring (St Marys – northern portion of the project Bringelly – southern portion) are presented below in Table 8-38. These statistics indicate that daily AQI values are generally ‘good’ with occasional days of ‘poor’ air quality or worse, usually driven by particulate matter concentrations.

Table 8-38 St Marys AQI value statistics

Period	St Marys AQI value statistics			Bringelly AQI value statistics		
	Annual daily average	95th percentile of daily values	Annual daily maximum	Annual daily average	95th percentile of daily values	Annual daily maximum
2013	57	105	670	53	92	1274
2014	50	88	272	48	82	263
2015	45	79	220	47	77	225

AQI value classification:Very good (0 to 33), Good (34 to 66), Fair (67 to 99), Poor (100 to 149), Very poor (150 to 199), Hazardous (200 +)

The OEH operates a state wide air quality monitoring network which provides information on current and historical air quality. The network includes 15 air quality stations around the greater Sydney region. The nearest stations in relation to the project are:

- St Marys (about 7.0 km to the north-east)
- Bringelly (about 5.0 km to the east)
- Prospect (20 km to the east)
- Liverpool (about 19 km to the east).

The primary pollutants of concern during construction and operations are NO2, CO and particulate matter. Concentrations of CO and PM2.5 are not measured at this station. Both CO and PM2.5 are measured at Prospect, although measurement of PM2.5 only commenced in December 2014.

A summary of the ambient concentrations of PM_{10}, $PM_{2.5}$, NO_2 and CO measured at these four stations from 2013 to 2015 is shown in Table 8-39.

Table 8-39 Summary of ambient pollutant concentrations measured from 2013 to 2015 at St Marys, Bringelly, Prospect and Liverpool

Station	Year	PM_{10} µg/m^3			$PM_{2.5}$ µg/m^3			NO_2 µg/m^3		CO mg/m^3
		100th %ile 24 hour	95th %ile 24 hour	Annual	100th %ile 24 hour	95th %ile 24 hour	Annual	100th %ile 1 hour	Annual	100th %ile 8 hour
St Marys	2013	93	33	16	-	-	-	76	11	-
	2014	45	28	18	-	-	-	64	8	-
	2015	53	27	15	-	-	-	66	8	-
Bringelly	2013	97	30	17	-	-	-	76	9	-
	2014	43	29	17	-	-	-	51	9	-
	2015	57	28	16	-	-	-	55	8	-
Prospect	2013	82	33	19	-	-	-	101	22	1.8
	2014	44	30	18	-	-	-	96	21	1.5
	2015	69	30	18	30	16	8	109	22	1.7
Liverpool	2013	99	37	21	74	19	9	115	23	2.4
	2014	41	33	19	24	16	9	90	21	2.5
	2015	69	31	19	32	17	9	123	20	2.1

Based on the results presented in Table 8-39 against the assessment criteria established in Table 8-37, the following observations can be made:

- 100th percentile (maximum) 24 hour-averaged PM10 background concentrations were found to exceed the criterion of 50 µg/m^3 at all four monitoring locations in 2013 and 2015, but were below this criterion in 2014. 95th percentile values of 24 hour-averaged concentrations ranged from 27 to 37 µg/m^3, with the highest values recorded at Liverpool
- Annually averaged PM10 background concentrations ranged from 15 to 21 µg/m^3 across the four sites for the three years considered (2013 to 2015), with the highest annual average concentrations recorded at Liverpool. These levels range from 15 to 9 µg/m^3 below the assessment criterion (30 µg/m^3)
- 100th percentile (maximum) 24 hour-averaged PM2.5 background concentrations measured at Prospect (2015) and Liverpool (2013 to 2015) exceeded the criterion of 25 µg/m^3, but 95th percentile 24 hour-averaged PM2.5 concentrations were below this value, ranging from 16 to 19 µg/m^3
- Annually averaged PM2.5 background concentrations were measured to already exceed the assessment criterion of 8 µg/m^3
- 100th percentile 1 hour averaged NO2 background concentrations were measured to be well below the assessment criterion (246 µg/m^3) at all of the four measurement sites and all of the three year's considered. Annually averaged NO2 background concentrations were also well below the annual criterion of 62 µg/m^3 with the highest concentration of 23 µg/m^3 recorded at Liverpool in 2013
- 100th percentile 8 hour-averaged CO concentrations measured at Prospect and Liverpool were found to be well below the assessment criterion (10 µg/m^3)
- VOCs are not presently measured at any OEH air quality monitoring stations. Historical studies have previously been completed by the NSW EPA to investigate baseline concentrations of air toxics. Annual and 24 hour-averaged benzene concentrations of 1.4 µg/m^3 and 4.2 µg/m^3 were measured at St Marys respectively. Annual benzene concentrations of 1.4 µg/m^3 were measured at Turrella Pacific Environment Limited, October 2015).

Considering the monitoring data presented above, the following background concentrations were adopted for the purpose of this assessment to characterise local and regional background air quality conditions. It is noted that the 1 hour averaged CO and VOC (as benzene) background concentrations have been approximated using the formula provided in the *AUSPLUME Gaussian Plume Dispersion Model Technical User Manual*, (Victorian Environment Protection Authority 2000) for estimating sub-hourly concentrations from hourly data. The formula was modified to estimate the 1 hour concentration from the available 8 hour and 24 hour averaged data respectively.

Table 8-40 Adopted pollutant background concentrations

Pollutant	Averaging time	Adopted background concentration (100th percentile)
PM_{10}	24 hour	29.4 µg/m^3 – North of Elizabeth Drive (M12) 29.0 µg/m^3 – South of Elizabeth Drive (M12)
	Annual	15.9 µg/m^3 – North of Elizabeth Drive (M12) 16.5 µg/m^3 – South of Elizabeth Drive (M12)
$PM_{2.5}$	24 hour	16.8 µg/m^3
	Annual	8.7 µg/m^3
NO_2	1 hour	68.4 µg/m^3 – North of Elizabeth Drive (M12) 60.9 µg/m^3 – South of Elizabeth Drive (M12)
	Annual	9.0 µg/m^3 – North of Elizabeth Drive (M12) 8.7 µg/m^3 – South of Elizabeth Drive (M12)
CO	1 hour	2.5 mg/m^3
	8 hour	1.7 mg/m^3
Volatile organic compounds (VOCs) as benzene	1 hour	2.6 µg/m^3

Nearby receivers

Land-use around the proposed upgrade of The Northern Road, is low-density residential at the northern extent and rural/residential land, generally south of Orchard Hills. Approximate distances to the nearest receiver and typical distances to receivers along each segment of the proposed upgrade route are summarised in Table 8-41. The closest properties are about 20 m from the project.

Table 8-41 Summary of surrounding receivers

Segment	Description	Nearest and typical distances to surrounding receivers (m)
Segment 1	The Northern Road between Glenmore Parkway and Bradley Street (contains Commonwealth land)	Nearest: About 50 m Typical: More than 100 m
Segment 2	The Northern Road between Bradley Street and Chain-O-Ponds Road (contains Commonwealth land)	Nearest: About 20 m Typical: 50 to 100 m
Segment 3	The Northern Road between Chain-O-Ponds Road and Kings Hill Road (contains Commonwealth land)	Nearest: About 20 m Typical: About 50 m
Segment 4	The Northern Road between Kings Hill Road and Littlefields Road (contains Commonwealth land)	Nearest: About 20 m Typical: About 40 m
Segment 5	The Northern Road between Littlefields Road and Elizabeth Drive (M12)	Nearest: About 40 m Typical: More than 50 m
Segment 6	The Northern Road between Elizabeth Drive (M12) and Park Road (former Northern Road)	Nearest: About 100 m Typical: About 100 m
Segment 7	The Northern Road between Park Road (former Northern Road) and future airport access	Nearest: More than 100 m Typical: More than 100 m
Segment 8	The Northern road south of future airport access	Nearest: About 50 m Typical: About 100 m

Potential impacts at these receivers were used to evaluate impacts from the project at a local scale.

8.6.5 Potential construction impacts

Construction activities have the potential to increase airborne particulate matter and cause nuisance impacts where construction is in proximity to sensitive receivers such as residential dwelling and community areas. Potential impacts could include:

- Temporary increase in air emissions from dust and products of combustion (from equipment operations)
- Temporary increased windborne dust emanating from disturbed/exposed surfaces
- Increased dust and debris arising from haulage of materials during construction
- Odours arising from uncovered contaminated and/or hazardous materials.

In particular, construction activities involving the handling, disturbance and management of materials are likely to have the highest potential to generate air quality impacts during construction.

Potential air quality impacts during construction have been evaluated using the risk-based approach. The full construction air quality risk assessment is provided in Appendix P and summarised below.

The following activities are considered to be high risk before the implementation of environmental management measures:

- Establishment and operation of construction compound sites and storage facilities
- Vegetation clearing, grubbing and removal
- Earthworks - Stripping, stockpiling and management of topsoil and unsuitable materials
- Road widening and re-alignment works, intersection works - Placement and compaction of sub-base course and base course.

The following activities are considered to be moderate risk before the implementation of environmental management measures at local receivers:

- Road widening and re-alignment works, intersection works - Excavation and preparation of subgrade
- Pavement construction – development of pavement and median
- Landscaping and demobilisation from the site.

The following activities are considered to present a low risk at local receivers before the implementation of environmental management measures:

- Early works including installation of construction signage and environmental controls, ground surveys, geotechnical and soil investigations, dilapidation and building surveys and protection of utilities
- Drainage and utilities works
- Bridge preparation and installation activities
- Installation of permanent traffic control signals and road furnishings; line marking and street lights.

Environmental management measures have been recommended including appropriate work practices and scheduling, equipment selection, monitoring and preventative controls (See Table 8-43). After the application of these measures, residual ratings have been calculated. ‘Moderate’ risk ratings remain for several phases of construction, indicating that careful management of emissions to air would be required during these particular periods of construction to minimise and effectively manage impacts at surrounding local receivers.

Though a potential for temporal residual impacts were predicted at a local scale during construction, they are not expected to be of an extent which would constitute a risk to regional air quality during the works.

8.6.6 Potential operational impacts

Potential impacts to air quality during the operational phase of the project are generally associated with motor vehicle emissions arising from changes in the volumes of motor vehicles, model of travel, such as free flow of congested and proximity to sensitive receptors. Key pollutants associated with exhaust fumes include carbon monoxide (CO) and nitrogen dioxide (NO_2).

Operational air quality impacts were predicted for the following four assessment scenarios using the TRAQ dispersion model:

- Scenario 1: Do minimum, year of opening (2021)
- Scenario 2: Proposed upgrade, year of opening (2021)
- Scenario 3: Do minimum, future year (2031)
- Scenario 4: Proposed upgrade, future year (2031).

Predictions for each scenario where made along eight segments of the project where traffic conditions change as a result of intersections with other arterial roadways, major street or motorways (see Table 8-42).

Predicted concentrations for each pollutant of potential concern and each relevant averaging period are summarised in Table 8-42. A more detailed account including predictions at typical and nearest receivers along each segment of the project is presented in Appendix P.

For ease of understanding, levels predicted in excess of criteria, as established in Section 4, have been displayed in **bolded** font.

Table 8-42 Summary of emissions predictions

Receiver	Background	Scenario 1 Do minimum (2021)		Scenario 2 Proposed upgrade (2021)		Scenario 3 Do minimum (2031)		Scenario 4 Proposed upgrade (2031)	
		Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative
Background, incremental and cumulative 24 hour-averaged PM_{10} results vs 50 µg/m^3 criterion									
Nearest (20m – 50m)	29.0 - 29.4	**0.7 - 2.2**	**29.7 - 31.6**	**0.7 - 2.6**	**29.7 - 32**	**0.4 - 2.3**	**29.4 - 31.7**	**1.1 - 3.8**	**30.1 - 33.2**
Typical (>100m)		**0.4 - 1.3**	**29.4 - 30.7**	**0.7 - 1.7**	**29.7 - 31.1**	**0.3 - 1.5**	**29.3 – 30.9**	**0.9 - 2.4**	**29.9 - 31.8**
Background, incremental and cumulative annually-averaged PM_{10} results vs 30 µg/m^3 criterion									
Nearest (20m - 50m)	15.9 - 16.5	**0.3 - 0.8**	**16.4 - 16.9**	**0.3 - 1.1**	**16.5 - 17**	**0.2 - 0.9**	**16.4 - 16.9**	**0.4 - 1.5**	**16.7 - 17.4**
Typical (>100m)		**0.2 - 0.5**	**16.4 - 16.8**	**0.3 - 0.7**	**16.4 - 16.9**	**0.1 - 0.6**	**16.3 - 16.8**	**0.4 - 1**	**16.7 - 16.9**
Background, incremental and cumulative 24 hour-averaged PM2.5 results vs 25 µg/m^3 criterion									
Nearest (20m - 50m)	16.8	**0.7 - 2.2**	**17.5 - 19**	**0.7 - 2.6**	**17.5 - 19.4**	**0.4 - 2.3**	**17.2 - 19.1**	**1.1 - 3.8**	**17.9 - 20.6**
Typical (>100m)		**0.4 - 1.3**	**17.2 - 18.1**	**0.7 - 1.7**	**17.5 - 18.5**	**0.3 - 1.5**	**17.1 - 18.3**	**0.9 - 2.4**	**17.7 - 19.2**
Background, incremental and cumulative annually-averaged PM2.5 results vs 8 µg/m^3 criterion									
Nearest (20m - 50m)	8.8	0.3 - 0.8	**9 - 9.5**	**0.3 - 1.1**	9 - 9.8	**0.2 - 0.9**	8.9 - 9.6	**0.4 - 1.5**	9.1 - 10.2
Typical (>100m)		0.2 - 0.5	**8.9 - 9.2**	**0.3 - 0.7**	9.0 - 9.4	**0.1 - 0.6**	8.8 - 9.3	**0.4 - 1**	9.1 - 9.7

Receiver	Background	Scenario 1 Do minimum (2021)		Scenario 2 Proposed upgrade (2021)		Scenario 3 Do minimum (2031)		Scenario 4 Proposed upgrade (2031)	
		Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative
Background, incremental and cumulative 1 hour-averaged NO2 results vs 246 µg/m^3 criterion									
Nearest (20m - 50m)	60.9 – 68.4	2.3 – 9.0	63.2 - 77.4	2.9 - 10.9	63.8 - 79.3	1.3 - 7.3	62.2 - 75.7	3.1 - 11.7	64 - 80.1
Typical (>100m)		1.4 - 5.6	62.3 - 74.0	2.6 - 7.2	63.5 - 75.6	0.9 - 4.5	61.8 - 72.9	2.4 - 7.4	63.3 - 75.8
Background, incremental and cumulative annually-averaged NO2 results vs 62 µg/m^3 criterion									
Nearest (20m - 50m)	8.7 - 9	0.5 - 1.8	9.2 - 10.8	0.6 - 2.2	9.3 - 11.2	0.3 – 1.5	9 - 10.5	0.6 - 2.3	9.3 - 11.3
Typical (>100m)		0.3 - 1.1	9 - 10.1	0.5 - 1.5	9.2 - 10.5	0.2 - 0.9	8.9 - 9.9	0.5 - 1.5	9.2 - 10.5
Background, incremental and cumulative 1 hour-averaged CO results vs 30 mg/m^3 criterion									
Nearest (20m - 50m)	2.5	0 - 0.4	2.5 - 2.9	0 - 0.5	2.5 - 3	0 - 0.4	2.5 - 2.9	0.2 - 0.6	2.7 - 3.1
Typical (>100m)		0 - 0.2	2.5 - 2.7	0 - 0.4	2.5 - 2.9	0 - 0.2	2.5 - 2.7	0 - 0.4	2.5 - 2.9
Background, incremental and cumulative 8 hour-averaged CO results vs 10 mg/m^3 criterion									
Nearest (20m - 50m)	1.7	0 - 0.3	1.7 - 2	0 - 0.4	1.7 - 2.1	0 - 0.2	1.7 - 1.9	0 - 0.4	1.7 - 2.1
Typical (>100m)		0 - 0.2	1.7 - 1.9	0 - 0.2	1.7 - 1.9	0 - 0.2	1.7 – 1.9	0 – 0.3	1.7 – 2.0

Receiver	Background	Scenario 1 Do minimum (2021)		Scenario 2 Proposed upgrade (2021)		Scenario 3 Do minimum (2031)		Scenario 4 Proposed upgrade (2031)	
		Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative	Road contribution	Cumulative
Background, incremental and cumulative 1 hour-averaged VOCs results vs 29 µg/m^3 criterion									
Nearest (20m - 50m)	2.6	0 - 0.2	2.6 – 2.8	0 - 0.2	2.6 - 2.8	0 - 0.2	2.6 – 2.8	0 - 0.4	2.6 – 3.0
Typical (>100m)		0 - 0.2	2.6 – 2.8	0 - 0.2	2.6 – 2.8	0 - 0.2	2.6 – 2.8	0 - 0.2	2.6 – 2.8

Considering the predicted concentrations of exhaust emissions from the four scenarios in relation to the nearest and typical setback distances from the project, the following conclusions have been made:

- Criteria for PM_{10}, NO_2, CO, VOCs and 24 hour-averaged $PM_{2.5}$ are expected to be met at surrounding nearby receivers for all four assessment scenarios, therefore the intent of each of the criteria in terms of managing health impacts to nearby receivers is expected to be achieved (refer to criteria in Section 8.6.3)
- The $PM_{2.5}$ annual criterion was predicted to be exceeded along each segment for each assessment scenario. This is a result of the adopted annual $PM_{2.5}$ background concentration (8.7 $\mu g/m^3$) already exceeding the 8 $\mu g/m^3$ criterion. However, comparisons between the predicted concentrations for the do minimum and proposed upgrade options were similar, indicating that the upgrade would not materially change annually averaged roadside PM2.5 concentrations from conditions if the 'do minimum' option was to be implemented.

As such, for the year of opening (2021) and design year (2031) time frames assessed and based on the presently available data, the proposed upgrade is not expected to result in unacceptable concentrations at surrounding receivers (i.e. at a local scale). Noting this, impacts at a regional scale were also assessed to be minimal.

8.6.7 Summary of impacts to the environment of Commonwealth Land

A summary of the potential air quality impacts to the environment of Commonwealth land as a result of construction and operation of the project is provided in this section.

Potential construction related air quality impacts are outlined in Section 8.6.5. Sensitive receivers have been identified in Table 7-16 and include receivers located on Commonwealth land. During construction there is the potential for dust and exhaust emissions to be generated from vehicles, plant and equipment being used on or in the vicinity of Commonwealth land. Airborne dust has the potential to impact upon the environment of Commonwealth land through the deposition of dust on vegetation or natural surfaces; however the potential impact is dependent on soil moisture, prevailing weather conditions, and duration and type of activities. Any potential impacts would be temporary and effectively mitigated through the measures outlined in Section 8.6.8.

Potential operational related air quality impacts are outlined in Section 8.6.6. This generally relates to motor vehicle emissions arising from changes in volumes of vehicles and models of travel in the vicinity of Commonwealth land. There would be minor operational impacts to the environment of Commonwealth land.

The potential air quality impacts to the environment of Commonwealth land during both construction and operation are not anticipated to be greater or different to those outside of Commonwealth land. The residual impacts are considered to be consistent with those outlined in Section 8.6.9.

8.6.8 Environmental management measures

Expected environmental outcomes

Safeguards and management measures identified in Table 8-43 have been developed to specifically manage potential impacts which have been predicted as a result of the proposed works which are described above in Section 6. Specific outcomes that would be achieved through the implementation of these measures include:

- Minimise and manage potential air quality / dust impacts from the construction of the project
- Control dust and exhaust emissions of plant and equipment from construction activities
- Minimise adverse impacts on existing air quality
- Ensure compliance with the relevant legislation requirements and conditions of approval
- Minimise and manage any complaints from the community or stakeholders.

Expected effectiveness

Roads and Maritime have experience managing potential air quality impacts associated with the construction and operational phases of large-scale road development projects.

Weather conditions such as wind direction, wind speed, soil moisture and rainfall or dew would substantially influence the day to day potential for dust generation and suspension. Accordingly, project personnel involved in the activities above need to consider the factors effecting dust generation in consultation with their environmental representatives to ensure appropriate mitigation measures are adopted.

It is expected that these recommendations, along with relevant requirements from project approvals, best practice guidelines and applicable legislation would be developed into the CEMP prepared to manage the relevant phases of the project. Routine auditing of the effectiveness of the implementation of the CEMP requirements would be routinely undertaken to ensure that management measures remain adequate, effective and fit for purpose.

Regular monitoring and inspections would be undertaken during construction to confirm the effectiveness of mitigation measures. Monitoring and inspections would include, but not be limited to:

- Project Contractor's supervisory inspections on a daily basis and environmental representative weekly inspections
- Monthly dust monitoring in accordance with the "*Approved Method for the Sampling and Analysis of Air Pollutants in NSW*" guidelines (DEC, 2005)
- Weather data at the premises, including rainfall measured and recorded in millimetres per 24-hour period at the same time each day from the time that the site office is established.

Table 8-43 outlines effective environmental management measures to specifically manage potential impacts which have been predicted as a result of the project.

Table 8-43 Air quality environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Excessive exhaust emissions arising from plant and equipment	AQ-1	• Plant and equipment would be operated in a proper and efficient manner by: – Inspecting the plant/equipment prior to commencement of works on site – Conducting routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Dust generation and emissions at compound locations	AQ-2	• Installation of perimeter screening around compound sites • Impose low speeds limits around compound sites to limit the generation of dust from vehicle movements • Apply wheel-wash or rumble grid facilities at access points to limit the tracking of materials beyond the site boundary • Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation • Regularly water stockpiles and limit the amount of materials stockpiled around the site. • Position stockpiling areas as far as possible from surrounding receivers • Limit stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers. • Consultation would be carried out consistent with the Community Consultation Framework in relation	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		to air quality near ancillary sites and relevant incident management process during construction			
Dust generation and emissions from construction activities and materials haulage	AQ-3	• Impose low speeds limits across all site haulage routes • Ensure that all loads are covered when materials are being hauled to and from site • Wherever possible, position internal haulage routes away from surrounding receivers • Regular watering of exposed and disturbed areas especially during inclement weather conditions. • Wherever possible, minimise the extent of disturbed and exposed surfaces, and restore as soon as possible • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers • Ensure that any material exposed areas are secured during project shutdown periods to prevent any dust emanating over adjacent roads • Install depositional dust gauges to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • These gauges should be installed at regular intervals along the project alignment at representative receiver locations. Gauges should	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		also be installed around major construction compound and stockpiling locations.			
Windborne dust emanating from non-vegetated surfaces	AQ-4	• Stage work to ensure that finished areas are revegetated as soon as possible • Regularly maintain and water revegetation areas to aid the establishment of adequate vegetation cover.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Odours arising from uncovered contaminated and/or hazardous materials.	AQ-5	• Application of odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Roadside air quality during operations	AQ-6	• Post-construction traffic measurements should be collected to verify that traffic volumes and characteristics are not materially different from the forecast numbers considered in this assessment. • Where material differences are identified, further assessment should be completed to confirm that the level of impacts remain consistent with the predictions of this study.	Roads and Maritime Services	Operation	Expected to be effective. Monitoring and reporting requirements of the OEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Cumulative dust impacts arising from con-current construction of the proposed upgrade and the Western Sydney Airport	AQ-7	• Develop construction program in consultation with the contractor(s) developing the Western Sydney Airport site. Maintain consultation through the course of both projects to plan activities in a manner which limits potential air quality-related impacts • Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time • Stop activities if dust is observed to be emanating from the airport.	Construction contractor	Prior to and during construction	Expected to be effective. Monitoring and reporting requirements of the OEMP to confirm effectiveness of measures.

8.6.9 Residual impacts

Local scale

Residual impacts are the potential impacts which may remain even after the environmental management measures outlined above have been implemented. Residual impacts associated with key phases of construction were assessed in detail using the 'residual risk rating' metric in Appendix P – Air Quality range from low to moderate in magnitude at a local scale. Those impacts assessed as having a moderate residual impact include:

- Emissions to air including dust and products of combustion (from equipment operations
- Windborne dust emanating from disturbed or exposed surfaces or stockpiles
- Dust and debris arising from haulage of materials
- Odours arising from uncovered contaminated or hazardous materials.

Due to the application of effective environmental management measures, residual adverse impacts to air quality from construction activities are considered to be temporary and of an acceptable nature.

Regarding operations, since air quality impacts were predicted to be minor, and the project was not predicted to result in air quality concentrations exceeding relevant criteria at surrounding receivers (excepting $PM_{2.5}$ which is already exceeded as a result of elevated background levels), no specific environmental management measures were recommended beyond post-opening traffic flow and composition verification monitoring.

Though the project is not expected to result in unacceptable air quality concentrations at surrounding receivers during operations, concentrations were predicted to marginally increase relative to the 'Do minimum' option. Relative concentrations would also increase markedly along the portion of the project which takes a new route from the existing road around Luddenham, which was previously mostly unaffected by road-related emissions.

Residual impacts as a result of the operation of the project are considered to be low and of an acceptable nature.

Regional scale

Residual emissions to air during construction would be temporal and are unlikely to be of a magnitude which would be of significance at a regional scale.

Regarding operations, noting the low level of impacts generally predicted at a local scale, it is not expected that the project would result in any significant changes to regional air quality. Even in the instance of PM2.5, though the project may further elevate concentrations above the annually averaged criterion of 8 $\mu g/m^3$ locally, this effect becomes comparable to the 'do minimum' option at around 200 m from the alignment and as such would not result in any material changes at a regional scale.

8.7 Resources and waste management

This chapter provides an overview of the assessment undertaken for resources usage and waste management impacts during construction and operation of the project.

Table 8-44 sets out the Secretary's Environmental Assessment Requirements (SEARs) as they relate to resource and waste management and states where in this EIS these have been addressed. It is noted that there are no specific Commonwealth EIS guidelines in relation to resources and waste management however general Commonwealth EIS guidelines in relation to the assessment of residual impacts have been addressed in Section 8.7.6.

Table 8-44 NSW and Commonwealth Environmental Assessment Requirements

Secretary's requirement	Where addressed in EIS
Resources and Sustainability — including: • outline of waste management for the project, including consideration of the waste hierarchy	Section 8.7 Chapter 10
• an overview of spoil management processes for the proposal, including consideration of the indicative cut/fill balance and reuse options for spoil generated by the proposal	Section 8.7.3

It is noted that although the project has been deemed a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), no specific Commonwealth assessment requirements in relation to resources and waste management have been issued in the guidelines for the content of a draft Environmental Impact Statement for this project. General requirements related to the assessment of residual impacts have been addressed in Section 8.7.4.

8.7.1 Policy setting

The *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) covers the requirements for waste generators in terms of storage and correct disposal of waste and their responsibility for the correct management of waste and these have been considered in the assessment of waste generated by the project, including the development of environmental management measures.

The Protection of the Environment Operations (Waste) Regulation 2014, in particular Part 7 outlines requirements for the transportation and management of asbestos waste.

The *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) promotes waste avoidance and resource recovery by developing waste avoidance and resource recovery strategies and programs. Roads and Maritime endeavours to manage waste in order to conserve resources and reduce impacts associated with waste disposal. The waste management hierarchy is a guide for prioritising waste management practices to achieve these outcomes. This hierarchy was established under the WARR Act. It sets out the preferred order of waste management practices from the most preferred to least preferred as follows:

- Waste Avoidance – Take action to avoid the generation of waste and to be more efficient in its use of resources. If unable to avoid generating waste, then reduce the amount of waste generated and reduce the toxicity or potential harm associated with its generation and management
- Resource Recovery – Maximise the reuse, reprocessing, recycling and recovery of energy from materials
- Disposal – Disposal is the least desirable option and must be carefully handled to minimise negative environmental outcomes.

In addition to managing waste in accordance with the relevant legislation, Roads and Maritime manages waste according to the NSW Waste Avoidance and Resources Recovery Strategy 2014-21 (EPA, 2015) and the NSW Waste Classification Guidelines (EPA, 2014).

A project sustainability strategy has also been developed for the project. The project sustainability strategy describes how sustainability will be integrated into the design, construction and operation of the project. The strategy has been prepared to align with the TfNSW Transport Environment and Sustainability Policy Framework and the Roads and Maritime Roads and Maritime Environmental

Sustainability Strategy. Further information regarding the project's sustainability strategy is outlined in Chapter 10 – Sustainability.

8.7.2 Assessment methodology

Resource use for the project was assessed by reviewing existing information and estimating the resources required for construction and their likely sources. Quantities and types of wastes that would be generated from the project were identified from the resource estimates and were used as the basis for the preliminary classification in accordance with the *Waste Classification Guidelines* (EPA, 2014).

8.7.3 Assessment of potential construction impacts

Waste generating activities

Waste generated during construction would primarily be from works associated with site preparation, relocation of utilities, and construction of road infrastructure and landscaping. Waste-generating activities would include:

- Vegetation clearance, generating green waste such as logs and mulched material
- Construction of temporary construction ancillary facilities, constructing roads, alternative property access would require vegetation clearance, road surface grading, temporary drainage structure installation and the placement of gravel road base where required, generating asphalt waste, pipe cuts and green waste
- Installation of environmental controls, fencing, silt fences, and lockable gates, generating material off cuts
- Demolition of dwellings and structures on land being wholly or partially acquired, potentially including asbestos materials
- Demolition of kerbs, fencing, pavements, barriers, signage, lighting, and parapets
- Project construction including earthworks, placement of pavement layers, drainage, concrete pour, utilities placement and protection, installation of road furniture.

Waste streams would include the following:

- Surplus spoil (excavated soil, sediment, rock) from bulk earthworks which is unable to be reused within backfilling or restoration
- Contaminated soils that may be exposed during construction, and if exposed, would require offsite disposal. Further detail regarding potential contamination located in the project area can be found in the Stage 1 Contamination Assessment provided in Appendix L
- Existing stockpile sites located within the road reserve. The quality of the material within the stockpiles is unknown and could potentially contain contaminated material, including asbestos
- Concrete, pavement, steel, and other materials from demolition of kerbs, fencing, pavements
- Surplus material from construction and general site reinstatement, such as fencing, sediment from temporary basins, concrete, steel, formwork, and sand bags
- Packaging materials from items delivered to site, such as pallets, crates, cartons, plastics, and wrapping materials
- Vegetative waste from clearing and grubbing
- Plant and vehicle maintenance waste, such as oil containers
- General office waste generated by onsite personnel, such as paper, cardboard, beverage containers, and food wastes
- Sewage waste generated through the use of personnel facilities.

Stockpiled materials can also cause adverse impacts when materials are mixed. For example, mixing of topsoils with subsoils, mixing of suitable and unsuitable material or mixing contaminated material can lead to materials that would have ordinarily been reused being rendered as waste.

For the project, there is a potential for contaminated material to be disturbed through construction activities. The majority of AEIs identified are likely to pose a low potential of exposure to site users and environmental receptors to contamination during construction of the upgrade. Potential environmental impacts associated with the incorrect management of contaminated materials could include:

- Inappropriate handling or disposal of contaminated or hazardous excavated materials resulting in long-term impacts to soils or water resources
- Adverse effects on human health (construction personnel, travelling public or nearby communities)
- Release of contaminants into underlying soils potentially affecting the ongoing use of those soils
- Release of contaminants into groundwater potentially affecting groundwater quality
- Movement of contaminated sediments into stormwater systems
- Adverse effects on flora and fauna including changes to behaviour or loss of life.

A detailed assessment of potential contamination impacts associated with the project is provided in Section 8.2.

Earthworks would be required across the project area including for road widening, bridge construction and drainage. Based on estimates drawn from the concept design, it is predicted that about 400 000 m³ of imported fill would be required for construction of the project. It is predicted that there would be about 240 000 m³ of excavation material that could be beneficially reused as fill for the project. Imported fill would either be virgin excavated natural material (VENM) or would comply with the conditions for reuse attached to a relevant resource recovery exemption.

Surplus spoil that is unable to be reused on-site would be transported for beneficial reuse off-site in accordance with a relevant EPA resource recovery exemption or disposed of at a licensed waste facility.

Resource use

Construction of the project would require various materials and pre-cast elements. The major construction materials required would include:

- General fill and select fill for earthworks
- Sand and soils for landscaping
- Geotextile materials
- Pavement materials including road base and sub-base
- Materials for lining drainage channels
- Aggregate for concrete, asphalt and bitumen
- Cement and concrete
- Steel for reinforcement
- Wood for use in formwork and other temporary structures
- Water
- Pre-cast concrete including pipes, culvert segments and roadside barriers
- Mechanical and electrical equipment for VMS.

Materials would be sourced from appropriately licensed facilities and commercial suppliers in nearby areas. None of the materials proposed to be used are considered to be in short supply. Material quantities would be determined throughout the detailed design phase prior to commencement of construction and reduced where possible through efficient design, construction and procurement processes

Equipment and vehicles on the construction site would consume a large quantity of fuel. It is estimated that up to 3.5 million litres of fuel (diesel and petrol) would be used to construct the project.

Electricity needs on the site would be minor, and connection of the office to the local power grid would be sufficient. It is estimated that up to 26 million kilowatt hours of power would be used to construct the project. Some generators may be necessary for emergency power supply.

Construction water

Construction of project would require water (non-potable and potable) for the following activities:

- Dust suppression
- Compaction of excavated fill material
- Gravel pavements
- Road sweepers
- Potable use in office amenities.

It is estimated that up to 50 mega litres of water (non-potable and potable) would be used to construct the project. This would be sourced from reusable non-potable water onsite where possible (eg treated site water from sediment basins, harvested rainwater), or from local potable water sources (eg water mains via metered standpipes or temporary piped water supply). No surface or groundwater would be extracted for construction.

Water would also be required during establishment of landscaped areas. The landscape establishment period is typically 12 weeks, with weekly watering of landscaped areas required during this period to assist growth and establishment.

8.7.4 Assessment of potential operational impacts

Waste

Waste generated by the operation of the project would be limited. The main waste streams would include:

- Oils, liquids and chemicals used for maintenance of plant and equipment used in road maintenance activities
- General litter along the motorway
- Landscape and vegetation waste
- Waste grit and soil from road sweepers.

Operational waste, including general litter clean up, would be managed in accordance with existing operational maintenance requirements for the project and the impact is expected to be minimal.

Resource use

During operation, the project would consume electricity as a result of:

- Street lighting
- Traffic signals
- To a lesser extent by maintenance activities.

The impacts related to resource use and resultant greenhouse gas emissions are discussed further in Section 8.8.4 and Section 8.8.6.

Greenhouse gas emissions generated from the operation and maintenance of road infrastructure are relatively small compared to indirect emissions associated with the fuel consumed by vehicles using the road network.

Operational water

Once landscaped areas are successfully established, it is not anticipated that there would be a requirement for water during operation of the project.

8.7.5 Summary of impacts to the environment of Commonwealth Land

Potential construction waste and resource use impacts are outlined in Section 8.7.3 and Section 8.8.4. During construction there is the potential for surplus waste to be generated from activities such as the removal of vegetation, installation of environmental controls, demolition and construction activities on Commonwealth land including surplus spoil generated during earthworks. There is the potential for contamination to be discovered during earthworks activities that would require management and/or offsite waste disposal. For construction activities on the DEOH site there is the potential for UXO and other contaminated materials such as asbestos to be encountered during earthworks. As described in Section 8.2.3, the discovery of unexpected contaminated material would be managed through the implementation of an unexpected finds procedure. Resources such as building materials, electricity, water and fuel to power vehicles and equipment would be required for construction works on Commonwealth land. Further, during construction the project is likely to reduce the availability of natural resources on Commonwealth land, including native vegetation. The potential impact would be minimised through the revegetation of embankments, roadside verges and within the median where appropriate. Any potential impacts would be temporary and/or effectively mitigated through the measures outlined in Section 8.7.6 and 8.8.6.

Potential operational waste and resource use impacts are outlined in Section 8.7.4 and Section 8.8.5. This generally relates to wastes generated during maintenance of the road including vegetation, litter, sediment and hydrocarbons. Resource use during operation is generally limited to fuel usage for road maintenance activities and electricity for road lighting and signals. There are minimal operational impacts to the environment of Commonwealth land; and these would be managed in accordance with existing operational maintenance requirements for the project.

The potential waste and resource use impacts to the environment of Commonwealth land during both construction and operation are not anticipated to be greater or different to those outside of Commonwealth land. The residual impacts are considered to be consistent with those outlined in Section 8.7.7 and Section 8.8.7

8.7.6 Environmental management measures

Table 8-45 outlines environmental management measures that have been developed to specifically manage potential impacts predicted as a result of the project. These measures should be incorporated into relevant Construction Environmental Management Plans (CEMPs) during construction and operations.

Expected environmental outcomes

Project-specific environmental management measures have been developed with the aim of minimising or mitigating, as far as practical, waste generation and resource use during the project's construction and operation.

Broadly, the expected project environmental outcomes specific to waste and resources are to:

- Establish measures to minimise waste, manage waste and conserve energy throughout the construction of the project

- Establish the preferred waste management hierarchy of avoidance, minimisation, reuse, recycling and finally disposal is followed
- Provide construction staff with an increased level of understanding and awareness of waste and resource use management issues
- Establish appropriate measures to address the relevant conditions of approval, and the effective mitigation measures detailed in the EIS
- Establish appropriate measures to comply with all relevant legislation.

Expected effectiveness

Roads and Maritime have experience managing potential impacts associated with resource use and waste generation as a result of road developments of similar scale and scope to this project.

A construction waste and energy management sub-plan (CWEMP) would be prepared as part of the CEMP to address the requirements of the project approvals, the environmental management measures outlined in the EIS and all applicable legislation. Roads and Maritime would engage waste contractors to manage the collection, recycling or disposal of waste that cannot be reused onsite. Waste contractors would also be required to provide evidence of the works compliance with legislative requirements, conditions of approval and standards and guidelines.

Audits and reporting on the effectiveness of environmental management measures is generally carried out to demonstrate compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP and CWEMP prepared for the project. As such, the management of waste throughout the project through implementing the measures outlined in Table 8-45 are considered to be effective.

A project sustainability strategy has also been developed for the project. The strategy identifies a hierarchy of targets and initiatives aimed at supporting the objective of the strategy. The project targets constitute actions to achieve the sustainability objectives of the project. The targets provide a measurable and verifiable framework to drive and track the project's sustainability performance. Further information regarding the project's sustainability strategy is outlined in Chapter 10 – Sustainability.

Table 8-45 Waste and resource use environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Inappropriate handling and/ or disposal of waste	WR-1	The waste minimisation hierarchy principles of avoid/reduce/reuse/ recycle/dispose would be used	Construction contractor	Construction	Proven to be effective
	WR-2	A project-specific *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented • Measures to be applied where waste is required to be handled and stored onsite prior to onsite reuse or offsite recycling/disposal • Specific measures to manage vegetation waste • Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and	Construction contractor	Pre-Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
	WR-3	All wastes, including contaminated wastes, would be identified and classified in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste*.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-4	Disposal of any non-recyclable waste would be in accordance with the POEO Act and *Waste Classification Guidelines: Part 1 Classifying Waste*.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-5	Trees and plant material would be mulched or chipped on-site and used in landscaping where practicable to stabilise disturbed soils where possible.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Inappropriate disposal of excavated material that cannot be reused in the project	WR-6	Where possible and fit for purpose, spoil would be beneficially reused within the project before off-site reuse of disposal options is pursued.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-7	Excavated material that is not suitable for on-site reuse or recycling would be transported to a site that may legally accept that material for reuse or disposal.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-8	Before being transported from construction sites, excavated spoil would be classified in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA, 2014) to ensure appropriate reuse of disposal.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-9	A Spoil Management Strategy would be developed prior to the commencement of construction and implement during construction. The strategy would identify spoil disposal site(s) and describe the management of spoil on-site and during off-site transport.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Resource use	WR-10	Wherever feasible and reasonable, construction material would be sourced from within the Sydney region.	Construction Contractor	Construction	Proven to be effective.

8.7.7 Residual impacts

In an effort to reduce the impacts of the project during construction, the waste management hierarchy would be adopted. Regardless, it is inevitable that some waste would be generated that is unable to be reused or recycled and would be disposal offsite. This could include contaminated material or hazardous waste, liquid wastes or certain plastics. These residual wastes would be stored separately in appropriate receptacles. Prior to disposal, the residual waste would be classified in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA, 2014). With effective mitigation, the residual impacts associated with construction of the project are expected to be minor.

Waste generated by the operation of the project would be limited and managed in accordance with existing operational maintenance requirements. With effective mitigation, the residual impacts associated with operation of the project are expected to be minor.

8.8 Climate change and greenhouse gas

This chapter provides an assessment of potential greenhouse gas (GHG) emissions during the construction and operation stages of the project and establishes the current and potential future climatic context for an assessment of key climate change risks to which the project may be exposed.

There are no requirements of the Secretary of the Department of Planning and Environment that are relevant for this environmental assessment. Although the project has been deemed a controlled action under the EPBC Act, no specific Commonwealth assessment requirements in relation to climate change and greenhouse gases have been issued in the guidelines for the content of a draft EIS for this project.

8.8.1 Assessment methodology

The methodology for this Climate Change and GHG assessment for the project has been based on the legislative and policy framework for the control of GHG emissions and minimisation of climate change.

The information sources used in carrying out the assessment are identified below, where applicable, and comprise Government policies, mapping, and previous assessments. A complete list of information sources used in the assessment is provided in the working paper. The assessment methodologies described below identify where those sources of information have been verified. Where used, specific tools such as ‘Carbon Gauge’ and TRAQ are discussed and described with regard to their use in assessing potential impacts.

Greenhouse gas assessment methodology

‘Greenhouse gases’ is a collective term for a range of gases that are known to trap radiation in the upper atmosphere, where they have the potential to contribute to the greenhouse effect (global warming). Creating an inventory of the likely GHG emissions associated with a project has the benefit of determining the scale of the emissions and providing a baseline from which to develop and deliver GHG reduction options. GHGs include:

- Carbon dioxide (CO2) – by far the most abundant, primarily released during fuel combustion.
- Methane (CH4) – from the anaerobic decomposition of carbon based material (including enteric fermentation and waste disposal in landfills).
- Nitrous oxide (N2O) – from industrial activity, fertiliser use and production.
- Hydrofluorocarbons (HFCs) – commonly used as refrigerant gases in cooling systems.
- Perfluorocarbons (PFCs) – used in a range of applications including solvents, medical treatments and insulators.

- Sulphur hexafluoride (SF6) – used as a cover gas in magnesium smelting and as an insulator in heavy duty switch gear.

It is common practice to aggregate the emissions of these gases to the equivalent emission of carbon dioxide. This provides a simple figure for comparison of emissions against targets. Aggregation is based on the potential of each gas to contribute to global warming relative to carbon dioxide and is known as the global warming potential (GWP). The resulting number is expressed as carbon dioxide equivalents (or CO2e).

The GHG inventory in this document is calculated in accordance with the principles of the Greenhouse Gas Protocol (GHG Protocol)[1]. The GHG emissions that form the inventory can be split into three categories known as 'Scopes'. Scopes 1, 2 and 3 are defined by the GHG Protocol and can be summarised as follows:

- Scope 1 – Direct emissions from sources that are owned or operated by a reporting organisation (examples – combustion of diesel in company owned vehicles or used in on-site generators)
- Scope 2 – Indirect emissions associated with the import of energy from another source (examples – importation of electricity or heat)
- Scope 3 – Other indirect emissions (other than Scope 2 energy imports) which are a direct result of the operations of the organisation but from sources not owned or operated by them (examples include business travel (by air or rail) and product usage).

The results of this study are presented in terms of the above-listed 'Scopes' to help understand the direct and indirect impacts of the project. The GHG Protocol (and similar reporting schemes) dictates that reporting Scope 1 and 2 sources is mandatory, whilst reporting Scope 3 sources is optional. Reporting significant Scope 3 sources is recommended. This assessment presents an assessment of all (Scopes 1, 2 and 3) sources of GHG deemed significant to the implementation of the project.

Carbon Gauge

The tool used for the assessment of construction, and limited operational impacts was 'Carbon Gauge' – a tool which automates many of the calculations, assumptions and default GHG emissions factors presented in the Greenhouse Gas Assessment Workbook for Road Projects, Developed by the Transport Authorities Greenhouse Group.

This tool provides a framework for assessing the GHG emissions associated with road construction projects through the completion of a materiality assessment, and then provision of standard carbon emissions factors for activities typically undertaken. This allows the user to build a GHG profile through input of standard data on the length and area of pavement, road features included and cost of construction, amongst other, accessible data. Carbon Gauge has been used to determine the GHG emissions associated with construction, and some elements of the operation of the project (power for intersections and fuel / materials used in maintenance activities).

Tools for Roadside Air Quality

Tools for Roadside Air Quality (TRAQ) is a tool for modelling emissions from vehicles using roads, using input data on traffic numbers and type, average traffic speeds, numbers of lanes and standard emissions factors for road going vehicles. As well as standard air quality parameters (such as carbon monoxide, nitrous oxides and particulate matter) the tool also projects emissions of GHG. TRAQ was used to determine emissions associated with current and future operational road use, both with and without the project.

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[1] The Greenhouse Gas Protocol is collaboration between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The Protocol provides guidance on the calculation and reporting of carbon footprints.

Climate change evaluation methodology

The methodology for conducting the climate change risk assessment has been based on the Australian Standard AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach.

Climate change is anticipated to have direct and indirect impacts on the project. The types of impacts are relatively well understood, however their severity and extent is uncertain. As such, risks need to be identified and assessed and strategies to treat them developed.

Risk analysis and evaluation was undertaken through desktop assessment, and in liaison with other specialist studies (such as hydrology). The risk assessment involved the following steps:

- Identification of the hazard and receptor
- Assessment of the potential exposure
- Identification of existing controls and their effectiveness
- Identification of the consequence rating (C1-C6) corresponding to the maximum credible impact across the consequence categories (may be more than one), given the existing controls and their effectiveness
- Identification of the likelihood of occurrence of those consequences at that level, taking into account business as usual controls and their effectiveness
- Assessment of the level of risk based on the intersection of the consequence and likelihood rating
- Identification of any action (e.g. risk treatment) and escalation based on the level of risk
- Recommendations of the next steps for detailed design to undertake prior to reconsideration of the level of consequence and likelihood (and therefore residual risk).

Within the risk assessment process, the risk resulting from the projected change in climate is assessed, whether this is a newly identified or elevated existing risk. For example, some risks are already present (flooding) but the frequency and intensification of these are projected to change. Other risks (such as migration of pests and weeds) may not be expected to happen in the absence of a changing climate.

Risk treatment options have begun to be developed for those risks classified as 'Medium' and above. These treatment options would be further detailed as the design progresses from definition design to detailed design, at which point, detailed modelling and decisions surround design components, would be further developed / incorporated.

8.8.2 Existing environment

An increase in global concentrations of GHGs has led to an increase in the Earth's average temperature (surface temperature) (IPCC, 2013). The most recent Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2013) states that 'human influence on the climate system is clear. This is evident from the increasing GHG concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system'.

In 2015 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Meteorology (BoM) released an assessment of observed climate change and projected future changes in Australia over the 21st century (CSIRO and BoM, 2015). This recent assessment confirms the long-term warming trend: showing that in Australia, the average surface air temperature has increased by 0.9 degrees Celsius (degrees Celsius) since records began in 1910, with most of the warming occurring since 1950. Australia's warmest year since 1910 was in 2013 (CSIRO and BoM, 2015a).

The AR5 states with high confidence that Australia is already experiencing impacts from recent climate change. Observed trends include changes in the frequency of air temperature extremes,

changes in mean and extreme rainfall, changes in the frequency and intensity of storm events, ocean warming, ocean acidification and sea level rise.

Due to the long lag times associated with climate processes, even if GHG emissions are mitigated and significantly reduced, the warming trend and associated impacts of climate change are expected to continue for centuries (IPCC, 2007)

Greenhouse gases and policy context

Carbon dioxide (CO_2) is a vital gas for photosynthesis and global climate regulation. Since CO_2 and other GHGs trap long wave radiation, changes in their concentrations in the atmosphere would influence the Earth's radiation balance and contribute to the warming of both the atmosphere and the Earth's surface. This phenomenon is known as the greenhouse effect. Atmospheric CO_2 varies annually, reflecting seasonal photosynthetic activity, its release or uptake from the ocean and fires in forests and tropical savannahs. In the past 650,000 years, CO_2 concentrations have varied between 180 and 300 ppm. Since the industrial revolution, concentrations have risen from about 280 ppm to over 400 ppm.

The combined radiative forcing (the effect of GHGs on global radiation balance) of GHGs such as carbon dioxide, methane and nitrous oxide increased almost fourfold between 1950 and 2011 (0.6-2.3 W/m^2), including an increase of almost 50per cent from 2007. The warming effect of increased atmospheric GHG concentrations is considered to have contributed to the observed increase in global mean temperature of 0.7°C from 1880 (IPCC, 2013).

On 3 December 2007, the former Australian Prime Minister, Kevin Rudd, signed the instrument of ratification of the Kyoto Protocol. Australia has met its Kyoto Protocol target of limiting emissions of GHG to 108 per cent of 1990 levels, on average, over the Kyoto period 2008–2012. Over the five reporting years in the Kyoto period (2008 to 2012), Australia's net emission of GHGs averaged 104 per cent of the base year level (DoE, 2014). As such, Australia has committed to meeting its Kyoto Protocol long-term target, and has set a target to reduce GHG emissions by 60 per cent on 2000 levels by 2050.

Additionally as a medium target the Government has committed to reduce Australia's carbon pollution to 25 per cent below 2000 levels by 2020 if the world agrees to an ambitious global deal to stabilise levels of GHGs in the atmosphere at 450 parts per million CO2 equivalent or lower. This would maximise Australia's contribution to an ambitious outcome in international negotiations. If the world is unable to reach agreement on a 450 parts per million target; Australia would still reduce its emissions by between 5 and 15 per cent below 2000 levels.

Following the 2015 Paris Climate Conference (COP21), international agreements were made to:

- Keep global warming well below 2.0 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius
- From 2018, countries are to submit revised emission reduction targets every 5 years, with the first being effective from 2020, and goals set to 2050
- Define a pathway to improve transparency and disclosure of emissions
- Make provisions for financing the commitments beyond 2020.

It is yet to be determined how Australia will deliver these commitments in detail.

Climate change predictions

Western Sydney has a highly variable climate. Annual and season rainfall and temperatures vary over a wide range. The area is periodically subject to extreme weather and climatic events which may disrupt the community, threaten health and safety and damage infrastructure and the environment. Western Sydney's climate is also changing, with signs evident in records of temperature. Those and other changes are projected to continue as increasing atmospheric concentrations of GHGs drive warming and other changes in the climate system.

Over the course of the 21st Century, western Sydney's climate is expected to become:

- Warmer: with increased average and extreme high temperatures, but fewer extreme cold temperatures
- Drier: rainfall is projected to decline. Reduced annual rainfall and increased evaporation is anticipated to result in drier soil conditions, less run-off in water supply catchments and reduced average river flows and groundwater recharge
- Subject to more extreme weather conditions: hydrological cycles are projected to intensify with atmospheric warming, leading to more intense extreme rainfall events. Heatwaves will become more frequent, intense and prolonged. While extreme weather conditions may become more extreme, they may become less frequent.

Projected changes in climate over the course of the 21st century may be disruptive to the operations of the project and users of western Sydney's road network, increase operations and maintenance costs and shorten its operating life. While climate change projections are uncertain, the opportunity exists to assess its implications for the project and to incorporate appropriate, proportional measures to help ensure its resilience under the climate it will experience over its operating life.

8.8.3 Assessment of potential construction impacts

Greenhouse gas emissions from the following activities were modelled to identify the potential impacts as a result of construction of the project:

- Plant and Equipment Fuel (construction, earthworks)
- Embedded emissions in materials used in pavement (road, bicycle path, footpath and median)
- Embedded emissions in materials used in structures
- Embedded emissions in materials used in drainage.

Impacts associated with fuel consumption for vegetation removal were not included as they do not trip the materiality threshold within CarbonGauge (clearance at 44.3Ha (443,000 m^2) is less than 60 per cent of the total pavement area (801,985m^2 for asphalt alone)). Greenhouse gas emissions associated with the loss of the vegetation itself is included.

For each of these areas, Carbon Gauge was used to determine the potential impacts, using standard emissions factors for road construction activities, referencing a relevant unit of activity. The activity data is presented in Table 8-46.

Table 8-46 Activity Data – Construction Greenhouse Gas Assessment

Activity	Inputs
Estimated Value	$519 Million
Construction Duration (Months)	30
Plant Equipment Fuel	100% Diesel
Concrete Footpaths	20,865 m^2
Bike Path – concrete	48,435 m^2
Median and traffic island infill	8,870 m^2
Full Depth Asphalt *	801,985 m^2

Activity	Inputs
Bridges – Precast Concrete	(1) 0.04 km long, 49m wide, (2) 0.078 km long, 50 m wide
Median Kerb, Type 2	39.087 km
Median Kerb, Type 5	8.813 km
Small <450 RCP	23.885 km
Medium 450 - 750 RCP	14.871 km
Large 750 - 1200 RCP **	11.105 km
Strip and respread topsoil	126,916 m^3
Cut to spoil	136,630 m^3
Cut to fill	904,694 m^3
Import and place filling	461,491 m^3
Vegetation Clearance	44.3 Ha (26.1 Ha classified as 'Open Forest' and 18.2 Ha classified as 'Grassland')

* Note includes a range of asphalt types broadly classified in Carbon Gauge as 'Full Depth Asphalt'
** Note includes some drains larger than this, but Carbon Gauge has a maximum size of 1200 x 600.

The GHG emissions associated with construction of the project are presented in Table 8-47.

Table 8-47 Activity Data – Construction Greenhouse Gas Assessment

Activity	Scope 1 (tCO2e)	Scope 2 (tCO2e)	Scope 3 (tCO2e)	Total (tCO2e)
Fuel Combustion – site vehicles	785	-	61	**846**
Fuel Combustion – Plant and Equipment	27,780	-	2,125	**29,905**
Fuel Combustion – Demolition and Earthworks	8,626	-	659	**9,285**
Material Usage – Aggregate	-	-	4,656	**4,656**
Material Usage – Concrete	-	-	5,242	**5,242**
Material Usage – Cement	-	-	3,670	**3,670**
Material Usage – Steel	-	-	3,208	**3,208**
Material Usage – Bitumen	-	-	16,269	**16,269**
Vegetation Removal	15,874	-	-	**15874**
Total	**53,065**	**-**	**35,890**	**88,955**

Table 8-47 shows that the construction of the project is expected to generate about 89 ktCO2e. Of this, the greatest proportion if related to the combustion of fuel in on-site construction plant and equipment. The use of bitumen as part of the asphalting process is the second largest contributor, followed by fuel used during demolition and earthworks activities.

8.8.4 Assessment of potential operational impacts

The transport sector contributes about 17 per cent of Australia's total GHG emissions (Department of the Environment, 2015b). Around 90 per cent of these emissions are attributed to the combustion of fuel for road transport (Climate Change Authority 2014; Maddocks et al. 2010). Reducing the contribution of emissions from road transport would have a substantial impact on reducing emissions from the transport sector, and for Australia's overall emissions profile.

Modelling was undertaken to determine the GHG emissions associated with a 'do minimum' case. This 'do minimum' case would act as a base case for comparative purposes. The 'do minimum' case is the realignment of The Northern Road to bypass Luddenham, and to avoid the area earmarked for the Western Sydney Airport, with no upgrades to the number of carriageways in each direction (i.e. remaining as single carriageways). This is taken as the representation of the existing environment for the purposes of GHG assessment.

In addition, modelling was undertaken to assess the GHG emissions associated with a 'with project' option.

Both cases incorporated GHG emissions associated with the following:

- Electricity consumption for powering intersections
- Fuel and material consumption for maintenance activities
- Fuel consumption from Road Traffic using the project.

Table 8-48 provides a comparison of the two cases.

Table 8-48 Traffic numbers (both directions) for 'do minimum' and 'with project' cases – year of opening (2021) and future year (2031)

Year	Operating scenario	Traffic / day	Greenhouse Gas Emission tCO_2e/y	GHG Efficiency $kgCO_2e/y$ / Vehicle
2021	'do minimum'	188,598	20,756	0.30
	'with project'	214,312	23,430	0.30
2031	'do minimum'	183,400	27,158	0.41
	'with project'	322,449	33,168	0.28

With forecast growth in traffic numbers, traffic modelling suggests that the 'do minimum' configuration would result in greater congestion, slowing average speeds and reducing the amount of traffic that can pass per unit time. Although traffic numbers are projected to decrease overtime as a result of the congestion; GHG emissions are projected to increase. This is due to much slower speeds, greater congestion during peak periods and therefore lower efficiency of travel. The effective rate of carbon emissions for an average vehicle The Northern Road under the 'do minimum' experiences a drop in fuel efficiency (and therefore greater emissions rate.

The project would allow for a greater number of vehicles to use the upgraded road – with fewer stop / starts, less congestion and a greater average speed. Expected vehicle numbers shows that traffic volumes are expected to increase substantially, with slight increases forecast for year of opening, and a significant increases by the year 2031. The project allows for an almost doubling of traffic numbers over the 10 year period post opening.

The GHG emissions associated with these traffic numbers were calculated data on traffic speeds, gradients and traffic mix types, as well as the numbers of vehicles. The results show that a small increase in GHG emissions from the 'Do Nothing' scenario is expected on year of opening, and a large increase in GHG emissions is expected from the future year scenario. This is directly associated with the significant increase in traffic numbers using the project.

Regardless, under the 'with project' scenario, GHG efficiency is projected to stay relatively similar to the 'do minimum' scenario at year of opening, both in 2021 and 2031. This represents traffic which is able to flow freely, greatly improving fuel efficiency.

Table 8-49 presents the emissions associated with operation of the project over a 50 year timeframe. Road traffic usage of the project is, as expected, the greatest contributor to the operational GHG inventory, forming 97 per cent of emissions. The total emissions from road traffic of the 'with project' over 50 years post year of opening are 1,736 ktCO2e, which compares to 1,326 ktCO2e for the 'do minimum' scenario. This is as a result of the greater number of vehicles moving through the road network in comparison to the 'do minimum' scenario.

Table 8-49 Emissions Data – Operational Greenhouse Gas Assessment (50 years)

Operating scenario	Traffic / day
Operation – Intersections	12,699
Operation – Street lighting	14,748
Operation – Maintenance	25,578
Operation – Road traffic	1,735,836
Total	**1,788,861**

Road traffic emissions for the project dominate the combined construction and operational GHG inventory when assessed over a 50 year period. Further, road traffic emissions are forecast to grow significantly from the current level due to the project allowing for regional population growth and access to other upcoming infrastructure (such as the Western Sydney Airport). However, due to improvements in road layout and widening, the efficiency of cars traversing the project area is forecast to improve.

This, as well as analysis of the benefits of fuel efficiency suggests that efforts during design and construction to support the free flow of traffic along the project is likely to have life cycle benefits gained during operation. This is supported by the project in efforts to:

- Widen the existing road to reduce congestion
- Reduce the extent to which the road changes grade
- Limit the number of intersections and turning lanes at which traffic needs to stop and start
- Support free flowing intersections with other major roads (such as the M12).

Climate change risk assessment

The potential impacts of climate change would be negligible during the construction phase due to its relatively short timeframe. These potential impacts are therefore not considered further in this assessment and the focus of the chapter is on potential operational impacts.

Risks to the operation and maintenance of the project that might be influenced by climate change have been identified. The detailed risk assessment carried out for the project (refer to Appendix Q - Climate change risk assessment) did not identify any risks rated as high or extreme. Five were identified as having a medium risk. These risks rated as medium are listed in Table 8-50 for consideration in the subsequent detailed risk assessment to be undertaken during detailed design.

Table 8-50 Climate change risks identified as ‘medium’ or higher

ID	Risk	Rating	Mitigation measures
3	Increased temperatures and the more frequent incidence and severity of heatwaves. Maintenance activities have to be postponed due to extreme heat. Delay in maintenance activities causes a backlog in work.	Medium	Use standard Roads and Maritime procedures for working in extreme heat.
9	"More severe extreme flood events. Drainage channels and culverts are too small as 100 year ARI storms (the design standard) is more severe as a result of climate change. Road is overtopped with flooding, and standing water in the road causes accidents and severe delays. Damage occurs to roadway requiring immediate rectification which increases maintenance costs."	Medium	Storm water modelling to review climate change projections and flooding for 10 per cent, 20 per cent and 30 per cent increases on standard 100 year ARI event. Scour protection would be provided at inlets and outlets. Further discussion on potential increases in flood risk is provided in the flooding and hydrology working paper.
10	Increase in the frequency and intensity of severe rainfall events. Drainage channels and exits of culverts suffer increased scour as 100 year ARI storms (the design standard) are more severe as a result of climate change Culverts and drainage channels are overwhelmed causing increased flooding on the up flow side of the culverts, and increased scour at the outflows. This results in increased road closures, and increased maintenance / rectification costs. Diverted water may produce increased flooding at existing properties.	Medium	Storm water modelling to review climate change projections and flooding for 10 per cent, 20 per cent and 30 per cent increases on standard 100 year ARI event.
14	More severe fire weather and elevated fire weather conditions. Increased local bushfires cause decreased visibility due to smoke effects Road users suffer reduced visibility due to smoke effects resulting in accidents.	Medium	Actively manage through road closures as appropriate.
20	Increased concentration of carbon dioxide in the atmosphere. Carbonation occurs to a greater depth in concrete structures, allowing exposure and degradation of reinforcement. Retaining walls, piers	Medium	Review standards for concrete cover of reinforcement to provide additional coverage as required.

ID	Risk	Rating	Mitigation measures
	and bridge deck elements are degraded quicker than anticipated shortening their design life. Shorter design life results in greater levels of inspection and maintenance needed, increase asset operational costs.		

The remaining risks were classified as 'Low' or 'Negligible'. For these risks, no risk treatment is proposed at this stage – although some of the risks would be followed up upon at detailed design stage.

The results of the assessment can be found in Appendix Q – Greenhouse gas.

8.8.5 Summary of impacts to the environment of Commonwealth Land

Potential construction and operation related greenhouse gas impacts are outlined in Section 8.8.3 and Section 8.8.4. Greenhouse gas emissions would be generated on or near Commonwealth land during construction of the project by the use of fuel in vehicles, plant and equipment as well as the embedded emissions within the construction materials used. During operation, greenhouse gas emissions would be generated by fuel consumption for maintenance activities, road traffic and electricity use to power intersections.

The potential greenhouse gas impacts to the environment of Commonwealth land during both construction and operation are not anticipated to be greater or different to those outside of Commonwealth land and the residual impacts are considered to be consistent with those outlined in Section 8.8.8.

8.8.6 Environmental management measures

Expected environmental outcomes

Road traffic emissions for the project dominate the combined construction and operational GHG inventory when assessed over a 50 year period. Further, road traffic emissions are forecast to grow substantially from the current level due to land use changes resulting from the Western Sydney Airport). However, due to improvements in road layout and widening, the efficiency of cars traversing the project area is forecast to improve.

This, as well as analysis of the benefits of fuel efficiency suggests that efforts during design and construction to support the free flow of traffic along the project is likely to have life cycle benefits gained during operation. This is supported by the project in efforts to:

- Widen the existing road to reduce congestion
- Reduce the extent to which the road changes grade
- Limit the number of intersections and turning lanes at which traffic needs to stop and start
- Support free flowing intersections with other major roads (such as the M12).

Additional measures for consideration during the design process include:

- Use of LED and low energy equipment for signals and signage
- Consideration of options for installation of renewable energy generation (small scale wind or solar photovoltaics) to power electronic equipment.

Expected effectiveness

Roads and Maritime have experience in managing potential impacts associated with GHG impacts as a result of road developments of similar scale and scope to this project.

A Construction Environment Management Plan (CEMP) would be prepared as part of the project, and this would detail those GHG mitigation measures to be implemented through construction stages. Audits and reporting of the effectiveness of environmental management measures is generally carried out to show compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP prepared for the project.

Environmental management measures

Environmental management measures relating to GHG and climate change are provided in Table 8-51.

Table 8-51 Greenhouse gas and climate change environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Emissions of greenhouse gases during construction	GHGC-1	Identify recycled materials (such as recycled aggregates in road pavement and surfacing; steel with recycled content) for use in construction or operation of the project where they are cost, quality and performance competitive	Construction contractor	Detailed design	Expected to be effective if carried out in accordance with the project-specific *Construction* Waste and Energy Management *sub-plan* (CWEMP).
	GHGC-2	Use of modern diesel engine equipment, to ensure highest fuel efficiency ratings	Construction contractor	Construction	Proven to be effective.
	GHGC-3	Specification of the use of biofuels, or biofuel blends in construction plant and equipment	Construction contractor	Pre-construction	Proven to be effective.
	GHGC-4	Provision of clear guidance to construction staff on equipment start up and shut down procedures to ensure that they are not left idling when not in use	Construction contractor	Pre-construction	Proven to be effective. Induction and training requirements of the CEMP to confirm effectiveness of measures.
	GHGC-5	Review of cut and fill balances for earthworks to ensure material is transported the least possible distances	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
	GHGC-6	Review of local options for import and export of fill materials as needed to reduce excess fuel used during transport	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design.
	GHGC-7	Specification and certification of steel from recycled sources where suitable for offsetting virgin steel	Construction contractor	Construction	Proven to be effective.
	GHGC-8	Specification of materials with low embodied energy / embodied GHG content, such as: Replacement of Portland cement in concrete mixes with low carbon alternatives such as fly-ash Use of warm mix asphalt versus hot mix	Construction contractor	Detailed design	Proven to be effective.
	GHGC-9	A project-specific *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented • Specific measures to manage vegetation waste	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
		• Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
Emissions of greenhouse gases during operation	GHGC-10	Opportunities to use renewable energy for road operation would be investigated.	Roads and Maritime	Detailed design	Expected to be effective. To be confirmed during detailed design.

8.8.7 Residual impacts

The project, by its nature, would result in the generation of GHG emissions particularly from road traffic usage. As such, regardless of the implementation of the management measures above, the project would result in residual GHG impacts.

Residual impacts from construction include:

- Impacts associated with the loss of carbon sink through removal of vegetation for construction of the project. Areas cleared for site compounds, and those associated with embankments are likely to be revegetated where appropriate. However, areas of removed vegetation that would be paved as part of the project would remain un-vegetated. Whilst the removal of the carbon sink represents a one-off emissions event, there would also be a small ongoing loss of carbon sink as the removed vegetation would not be able to sequester carbon. This impact is relatively minor as the removed vegetation is mature forest and grassland, both of which have lower sequestration potential (than younger forest, or recently converted grassland).

Residual impacts from the operation of the project are considered to be minor to moderate and would include:

- Road traffic usage – the emissions of greenhouse gases from road vehicles using the project. It could reasonably be expected that the energy efficiency (and emissions intensity) of road traffic would improve over the life of the project, and as such the forecast emissions forecast would be lower than projected. This source of emissions would however likely remain by far the largest and most substantial for the project
- Electricity consumption – ongoing emissions associated with the generation of electricity to power signals and signs within the project. It should be noted that within the assessment that these emissions are based on emissions rates for current power generation. Future power generation is likely to be lower in emissions intensity, and as such the forecasts may be lower than expected. The project sustainability strategy also identifies targets for electricity consumption – see Chapter 10
- Minor ongoing impacts associated with maintenance activities.

It is expected that the residual impacts to climate change and greenhouse gases from operation of the project would be managed to an acceptable level. However, due to improvements in road layout and widening, the efficiency of cars traversing the project area is forecast to improve.

8.9 Hazard and risk

Environmental hazards resulting from the construction and operation of the project, and the identification of measures to avoid, mitigate or manage these risks, are addressed throughout Chapter 7 and Chapter 8 of this EIS/Draft EIS.

Hazards arising from incidents during project construction and operation could also pose impacts to human health, as well as that of the environment.

It is noted that there are no specific Secretary's Environmental Assessment Requirements (SEARs) in relation to hazards and risk. Table 8-52 below sets out the requirements of the Commonwealth EIS Guideline as they relate to hazards and risk and states where in this EIS these have been addressed.

Table 8-52 NSW and Commonwealth Environmental Assessment Requirements

Commonwealth EIS Guidelines	Where addressed in EIS
Impacts to the environment (as defined in section 528) should include but not be limited to the following:	Section 8.9.1

Commonwealth EIS Guidelines	Where addressed in EIS
• Creation of any risks or hazards to people or property that may be associated with any component of the action.	Section 8.9.2

8.9.1 Assessment of potential construction impacts

The following hazards and risks may be associated with the project during construction of the project without effective mitigation:

- Potential short and long-term impacts resulting from the accidental release or improper handling and storage of dangerous goods and hazardous substances within temporary ancillary facilities
- Potential short and long-term hazards resulting from the accidental release of dangerous goods or hazardous substances from vehicles transporting those materials to and from construction compounds in the event of a crash
- Workplace and public health and safety hazards, such as dangers to construction workers, road users and the general public
- Potential short-term hazards to road users and the general public relating to the rupture or interference with underground services
- Potential short-term hazards associated with bushfires.

Storage and handling of dangerous goods and hazardous substances

The types of hazardous substances that would be transported to the site and used within the project area during construction may include (but are not limited to):

- Diesel fuels
- Oils, greases and lubricants
- Explosives (Class 1)
- Gases (oxy-Acetylene) (Class 2.1)
- Bitumen (Class 3 PGIII)
- Paints and epoxies (Class 3 PGII and Class 3 PGIII)
- Herbicides (Class 6.1 PGII)
- Hydrated lime (non-dangerous good)
- Curing compounds (non-dangerous good).

The storage, handling and use of dangerous goods and hazardous substances would be carried out in accordance with the *Work Health and Safety Act 2011* (WHS Act), the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005) and relevant Australian Standards.

The location and purpose of each temporary ancillary facility is detailed in Chapter 5. The estimated quantities of dangerous goods and hazardous substances that would be stored and used within ancillary facilities would be confirmed by the construction contractor and addressed in relevant CEMPs for the project. A register and inventory of the dangerous goods and hazardous substances to be stored at each temporary ancillary facility would be kept as part of the Incident Response Management Plan for the project. Material Safety Data Sheets would also be obtained for each relevant material.

State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33) does not apply to the project (refer to Chapter 2 (Assessment process)). However, the principles of SEPP 33 have been reviewed to identify potential hazards associated with the project.

The quantities of hazardous goods required are expected to be low and below the thresholds requiring preparation of a preliminary hazard analysis (PHA) as detailed in '*Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive Development Application Guidelines*' (DPE, 2011). As such, a preliminary hazard analysis is not required.

Potential inadvertent toxic impacts, fire and explosions resulting from the handling, storage and transportation of hazardous materials may adversely affect the quality of the local environment and impact human safety. However, the potential for such incidents to occur is considered to be low in view of the following factors:

- Hazardous substances would be transported in accordance with relevant legislation and codes
- The likelihood of a crash occurring during the transportation of hazardous substances to and from work sites and spillage to the receiving environment is considered low
- The project is located in a sparsely populated area and it is unlikely the incident would impact on local properties
- Impacts to road users would be limited to those directly involved in the incident
- Implementation of environmental management measures such as those identified in Section 8.9.3 would reduce the likelihood of impact to the environment, construction personnel and the public.

Construction workplace hazards

Workplace hazards could also occur during construction of the project.

Rock falls and steep slopes (near large cuts and fills) can present a potential hazard during construction. Rock fall hazards occur where instability exists at proposed cuts (see Table 5-8). A rock fall could potentially injure construction personnel, other persons in the vicinity of the activity and cause damage to construction equipment. Steep slopes may pose a danger for construction personnel, who could slip and fall, or be injured by unsecured equipment. Standard construction and mitigation measures would be applied to manage rock fall, including the use of appropriate personal protective equipment, scaling, installation of properly secured ground support, safety fencing and overhead protection.

The potential rupture of underground services when excavating could give rise to hazards in the form of electrocution or fire if a gas main is impacted. The likelihood of impacts associated with these hazards would be minimised by undertaking utility checks (such as dial before you dig), consulting with the relevant service infrastructure provider and if required, relocating and/or protecting utilities within the project area prior to the commencement of construction. This would require particular attention when working over or in the vicinity of the high voltage 330kV transmission lines located in the project area.

Hazardous materials including asbestos may be encountered during demolition works and utility relocations. Microscopic asbestos fibres that become airborne can become a health risk if inhaled into the lungs. Areas that potentially include asbestos are described in Section 8.2 (Soils water and contamination). The management of potential asbestos waste is described further in Section 8.7 (Resource use and waste minimisation).

Bushfire

A search of the *Penrith City Council LGA – Bushfire Prone Land Map (2014)* and *Liverpool City Council – Bushfire Prone Land Map (2014)* was conducted to confirm that the project would be partly located within and near bushfire prone land.

Temporary ancillary facilities and construction infrastructure would be generally less sensitive to bushfire than operational facilities, given the temporary nature of the construction compounds and the absence of critical infrastructure within the compounds.

Notwithstanding, measures to mitigate and manage bushfire would be developed and included as part of site-specific hazard and risk management measures within the project CEMP.

Temporary construction compounds would be maintained in a tidy and orderly manner to minimise potential fuel loads in the event that the compounds are affected by fire. Storage and management of dangerous goods and hazardous materials would occur in a safe, secure location consistent with the requirements of applicable Australian Standards.

Construction activities involving flammable materials and ignition sources (for example, welding) would be proactively managed to ensure that the potential for fire is effectively minimised. High risk construction activities, such as welding and metal work, would be subject to a risk assessment on total fire ban days and restricted or ceased as appropriate. Construction personnel would be inducted into the requirement to safely dispose of cigarette butts.

Overall, the hazards and risks associated with construction of the project are considered low and would be managed with the implementation of the standard management and mitigation measures such as those identified in Section 8.9.3.

8.9.2 Assessment of potential operational impacts

It is not anticipated that significant volumes of hazardous substances would be used by Roads and Maritime during operation of the project. However, dangerous goods are permitted to be transported in significant quantities on The Northern Road in accordance with relevant regulations and codes and may include:

- Flammable and combustible petrol, diesel and liquefied petroleum gas
- Toxic gases, such as ammonia and chlorine
- Corrosive acids and alkalis
- Other toxic materials, such as pesticides
- Nitrogen-based fertilisers.

The nature of the project means that there is an inherent risk of vehicle collision associated with its operation, which could result in the accidental spill of dangerous goods. This would have the potential to adversely affect the quality of the local environment and impact human safety, with potential hazards including toxic effects, fire and explosions.

Contaminants either directly associated with the spill or hazardous material clean-up may enter the receiving environment from both paved and unpaved surfaces. However, the potential for such a spill and consequential impacts is considered to be low in view of the following factors:

- Dangerous goods vehicle movements along the road are expected to account for a very minor proportion of total daily traffic movements and the probability of a crash involving a truck containing dangerous goods is low
- The high road design standard of the project would reduce the potential for road crashes relative to the existing situation
- The project includes an incident response facility
- The existing stringent legislative controls on the transport of dangerous goods reduce the likelihood of impacts
- Most incidents would have limited potential to affect those not directly involved in the crash or incident, as most of the project is located within a sparsely populated area

- In the unlikely event of a traffic crash involving a vehicle carrying hazardous substances, any spills would typically be contained to the roadway area by the appropriate incident and emergency response teams
- The operational infrastructure of the project is largely invulnerable to bush fire due to its incombustible nature (road surface materials, retaining walls, road barriers)
- The project would not increase the extent of bushfire prone land
- Hazards and risks associated with the project during operation are considered low and would be managed with the implementation of standard management and mitigation measures identified in Section 8.9.3.

8.9.3 Summary of impacts to the environment of Commonwealth Land

Potential impacts to the environment on Commonwealth land as a result of hazards and risks during construction and operation of the project are not expected to be greater or different to those outlined in Section 8.9.2 and Section 8.9.3. There would not be any temporary construction ancillary facilities located on Commonwealth land.

During construction, potential hazards may arise from the use of hazardous substances as a result of accidental release or improper management; the discovery of hazardous material such as UXO or asbestos, potential interface with underground services and bushfires on or adjacent to Commonwealth land. The impacts on Commonwealth land would be dependent upon the type and duration of activities being undertaken and prevailing weather conditions. Any potential impacts would be managed through the measures outlined in Section 8.9.4.

Operational impacts on Commonwealth land would only arise in the event of a vehicle incident or accidental spill during road maintenance activities. The residual impacts are considered to be consistent with those outlined in Section 8.6.9.

8.9.4 Environmental management measures

As described throughout this chapter, the project has been designed to minimise the likelihood of incidents and accidents. Environmental management measures relating to hazards and risk are outlined in Table 8-53. In addition to these measures, a Work Health and Safety Plan would be implemented during construction of the project. This would support the management measures and procedures included in the CEMP for the project and would be supplemented by site and activity specific Safe Work Method Statements.

Expected environmental outcomes

Project-specific environmental management measures have been developed with the aim of minimising or mitigating, as far as practical, hazards and risks associated with construction and operation of the project. Additionally, hazard and risk management planning would be incorporated throughout the CEMP.

Broadly, the expected project environmental outcomes specific to hazard and risks are to:

- Avoid and minimise the environmental and human health impacts arising from the construction and operation of the project
- hazardous events during construction are avoided, or managed to minimise risk if they do occur
- Ensure the preferred waste management hierarchy of avoidance, minimisation, reuse, recycling and finally disposal is followed
- Ensure the correct handling and storage of hazardous martials and wastes
- Provide construction staff with an increased level of understanding and awareness of hazards and risks

- Ensure appropriate measures are implemented to address the relevant conditions of approval, and the mitigation measures detailed in the EIS/draft EIS
- Ensure appropriate measures are implemented to comply with all relevant legislation.

Expected effectiveness

Roads and Maritime has experience managing hazards associated with road developments of similar scale and scope to this project.

Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

Audits and reporting on the effectiveness of environmental management measures is generally carried out to demonstrate compliance with management plans and other relevant approvals and would be outlined in detail in the CEMP prepared for the project.

Table 8-53 Hazard and risk environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
General	HR-1	Hazard and risk management planning would be incorporated throughout the CEMP, which may include items such as: • Details of the hazards and risks associated with construction activities • Risk management measures, including those identified in Chapters 7 and 8 of this EIS • Procedures to comply with all legislative and industry standard requirements • Contingency plans, as required • Site-specific Work, Health and Safety plans and activity specific Safe Work Method Statements • Training for all personnel (including subcontractors) in site inductions, including the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
Storage of dangerous goods and hazardous substances	HR-2	Storage of dangerous goods and hazardous materials would occur in accordance with suppliers' instructions and relevant Australian Standards and may include bulk storage tanks, chemical storage cabinets / containers or impervious bunds.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
	HR-3	Storage, handling and use of dangerous goods and hazardous substances would be in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).	Construction contractor	Construction	Proven to be effective if carried out in accordance with Work Health and Safety Act 2011 and the Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW, 2005).
	HR-4	Secure, bunded areas would be provided around storage areas for oils, fuels and other hazardous liquids.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
	HR-5	Material Safety Data Sheets would be obtained for dangerous goods and hazardous substances stored onsite prior to their arrival.	Construction contractor	Construction	Proven to be effective.
Contamination from transportation of hazardous goods	HR-6	Transport all hazardous substances in accordance with relevant legislation and codes, including the Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (National Transport Commission, 2008).	Construction Contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
					testing and monitoring of any fire and life safety systems.
Bushfire	HR-7	Measures to mitigate and manage bushfire would be developed and included as part of site-specific hazard and risk management measures within the CEMP	Construction Contractor	Construction	
Incident response	HR-8	An Incident Response Management Plan would be developed and implemented. The response to incidents within the road would be managed in accordance with the memorandum of understanding between Roads and Maritime and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services. An incident response facility has been provided for the project.	Roads and Maritime	Operation	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.

8.9.5 Residual impacts

The environmental safeguards outlined in Table 8-53 have been designed to minimise the potential impacts to people and the environment. Regardless, construction and operation of the project still involves some level of residual impact.

An unplanned incident could still occur occurs without prior notice which can degrade safety, harm the environment and/or slow traffic flow. There is the possibility that unplanned incidents can result in severe injury and/or death and may require the partial or full closure of the affected roadway for an extended period. This risk is inherent with the operation of a major road network.

With the implementation of the safeguards identified in this chapter, the residual impact associated with hazards and risks associated with the project are considered low.

9 Cumulative Impacts

This chapter provides a summary of the cumulative impacts associated with the project.

Table 9-1 sets out the Secretary's Environmental Assessment Requirements (SEARs) and Commonwealth EIS Guidelines as they relate to cumulative impact and identifies where in this EIS these have been addressed.

Table 9-1 SEARS and Commonwealth EIS Guidelines for cumulative impacts

Environmental assessment requirements	Where addressed in the EIS
Secretary's Environmental Assessment Requirements	
Where relevant, the assessment of the key issues below, and any other significant issues identified in the risk assessment, must include:	
consideration of potential cumulative impacts due to other development in the vicinity	Section 9.2
an analysis of the proposal, including an identification of how relevant planning, land use and development matters (including relevant strategic and statutory matters) have been considered in the impact assessment (direct, indirect and cumulative impacts) and/or in developing management/ mitigation measures	Section 9.2
Traffic and Transport — including: • having reference to the cumulative construction impacts of other major projects preparing for or commencing construction.	Section 9.2.1
Noise and Vibration — including: • cumulative effects of construction works undertaken concurrently	Section 9.2.1
Hydrology, Soils and Water — including: • cumulative impacts on regional hydrology	Section 9.2.1
Commonwealth EIS Guidelines	
This should provide the background and context of the action including: • how the action relates to any other actions (of which the Proponent should reasonably be aware) that have been, or are being, taken or that have been approved in the region affected by the action;	Section 9.2.1

Environmental assessment requirements	Where addressed in the EIS
The EIS should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity)	Section 9.2.1
The EIS should also address the potential cumulative impact of the proposal on ecosystem resilience. The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience. Where relevant to the potential impact, a risk assessment should be conducted and documented	Section 9.2.1

9.1 Nature of cumulative impacts

Cumulative impact may arise from the interaction of the construction and operation of the project and other proposed activities (including projects) locally and regionally. When considered in isolation, a particular impact from one project may be considered minor, but when the impact of multiple projects on the same receivers is considered, the impact may be much more substantial. Typical cumulative impact associated with transport and infrastructure projects include:

- Impact on traffic, transport and road users
- Changes to local and regional amenity, including noise, visual quality and air quality
- Social and economic effects, including changes to land use, access and businesses
- Environmental changes including effects on water quality, hydrology and biodiversity.

Another type of cumulative impact is known as construction fatigue. This concept relates to sensitive receivers that experience construction impacts from a variety of projects over a long period of time with few or no breaks between construction periods. Construction fatigue typically relates to amenity impacts from projects that are constructed consecutively or ‘back to back’.

The impact associated with the construction and operation of the project and other relevant projects are the subject of this cumulative impact assessment.

The following sections provide an assessment based on the most current and publicly available information.

9.1.1 Study area and approach

This assessment of cumulative impact focused on the key environmental issues that are assessed in detail in Chapter 7 and Chapter 8 of this EIS.

The assessment of cumulative impact addresses potential construction phase interfaces with other significant infrastructure and development projects as well as the operational relationship of the project to other projects.

The identification of projects for consideration was based on the following criteria:

- Other projects part of the overall The Northern Road Upgrade were considered
- Project size – given the extent of development within Sydney, major projects (as determined by DPE) were considered
- The Western Sydney Airport project

- Project boundary – only projects located within LGAs intersected by or adjacent to the project areas (Penrith and Liverpool LGA) were considered
- Project timeframe – projects likely to be undertaken at some point during the construction period of the project were considered
- Projects where cumulative operational impacts would be a consideration.

Broader program of upgrade work

The project is part of the overall The Northern Road Upgrade, a 10 year investment program to upgrade The Northern Road from Mersey Road, Bringelly, to Jamison Road, Penrith. The project would tie into The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, Penrith to the north and The Northern Road Upgrade, Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2) to the south.

The individual components of The Northern Road Upgrade are outlined in Table 9-2 along with the proposed construction timeframes for each project. Separate applications for approval have been (or would be) lodged for each component project and would be assessed separately.

Table 9-2 Comparison of construction timing for components of The Northern Road Upgrade

The Northern Road Upgrade project	Project construction timing																			
	2016				2017				2018				2019				2020			
The Northern Road Upgrade, Old Northern Road Narellan, to Peter Brock Drive, Oran Park (Stage 1)																				
The Northern Road Upgrade, Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2)																				
The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, Penrith																				
Mersey Road to Glenmore Parkway (this project)																				

As shown in Table 9-2, the construction timeframes of the other components of The Northern Road Upgrade would overlap with that proposed for the project and therefore are likely to result in cumulative impacts during those periods.

For the period during which the separate upgrades of The Northern Road are being constructed concurrently, the impact would be greatest for those motorists travelling along The Northern Road

between Penrith and Narellan and potentially for residents located near the tie-in points for each component.

The construction strategy for the project (and the wider program of works) focuses on balancing the need for construction to occur in a safe and efficient manner while managing constructability constraints and minimising cumulative impacts on the environment, road users and the surrounding road network.

Table 9-3 identifies the respective environmental impacts identified for the individual components of The Northern Road Upgrade.

Table 9-3 Identified environmental impacts of The Northern Road Upgrade components

Project	Construction impacts	Operational impacts
The Northern Road Upgrade, Old Northern Road Narellan, to Peter Brock Drive, Oran Park (Stage 1)	The main potential environmental impacts during construction include: • The partial or total acquisition of 35 properties • Construction noise experienced by properties close to the project site • Temporary disruptions to traffic flow and access • Other amenity impacts, including the potential for dust generation and visual impacts.	The main potential environmental impacts during operation of the project include: • Increased noise levels for properties close to the project site, with about 10 properties requiring additional noise mitigation • Changes to the visual environment with the widening of the road and signalised intersections, and removal of vegetation • Changes to property access due to the provision of a central median.
The Northern Road Upgrade, Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2)	The main potential environmental impacts during construction include: • Amenity impacts such as noise and vibration and dust generation, • Disruptions to traffic and property accesses • Increased likelihood of spills and contamination and the occurrence of erosion and sedimentation • Removal of vegetation including TSC Act and EPBC Act listed communities • Removal of habitat for threatened fauna • Increase in traffic volumes along Robinson Road, Jersey Road and Carrington Road because of the proposed temporary diversion from Bringelly Road • Impacts to six Aboriginal heritage	The main potential environmental impacts during operation of the project include: • Changes to access for properties during operation • Impacts to 14 Aboriginal cultural heritage items • Impacts to four non-Aboriginal listed heritage sites including the State heritage register listed • Property acquisition and leasing of property • Changes to the visual environment with the widening of the road and signalised intersections, and removal of vegetation. • Reduction in passing trade for the shops located at Bringelly Village

Project	Construction impacts	Operational impacts
	sites (with four sites already assessed as part of adjoining upgrades.	• Changes to property access due to the provision of a central median.
The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, Penrith	The main potential environmental impacts during construction include: • Temporary disruptions and diversions to traffic, including reduced speed limits through construction zones • Amenity impacts such as noise, vibration and dust generation • The project would impact on up to 2.4 ha of remnant native vegetation and up to 3.9 ha of planted vegetation along the M4 Motorway • Increased potential for spills and contamination and the occurrence of erosion and sedimentation • The partial acquisition of land from 44 individual properties along The Northern Road and some adjoining roads • Temporary leases of 12 individual parcels of land for use as ancillary sites (construction compounds, site offices, plant and materials storage, etc.) during construction.	The main potential environmental impacts during operation of the project include: • Operational noise impacts for receivers in close proximity to the proposed road upgrade • Two Aboriginal archaeological sites would be impacted by the project • Property adjustments, including relocation of boundary fencing and driveways • Visual changes due to the proposed new M4 Motorway bridge, and the introduction of new retaining walls • Visual changes due to the widening of The Northern Road and upgrading of intersections, as well as the removal of some roadside vegetation • Changes to access to and from some adjoining roads, including removal of right turns at Homestead Road and Castle Road.

The project has the potential to have cumulative impacts with other nearby developments that are not related to The Northern Road Upgrade program of work. This includes major projects identified in the DPE major projects register, in suburbs along and around the project alignment, and proposed future infrastructure developments such as the M12 Motorway. These projects have yet to be referred to DPE but, subject to approval, are likely to be under construction at a similar time to the project.

Key projects and developments considered in this cumulative impact assessment are discussed below.

Western Sydney Airport

The Western Sydney Airport is a major strategic driver of many of the developments and land use changes being planned for western Sydney. The airport's development is a long-term commitment of the NSW and Australian governments.

The Western Sydney Airport is not likely to be operational until the middle of the next decade, at the earliest, and no construction start date has yet been confirmed.

The *Western Sydney Airport Environmental Impact Statement* (Australian Government, 2016) states that site preparatory works may commence from mid-2016 and continue for around six and a half years. Sectors of the airport site may be subject to progressive handover to the aviation infrastructure works which would then be completed over about five years to December 2024. Indicative construction dates are as follows:

- Aviation infrastructure works start mid-2019 and end mid-2024
- Commissioning and operational readiness occurs late 2023 until late 2024, allowing for a start of operations in early January 2025.

Table 9-4 compares the indicative construction periods of the Western Sydney Airport with the project.

Table 9-4 Comparison of construction timing for the Western Sydney Airport and the project

Western Sydney Airport and the project	Project construction timing																			
	2018				2019				2020				2021				2022				2023			
Aviation infrastructure works for the planned airport																								
The Northern Road Upgrade, Mersey Road to Glenmore Parkway (this project)																								

As shown in Table 9-4, the indicative construction timeframes of the Western Sydney Airport would overlap with that proposed for the project and therefore are likely to result in cumulative impacts during those periods.

The *Western Sydney Airport Environmental Impact Statement* identified a number of construction and operational impacts associated with the planned airport outlined below.

Temporary construction impacts including:

- Increases in dust emissions from large scale bulk earthworks
- Increases in noise related to construction of the site and construction vehicles entering and leaving the site
- An additional 1,254 vehicle movements per day on the surrounding road network during the construction period
- The removal of about 1,065 ha of vegetation, comprising 280 ha of native vegetation
- At least 39 Aboriginal heritage sites recorded at the airport site, all of which comprise artefact occurrences. Construction activities would also affect about 500 ha of archaeologically sensitive landforms

- A total of 19 European heritage items have been recorded at the airport site and an additional 22 heritage items have been recorded in the surrounding area
- Visual impacts from construction.

Permanent operational impacts including:

- Increased noise levels associated with changes to the pattern of aircraft movements in the airspace above western Sydney
- Noise impacts on the Luddenham and Badgerys Creek areas from ground-based noise associated with airport operations
- Increases in emissions to air (NO2, PM, CO and SO2) as well as increases in GHG and ozone emissions
- Traffic entering and exiting the airport (about 41,800 vehicles entering and leaving the airport site each day by 2030)
- Changes to existing groundwater levels and recharge conditions
- Moderate to high visual impacts as a result of overflights have been identified for Luddenham and Mount Vernon.

Urban growth areas in western Sydney

Urban growth areas, for this assessment, are considered to be:

- South West Priority Growth Area
- Western Sydney Priority Growth Area.

Chapter 3 of this EIS establishes the need for the project in the context of a number of government strategic plans that provide an overall framework to guide long-term developments in western Sydney and other parts of the metropolitan area. While these strategic plans do not contemplate individual projects, they place a heavy emphasis on the future development of western Sydney, and herald major changes for the western Sydney region in coming years.

The NSW Government established the South West Priority Growth Area (formerly known as the South West Growth Centre) in 2015 to streamline the supply of greenfield land for urban development, and coordinate the sustainable delivery of infrastructure through the NSW DPE over the next 25 to 30 years. The South West Priority Growth Area comprises 18 precincts and covers about 17,000 ha. It is expected to accommodate about 110,000 new dwellings for 300,000 people (DPE, 2015). To date, seven precincts within the South West Priority Growth Area have been rezoned to allow urban development, with the potential for about 42,560 new homes.

Detailed planning for stage 1 of Leppington Precinct (south-east of the project area) has recently been finalised. Upon rezoning, it is expected the Leppington Precinct will provide land for about 2500 additional homes.

The project, and the other upgrades of The Northern Road, are being planned and developed in parallel with the development of the South West Priority Growth Area.

The Western Sydney Priority Growth Area (formerly Broader Western Sydney Employment Area) is identified in *A Plan for Growing Sydney* (DPE, 2014). It extends from the intersection of the M4 Western Motorway and WestLink M7 Motorway, to south of The Northern Road / Elizabeth Drive intersection.

The WSPGA identifies about 10,000 ha of currently low intensity rural activity lands to be developed as a diverse employment centre, providing businesses in the region with land for industry and employment, catering for transport and logistics, warehousing and office space. It is anticipated to provide over 57,000 jobs over the next 30 years, and over 200,000 jobs once it is fully established. The redevelopment of this area will involve substantial changes to the local road network, and place significant pressure on arterial roads that will service the employment area.

The project is located partly within the WSPGA and is also being planned and developed in parallel with the development of the WSPGA.

The lack of detail relating to individual projects or projects to be conceived under these strategies permits only a limited assessment of their cumulative impacts with the project. However, it is considered that the extent and the scale of changes being contemplated for western Sydney, and the long but undetermined timeframes over which they will occur, would be a likely cause of some uncertainty and anxiety for residents and land owners of the affected areas.

The M12 Motorway

The new M12 Motorway would provide direct access to the Western Sydney Airport and connect to Sydney's motorway network.

The project is for an east–west motorway of about 15 – 17 km between the M7 Motorway and The Northern Road which would provide increased road capacity and reduce congestion and travel times in the future. It would also improve the movement of freight in and through western Sydney and is expected to serve the Western Sydney Priority Land Release Area and the Western Sydney Employment Area.

The M12 Motorway preferred corridor option was announced in late 2016 with construction expected to start around 2020, subject to approval. Based on these indicative timeframes, construction of the M12 Motorway is not planned to significantly overlap with construction of the project, although it may occur in a consecutive manner.

At the time of preparing this EIS, M12 Motorway Preferred Corridor Route Report (RMS, 2016) has been published. The preliminary design and access strategy is expected to be displayed in mid-2017. It will be followed by the Environmental Impact Statement (EIS) which is expected to be on display in 2018

Based on the predicted timing of construction for the M12 Motorway, there may be a short overlap with construction of the project and cumulative impacts could be expected as well as construction fatigue.

M4 Smart Motorway civil work

The M4 Motorway would be upgraded to provide a managed motorway system between the Pitt Street overbridge at Parramatta and the connection to the Great Western Highway at Lapstone, to form the M4 Smart Motorway. Construction for the M4 Smart Motorway would involve the installation of Intelligent Traffic System (ITS) infrastructure and minor upgrades to interchanges, including the interchange with The Northern Road. Although the project would not directly tie into M4 Smart Motorway infrastructure at the M4 Motorway interchange, traffic flows from the M4 Western Motorway would influence the project via the planned The Northern Road Upgrade, between Glenmore Parkway, and Jamison Road, Penrith (Stage 3).

Construction of the M4 Smart Motorway is likely to occur simultaneously with construction of the project.

Other nearby developments

A search of the DPE Major Projects Register identified several State Significant Developments proposed within the Penrith and Liverpool LGAs and in proximity to the project. Table 9-5 discusses these developments.

Table 9-5 Other significant developments near the project

LGA	Project or development	Location and anticipated construction timing
Penrith	**Oakdale South Industrial Estate** A staged development of 117 ha of	Oakdale South, About 12 km to the east of the project corridor.

LGA	Project or development	Location and anticipated construction timing
	land within the Western Sydney Employment Area (WSEA). The proposed development of the estate seeks to establish a regional warehouse and distribution hub that would ultimately operate as part of an integrated and synergistic network of custom designed, state of the art facilities incorporating all of the Oakdale Estate lands.	Stage 1 construction commenced mid-2016 and is expected to be complete within 12 months.
	Erskine Park Resource Management Facility Development of a Resource Management Facility on a site adjacent to an existing landfill operation. The facility would be developed in two stages, the first being a Waste Transfer Station (WTS) and the second being a Resource Recovery Facility (RRF).	Erskine Park, about 9 km east of the project corridor. Construction to begin in late 2016 with operations starting in mid- to late 2017
Liverpool	There were no major or strategic projects were identified in proximity to the project corridor	

9.2 Potential cumulative impacts

The potential cumulative impacts of these projects are considered as follows in relation to:

- Concurrent impacts, ie potential cumulative impacts as a result of projects being constructed at the same time
- Consecutive impacts, ie potential cumulative impacts as a result of a project being constructed before and after the construction of the project.

Table 9-6 provides a high level assessment of the likelihood of the identified projects interacting with the project to produce cumulative impacts. The likelihood is based on the construction period of each development in relation to the project and the minimum separation distance from the affected section of the project.

Table 9-6 Likelihood of project interactions with the project

Existing or proposed project	Likelihood of interaction	Timing of construction	Minimum distance to project
The Northern Road Upgrade, Old Northern Road Narellan, to Peter Brock Drive, Oran Park (Stage 1)	The Northern Road Upgrade Stage 1 construction phase would overlap with that proposed for the project. Some interaction is therefore likely but would	Currently under construction, scheduled for completion by early 2018.	About 11 km.

Existing or proposed project	Likelihood of interaction	Timing of construction	Minimum distance to project
	be limited to occasional/infrequent movement of construction related vehicles along The Northern Road through the project area.		
The Northern Road Upgrade, Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2)	The Northern Road Upgrade Stage 2 construction phase would overlap with that proposed for the project. The two projects are adjacent to one another and it is likely there would be interaction between them at the tie-in point. Impacts would relate to traffic control measures such as reduced speeds.	Early to mid-2017 through mid-2019.	0 km (projects meet at Mersey Road).
The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, Penrith	The Northern Road Upgrade Stage 3 construction phase would overlap with that proposed for the project. The two projects are adjacent one another therefore it is likely there would be interaction between them, at the tie-in point south of Glenmore Parkway, and also in the form of construction traffic and some flow-on impacts to general traffic.	Early to mid-2017 through end 2019.	0 km (projects meet just south of Glenmore Parkway.
Bringelly Road Upgrade Stage 1 and 2	Bringelly Road Stage 2 terminates at its intersection with The Northern Road just south of Mersey Road. Construction scheduled for commencement in 2017, for completion in mid-2019 therefore likelihood of interaction is high. Bringelly Road Stage 1, from Camden Valley Way	Stage 1: 2015 to late 2017 Stage 2: early 2017 to mid-2019.	2.9 km (projects meet at junction of The Northern Road and Bringelly Road, 2.9 km south of Mersey Road).

Existing or proposed project	Likelihood of interaction	Timing of construction	Minimum distance to project
	to King Street, is currently under construction, scheduled for completion by late 2017 therefore likelihood of interaction is low.		
Western Sydney Airport at Badgerys Creek	Aviation infrastructure works are scheduled to overlap with the project's construction schedule by about one year. There is a high likelihood of interaction between the two projects.	Mid-2019 through 2024 (Aviation infrastructure works).	The project would be directly adjacent to the site of the planned airport, south of Elizabeth Drive. The Northern Road would provide a means of access during airport construction works.
South West Priority Growth Area	The project, and the other upgrades of The Northern Road, are being planned and developed in parallel with the development of the South West Priority Growth Area. There is a high likelihood that some projects enabled by the SWPGA would be under construction during the project's construction phase.	2015 – 2045.	The project would lie to the north of the South West Priority Growth Area. The project would be an important element in the overall planning of the SWPGA and would facilitate the development of the area.
Western Sydney Priority Growth Area	The project, and the other upgrades of The Northern Road, are being planned and developed in parallel with the development of the Western Sydney Priority Growth Area. There is a high likelihood that some projects enabled by the WSPGA would be under construction during the project's construction phase.	2015 – 2045.	The project would intersect the Western Sydney Priority Growth Area at its southern end and in the vicinity of Elizabeth Drive. The project would be an important element in the overall planning of the WSPGA and would facilitate the development of the area.
M12 Motorway	Potential interaction between commencement of M12 Motorway construction and final stage of The Northern Road construction.	Scheduled to commence in 2020.	M12 Motorway intersection with The Northern Road proposed in vicinity of Elizabeth Drive.

Existing or proposed project	Likelihood of interaction	Timing of construction	Minimum distance to project
Oakdale South Industrial Estate	This development at Erskine Park is remote from The Northern Road and there is little likelihood of interaction. The subject site is accessed from The Westlink M7 Motorway and Old Wallgrove Road.	Subject to Department of Planning and Environment approval of development.	About 11 km.
Erskine Park Resource Management Facility	This development, also at Erskine Park is remote from The Northern Road and there is little likelihood of interaction. The subject site is accessed from the M4 Motorway, Mamre Road and Erskine Park Road.	Department of Planning and Environment completed assessment in August 2016 with recommendation for approval. Minister's approval in October 2016. Stage 1 to commence in 2017.	Site is about 8.5 km east of The Northern Road, on northern side of the WaterNSW supply pipelines.

9.2.1 Key cumulative impact considerations

Traffic and transport – cumulative construction impacts

Construction of the project is likely to be undertaken at the same time as other projects within the region, including:

- The Northern Road upgrade between Glenmore Parkway and Jamison Road
- M4 Smart Motorway civil work
- Bringelly Road Upgrade Stage 1 and 2.

As construction of these projects would take place simultaneously, traffic generated by these combined construction projects would impact primarily on the arterial road network with additional trucks travelling along the key arterials through the surrounding area. This would mean that higher than normal car and truck movements (in the order of 200 to 300 trucks per day and 450 to 700 light vehicles per day) would be likely to occur on The Northern Road and Elizabeth Drive.

For heavy vehicles, this would represent up to a 37 per cent increase in heavy vehicle volumes on The Northern Road and an increase in total traffic volumes of 4 per cent. Heavy vehicles would be travelling largely outside of the peak period and would represent a small proportion of the hourly and daily traffic volumes, being well within the design capacities for these roads and unlikely to reduce their Level of Service .

For light vehicles, traffic generation is likely to be concentrated in the morning and evening peak periods, with an average cumulative traffic generation of between 120 to 180 vehicles per hour during these periods along The Northern Road. This would represent an increase in peak period traffic volumes of between 13 and 15 per cent. This increase in traffic volume would be in excess of forecast 2021 traffic volumes on The Northern Road. Based on modelling of the 2021 and 2031 Do Minimum scenario shown in Section 7.1, if all of this traffic were to use The Northern Road, this

would likely result in some intersections along the Northern Road performing at unacceptable Levels of Service.

However, given the location of works being undertaken for other projects in the area, it is unlikely that all of the traffic generated by these projects would use The Northern Road, as these construction areas are more directly accessed via the M4 Motorway (The Northern Road upgrade between Glenmore Parkway and Jamison Road, M4 Smart Motorway civil work) or Camden Valley Way (Bringelly Road upgrade).

In addition to the impacts of concurrent construction, the following projects would be taking place in the surrounding area following completion of the project:

- M12 Motorway
- Western Sydney Airport.

Both these projects would have lengthy construction periods and would result in continuous construction activity taking place in the area surrounding the project for up to five years. Construction traffic management plans for this project should be developed in consultation with plans for these projects so that increased traffic on the local road network would be spread over the road network to ensure that construction traffic is not concentrated on any one particular route if there are alternatives available. This consultation process would be managed by and/or through lines of communication agreed through Roads and Maritime Services.

Construction activities and the additional traffic associated with them are likely to result in lower travel speeds and increased delays at intersections along The Northern Road. Increased heavy vehicle volumes may also result in delays in sections where cars are unable to overtake vehicles along The Northern Road. Vehicles wishing to avoid these delays may use alternative routes to travel north or south through the area, such as:

- Mulgoa Road
- Luddenham Road
- Elizabeth Drive
- Mamre Road
- Greendale Road.

These alternative routes are comparable in capacity and speed to The Northern Road and would be a detour of between 2 and 10 km for drivers wishing to avoid The Northern Road.

Traffic and transport – cumulative operational impacts

In assessing the effects of the project the traffic modelling has taken into account the likely cumulative effects of the project with other planned road upgrade and traffic generating development projects in place (subject to relevant funding and planning approval), namely:

- The Northern Road upgrade between Glenmore Parkway and Jamison Road
- Bringelly Road upgrade
- South West Priority Growth Area
- Western Sydney Priority Growth Area
- M12 Motorway
- Western Sydney Airport and associated accesses.

The cumulative traffic assessment has taken into account the traffic generation from the planned land developments in the area through the use of future traffic demand forecasts from Roads and Maritime's Strategic Traffic Assignment Model (STAM). Broader traffic implications of other employment lands in the broader Western Sydney Employment Area, as well as the Western Sydney Airport, have all been accounted for in future travel demands for the project.

The microsimulation traffic model for The Northern Road also includes the proposed The Northern Road upgrade between Glenmore Parkway and Jamison Road. Consequently, the likely cumulative impacts of the projects listed above have been reflected within this assessment, as they are included within the core set of assumptions that underlie the traffic modelling for the project.

A summary of the network-wide statistics from the Aimsun traffic model, showing total vehicle kilometres of travel (VKT), total hours of travel (VHT) and average network speed with and without the project is shown in Table 9-7. Analysis of these network statistics shows that average network speeds are consistently higher for all scenarios with the project.

Table 9-7 Summary of network statistics

Scenario	VHT (hours)	VKT (km)	Average Speed (km/h)	Unreleased Traffic (4 hours)
2021 AM without project	2,083	122,599	58.8	116
2021 AM with project	2,145	132,899	62.0	0
Difference	62	10,300	3.2	-116
2031 AM without project	4,166	140,195	33.6	5,407
2031 AM with project	3,583	203,767	56.9	0
Difference	-583	63,572	23.3	-5,407
2021 PM without project	3,166	158,190	50.0	398
2021 PM with project	2,826	167,154	59.2	0
Difference	-340	8,964	9.2	-398
2031 PM without project	8,054	162,478	20.2	8,945
2031 PM with project	4,694	256,586	54.7	0
Difference	-3,360	94,108	34.5	-8,945

The table above shows that with the project, vehicles travel further in less time and with greatly improved average network travel speeds. Furthermore, analysis of the modelled scenario without the project shows that there is insufficient capacity through the corridor to serve the cumulative forecast traffic demand that results from the completion of the projects and developments likely to arise in the surrounding area.

The large volumes of unreleased traffic (traffic that was unable to enter the model during the modelled period due to congestion or queuing), particularly in the 2031 scenarios demonstrate that a substantial amount of forecast traffic would be unable to travel along the corridor if the project was not built due to capacity constraints. At the 2031 forecast year, these unreleased trips account for between 21 and 27 per cent of forecast traffic demand through the corridor.

In reality, it is unlikely that this unreleased traffic demand would be realised; it is likely that some proportion of these trips would take place outside of the modelled period, while others may redistribute across the wider road network (although current alternatives are limited to Mulgoa

Road, Luddenham Road and Mamre Road, which have comparably low capacity to The Northern Road).

Overall, the project would improve the road network performance in the study area, reducing overall delays and increasing the average network speeds. This would facilitate the projected traffic increase associated with future growth and development planned for the surrounding areas, including the Western Sydney Airport. It is also likely that the project would unlock other development potential for surrounding land that would otherwise remain undeveloped by facilitating travel to and from these areas.

Noise and vibration – cumulative construction impacts

Assessing the potential for additive or 'cumulative' noise impacts resulting from two or more unrelated construction projects being undertaken concurrently is complex given the number of noise sources, possible operating locations and the variation in exertion effort of plant at any one time. Also to be considered is the variation of preferences within an impacted community as to whether a slightly louder but shorter exposure or a longer but quieter exposure to a set of works is preferred. Often, the wider community's reaction to cumulative noise impacts is most a function of how well they are engaged and informed about the construction programs, and the extent to which the separate works can be coordinated (if at all) to win timing, scheduling or impact-management efficiencies.

The construction of the project may overlap with the construction of aviation infrastructure works Western Sydney Airport. However, given the spatial separation between the project and these works, the more likely cause of cumulative construction noise impacts relates to the potential for the project's road tie-in works to be undertaken concurrently with the construction process of nearby (but unrelated) upgrades of The Northern Road.

Increases in the level of construction noise to a receiver do not result necessarily result where two adjacent works sites are in concurrent operation. This is because one site may be operating more loudly than the other, such that there is only a marginal increase in total noise. Noise levels add logarithmically such that a noise source that is 10dB(A) quieter – or in lay terms, half as loud - than another operating alongside it would not add to the total noise level. In the worst case, two noise sources of equal loudness (eg, one rock breaker at each work site) operating concurrently would cause the total noise level at a receiver to increase by 3dB(A). This level of increase in noise is "just noticeable". In any case, unless the outcome is intentionally managed, it is not often the case that sustained increases in the level of noise results from concurrent construction operations. The felt impact of cumulative construction noise is most often related to any time extension of loud noise exposure sensitive receivers are exposed to due to multiple construction programs. The project would give consideration to the aforementioned matters should its construction scheduling indicate the potential for cumulative noise impacts.

Given that project traffic would generally be contained to major roads, the potential for cumulative traffic impacts is small, although finite. In the worst case, an increase in received traffic noise levels of 3 dB(A) could result where construction traffic from two projects are simultaneously present on a given road corridor. However, noise impacts from construction traffic are first determined in respect of whether the increase in traffic created is substantial relative to existing traffic volumes. Where this is not the case – as for this project – then the potential for cumulative traffic noise impacts is negligible.

Noise and vibration – cumulative operational impacts

The project's operational noise impact assessment documented in Section 7.2 showed that the receivers expected to experience the greatest increase in traffic noise are:

- The semi-rural receivers adjacent to the new bypass alignment
- The semi-rural receivers located near the bypass' northern or southern junctions with the existing The Northern Road. These receivers would have exposure to noise from both the existing The Northern Road and the new bypass

- The receivers situated to the west of the existing The Northern Road between Chain-o-Ponds Road and Littlefields Road. The offset distance to the upgraded The Northern Road would be marginally reduced for these receivers.

The cumulative operational noise impacts of the project are likely to be experienced mostly by receivers close to the locations where two or more projects tie in with one another. There are three locations where this would occur either when the project opens, or in the near future:

- The project's tie-in with The Northern Road Upgrade from Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith (Stage 3)
- The project's tie-in with The Northern Road Upgrade from Peter Brock Drive, Oran Park to Mersey Road, Bringelly (Stage 2)
- The project's (future) tie-in with the M12 Motorway in the vicinity of Elizabeth Drive.

The completion of any of the adjacent or nearby projects in combination with the project may create, in effect, a cumulative operational noise impact that can increase traffic noise to nearby receivers. It is to be recognised however that within NSW, road developments proposed for urban or semi-urban regions where there already exists background traffic noise - including this project – are required to account for this additive or cumulative effect explicitly in any case. The RMS' NMG requires assessment of the increase in existing traffic noise levels (e.g. assessing whether the "Build minus No Build" increase in noise is greater than 2dB(A)) created by the project, and further, where that increase is substantial, requires the project to provide noise mitigation (eg at-property acoustic treatments) in part, to offset this "cumulative" impact. In this way, the cumulative impact is both assessed and, potentially, also accounted for. If the project is required to provide noise mitigation, then a reduction of operational noise to part of the community can result.

Cumulative biodiversity impacts

The potential biodiversity impacts of the project must be considered as a consequence of the construction and operation of the project within the existing environment. The project would not act alone in causing impacts to biodiversity. The incremental effects of multiple sources of impact (past, present and future) are referred to as cumulative impacts and provide an opportunity to consider the project within a strategic context.

The accumulating impacts of historic vegetation clearing for agriculture, urban development, and development and maintenance of infrastructure would likely include continued loss of biodiversity on the Cumberland Plain. The Cumberland Plain Mitchell Landscape is an over-cleared landscape with 89 per cent of native vegetation having been cleared. Only 11 per cent of the original native vegetation remains. Due to the likely expansion of western Sydney and creation of housing and associated infrastructure, further impacts to biodiversity are likely to result in this region.

While data from all recent projects (or planned projects) in the locality is not freely available, some information on the likely biodiversity impacts from recent projects is available as follows:

- The predicted impacts from the Northern Road Upgrade – Glenmore Parkway, Glenmore Park to Jamison Road, Penrith are anticipated at about 2.4 ha of remnant native vegetation and up to 3.9 ha of planted vegetation along the M4 Motorway (6.3 ha in total) (Jacobs, 2016a)
- The predicted impacts from the Northern Road Upgrade Narellan to Bringelly are anticipated at about 59.2 ha of native vegetation (SKM, 2012)
- The construction footprint of the M4 Managed Motorway project is anticipated to impact on about 31.25 ha of planted and remnant vegetation in various states of condition. This area of clearing includes 3.82 ha of remnant vegetation (Jacobs, 2015)
- The footprint of the Western Sydney Airport is predicted to impact on 280.8 ha of native vegetation (GHD, 2016).

When considered together, these projects combine to remove over 387 ha of remnant native vegetation from the Cumberland Plain. This is a large cumulative impact in terms of the over-cleared nature of the region. The planned industrial / employment lands in the South West Growth

Centres, realignment of transmission lines, provision of water pipelines, and the proposed M12 Motorway and other future orbital road links are also likely to add to the existing impacts.

It has been suggested that when a landscape reaches a vegetation retention threshold of ~30 per cent, most species would be lost from the ecosystem (McAlpine et al. 2002). With only 11 per cent of the original vegetation remaining in the Cumberland Plain Mitchell Landscape and all native vegetation classified as endangered or critically endangered, this landscape has passed a critical threshold for many species from which any further impacts are likely to result in detrimental and irreversible impacts.

Historic human activities including clearing for agriculture have resulted in the Cumberland Plain becoming a highly fragmented landscape. Most vegetation now occurs as small fragments in an agricultural setting of improved pasture and cropping with the only significant areas of native vegetation remaining in National Parks or Nature Reserves and Defence land. The project is likely to result in localised fragmentation of local wildlife corridors between The Northern Road and Willowdene Avenue where some intact habitat patches would be broken apart and the hard barrier introduced by the project would restrict fauna movement. When considered in the context of past habitat removal, the project, and any future projects would likely result in increases to landscape fragmentation where native vegetation is removed. The planned industrial / employment lands in the South West Growth Centres, realignment of transmission lines, provision of water pipelines, and the planned M12 Motorway and other future orbital road links are also likely to add to the existing impacts to these species

There is a chance of fauna mortality during the operational phase the project through vehicle collision (i.e. roadkill). Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly those common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roadways for movement pathways or as foraging habitat. As there are no definitive data on current rates of roadkill or fauna population densities in the study area, the consequences of historic and current vehicle strike on local populations is unknown. With the creation of a new road the risk of vehicle strike is increased. When considered in the context of past road development, the project, and any future road upgrade projects would likely result in increases to the incidence of roadkill. The planned M12 Motorway and other future orbital road links are also likely to add to the chance of vehicle strike impacts to local fauna population.

Cumulative impacts to matters of national environmental significance

While data from all recent projects (or planned projects) in the locality is not freely available, some information on the likely cumulative impacts to MNES is available.

The footprint of the Western Sydney Airport is predicted to impact on 90.8 ha of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community (CPSWSGTF) ecological community (GHD, 2016). This is considered likely to result in a significant impact to this critically endangered ecological community (CEEC) as it is likely to threaten the viability and persistence of the CEEC within the locality (GHD, 2016). The Northern Road Upgrade – Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith (Jacobs, 2016a) would not impact on any CPSWSGTF ecological community.

The M4 Smart Motorway project would impact 0.76 ha of the CPSWSGTF Forest ecological community (Jacobs, 2015). The Northern Road Upgrade from Narellan to Bringelly would result in removal of 48.5 ha of CPSWSGTF (SKM, 2012). The cumulative impacts of these four projects, along with the project itself, would result in a cumulative impact to this CEEC of over 156 ha. There is also likely to be ongoing impacts to this CEEC in the future which cannot be currently quantified. These cumulative impacts to this CEEC are considered to be significant cumulative impacts.

Recent projects in the locality have had an impact on the listed plant species *Pultenaea parviflora*. The construction footprint of the M4 Managed Motorway project is anticipated to result in the removal of one plant and about 2.41 ha of potential habitat (Jacobs, 2015). The Northern Road Upgrade – Glenmore Parkway, Glenmore Park to Jamison Road, Penrith is not predicted to impact on *Pultenaea parviflora* (Jacobs, 2016a).

Likewise, the Northern Road Upgrade from Narellan to Bringelly is not expected to impact on *Pultenaea parviflora* (SKM, 2012). The footprint of the Western Sydney Airport is predicted to impact on four *Pultenaea parviflora* plants and up to 221.3 ha of potential habitat (including good and poorer quality habitats) (GHD, 2016). Combined with the predicted impacts from the project, the cumulative impacts to *Pultenaea parviflora* is likely to be direct removal of eight plants (including the four plants to be impacted by the project) and up to 224.69 ha of potential habitat (including the 0.98 ha of habitat to be impacted by the project). When the potential impacts of the project on *Pultenaea parviflora* are considered in isolation, a significant impact to this species is considered unlikely. However, when the potential impacts to this species are considered in the context of other projects in the locality, the potential impacts to *Pultenaea parviflora* are likely to be significant and may lead to the long-term decline of this species in the locality. This is largely due to the extensive potential impacts to habitat from the development footprint of the Western Sydney Airport.

The project has the potential to remove about 24.41 ha of foraging habitat for the Grey-headed Flying-fox, Large-eared Pied Bat, Regent Honeyeater and Swift Parrot. Within the Cumberland sub-region, this potential habitat removal represents less than 0.1 percent of the currently available habitat for these species. These species do not breed in the study area so no impact to important breeding habitat is predicted. The project is not considered likely to reduce the population size of these four species. When the potential impacts of the project on habitat for these four listed fauna species are considered in the context of impacts from other projects, the impacts to potential habitat are more intense. The cumulative impacts to potential habitat for these four species from some known projects are as follows:

- The predicted impacts from The Northern Road Upgrade – Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith are anticipated at about 2.4 ha of remnant native vegetation and up to 3.9 ha of planted vegetation along the M4 Motorway (6.3 ha total) (Jacobs, 2016a). These four species may utilise this habitat on occasion
- The predicted impacts from the Northern Road Upgrade Narellan to Bringelly are anticipated at about 59.2 ha of native vegetation (SKM, 2012). These four species may utilise this habitat on occasion
- The construction footprint of the M4 Managed Motorway project is anticipated to impact on about 31.25 ha of planted and remnant vegetation in various states of condition. This area of clearing includes 3.82 ha of remnant vegetation (Jacobs, 2015). These four species may utilise this habitat on occasion
- The footprint of the Western Sydney Airport is predicted to impact on 120.6 ha of woodland (GHD, 2015). These four species may utilise this habitat and this level of impact to potential habitat for these four species is considered extensive.

When considered together, these projects combine to impact on over 214 ha of habitat for these four listed species from the Cumberland Plain (the project is predicted to impact on about 24.41 ha of habitat). This is a large cumulative impact in terms of the over cleared nature of the region. Given the area of habitat that would be lost from the cumulative impacts of these projects, and the context of the region, the potential cumulative impacts to the Grey-headed Flying-fox, Large-eared Pied Bat, Regent Honeyeater and Swift Parrot are likely to be significant.

The planned industrial / employment lands in the South West Growth Centres, realignment of transmission lines, provision of water pipelines, and the proposed M12 Motorway and other future orbital road links are also likely to add to the existing impacts to these species.

Impacts on ecosystem resilience

Ecosystem resilience is generally accepted to be the capacity of an ecosystem to recover from disturbance or withstand ongoing pressures. The potential cumulative impacts of vegetation clearing are discussed above and the impact of ongoing vegetation clearance from concurrent and recent projects in the region has been examined. However, with specific regard to ecosystem resilience, the combined effect of vegetation and habitat removal to the critically endangered

CPSWSGTF ecological community and EPBC Act listed species including the Grey-headed Flying-fox, Large-eared Pied Bat, Regent Honeyeater and Swift Parrot is likely to be detrimental.

It has been proposed that when a landscape reaches a vegetation retention threshold of ~30 per cent, most species would be lost from the ecosystem (McAlpine *et al*. 2002). With only 11 per cent of the original vegetation remaining in the Cumberland Plain Mitchell Landscape and all native vegetation classified as endangered or critically endangered, this landscape has passed a critical threshold for many species from which any further impacts are likely to result in detrimental and irreversible impacts. Due to the historic and ongoing impacts on the Cumberland Plain, ecosystem resilience is already poor. The ecosystems that are present, particularly the critically endangered CPSWSGTF ecological community, have collapsed into a state no longer representative of natural conditions and ecosystem processes have been irreversibly altered. The project would remove additional areas of vegetation, would introduce barriers to fauna movement and interrupt other ecosystem processes which would add further pressures on ecosystem resilience in the local area.

Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases is listed as a Key Threatening Process (KTP) under the EPBC Act and is relevant in the context of the project. The project would actively contribute to the functioning of this KTP. A detailed assessment of potential greenhouse gas (GHG) emissions during the construction and operation stages of the project is provided in Section 8.8 and Appendix Q.

Climate change is likely to have significant impacts on Australia's biodiversity in the next century due to likely responses to the predicted increases in atmospheric carbon dioxide concentration, increased temperature, changes to rainfall patterns, and sea level rise. Human-induced climate change by the emission of greenhouse gases is known to impact on plant and animal species. The response of organisms to future climate change (however caused) is likely to differ from that in the past because climate change is compounded by a landscape in which the distribution of natural vegetation communities and habitats has been highly modified by humans. This may limit the ability of organisms to survive climate change through dispersal (Department of Environment and Heritage, 2005). Pest species and some native species may be advantaged by climate change. Fire regimes may also change and affect the species composition and the structure of ecological communities (NSW Scientific Committee, 2000).

Species at risk include those with long generation times, poor mobility (sessile species), narrow ranges, specific host relationships, and isolated and highly specialised species (Busby & Pearman 1988). Changes in essential microhabitat conditions in areas that are fragmented from suitable habitats and/or are at the limit of a species' distribution could result in localised extinctions, affecting the recovery of threatened species.

The project involves the upgrade and realignment of an existing road to allow a greater number of vehicles to travel with greater efficiency. The potential impacts associated with this activity include GHG emissions associated with the construction of the upgrade and realignment, and the change in GHG emissions associated with its operation, in absolute and relative terms. Impacts associated with vegetation removal were not included as they do not trip the materiality threshold within CarbonGauge (clearance at 44.3Ha is less than 60 per cent of the total pavement area (801,985 m^2 for asphalt alone)) (Jacobs, 2016b).

Land clearance has been minimised through the design process. However, due to the nature of the project, it would contribute to loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases. Residual impacts from construction include impacts associated with the loss of carbon sink through removal of vegetation. Areas cleared for site compounds, and those associated with embankments are likely to be revegetated where appropriate. However, areas of removed vegetation that would be paved as part of the project would remain cleared. Whilst the removal of the carbon sink represents a one-off emissions event, there would also be a small ongoing loss of carbon sink as the removed vegetation would not be able to sequester carbon. This impact is relatively minor as the removed vegetation is mature forest and grassland, both of which have lower sequestration potential (than younger forest, or recently converted grassland).

Future projects including the planned industrial / employment lands in the South West Growth Centres, realignment of transmission lines, provision of water pipelines, and the proposed M12

Motorway and other future orbital road links are also likely to add to the existing impacts from land clearance. The footprint of the Western Sydney Airport is predicted to impact on 280.8 ha of native vegetation (GHD, 2016) which would contribute the most to loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases in the locality.

In the context of the study area, habitat for plant and animal species is likely to be altered by human-induced climate change and this would be compounded by the vegetation and habitat removal impacts of the project. Land suitability may change causing species to colonise new areas resulting in a shift in habitats. Impacts such as vegetation and habitat removal, fragmentation and isolation of habitats and the creation of barriers to dispersal are likely to compound the effects of climate change for threatened species.

Visual amenity, built form and urban design

The project's visual impact would be greatest in the proposed bypass sections, around the airport site and the village of Luddenham, where it would introduce a major six lane road formation into what is currently a (mostly) cleared rural landscape. However, given that the road itself would mostly be at ground level, the visual catchment for the new sections of road would be limited by topography and the natural screening afforded by vegetation.

Visually, the cumulative impact of all developments either planned or under way in and around the project's study area would be dominated, over time, by the changes to the landscape that would result from the development of the Western Sydney Airport at Badgerys Creek. The development of the airport, and the associated infrastructure, facilities, industry and services it would generate, would overshadow the project in the long-term.

Further, the planned construction of the M12 Motorway would also contribute significantly to changes in visual amenity and urban design in the vicinity of the project. The proposed M12 Motorway would be a new motorway-standard transport link about 15 – 17 km in length between the M7 Motorway and The Northern Road, on a mostly greenfield alignment. The preliminary M12 Motorway corridors are 300 m wide, though the final width of the motorway is expected to be less and would fall within the final corridor. A corridor of this width would itself result in a major visual change.

Air quality construction cumulative impacts

Dust and other emissions associated with construction activities would vary in intensity during construction of the project and would be influenced by the nature of construction activities occurring in specific locations. The greatest potential for cumulative effects would relate to other concurrent projects in close proximity to The Northern Road.

Construction activities such as clearing of vegetation and topsoil, excavation and levelling of soil, haulage of spoil and fill and wind erosion from unsealed surfaces and stockpiles could all contribute to degraded air quality if unmitigated.

However, cumulative construction impacts are unlikely to significantly vary from those discussed in Chapter 8.6 (Air Quality) following the application of mitigation and management measures adopted for this project.

Air quality operation cumulative impacts

As presented in the Western Sydney Airport Environmental Impact Statement, emissions of pollutants to air from airport operations (most notably NO2) are predicted to contribute to overall concentrations at surrounding nearby receivers. The potential for cumulative impacts between the roadway emissions and airport emissions is most likely to occur at a small number of receivers located along Adams Road, east of the proposed upgrade route. This is because of the prevailing wind conditions which are from the south-west. Contributions from The Northern Road would be minimal at these locations noting that they are more than 100 m from the proposed alignment.

Cumulative concentrations at these locations are therefore likely to be below the assessment criteria.

When winds blow from the southeast, which are generally uncommon but occur most frequently during summer, there is also the potential for short-term cumulative impacts at receivers located around Luddenham. As above, considering the distance to these receivers from the alignment of the proposed upgrade, contributions to overall concentrations at these locations would again be minimal, and resulting overall concentrations are likely to be below criteria.

Socio-economic construction cumulative impacts

Interaction with nearby projects during construction and operation may change the social impacts or benefits of the project.

During construction, potential cumulative impacts may be associated with:

- Prolonged duration of construction impacts, resulting in:
  - Extended periods of traffic disruptions for motorists, public transport users, pedestrians and cyclists
  - Commercial vehicle movements
  - Extended periods of impacts on amenity for communities in the study area, associated with increased noise, dust and traffic
  - Construction fatigue, particularly for communities closest to the construction works
  - Increase in construction traffic, associated with haulage of materials, plant and equipment for the various construction projects, impacting on community perceptions of safety
- Increased demand for construction workers, providing benefits for local workers.

As indicated in Section 7.4.3, an influx of construction workers in the study area associated with construction of various projects and potential increased demand for goods and services locally and regionally, may off-set in part, reduced trade for businesses in Luddenham town centre associated with reductions in traffic.

Acquisition of rural land for the project is also likely to further diminish the availability of land for agriculture in the study area and the wider region. Urban development, including residential and industrial developments and acquisition of land for the Western Sydney Airport has resulted in the loss of land available for agricultural purposes.

Completion of the realigned road corridor prior to construction for the Western Sydney Airport would support construction access to the airport. This would assist in minimising potential impacts on residents, businesses and facilities within Luddenham town centre associated with construction traffic for the airport. This would assist in reducing perceptions of safety associated with increased construction traffic through the town.

Socio-economic construction cumulative impacts

During operation, potential cumulative impacts would be associated with improved travel benefits for regional communities, business and industry, including freight, associated with the completion of the whole The Northern Road program of works.

Potential adverse cumulative impacts would generally be associated with changes in air quality or noise. These impacts have been addressed earlier in this EIS.

Mitigation measures would be implemented for each project to manage the impacts of the individual projects. Coordination between the various projects in the planning of major works and possible disruptions, if possible, would assist in minimising potential cumulative impacts.

9.3 Environmental management measures

Environmental management measures relating to cumulative impacts during construction and operation are provided in Table 9-8. Environmental management measures provided throughout Chapter 7 and Chapter 8 would also be key to minimising cumulative impacts related to The Northern Road Upgrade.

Table 9-8 Cumulative impacts environmental management measures

Impact	Ref #	Environmental management measures	Responsibility	Timing	Effectiveness of measures
Cumulative impacts	CI-1	Consultation would be undertaken with local communities potentially affected by the impacts of multiple projects in addition to the project.	Roads and Maritime / Construction Contractor	Construction	Expected to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	CI-2	Where relevant, consultation would be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	CI-3	Construction traffic management plans for this project should be developed in consultation with plans for these projects so that increased traffic on the local road network would be spread over the road network to ensure that construction traffic is not concentrated on any one particular route if there are alternatives available	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.

10 Sustainability

This chapter explains how sustainability principles relate to the design, construction, and operation of the project.

Table 10-1 sets out the Secretary's Environmental Assessment Requirements (SEARs) as they relate to sustainability and states where in this EIS these have been addressed.

Table 10-1 Secretary's environmental assessment requirements for sustainability

Secretary's requirement	Where addressed in EIS
a detailed description of the project including: • details of how the principles of ecologically sustainable development would be incorporated in the design, construction and ongoing operation phases of the project.	Section 4.4 Chapter 10 Chapter 13
• discussion of how the principles of sustainability have been incorporated into the assessment of the project	Consideration of resources usage and waste management and sustainability impacts is described in Section 8.7.

It is noted that although the project has been deemed a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), no specific Commonwealth assessment requirements in relation to sustainability have been issued in the Commonwealth EIS Guidelines for the project, however Section 3A of the EPBC Act outlines principles of ecologically sustainable development. The EPBC Act principles of ecologically sustainable development are summarised below.

a) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations

b) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation

c) The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations

d) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making

e) Improved valuation, pricing and incentive mechanisms should be promoted.

These principles have been considered and incorporated into the following assessment of sustainability.

10.1 What is sustainability

The most common definition of sustainability, from the World Commission on Environment and Development report *Our Common Future* is 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development,1987). Other definitions vary depending on the perspectives and specific needs of users but most definitions recognise that social and economic wellbeing is invariably linked to maintaining ecosystem health and preserving natural resources.

Well-functioning infrastructure is essential for sustained economic growth, international competitiveness, public health, and overall quality of life (Mirza, 2006). Infrastructure sustainability has recently been defined by the Infrastructure Sustainability Council of Australia (ISCA) as 'infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes over the long-term' (ISCA, 2016). However, this definition can only be made meaningful at the infrastructure project level by understanding and appreciating the specific project context. Considerations may include:

- The institutional setting and regulatory framework surrounding project development
- Opportunities and constraints associated with the physical project site
- The perspectives, needs and interests of key stakeholders
- Project timeframes, targets and objectives
- The life expectancy of the infrastructure asset.

Significant benefits can be achieved by integrating sustainability considerations early and throughout all project phases. Implementing sustainable practices can create cost savings, improve work efficiencies and increase the security of the resources we use. This is important for the road and transport industries in particular, which use large quantities of construction materials and consume large amounts of electricity and fuels to run their operations.

The benefits of early consideration of sustainability include:

- Infrastructure with a minimum environmental footprint that is relatively low maintenance, and uses materials that are durable and/or in plentiful supply locally
- Reduced project risks and costs
- Infrastructure that is sensitive to the surrounding environment and that contributes to the liveability of communities in NSW
- Infrastructure that is adaptable to future needs and better integrated with other transport modes such as cycling, walking and public transport
- Improved engagement with the construction supply chain to encourage more sustainable outcomes for the construction industry
- Better contingency planning for environmental issues
- Ease of movement through the sustainability component of the Transport for NSW framework for investment gating and assurance.

10.2 Project sustainability framework

The sustainability framework adopted for the project is based on the following documents:

- Transport Environment and Sustainability Policy Statement (TfNSW, 2013)
- Transport Environment and Sustainability Policy Framework (TfNSW, 2013a)
- Roads and Maritime Environmental Sustainability Strategy 2015-19 (RMS, 2016)
- Roads and Maritime Environmental Technical Guide - Sustainability in infrastructure design and construction (RMS, 2016a)
- The Northern Road Upgrade, Mersey Road to Glenmore Parkway Draft Sustainability Policy and Sustainability Strategy (see Section 10.3.1).

The *Transport Environment and Sustainability Policy Statement* explains that NSW transport agencies are committed to delivering transport services, projects, operations and programs in a manner that balances economic, environmental and social issues to ensure a sustainable transport system for NSW. The statement indicates that this is to be achieved by:

- Enabling development, expansion and management of the transport network to be carried out in a sustainable way, resilient to climate change
- Minimising the impacts of transport on the environment, encompassing transport operations, infrastructure delivery and maintenance and corporate activities
- Enhancing the quality of life for transport customers by procuring, delivering and promoting sustainable transport options.

The companion *Transport Environment and Sustainability Policy Framework* (TfNSW, 2013a) presents a collective and coordinated approach to deliver the NSW Government's environmental and sustainability agenda across transport agencies.

The *Roads and Maritime Environmental Sustainability Strategy 2015-19* (RMS, 2016) is Roads and Maritime's commitment to embed sustainability considerations into their business and minimise their environmental footprint and deliver positive economic outcomes for the people of NSW. The approach to drive sustainability in the document outlines nine key focus areas that deliver on the strategic priorities and that are aligned with the *Transport for NSW Environment and Sustainability Framework*. The supporting *Roads and Maritime Environmental Technical Guide - Sustainability in infrastructure design and construction*, has been developed to assist Roads and Maritime staff and contractors embed sustainability considerations in the planning, development and delivery of road and maritime infrastructure. It sets out:

- What sustainability means within the context of infrastructure design and construction
- Roads and Maritime sustainability principles and objectives
- Key considerations at each project phase from initiation through to finalisation and decommissioning
- Practical guidance and examples of initiatives (sustainability initiatives) that would assist achieve Roads and Maritime sustainability objectives. The sustainability framework for the project is illustrated in Figure 10-1.

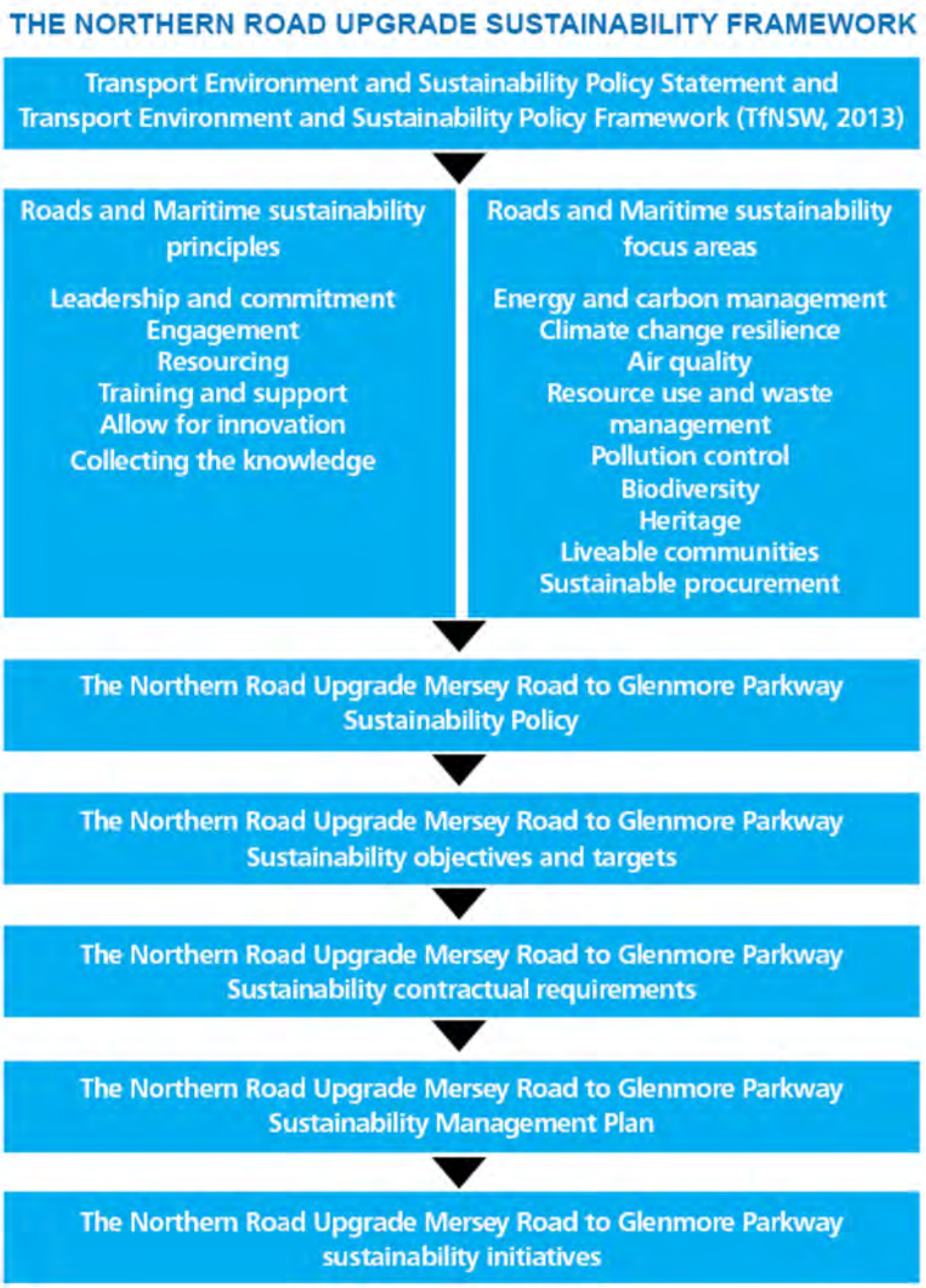

Figure 10-1 Transport Environment and Sustainability Policy Framework

10.3 Project sustainability strategy

The project sustainability strategy describes how sustainability will be integrated into the design, construction and operation of the project. The strategy has been prepared to align with the TfNSW *Transport Environment and Sustainability Policy Framework* and the *Roads and Maritime Roads and Maritime Environmental Sustainability Strategy*. The project's sustainability strategy was developed in collaboration with the design teams for each stage of the project, key members of the

EIS Team (see Appendix S) and the Roads and Maritime project management team (including the environment, community and procurement personnel).

Sustainability questionnaires for both the design and delivery phases of the project were developed to prompt the relevant teams to consider potential sustainability initiatives that have been, or could be considered and implemented. These questionnaires were developed in accordance with the *Roads and Maritime Technical Guide Sustainability in infrastructure design and construction*.

10.3.1 Project sustainability policy

The sustainability strategy includes a Draft Sustainability Policy which identifies the overarching commitments to the principles of sustainability. It is the primary document for setting the project direction on sustainability matters that the project team has committed to following.

The Northern Road Upgrade, Mersey Road to Glenmore Parkway Draft Sustainability Policy

Roads and Maritime The Northern Road project team is committed to:

- Sustainability leadership and continual improvement
- Integrating governance, environmental, social and economic considerations into decision-making processes within the project
- Enhancing positive environmental, social and economic outcomes wherever possible, while minimising adverse impacts, resource use and embodied impacts.

These commitments would be met by:

- Establishing sustainability objectives and targets, aligned to TfNSW and Roads and Maritime sustainability policy
- Embedding sustainability requirements within key roles, contracts and procurement criteria
- Influencing and partnering with contractors, subcontractors and suppliers to adopt sustainable practices
- Monitoring and reporting on performance against sustainability objectives
- Implementing corrective actions where required and sharing lessons learnt
- Periodically reviewing and evaluating sustainability policy and management systems to ensure continual improvement
- Providing a safe and accessible road integrated into the urban environment and transport system
- Establishing positive relationships with the community through ongoing and open engagement
- Providing local training, education, apprenticeships and employment opportunities
- Protecting and promoting cultural heritage, community health and wellbeing
- Proactively managing environmental and heritage resources
- Minimising energy, water, materials use and waste through the Project life-cycle
- Building in resilience to potential climate change impacts
- Minimising land take requirements
- Minimising pollution and environmental harm.

All staff involved in the delivery of the project have shared responsibility to actively contribute to the achievement of this policy.

10.3.2 Sustainability focus areas, objectives and targets

The sustainability strategy includes a set of project focus areas, objectives and targets to deliver on the commitments of the sustainability policy.

Project focus areas

The project sustainability strategy identifies 11 high level overarching sustainability focus areas to deliver on the commitments of the sustainability policy. These include the nine focus areas provided in the Roads and Maritime sustainability strategy and two additional focus areas, 'Leadership and continual improvement' and 'Workforce' which address the guiding principles provided in the Roads and Maritime sustainability strategy (refer to Figure 10-1).

Project objectives

The objectives identify the overarching aims to be realised under each focus area. The objectives align to the Roads and Maritime sustainability strategy as appropriate. The objectives are supported by a hierarchy of targets and initiatives to achieve these aims.

Project targets

The project targets constitute actions to achieve the sustainability objectives of the project. The targets provide a measurable and verifiable framework to drive and track the project's sustainability performance. The targets have been developed through a review of:

- Current project design and key project objectives
- Roads and Maritime Technical Guide: Sustainability in Infrastructure Design and Construction (Roads and Maritime, 2016)
- A review of sustainability certification frameworks such as ISCA
- Industry best-practice
- Draft Transport for NSW Social Procurement Workforce Policy.

The sustainability targets for the project are presented in Table 10-2. These targets were reviewed and agreed at a sustainability workshop held on the 27 February 2017 with representatives from Roads and Maritime project team, Roads and Maritime sustainability team, relevant design teams and EIS project team members.

Targets constitute benchmarks to be verified through documentary evidence as the project progresses. The targets may be refined as the project scope and design develops.

Project initiatives

Project initiatives identify activities that can contribute towards project targets and objectives. Initiatives have been identified through a review of:

- Current project design and assessment
- Roads and Maritime Technical Guide: Sustainability in Infrastructure Design and Construction (Feb, 2016)
- Questionnaire responses provided by the project design and delivery teams.

The initiatives recorded on a live tracking resister and can be categorised into:

- Initiatives that have already been incorporated into the project design
- Initiatives that will be incorporated into later project stages (design, construction or operations).

Table 10-2 The Northern Road Upgrade, Mersey Road to Glenmore Parkway sustainability strategy

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
Leadership and continual improvement Align the project with TfNSW and Roads and Maritime sustainability policies Embed sustainability into decision making, contracts and processes Monitor sustainability performance Share sustainability knowledge and lessons learnt Support culture of continuous improvement	Appoint a Sustainability Manager with relevant experience to drive the achievement of sustainability outcomes on behalf of Roads and Maritime.	Roads and Maritime has committed to appointing a Sustainability Manager to drive the achievement of sustainability outcomes during design and construction phases. During the remaining design and construction phases, knowledge and lessons learned would be shared across the component projects through participation at regular sustainability workshops. Quarterly project progress reports and an annual Sustainability Report would be prepared during the construction phase. Lead contractors would be required to achieve ISO14001, ISO9001 and AS/NZS4801 accreditation and to appoint a Sustainability Representative to drive and report on sustainability performance.
	Contractor to appoint a Sustainability Representative with relevant experience to drive the delivery of sustainability outcomes.	
	Conduct quarterly sustainability meetings during remainder of detailed design and construction phases.	
	Prepare a Construction Sustainability Management Plan to embed project sustainability objectives, commitments and targets into the project delivery management systems.	
	Prepare quarterly reporting of performance against sustainability targets during construction.	
	Conduct annual reporting to RMS Senior Management and DPE and DoEE against sustainability targets.	
	Achieve ISO14001, ISO9001 and AS/NZS4801 accreditation of the project management systems.	

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
Energy and carbon management Minimise energy use and reduce greenhouse gas emissions without compromising the delivery of services to our customers.	Prepare a greenhouse gas assessment during design covering Scope 1 and Scope 2 emissions and land clearing as a minimum, for the infrastructure lifecycle of the asset (construction and operation).	A greenhouse gas assessment has been carried out for the project using the 'Carbon Gauge' tool (refer to Section 8.8 of this EIS). Scope1,2 and 3 emissions were calculated for the construction and operational stage and mitigation measures proposed. The project design has aimed to reduce operational road traffic emissions by supporting the free flow of traffic by: • Widening the existing road between Glenmore Parkway and Littlefields Road to reduce congestion • Reducing the extent to which the road changes grade • Limiting the number of intersections and turning lanes at which traffic needs to stop and start • Supporting free flowing intersections with other major roads (such as the M12) • Providing improvements to public and active transport facilities, promoting sustainable and efficient journeys. At least six per cent of construction energy required for the project would be sourced where possible from an accredited GreenPower energy supplier. A project-specific design stage Energy Management Plan and a *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared to identify and implement further energy and carbon saving opportunities for example: • Use of LED and low energy equipment for signals and signage • Consideration of options for installation of renewable energy generation (small scale wind or solar photovoltaics) to power electronic equipment • Use of biofuels in construction plant and equipment • Use of GreenPower • Construction workforce travel plans. Whole of life costing would be used to identify opportunities with a
	Prepare an Energy Management Plan to identify and implement design stage energy saving opportunities.	
	Prepare an Energy Management Plan to identify and implement construction stage energy saving opportunities.	
	Prepare a workforce travel plan to reduce travel emissions.	
	Implement a range of opportunities with a financial payback of four years or less.	
	Source a minimum of 10 per cent of electricity from renewable energy generated onsite and/or accredited GreenPower during construction – only when connected to the grid.	
	Source a minimum of 10 per cent of electricity from renewable energy generated onsite and/or accredited GreenPower during operation – only when connected to the grid.	

Sustainability focus area and objectives	Sustainability targets		Alignment of this proposal
			financial payback of four years or less.
Climate change resilience Design and construct transport infrastructure to be resilient to climate change impacts	Prepare climate change risk assessment to identify risks over the life of the asset		A climate change risk assessment has been conducted for the concept design (refer to Section 8.8 of this EIS). Risks to the operation and maintenance of the project have been identified. No high or extreme risks were identified. Five medium risks were identified relating to: • Conducting maintenance in extreme heat • More severe extreme flood events • Increase in the frequency and intensity of severe rainfall events • More severe fire weather and elevated fire weather conditions • Increased concentration of carbon dioxide in the atmosphere. Mitigation measures have been identified in the climate change risk assessment to address these medium risks and would be considered during project design and construction. Separate systems are to be used for drainage of each carriageway to reduce peak runoff volumes during storm events.
	Identify and implement adaptation measures to mitigate all high and extreme residual climate change risks		
	Stretch target: Identify and implement adaptation measures to mitigate all medium residual climate change risks		
Air Quality Minimise the air quality impacts of road projects and support initiatives that aim to reduce transport related air emissions.	Aim for no recurring or major exceedances of air quality objectives at construction and operation.		Air quality mitigation measures outlined in the EIS have been developed to specifically manage potential construction related impacts (refer to Section 8.6 of this EIS). Air quality monitoring and reporting requirements would be incorporated in the CEMP to confirm effectiveness of measures. Contractors would be required to report on compliance with air emissions standards for mobile non-road diesel plant and equipment as per the NSW Government Resource Efficiency Policy.
	Report on and aim to achieve compliance with air emissions standards for mobile non-road diesel plant and equipment as per the NSW Government Resource Efficiency Policy.		
Resource use and waste management	Materials	Prepare a Resource Use and Waste Management Plan to identify and implement	Recycled products would be used during construction of the project to reduce the demand on resources, in instances where the use of such materials is cost and performance competitive. This

Sustainability focus area and objectives	Sustainability targets		Alignment of this proposal
Minimise the use of non-renewable resources and minimise the quantity of waste disposed to landfill.		opportunities to minimise embodied impacts.	may include the use of fly ash and slag within concrete mixes. Resource recovery principles would be applied to the construction of the project, including recovery of resources for reuse, recycling and reprocessing, where possible.
		Best endeavours to target at least ten per cent of cement replacement material (measured by mass) used in concrete, whilst maintaining current quality and whole-of-life costs.	
		Best endeavours to target at least ten per cent of recycled material used in road base and sub-base, whilst maintaining current quality and whole-of-life costs.	
		Source at least 80 per cent of steel used in construction from suppliers certified under Australian Certification Authority for Reinforcing Steels or similar international association or organisation.	
	Water use	Estimate potable water use, and identify opportunities to reduce water use during construction and operation (excluding Sydney Water main relocation activities).	A water balance would be prepared during the detailed design stage of the project. The outcomes of this study would be used to improve water efficiency throughout construction and operation of the project. The water balance would be updated during construction. Water efficiency measures would be implemented with a focus on achieving water savings and targeting water recycling and re-use.
		Implement a range of water saving opportunities with a financial	

Sustainability focus area and objectives	Sustainability targets		Alignment of this proposal
		payback of four years or less.	During construction, non-potable water sources would be given preference over potable sources where appropriate. Rainwater would be harvested on-site at construction compounds and re-used as part of the project where possible. The extent to which non-potable water can be used during the project would be reviewed and refined during detailed design. Construction water would either be re-used on site wherever feasible, or discharged into the local stormwater system in accordance with the requirements of an Environment Protection Licence. Preference would be given to reusing as much water as is practicable before discharging.
		Source at least 15 per cent of non-potable water use (e.g. dust suppression, concrete mixing) from non-potable sources.	
		Use rainwater and/or stormwater to provide passive irrigation to all tree plots and vegetated areas.	
		Monitor and report water use during construction.	
	Waste	Prepare construction Waste Management Plan following waste hierarchy principles.	Waste generating activities and waste streams associated with construction and operation of the project have been identified in Section 8.7 of this EIS. A project-specific *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared before construction and would include procedures for the identification, handling, disposal and reporting of waste, with a focus on waste and packaging reduction and recycling. Further details are provided in Table 8-43 of this EIS. As part of the concept design, opportunities have been identified for prefabrication of box culverts, super-T bridge beams, W-Beam and wire rope safety fence, lighting columns. This will be further investigated during detailed design.
		Reuse/recycle a minimum of 85 per cent of construction and demolition generated materials (uncontaminated) (diversion from landfill).	
		Implement packaging take-back arrangements with suppliers.	
	Spoil	Reuse/recycle a minimum of 90 per cent of usable spoil (uncontaminated surplus	Grading of The Northern Road has been undertaken with the intent to balance earthworks while still considering other constraints e.g. property access, side streets, utilities and flood immunity.

Sustainability focus area and objectives	Sustainability targets		Alignment of this proposal
		excavated material).	Temporary ancillary facilities would provide areas for stockpiles during construction of the project. Where possible and fit for purpose, spoil would be beneficially reused within the project before off-site reuse of disposal options is pursued.
		Incorporate sufficient storage areas and identify opportunities for reuse within reasonable transport distances.	
	Land	Minimise land use and acquisition as far as practicable.	The project has been designed to make efficient use of land by utilising the existing transport corridor where possible, minimising acquisition of private properties and maximising use of government land. Where new road corridor is proposed, the route options process has sought to minimise the impacts of the project on residential and agricultural land and ecologically sensitive areas. Socio-economic and land use impacts and proposed mitigation measures are described in Section 7.4. The design has sought to reduce land use through: • Narrowing the road median • Consideration of 1:2 batters instead of 1:4 batters to minimise land take on Commonwealth land. • Using the road shoulder with minimal widening to provide a bus lane. Co-ordination of design with adjacent stages is occurring to assist design packages tie in correctly to avoid material wastage and rework.
		Restore all disturbed land not required for operational phase.	
Pollution control Minimise noise, water and land pollution from road and maritime construction,	Aim for no recurring or major exceedances of water discharge or water quality goals during construction and operation.		The management of pollution, emissions, hazardous materials and pavement run-off are outlined in the EIS. Water quality control measures include the provision of temporary sediment basins during construction and operational water quality swales for operation.
	Aim for no recurring or major exceedances of		

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
operational and maintenance activities.	air quality objectives during construction and operation. Adopt noise mitigation measures where reasonable and feasible.	A Noise and Vibration Impact Assessment, conducted as part of EIS, considered noise reduction techniques including: • Road gradient modifications – Road gradients have been reduced where feasible. • At source mitigation • At-property treatments
Biodiversity Improve outcomes for biodiversity by avoiding, mitigating or offsetting the potential impacts of road and maritime projects on plants, animals and their environments.	Prepare a Flora and Fauna Management Plan to avoid and proactively manage any impacts to flora and fauna in accordance with the Roads and Maritime Biodiversity Guidelines. Offset biodiversity impacts and promote regeneration of local native vegetation communities.	Biodiversity impacts were identified early and considered in route options development. A biodiversity assessment has been prepared in accordance with the *Framework for Biodiversity Assessment* and the *NSW Biodiversity Offset Policy for Major Projects*. This considers measures to avoid and minimise impacts to biodiversity in a biodiversity assessment report (BAR), and the preparation of a biodiversity offsets strategy (BOS) to offset residual impacts. Project impacts would be managed in accordance with the Roads and Maritime Biodiversity Guidelines. Additional detail is provided in Section 7.6, and **Appendix I**.
Heritage Ensure cultural heritage is conserved and managed according to its heritage significance and that it contributes positively to awareness of the past	Prepare a Cultural Heritage Management Plan to avoid and proactively manage any impacts to Heritage items.	Heritage constraints were identified early and considered in route options development. Impacts to heritage items have been avoided and mitigated where practicable and management measures to be implemented throughout construction of the project have been provided. An assessment of potential impacts and proposed mitigation and management measures with regards to Aboriginal and non-Aboriginal heritage are provided in Section 8.3 and Section 8.4 respectively. Aboriginal stakeholders have been consulted regarding the mitigation plan and ongoing Cultural Heritage Management Plan to ensure upfront agreement regarding impacts to Aboriginal heritage and appropriate management of Aboriginal heritage.

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
Liveable communities Provide high quality urban design outcomes that contribute to the liveability of communities in NSW.	Establish and implement appropriate community engagement strategy.	The project would contribute to reducing congestion on the existing road, cater for future travel demand, improve transport connections to planned developments, improve safety and improve facilities for public and active transport. Design initiatives for the project include: • Provision of additional lanes to cater for existing and future traffic demand • Upgrades to intersections to reduce congestion and likelihood of collisions • Incorporation of Intelligent Transport Systems (ITS) infrastructure which would provide information on traffic conditions and incidents to road users • Removal of opposing-lane overtaking and the associated risk of head-on crashes. • Provision of off-road shared pathway to improve safety for pedestrians, cyclists and motorists • Provision of dedicated southbound and northbound bus lanes • Upgraded bus stops and supporting possible new bus routes have been provided • Shared path provided along the western side of the upgrade and a footpath along the eastern side as required. The bypass of Luddenham town centre would result in The Northern Road moving away from homes, businesses and facilities in the Luddenham town centre, reducing through traffic, including heavy vehicles, within the town centre. This would reduce traffic noise and improve local air quality, impacting positively on local amenity and the public domain within the town. A reduction in through traffic would also support an improved pedestrian environment and safer and improved access for pedestrians, cyclists and motorists within the town centre and to adjoining areas, further improving local amenity in the town.
	Prepare urban design and landscape plan.	
	Improve customer journeys and road safety through design.	
	Improve facilities for public and active transport to promote sustainable and efficient journeys.	
	Consider future community needs in design	

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
		Extensive community consultation has been carried out for the project in selecting preferred project as detailed in Section 6 of this EIS. A Landscaping and Urban design is being prepared for the project in accordance with Roads and Maritime policy and guidelines.
Sustainable procurement Procure infrastructure, goods and services that over their lifecycle deliver value for money and contribute to the environmental, social and economic wellbeing of the community.	Prepare a sustainable procurement plan for the project for matters covered by the sustainability strategy goals and targets. Incorporate sustainability criteria into project contracts and tender evaluation criteria. Monitor sustainability performance (objectives / targets / indicators) of key suppliers (contracts >$1,000,000 in total).	A sustainable procurement plan would be prepared for the construction tender process of the project. Sustainability targets and sustainability requirements would be built in to supplier and subcontractor contracts as appropriate, and procedures established for managing non-compliance. Due to the complexity of construction supply chains, engagement activities would focus particularly on those sourcing categories and suppliers that are high risk or have a high material impact, including: materials (concrete and steel), fuel, electricity and workforce development (see below).
Workforce Facilitate economic prosperity and development and provide a resilient local workforce.	Prepare a sustainable workforce plan in accordance with draft *TfNSW Social Workforce Procurement Policy and Social Procurement Workforce for Major Projects.* Achieve NSW Government for Infrastructure projects Social Procurement Workforce targets (Infrastructure Skills Legacy Program) where feasible: • 20 per cent of the total labour force of a project to be made up of 'learning workers' (defined as trainees and workers who need to update their qualifications to meet the needs of the infrastructure project) • 20 per cent of all trades positions on a	A Training Management Plan would be prepared before construction, detailing initiatives to maximise employment and training opportunities (including apprenticeships/traineeships/structured training), in particular for young people, disadvantaged groups, Aboriginal and Torres Strait Islanders, the unemployed and locals. An Aboriginal Participation Plan would be prepared before construction, detailing initiatives to improve Aboriginal and Torres Strait Islander participation in construction of the project and provide opportunities to Aboriginal and Torres Strait Islander enterprises during the design and construction phases.

Sustainability focus area and objectives	Sustainability targets	Alignment of this proposal
	project to be made up of apprentices • 2 per cent of women in trade-related work • 1.5 per cent of the total contract value of a project to support Aboriginal participation • 8 per cent of the total project workforce aged less than 25 years • Strategies to ensure projects employ and train people from the local region.	

10.4 Ecologically sustainable development

Ecological Sustainable Development (ESD) has been given statutory recognition in the EP&A Act (as defined in the EP&A Regulation) and the *Environment Protection and Biodiversity Act 1999* (EPBC Act). Simply defined, ESD is development which aims to meet the needs of people today, while conserving our ecosystems so that future generations can meet their needs.

The EP&A Regulation and the EPBC Act emphasise the need for effective integration of economic and environmental considerations in decision-making processes and set out the following ESD principles

The precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

- Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
- An assessment of the risk-weighted consequences of various options.

Inter-generational equity – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Conservation of biological diversity and ecological integrity – that conservation of biological diversity and ecological integrity should be a fundamental consideration.

Improved valuation, pricing and incentive mechanisms – that environmental factors should be included in the valuation of assets and services, such as:

- Polluter pays - those who generate pollution and waste should bear the cost of containment, avoidance or abatement
- The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
- Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

The way these four tenets of ESD have been recognised and applied during the development and assessment of the project is considered below.

10.4.1 Precautionary principle

The precautionary principle deals with certainty in decision-making. It provides that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

The precautionary principle has been applied during the design and development of the project. Potential environmental impacts associated with the project were considered in the alternatives and options analysis carried out for the project. This included identifying opportunities to avoid and minimise surface disturbance, and potential impacts to threatened and endangered ecological communities and species (refer to Chapter 4 Project development and alternatives).

The threat of serious or irreversible environmental damage is one of the essential preconditions to the engagement of the precautionary principle. This EIS has identified a number of environmental impacts associated with the project and the environmental management measures that would mitigate those impacts during construction and operation. Implementation of the identified environmental management measures would result in acceptable residual impacts and no

significant likelihood of serious or irreversible environmental harm. In addition, impacts to threatened ecological communities and threatened fauna as a result of construction and operation of the project would be offset in accordance with the biodiversity offsets policy.

10.4.2 Inter-generational equity

Clause 7(4) of Schedule 2 of the EP&A Regulation 2000 provides that the principle of inter-generational equity is, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

For road projects, the environmental aspects that are most relevant are waste and resources, socio-economics, biodiversity, water quality, air quality, climate change and cumulative impacts. Table 10-3 considers these matters.

Table 10-3 Intergenerational equity considerations

Theme	Scope
Waste and resources	The resource demand and waste generation associated with the project would be short-term (mostly limited to the construction phase) and are not of a scale that is likely to affect the access of future generations to resources or waste disposal sites.
Socio-economics	The project would require some property acquisition which would affect residents and businesses. During operation the project would provide improved access and connectivity, travel time savings, better travel time reliability and savings in transportation and vehicle operating costs. Future generations would not be affected by the small amount of property acquisition required. They would however benefit from the operation phase benefits of the project including the economic benefits and improved accesses for business.
Biodiversity	The project would have a significant impact on ecological communities and their habitats. Up to 39.61 ha of remnant native vegetation including vegetation constituting threatened ecological communities as listed under the TSC Act and EPBC Act would be cleared. Preliminary route options assessments were undertaken to minimize this amount where possible. Calculations provided in this EIS for vegetation clearing are to be used as the basis of offsetting the impacts identified to threatened ecological communities. The Biodiversity Offset Strategy addresses residual impacts that cannot be mitigated.
Water quality	During operation the main potential impact to water quality would be spills and runoff from the road surface containing pollutants such as heavy metals, brake dust, hydrocarbons and rubber particles. Any spills would be remediated. Residual impacts would only have a minor effect on the quality of the environment for future generations (refer to Section 8.2). Construction impacts would be short-term and minor given the standard mitigations employed.

Theme	Scope
Air quality	During operation the project would result in small changes to air quality, which in most cases would represent an improvement (refer to Section 8.6). Future generations would benefit from these air quality improvements
Climate change	Sources of greenhouse gas emissions during the construction and operation of the project have been identified and quantified. Measures have been proposed to minimise these emissions (refer to Section 8.8). The potential effects of climate change have been considered as part of the drainage design.
Cumulative impacts	Potential cumulative impacts of the project have been assessed (refer to Chapter 9). Construction and operational impacts would be expected as a result of the project however with appropriate use of the mitigation measures outlined in this EIS the impacts of those impacts are not expected to be significant.

10.4.3 Conservation of biological diversity and ecological integrity

The twin principles of biodiversity conservation and ecological integrity have been a fundamental consideration during the course of the design and assessment process with a view to identifying, avoiding, minimising and mitigating impacts.

The construction of the project would affect up to 39.6 ha of remnant native vegetation including vegetation constituting threatened ecological communities as listed under the TSC Act and EPBC Act. In addition, the project would impact on a threatened plant species (TSC Act and EPBC Act) and a threatened population (TSC Act) (refer Section 7.3).

Potential impacts on threatened fauna were also assessed as not likely to be significant. These impacts relate to disturbance and removal of potential habitat.

Despite avoidance and mitigation measures to minimise impacts to biodiversity, residual impacts from the clearing of threatened ecological communities and threatened species as a result of the construction and operation of the project are considered to be significant and would require offsetting.

In accordance with the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014), the required offsets for the project have been calculated using the FBA methodology and the BBCC. A summary of the biodiversity offset credits required for the project is presented in Section 7.3 and the Biodiversity Offset Strategy (BOS) (Appendix I).

10.4.4 Improved valuation and pricing and incentive mechanisms

The principle of internalising environmental costs into decision making requires consideration of all environmental resources which may be affected by a project, including air, water, land and living things. While it is often difficult to place a reliable monetary value on the residual, environmental and social effects of a project, the value placed on environmental resources within and around the corridor is evident in the extent of environmental investigations, planning and design of impact environmental management measures to prevent adverse environmental impacts as identified in this EIS.

Costs associated with the planning and design of measures to avoid / minimise adverse environmental impacts and the costs to implement them have been included in the overall project costs and cost benefit analysis carried out. Upfront capital costs would be provided by a combination of funding by the NSW and Commonwealth Governments.

10.4.5 Section 3A of the EPBC Act

Section 3A of the EPBC Act outlines principles of ecologically sustainable development that have been considered throughout all phases of the project design and assessment as discussed below.

a) Decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations.

The potential for long-term and short-term impacts of potential alternatives to the project has been considered throughout route options development. During route options development (refer Section 4.4), a proactive approach to identifying and avoiding potential impacts associated with the project by:

- Carrying out preliminary environmental assessment early to inform the route options process
- Establishing environmental goals for the project
- Avoiding or minimising ecological impacts to vegetation communities and avoiding other areas of high sensitivity
- Avoiding where possible areas of cultural heritage significance
- Collating and considering environmental data and impacts for the different alternatives and options. Route option assessment criteria (MCA) included environmental criteria such as impacts on biodiversity and Aboriginal heritage.

The assessment provided in this EIS has, where required, identified where potential impacts are either long-term or short-term and these impacts have been weighed up against the overall benefits of the project

a) If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

This principle is otherwise known as the precautionary principle.

b) The principle of inter-generational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.

The principles of inter-generational equity and how they have been considered throughout the project are discussed in Section 10.3.2. Furthermore, how the principles of inter-generational equity were considered during route options assessment is outlined in Section 4.4.

c) The conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making.

The conservation of biological diversity and ecological integrity is discussed in Section 10.3.3. Furthermore, how the principles of inter-generational equity were considered during route options assessment is outlined in Section 4.4.

d) Improved valuation, pricing and incentive mechanisms should be promoted.

The principle of improved valuation, pricing and incentive mechanisms is discussed in Section 10.3.4. Furthermore, how the principles of inter-generational equity were considered during route options assessment is outlined in Section 4.4.

11 Environmental risk analysis

This chapter explains how environmental issues for the project were identified and evaluated through an environmental risk analysis process. It also provides a summary of the environmental risk analysis results. The relevant Secretary's Environmental Assessment Requirements (SEARs) for this chapter are provided in the table below.

Table 11-1 Secretary's environmental assessment requirements for environmental risk analysis

Secretary's requirement	Where addressed in EIS
Environmental Risk Analysis Notwithstanding the above assessment requirements, the EIS must include an environmental risk analysis to identify potential environmental impacts associated with the proposal (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EIS.	Chapter 11

11.1 Overview

Before lodging the application for project approval, Roads and Maritime reviewed the outcomes of preliminary investigations and community and stakeholder consultation and identified those environmental issues of most importance for the project through a preliminary environmental risk analysis.

The findings formed the basis of Roads and Maritime's project application, and helped the Secretary formulate the 'key issues' for the project as outlined in the SEARs. As required by the SEARs, the process of environmental risk analysis continued during the course of preparing the environmental assessment. The emphasis was on using the detailed information gathered during the assessment process to review the environmental aspects of the project. More specifically, the analysis:

- Identified environmental issues, including key issues in the SEARs, and any other issues
- Examined potential impacts and proposed mitigation measures in relation to the identified issues
- Identified the nature and extent of impacts likely to remain after mitigation measures are applied.

Based on this analysis, an environmental risk category was assigned to each potential impact. This enabled the identification of any matters that might be considered as additional key issues, and provided a basis for an appropriately detailed assessment of these additional key issues in this environmental assessment.

The project has the potential to significantly impact on MNES including EPBC listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest and also significantly impact upon areas of Commonwealth Land associated with the Defence Establishment Orchard Hills (DEOH) and land purchased by the Australian Government for the Western Sydney Airport.

Accordingly, the project was referred to the then Australian Government Department of the Environment (now Department of the Environment and Energy) on 13 May, 2016. On 21 July, 2016,

the Federal Minister for the Environment and Heritage decided that the project has the potential to significantly impact on MNES and Commonwealth Land and is therefore a 'controlled action'.

The environmental risk categories are described in Table 11-2.

Table 11-2 Environmental risk categories

Risk category	Description
Key Issue	High or moderate impact (actual or perceived) requiring further investigation to identify specific management and mitigation measures.
Other issue	Moderate or low impact that can be managed effectively with standard and best practice management and mitigation measures.

11.2 Environmental risk analysis results

A summary of the environmental risk analysis results is provided in Table 11-3. The results of the environmental risk analysis did not identify any key environmental impacts additional to those identified in the SEARs. None of the additional environmental issues assessed for the project were considered to constitute key issues.

Table 11-3 Environmental risk analysis

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
Traffic and transport	**Yes**			**Key issue**	**Section 7.1**
		Construction impact: Potential for safety impacts, due to temporary road arrangements or the proximity of construction activities to general traffic. *Mitigation:* Traffic control plans would address safety risks and would be incorporated in the Construction Traffic Management Plan developed, for the project.	Safety measures would address safety risks for construction workers and motorists. With mitigation, residual safety risks are expected to be minor.		Section 7.1.3 outlines potential construction impacts A summary residual impacts is presented in Section 7.1.7
		Construction impact: Temporary impacts to The Northern Road and surrounding local roads (disruptions and delays) due to reduced speed limits, increased truck and construction machinery movements and temporary traffic management procedure. *Mitigation:* Measures to manage construction related delays as part of the Construction Traffic Management Plan.	Minor and temporary delays may and increased travel times associated with reduced speed limits and additional construction vehicles.		Section 7.1.3 outlines potential construction impacts A summary of residual impacts is presented in Section 7.1.7
		Construction impact: Potential for cumulative traffic impacts due to concurrent construction with other The Northern Road upgrade projects or other nearby developments. *Mitigation:* Coordination between the various	Minor and temporary delays may and increased travel times associated with reduced speed limits and additional construction vehicles.		Section 9.2 outlines potential cumulative impacts associated with traffic and transport

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		projects in the planning of major works to schedule construction activities in a way that minimises traffic disruption.			
		Operational impact: Changes to property access due to the provision of a wide central median that would remove existing right turns at some intersections and property accesses. *Mitigation*: Consultation with the community and affected property owners.	Longer travel distances and times for trips for those affected by changed access arrangements would be a minor adverse impact		Section 7.1.4 outlines potential operational impacts A summary of residual impacts is presented in Section 7.1.7
		Operational impact: Improved future traffic performance along The Northern Road and intersections providing travel time saving and increased capacity.	Travel speeds and intersection performance are expected to improve providing s travel time savings for traffic compared to the Do-minimum scenario.		Section 7.1.4 outlines potential operational impacts A summary of residual impacts is presented in Section 7.1.7
Noise and vibration	**Yes**			**Key Issue**	**Section 7.2**
		Construction impact: Noise associated with construction activities and compound / laydown areas. *Mitigation*: Prepare a Construction Noise and Vibration Management Plan. Implement	Mitigation would reduce impacts, but temporary, substantial construction noise and disturbance is still expected at some locations.		Section 7.2.5 outlines potential construction impacts A summary of residual impacts is

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		reasonable and feasible measures to address construction noise.			presented in Section 7.2.9
		Construction impact: Noise associated with construction traffic. *Mitigation:* The Construction Noise and Vibration Management Plan would identify requirements for minimising night-time construction traffic and include out-of-hours work procedures.	Mitigation would reduce impacts, but temporary, substantial construction noise is still expected at some locations. This would typically be short-term in nature.		Section 7.2.5 outlines potential construction impacts A summary of residual impacts is presented in Section 7.2.9
		Construction vibration: Building damage is unlikely due to achieved separation distances. Some potential for vibration to be perceptible at times during work. *Mitigation:* Prepare a Construction Noise and Vibration Management Plan and implement measures to address construction vibration (including equipment selection, working distances and response to vibration related complaints).	With mitigation, residual construction vibration impacts are expected to be minor.		Section 7.2.5 outlines potential construction impacts A summary of residual impacts is presented in Section 7.2.9
		Operational impact: Road traffic noise associated with changes to traffic and road geometry. *Mitigation*: Implement reasonable a feasible road traffic noise mitigation.	Noise affected residences would be eligible for noise mitigation treatments to minimise operation road traffic noise.		Section 7.2.6 outlines potential operational impacts A summary of residual impacts is presented in Section 7.2.9

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
Biodiversity	**No**			**Key Issue**	**Section 7.3**
		Construction impact: Clearing of vegetation including threatened species and communities listed under both the TSC Act and the EPBC Act. *Mitigation:* A Flora and Fauna Management Plan would be included in the project CEMP. The plan would identify potential impacts, describe mitigation measures and controls. Preparation of a biodiversity offset strategy	Significant. Offsetting would assist in addressing residual impacts.		Section 7.3.5 outlines potential construction impacts A summary of residual impacts is presented in Section 7.3.8. Biodiversity offsets are outlined in Section 7.3.9
		Operational impact: Fragmentation of identified biodiversity links and habitat corridors *Mitigation*: Connectivity measures would be implemented in accordance with the *Wildlife Connectivity Guidelines for Road Projects*	Minor. Connectivity measures would potentially reduce the risk of road strike in some locations.		Section 7.3.5 outlines potential operational impacts A summary of residual impacts is presented in Section 7.3.8. Biodiversity offsets are outlined in Section 7.3.9
Social and economic	**No**			**Key Issue**	**Section 7.4**
		Pre-construction impact: Impacts on residents and businesses as a result of the total or partial acquisition. Mitigation: Early and on-going consultation. Carry out acquisition consistent with the requirements of the *Land Acquisition (Just*	With mitigation, residual impacts would be minimised to the extent possible.		Section 7.4.3 outlines potential acquisition impacts

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		Terms Compensation) Act 1991. Establish a direct contact at Roads and Maritime for businesses to consult with as required.			
		Construction impact: Reduced local amenity (dust, noise and visual impact) from construction activities. *Mitigation:* Roads and Maritime would continue to consult with the community, in accordance with the Draft Community Involvement Plan. Mitigation measures in this EIS for dust, noise and visual impacts would be implemented.	With mitigation, there would still be a minor and temporary degree of construction related disruption to residents and users' of community facilities and recreational areas.		Section 7.4.3 outlines potential construction impacts A summary of residual impacts is presented in Section 7.4.7.
		Operational impact: Changes to some land-use including the transfer of about 43 ha of land currently owned by the Commonwealth Mitigation: Consultation between Roads and Maritime and the Commonwealth Government regarding the transfer of land.	With mitigation, residual impacts would be minimised to the extent possible.		Section 7.4.4 outlines potential operational impacts A summary of residual impacts is presented in Section 7.4.7.
		Operational impact: Adverse impacts to business and economic activity within Luddenham as a result of the bypass *Mitigation*: On-going consultation with local business owners, including owners of agricultural businesses, located close to construction works about the timing, duration and likely impact of construction activities on their business operations	With mitigation, residual impacts would be minimised to the extent possible.		Section 7.4.4 outlines potential operational impacts A summary of residual impacts is presented in Section 7.4.7.

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		would be carried out. Revitalisation of Luddenham is being pursued by Roads and Maritime in consultation with Liverpool City Council			
Flooding and hydrology	**Yes**			**Other issue**	**Section 8.1**
		Construction impact: Construction sites could increase potential runoff and scour to during heavy rainfall *Mitigation:* Appropriate scour protection measures would be implemented at drainage structures during construction	With mitigation, residual impacts would be minimised to the extent possible.		Section 8.1.3 outlines potential construction impacts A summary of residual impacts is presented in Section 8.1.7
		Construction impact: A flood event to occur during construction of the project *Mitigation:* Temporary works would consider flood impacts during construction. Should construction staging require a temporary departure from the design (eg higher embankments for preloading, temporary diversions or temporary crossings), flood impacts would be assessed before finalising the approach	With mitigation, residual impacts would be minimised to the extent possible.		Section 8.1.3 outlines potential construction impacts A summary of residual impacts is presented in Section 8.1.7
		Operational impact: The project would result in increased peak flows in most catchments for events up to 100 year ARI.	With the implementation of the drainage strategy the project would not result in any significant residual flooding and hydrological		Section 8.1.4 outlines potential operational impacts

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		Mitigation: The key recommendations of the transverse drainage strategy would be considered throughout detailed design and in consultation with landowners to minimise potential impacts	impacts.		A summary of residual impacts is presented in Section 8.1.7
		Operational impact: The project would increase the scour potential in the drainage lines which run through DEOH site in Commonwealth land. *Mitigation:* Appropriate scour protection measures would be implemented along any temporary drainage lines within the project construction area.			Section 8.1.4 outlines potential operational impacts A summary of residual impacts is presented in Section 8.1.7
Soils, water and contamination	**Yes**			**Other issue**	**Section 8.2**
		Construction impact: Impacts on soil and water quality from erosion and sedimentation and accidental spills Mitigation: Soil and Water Management Plan (SWMP) would be prepared as part of the CEMP. Erosion and sediment controls would be implemented before any construction starts and sediment basins would be regularly serviced and maintained to comply with water quality and capacity requirements.	With mitigation, residual impacts are expected to be minor and limited. Similarly in the event of an unexpected leak or spill, potential contamination impacts to surface or groundwater may occur before appropriate containment or clean-up operations can be implemented.		Section 8.2.3 outlines potential construction impacts A summary of residual impacts is presented in Section 8.2.9
		Construction impact: Disturbance of contaminated land within the road corridor. *Mitigation*: Prepare a Contaminated Land Management Plan to address	With mitigation, residual impacts are expected to be manageable and minor.		Section 8.2.3 outlines potential construction impacts

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		risks associated with handling and disposal of contaminated soils			A summary of residual impacts is presented in Section 8.2.9
		Operational impact: Increase in the transport of road surface pollutants (brake dust, rubber, oils, fuels) to local waterways via the pavement drainage system. Risk of spills. *Mitigation:* Design would consider practicable measures to optimise pollution mitigation such as water quality swales	With mitigation, residual impacts are expected to be limited.		Section 8.2.4 outlines potential operational impacts A summary of residual impacts is presented in Section 8.2.9
Aboriginal heritage	**No**			**Other issue**	**Section 8.3**
		Construction impact: Potential harm of the project on 28 Aboriginal archaeological heritage sites. *Mitigation*: Salvage excavation must be completed prior to any activities which may harm Aboriginal objects in accordance with the management procedures outlined in Appendix M.	Residual impacts as a result of construction of the project are expected to be limited to the 16 partially and 12 wholly impacted sites located within the construction footprint		Section 8.3.3 outlines potential impacts A summary of residual impacts is presented in Section 8.3.6
		Construction impact: Disturbance or destruction of previously unidentified Aboriginal heritage artefacts in the road corridor or site compound	With mitigation, residual impacts are expected to be limited.		Section 8.3.3 outlines potential impacts

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		locations. *Mitigation*: Develop and implement procedures for unexpected finds.			A summary of residual impacts is presented in Section 8.3.6
Non-Aboriginal heritage	**No**			**Other issue**	**Section 8.4**
		Construction impact: Direct impacts to three Non-Aboriginal heritage sites including Miss Lawson's Guesthouse, Miss Lawson's Inn and the Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place, including the Chaffey Brothers Irrigation Scheme Canal. *Mitigation:* Management in accordance with the detailed measures outlined in this EIS including archival photography and salvage archaeological investigations. A Construction Cultural Heritage Management Plan would be prepared as part of the CEMP prior to construction in consultation with the NSW Heritage Division of OEH	Although the proposed salvage excavation would recover data about these sites, the sites would be impacted as a result of the works.		Section 8.4.4 outlines potential impacts A summary of residual impacts is presented in Section 8.4.8
		Construction impact: Construction impact: Disturbance or destruction of previously unidentified historic heritage (relics) in the road corridor or site compound locations. *Mitigation*: Develop and implement a procedure for unexpected finds.	With mitigation, residual impacts are expected to be limited and minor.		Section 8.4.4 outlines potential impacts A summary of residual impacts is presented in Section 8.4.8

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
Urban design and VIA	**No**			**Other issue**	**Section 8.5**
		Construction impact: Visual impact associated with construction activities and construction compounds. *Mitigation*: Consider the provision of barriers to screen views from visually sensitive nearby areas such as rural dwellings, residential and recreational areas. Rehabilitation of sites after construction in accordance with a detailed landscape plan.	Construction activities would be visible from some locations but visual impacts would be temporary and minor to moderate.		Section 8.5.4 outlines potential construction impacts A summary of residual impacts is presented in Section 8.5.8
		Operational impact: Moderate to high impacts on landscape character zones and views along the road corridor. Mitigation: The urban design and landscape concept developed for the project would be adopted during detailed design and implemented as part of the Urban Design Landscape Plan.	Moderate to high and high visual impacts are anticipated at some locations.		Section 8.5.5 outlines potential operational impacts A summary of residual impacts is presented in Section 8.2.9
Air quality	**No**			**Other issue**	**Section 8.6**
		Construction impact: Construction impact: Mobilisation of dust and odour from construction activities and compound sites. *Mitigation*: Prepare an Air Quality Management Plan to detail potential sources and impacts of dust and measures to minimise dust including minimising exposed surfaces, water suppression and covering of	With mitigation, residual impacts are expected to be limited and minor.		Section 8.6.5 outlines potential construction impacts A summary of residual impacts is presented in Section

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		loads.			8.6.9
		Operational impact: The project is not expected to result in unacceptable concentrations at surrounding receiver. *Mitigation*: No specific mitigation proposed.	Minor. Air quality is anticipated to meet criteria across the project.		Section 8.6.6 outlines potential operational impacts A summary of residual impacts is presented in Section 8.6.9
Resources and waste	**No**			**Other issue**	**Section 8.7**
		Construction impact: Generation and disposal of waste *Mitigation*: The waste minimisation hierarchy principles of avoid/reduce/reuse/ recycle/dispose would be used A project-specific *Construction* Waste and Energy Management *sub-plan* (CWEMP) would be prepared before construction	Minor. With mitigation, residual impacts are expected to be limited.		Section 8.7.3 outlines potential construction impacts A summary of residual impacts is presented in Section 8.7.7
Climate change and GHG	**No**			**Other issue**	**Section 8.8**
		Construction impact: Increase in greenhouse gas emissions from construction (Scope 1 and 3	Minor. With mitigation, there would still be greenhouse gas emissions associated with the		Section 8.8.3 outlines potential construction

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		emissions). *Mitigation*: To minimise emissions, the project would maximise reuse and recycling, implement energy efficiency measures, and source materials locally where possible to reduce transport emissions.	construction of the project.		impacts A summary of residual impacts is presented in Section 8.8.7
		Operational impact: Increased energy use (and Scope 2 emissions) due to the operation of the road (lighting, signals, and maintenance). *Mitigation:* Opportunities to use renewable energy for motorway operation would be investigated.	Minor. With mitigation, there would still be greenhouse gas emissions associated with the operation of the project.		Section 8.8.4 outlines potential operational impacts A summary of residual impacts is presented in Section 8.8.7
Cumulative impacts	**No**			**Other issue**	**Chapter 9**
		Construction impact: Additional impacts arising from interaction with adjacent upgrade projects and other surrounding developments during the construction period. *Mitigation*: Local communities potentially affected by the impact of multiple projects would be consulted. Where relevant, consultation would be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	With mitigation, there would still be a degree of construction related disruption to residents and the local community. Affected people would be kept informed about the nature and duration of expected impacts.		Potential cumulative impacts are outlined in Section 9.2

Sub-issue	Key SEAR issue?	Potential impacts and environmental management measures	Potential residual impacts	Risk category following analysis	EIS reference
		Operational impact: Cumulative benefit due to reduced congestion when other stages of The Northern Road are complete. Mitigation: Cumulative benefit. No mitigation required.	Cumulative benefit.		Potential cumulative impacts are outlined in Section 9.2 The need for the project, including project benefits are outlined in Chapter 3

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12 Summary of environmental management measures

This chapter summarises how the project would be managed during construction and operation. The identified environmental impacts would continue to be managed during detailed design to reduce potential environmental impacts. This chapter also describes the proposed framework for managing the potential impacts of this project through the creation of Construction Environmental Management Plans and sub-plans which set out specific impact mitigation and management measures. A summary of site-specific environmental safeguards is provided as detailed in Chapter 7 and Chapter 8 of this EIS.

The relevant Commonwealth EIS Guidelines for this chapter are provided in Table 12-1 below.

Table 12-1 Commonwealth Environmental Assessment Requirements

Requirement	Where addressed in EIS
Commonwealth EIS Guidelines (Commonwealth EPBC Act)	
The EIS must provide information on proposed safeguards and mitigation measures to manage the relevant impacts of the action. Specific and detailed descriptions of proposed measures must be provided and substantiated, based on best available practices and must include the following elements.	Chapters 7 and 8 Chapter 12
A consolidated list of mitigation measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the action, including: • A description of proposed safeguards and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State governments, local governments or the Proponent;	Chapter 12
A detailed outline of an Environmental Management Plan (EMP) that sets out the framework for continuing management, mitigation and monitoring of relevant impacts of the action, including any provisions for independent environmental auditing. The EMP needs to address the project phases (construction, operation, decommission) separately. It must state the environmental objectives, performance criteria, monitoring, reporting, corrective action, responsibility and timing for each environmental issue. The EMP should also describe contingencies for events such as failure of sewerage systems, heavy or prolonged rainfall, or saltwater intrusion into ground water.	Section 12.2 Section 12.4 Section 8.2.3 No sewerage systems would be impacted by the project
The EIS must include information on any other requirements for approval or conditions that apply, or that the proponent reasonably believes are likely to apply, to the proposed action. This must include: • A description of the monitoring, enforcement and review procedures that apply, or are proposed to apply, to the action.	Chapters 7, 8 and 10

12.1 Environmental management framework

Roads and Maritime manages its environmental responsibilities and environmental performance through the implementation of an environmental management framework that is broadly consistent with the principles contained within the ISO 14000 series and standards. This includes establishing a corporate environmental policy, setting environmental direction through objectives and targets, integrating these into work systems, and providing measures for continuous improvement.

Roads and Maritime's Environment Policy Statement (2016) outlines the agency's commitment to effectively manage any impacts that lead to an adverse impact on the environment. The project has been assessed in accordance with the SEAR's and Commonwealth EIS guidelines and developed in accordance with 'Project Pack'. Project Pack is an over-arching project management system developed by Roads and Maritime for major infrastructure projects. The system effectively integrates environmental management into all phases of the project to ensure impacts are effectively managed.

Should the project be approved, Roads and Maritime would ensure the commitments made in this EIS, including any conditions of approval or legal requirements are fulfilled. As outlined in Chapter 7 and 8, the environmental management measures would be monitored during construction and operation of the project to confirm their effectiveness, and whether any additional measures are required.

The management of environmental impacts during construction is documented in the Construction Environmental Management Plan (CEMP). The CEMP provides the system to manage and control the environmental aspects of the project during pre-construction and construction. It also provides the overall framework for the system and procedures to ensure environmental impacts are minimised and legislative requirements are fulfilled. This includes the preparation of environmental sub-plans, which detail how environmental issues are managed through construction. Refer to Section 18.2 for further information on the structure and implementation of the CEMP and sub-plans.

The management of environmental impacts during the projects operation is best achieved through its design. The iterative design and environmental assessment process allows impacts to be avoided or minimised where possible. Roads and Maritime has an ongoing obligation to minimise the environmental impacts during all phases of the project including during detailed design when the design is being optimised. Where environmental controls have been incorporated into the design there is a program of monitoring and review including independent auditing, to ensure the controls comply with stated objectives. Refer to Section 12.3 for a discussion on the environmental management during operation.

12.2 Construction Environmental Management Plan

Roads and Maritime have developed, through its contract specifications, a model specification that requires construction contractors to implement an environmental management system in the form of a CEMP. CEMP's are prepared in accordance with:

- Roads and Maritime's QA specification G36
- Guideline for the preparation of Environmental Management Plans (DIPNR, 2004)
- AS/NZS ISO14001: 2004, 'Environmental Management Systems - requirements with guidance for use'.

The CEMP provides a structured approach to the management of environmental issues identified in the EIS during construction of the project. Implementing the CEMP would effectively ensure that the project meets regulatory and policy requirements in a systematic manner and continually improves its performance. The strategies defined in the CEMP would be developed with consideration of the project approval requirements, and mitigation measures presented in the EIS. The CEMP establishes the system for implementation, monitoring and continuous improvement to minimise impacts from the project on the environment.

In particular, the CEMP:

- Assigns responsibilities for planning, implementing, maintaining and monitoring environmental controls including the responsibilities of sub-contractors
- Provides specific mitigation measures and controls that can be applied to avoid or minimise negative environmental impact
- Provides specific mechanisms for compliance with applicable policies, approvals, licences, permits, consultation agreements and legislation
- States objectives and targets for issues that are important to the environmental performance of the project
- Outlines a monitoring regime to check the adequacy of controls as they are implemented during construction. This includes monitoring to validate the impacts predicted for the project, to measure the effectiveness of environmental controls and implementation of the CEMP, and to address approval requirements. Where non-conformance is detected further analysis would be carried out, identifying and implementing corrective actions to rectify the non-conformance
- Includes the requirements of regular inspections to evaluate the effectiveness of controls and compliance with CEMP and sub-plans. This includes daily and post rainfall inspections by the contractor and weekly or fortnightly inspections by Roads and Maritime and regulatory agencies. Any maintenance or deficiencies in controls would be recorded and provided to the contractor for corrective action
- Provides details of communications within the project team and with government authorities and the community. This includes the requirement to prepare and implement a community communications strategy and a complaints and enquiries procedure in accordance with AS 4269: Complaints Handling
- Includes copies of approvals, licenses and permits
- Includes the provision of environmental sub-plans which detail how construction activities would be managed to avoid or minimise impacts including the type, location and timing of environmental controls. Refer below for more detail on CEMP sub plans
- Provides an emergency response procedure for mitigating environmental damage and procedures for planning restoration activities consistent with Roads and Maritime's Environmental Incident Classification and Reporting Procedure. The procedure provides a process of systematically responding to and managing emergency situations, it also outlines the process of, and legal requirements for, reporting and notification of incidents
- Provides details of training and awareness programs for personnel working on the project. This includes a compulsory site induction that outlines the requirements of the CEMP and legislative requirements, regular tool box talks on specific environmental issues, and daily pre-start meetings
- Provides for an environmental auditing program including six monthly audits carried out by the contractor to verify compliance with the CEMP and sub-plans, conditions of approval, relevant legislation. External audits would also be carried out every six months in accordance with ISO 19011:2003 - Guidelines for Quality and/or Environmental Management Systems Auditing
- Provides a mechanism for regular evaluation of environmental performance. This includes regular management reviews by the contractor, and an annual review conducted by the contractor and stakeholders as part of the continual improvement process.

12.2.1 Objective and targets

As a means of assessing environmental performance during construction of the project, environmental objectives and targets would be established. These objectives and targets would be developed with consideration of key issues identified in the EIS. The targets would be incorporated into relevant environmental management sub-plans.

The performance of the project against the objectives and targets would be documented in the project construction compliance reports and at least on an annual basis as part of the management review. Environmental objectives and targets for the project are provided in Table 12-2 below.

Table 12-2 Environmental objectives and targets

Objective	Target	Measurement tool
Construction the project in accordance with environmental approvals.	Full compliance with statutory approvals.	Audits, construction compliance reporting, management view.
Compliance with all legal requirements.	No regulatory infringements (PINs or prosecutions). No formal regulatory warning.	Audits, construction compliance reporting, management view.
Implement a rigorous and comprehensive Environmental Management System (EMS that meets the requirements of AS/NZS ISO 14001.	Address non-conformances and corrective actions within specific timeframes.	Audits, management reviews.
Engage with the affected and broader community, minimise complaints and respond to any complaints within a suitable timeframe.	Disseminate regular project updates and other information through the Project website and other tools identified in the Draft Community Involvement Plan. Record and respond to complaints within the timeframe specified in the Draft Community Involvement Plan.	Review complaints register, construction compliance report, audits.
Continuously improve environmental performance.	Develop and maintain a program of ongoing environmental training. Capture and disseminate lessons learnt from environmental incidents to minimise repeat issues. Encourage and reward innovation and effort throughout the works force.	Audits, Construction compliance report, management review.

12.2.2 CEMP sub-plans

The CEMP is the overarching management plan for a suite of environmental management documents. It provides a structured and systematic approach to environmental management during construction to:

- Ensure compliance with all applicable environmental laws, obligations and approvals
- To minimise environmental impacts.

A number of environmental management sub-plans support the CEMP. These documents are prepared to identify requirements and processes applicable to specific impacts described in the EIS. They would address requirements of conditions of approval and other measures identified in the EIS. A list of construction sub-plans and strategies for the project, and their approval requirements, are provided in Table 12-3 below:

Table 12-3 CEMP sub-plans

CEMP sub-plans	
Flora and Fauna Management Plan	
Statutory basis	Statutory requirements for managing biodiversity are outlined in: • Commonwealth Environment Protection Biodiversity Conservation Act 1999 • NSW Environmental Planning and Assessment Act 1979 • NSW Threatened Species Conservation Act 1995 • NSW Fisheries Management Act 1994 • NSW Noxious Weeds Act 1993.
Relevant guidelines	• National Standards for the Practice of Ecological Restoration in Australia (Society for Ecological Restoration Australasia, 2016) • Roads and Maritime QA Specification G36 – Environmental Protection (Management System) • Roads and Maritime QA Specification G40 – Clearing and Grubbing • Roads and Maritime QA Specification R176 – Native Seed Collection • Roads and Maritime QA Specification R178 – Vegetation • Roads and Maritime QA Specification R179 – Landscape Planting • Roads and Maritime Environmental Direction No.25 - Management of Tannins from Vegetation Mulch (January 2012) • RTA Biodiversity Guidelines – Protecting and managing Biodiversity on RTA projects (September 2011) • NSW Fisheries, Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003) • Fish Note – Policy and Guidelines for Fish Friendly Waterway Crossings – November 2003 • NSW Department of Primary Industries, Policy and guidelines for fish habitat conservation and management, (2013 update) • NSW National Parks & Wildlife Service, 2001. Policy for the Translocation of Threatened Fauna in NSW: Policy and Procedure Statement No. 9 Threatened Species Unit, Hurstville NSW • DECCW, 2008. Hygiene protocol for the control of disease in frogs • Relevant recovery plans, priority action statements and best practice guidelines.
Responsibility	• The Flora and Fauna Management Plan would be prepared in consultation with OEH, DoEE and any other relevant agencies as required by conditions of approval • The Flora and Fauna Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site

CEMP sub-plans	
	controls in accordance with the management plan, CEMP, any all relevant legislation.
Objectives	• Ensure controls and procedures are implemented during construction and operational activities to avoid, minimise or manage potential adverse impacts to flora and fauna within and adjacent to the project footprint • Ensure measures are implemented to address any relevant conditions of approval, and measures outlined in the EIS • Ensure measures are implemented to comply with all relevant legislation.
Soil and Water Management Plan	
Statutory basis	Statutory requirements for managing soil and water are outlined in; • Commonwealth Environment Protection Biodiversity Conservation Act 1999 • NSW Environmental Planning and Assessment Act 1979 • Environmental Planning and Assessment Regulation 2000 • Protection of the Environment Operations Act 1997 (POEO Act) • Water Management Act 2000.
Relevant guidelines	• Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) • National Water Quality Management Strategy (NWQMS) (Department of Sustainability, Environment, Water, Population and Communities (DSEWPC), 1994) • Managing Urban Stormwater: Soils and Construction. Landcom, (4th Edition) March 2004 (reprinted 2006) (the “Blue Book”). Volume 1 and Volume 2 • Volume 2A Installation of Services (DECCW, 2008) • Volume 2C Unsealed Roads (DECCW, 2008) • Volume 2D Main Roads Construction (DECCW, 2008) • DIPNR Roads and Salinity Guideline, 2003 • Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. • NSW Fisheries, November 2003. Fishnote – Policy and Guidelines for Fish Friendly Waterway Crossings (Ref: NSWF – 1181) • Environmental Management of Construction Site Dewatering (RTA, 2011) • RTA’s Code of Practice for Water Management – Road Development and Management (1999) • Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (EPA, March 2004) • RMS Environment Direction Management of Tannins from Vegetation Mulch • Stockpile Site Management Guideline, RMS, 2011

CEMP sub-plans	
	• Environmental Best Management Practice Guideline for Concreting Contractors (DEC, 2004 • RMS Road Design Guideline: Section 8 Erosion and Sedimentation (RTA, 2003) • RMS Guideline for Construction Phase Water Quality Monitoring (RTA, n.d.) • RMS Erosion and Sedimentation Management Procedure (RTA, 2009) • Procedures for Selecting Treatment Strategies to Control Road Runoff (RTA, 2003a) • RMS Water Policy (RTA, 1997) • RMS QA Specification G38 (RMS, 2011) • Road Runoff and Drainage: Environmental Impacts and Management Options, AP-R180 (Austroads, 2001) • Floodplain Development Manual (DIPNR, 2005) • RMS Technical Guideline: Environmental Management of Construction Site Dewatering (RTA, 2011) • The relevant targets within the State Water Management Outcomes Plan (NOW, 2003) • NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002) • Guidelines for Treatment of Stormwater Runoff from Road Infrastructure, AP-R232 (Austroads, 2003).
Responsibility	• The Soil and Water Management Plan would be prepared in consultation with EPA, DPI Water, DoEE and any other relevant agencies as required by conditions of approval • The Soil and Water Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site controls in accordance with the management plan, CEMP, and any all relevant legislation.
Objectives	• Ensure appropriate controls and procedures are implemented during construction activities to avoid or minimise erosion and sedimentation impacts and potential impacts to water quality in rivers, creeks and groundwater along the project • Ensure appropriate measures are implemented to address the relevant conditions of approval and management measures outlined in the EIS • Ensure compliance with the project's Environment Protection License (EPL) • Ensure appropriate measures are implemented to comply with RMS specification G38, G36 and G40, and all relevant legislation.

CEMP sub-plans	
Cultural Heritage Management Plan	
Statutory basis	Statutory requirements for managing heritage are outlined in: • Commonwealth Environment Protection Biodiversity Conservation Act 1999 • NSW Environmental Planning and Assessment Act 1979 • National Parks and Wildlife Act 1974 (NPW Act). • Heritage Act 1977 (Heritage Act) • Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth) • Liverpool LEP, Penrith LEP.
Relevant guidelines	• RMS Specification G36 – Environmental Protection (Management System) • RMS Unexpected Heritage Items Procedure (March 2015) • DEC Interim Community Consultation Requirements for Applicants (December 2004) • Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, July 2005) • Specification D&C G36 – Environmental Protection (Roads and Maritime, 2013a) • Assessing Significance for Historical Archaeological Sites and Relics (DPE, 2009) • How to Prepare Archival Recording of Heritage Items (NSW Heritage Office, 1998) • Photographic Recording of Heritage Items Using Film or Digital Capture (DPE, 2006) • Archaeological Assessments Guideline (Heritage Office, 1996).
Responsibility	• The Cultural Heritage Management Plan would be prepared in consultation with OEH, DoEE and any other relevant agencies as required by conditions of approval • The Cultural Heritage Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site controls in accordance with the management plan, CEMP, any all relevant legislation.
Objectives	• Ensure appropriate controls and procedures are implemented during construction to avoid or minimise potential adverse impacts to Aboriginal and non-Aboriginal heritage along the project corridor • Ensure appropriate measures are implemented to address the relevant conditional of approval and the safeguards detailed in the EIS

CEMP sub-plans	
	• Ensure appropriate measures are implemented to comply with all relevant legislation.
Traffic Management Plan	
Statutory basis	The statutory basis for managing traffic and transport is the project approval under: • Commonwealth Environment Protection Biodiversity Conservation Act 1999 • NSW Environmental Planning and Assessment Act 1979 • Traffic and transport management would also be governed by - an approved and valid Road Occupancy Licence (ROL); - an approved relevant Speed Zone Authorisation (SZA); and - Australian Road Rules.
Relevant guidelines	• RMS QA Specification G10 – Traffic Management • RMS Traffic Control at Worksites Manual (2010) • Traffic Signal Design Guide • RMS Technical Directions and Supplements • Austroads guide to road safety part 6 • Road safety audit 2009 • Austroads guide to traffic management 2009 • Austroads standards • RMS NSW Bicycle Guidelines • Guide: Signposting (RTA, July 2007) • Tourist Signposting guide (RMS and Destination NSW, 2012).
Responsibility	• The Traffic and Transport Management Plan would be prepared in consultation with DPE, DoEE and any other relevant agencies as required by conditions of approval • The Traffic and Transport Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site controls in accordance with the management plan, CEMP, any all relevant legislation.
Objectives	• Ensure appropriate controls and procedures are implemented during construction activities to address potential traffic impacts along the project corridor

CEMP sub-plans	
	• Ensure appropriate measures are implemented to address the relevant conditions of approval, and the safeguards detailed in the EIS • Ensure appropriate measures are implemented to comply with all relevant legislation.
Noise and Vibration Management Plan	
Statutory basis	Statutory requirements for managing heritage are outlined in: • Commonwealth Environment Protection Biodiversity Conservation Act 1999 • NSW Environmental Planning and Assessment Act 1979 • Protection of the Environment Operations Act 1997 (POEO Act) • Protection of the Environment Operations (Noise Control) Regulation 2008.
Relevant guidelines	• NSW Industrial Noise Policy (INP) (EPA, 2000) • Road Noise Policy (RNP) (DECCW, 2011) • Interim Construction Noise Guideline (ICNG) (DECC, 2009) • Assessing Vibration: A Technical Guideline (DEC, 2006) • German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures • British Standards BS 7385 Part 2 ‘Evaluation and measurement for vibration in buildings.
Responsibility	• The Noise and Vibration Management Plan would be prepared in consultation with NSW Environment Protection Authority, DoEE and any other relevant agencies as required by conditions of approval • The Noise and Vibration Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site controls in accordance with the management plan, CEMP, any all relevant legislation.
Objectives	• Identifying sensitive receivers and ensuring appropriate environmental controls and procedures are implemented during construction activities • Minimising potential adverse noise and vibration impacts to the environment and community • Managing impacts if they occur through a systematic analysis of mitigation strategies • Ensuring appropriate management and mitigation measures are implemented to address the relevant conditional of approval and mitigation measures detailed in the EIS • Ensuring appropriate management and mitigation measures are implemented

CEMP sub-plans	
	to comply with all relevant legislation.
Waste Management Plan	
Statutory basis	Statutory requirements for managing heritage are outlined in: • Protection of the Environment Operations Act 1997 • Protection of the Environment Operations (General) Regulation 2009 • Protection of the Environment Operations (Waste) Regulation 2005 • Waste Avoidance and Resource Recovery Act 2001 (WARR Act); • Contaminated Land Management Act 1997 • National Greenhouse and Energy Reporting Act 2007 • Noxious Weeds Act 1993 • Environmentally Hazardous Chemicals Act 1985 • Energy Efficiency Opportunities Act 2006 (EEO Act).
Relevant guidelines	• Waste Avoidance and Resource Recovery Strategy 2007 (DECC, 2007) • Waste Reduction and Purchasing Policy (RTA, 2009) • Waste Classification Guidelines 2014 (OEH) (EPA Publication) • Best Practice Waste Reduction Guidelines for the Construction and Demolition Industry (tools for Practice), Natural Heritage Trust, 2000.
Responsibility	• The Waste Management Plan would be submitted for approval to DPE, as part of the CEMP, and in accordance with any condition of approval • The construction contractor would be responsible for implementing site controls in accordance with the management plan, CEMP, any all relevant legislation.
Objectives	• Ensure measures are identified and implemented to minimise waste, manage waste and conserve energy throughout the construction of the project • Ensure the preferred waste management hierarchy of avoidance, minimisation, reuse, recycling and finally disposal is followed • Provide construction staff with an increased level of understanding and awareness of waste and resource use management issues • Ensure appropriate measures are implemented to address the relevant conditions of approval, and the mitigation measures detailed in the EIS • Ensure appropriate measures are implemented to comply with all relevant legislation.

12.2.3 Non-conformance and corrective action

For each non-conformance identified a corrective/preventative action (or actions) must be implemented. In addition environmental management improvement opportunities can be initiated as a result of incidents or emergencies, monitoring and measurement, audit findings or other reviews. Improvement opportunities may also result in the implementation of corrective/preventative actions.

Corrective/preventative actions and improvement opportunities would be entered into the contractor's quality system database and include detail of the issue, action required and timing and responsibilities. The record would be updated with date of close out and any necessary notes. The database would be reviewed regularly to ensure actions are closed out as required.

Non-conforming activities may be stopped, if necessary, by personnel outlined in the CEMP. The works would not commence until a corrective / preventative action has been closed out. Procedures for rectifying any non-compliance identified during environmental auditing, review of compliance or incident management are also documented in a compliance tracking program. A compliance tracking program would be established to track compliance against the following for pre-construction and construction phases of the project.

- Conditions of approval
- Safeguards identified in the EIS and submissions report
- Legislative requirements
- Licensing conditions
- Contract specifications relating to environmental matters.

12.3 Summary of construction safeguards and management measures

Environmental safeguards and management measures for construction of the project outlined in Chapters 7 and 8 of this EIS would be incorporated as part of further development of the design and applied during construction and operation.

These safeguards would minimise potential adverse impacts of the project. All safeguards described in this EIS would be incorporated into the contractor's CEMP. The timing and responsibility for the implementation of the safeguards would also be outlined in the CEMP. Roads and Maritime would retain responsibility for some of the safeguards including those related to detailed design, however the construction contractor would be responsible for implementing the majority of safeguards. The estimated costs of environmental mitigation measures have been captured in project capital costs and, whilst difficult to quantify specifically, would represent less than 10 per cent of project costs. Safeguards and management measures applicable to the project are listed in Table 12-4.

Table 12-4 Summary of construction environmental safeguards and management measures

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Construction impacts	T-1	A Construction Traffic Management Plan (CTMP) would be developed, approved, implemented and monitored as part of the project. The TMP would: • Outline the general principles and procedures for the development of specific construction traffic control plan (CTP's), taking into consideration where possible other construction works utilising similar haulage and access routes • Ensure safe and continuous traffic movement for construction workers and the general public • Maintain the capacity of existing roads where possible • Identify the requirements for temporary speed restrictions where traffic may pose a safety risk to workers • Maintain continuity of access to local roads and properties, particularly along the existing alignment of The Northern Road (may require temporary u-turn facilities). Where access is affected, RMS would consult with residents for alternative access arrangements • Details of access to construction sites including measures to prevent	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CTMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		construction vehicles queuing on public roads • Provide temporary traffic control where necessary • Provide appropriate warning and signage for traffic in the vicinity of work areas • Include methods to minimise road user delays such as undertaking works around live traffic including tie-in and bridge work outside of peak periods • Undertake construction activities off-line where possible to minimise the requirement to operate temporary traffic control and reduced speed zones • Develop a communication plan to advise local residents and businesses of any changes to traffic conditions during construction • Consult with bus operators regarding temporary bus stop relocations during construction and proposed bus stops during operation.			
Construction staging	T-2	Staging plans to be prepared in consultation with adjoining contractors and for each stage of the upgrade.	Construction contractor	Construction	Proven to be effective. The requirements for staging plans would be outlined within the TMP. Monitoring and reporting requirements of the

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
					TMP to confirm effectiveness of measures.
Road damage	T-3	Undertake a pre-construction dilapidation survey of local roads used for construction. Defects caused by construction activities would be rectified prior to completion of construction.	Construction contractor	Construction	Proven to be effective.
Property access	T-4	Access to properties along affected roads would be maintained during construction. The need for any alternative and/or temporary access arrangements would be agreed with affected property managers/owners.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.
Construction noise impacts	NV-1	Construction Noise and Vibration Management Plan (CNVMP) would be prepared during the detailed design stage of the project and applied to all construction processes throughout the project. The CNVMP would be prepared in accordance with the requirements in the ICNG and RMS CNVG. The CNVMP would nominate: • Noise goals at all sensitive receivers • Restrictions on the hours of construction activity including an out-of-hours work	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		procedure • Works programming that has the aim of minimising impacts on sensitive receivers • Noise and vibration mitigation measures consistent with the RMS CNVG • The project's commitments to noise and vibration monitoring and reporting • Protocols for engaging with and notifying residents of any work processes that may impact them • Describe an out-of-hours work procedure (with proforma) to be applied to all construction assessments, which is consistent with the applicable Environmental Protection Licence (EPL) for the project. • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
	NV-2	Viable mitigation measures that would be expected to be deployed by the construction contractor once the final construction sequencing and scheduling is known include: • Restricting works to standard construction hours as far as practicable, considering	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		safety and traffic management requirements • Selecting quieter plant and equipment • Erecting temporary acoustic hoarding to reduce noise form works within a confined area • Deploying mobile hoardings (eg, acoustic screen curtains mounted on a wheeled trailer) to track moving, but tightly-contained processes • Maximising offset distances between receivers and noisy plant or activities • Orientating plant and processes away from residences, where reasonably practicable • Scheduling works for times outside of heightened sensitivity for the impacted receiver, eg, outside of school hours • Scheduling respite periods for noise-intensive processes undertaken near receivers, eg limiting operation of pavement sawing to three hours at a time • Planning any out-of-hours (OOH) works so that noisier works are carried out in the earlier part of the evening or night-time • Minimising the number of consecutive nights of works adjacent to any particular set of receivers			monitoring results.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Restricting heavy vehicle movements, heavy deliveries and loading and unloading processes to daytime periods and to areas well away from receivers • Regularly maintaining and monitoring plant and equipment to ensure that their noise emissions are not excessive • Minimising the annoyance from reversing alarms by either fitting closed circuit monitors or non-tonal reversing alarms ("quackers") on vehicles or deploying 'spotters' to oversee reversing movements • Reducing throttle settings and switching off equipment when it is not being used.			
	NV-3	Implement operational noise mitigation early in the construction program, where possible, to minimise construction noise impacts	Roads and Maritime	Construction	Proven to be effective
General construction impacts	B-1	A Flora and Fauna Management Plan (FFMP) would be developed for the project. The plan would include procedures for pre-clearance surveys that are consistent with the *Roads and Maritime Biodiversity Guidelines* (RTA, 2011). The FFMP would outline: • Details of pre-construction surveys to verify the construction boundaries/ footprint of the project and to confirm the	Contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		vegetation to be cleared as part of the project, identify habitat trees to be felled in a staged approach and identification of fauna release areas should fauna be encountered during vegetation removal • Updated sensitive aerial vegetation maps based on clearance surveys and previous survey work • Exclusion zones and fencing or other means to demarcate vegetation to be retained (endangered ecological communities) in close proximity to the works • Clearing of vegetation and removal of bush rock (Guide 7) including implementation of the pre-clearing process (Guide 1) and the associated staged habitat removal process where hollow-bearing trees, habitat trees or bush rock is to be removed • Weed management (see Guide 6) through the use of mechanical weed control methods such as slashing or mowing, as well as a range of herbicides • Pathogen management (see Guide 7) through the implementation of hygiene protocols such as the provision of vehicle and boot wash down facilities and ensuring vehicles and footwear are free of soil before entering or exiting the site,			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		as well as the establishment of exclusion zones and designated access tracks • Mechanism for the monitoring, review and amendment of this sub-plan.			
Removal of native vegetation, threatened species and threatened species habitat	B-2	Native vegetation removal would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected effective. The design has been optimised throughout design options to minimise impacts to vegetation
	B-3	Pre-clearing surveys would be undertaken in accordance with *Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify and locate habitat features on site, and mark those to be protected during clearing • Identify suitable habitat areas for fauna relocation (if encountered during clearing works) • 24 hours prior to clearing, licensed wildlife carers and/or ecologists should capture	Contractor	Pre-construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		and/or remove fauna that have the potential to be disturbed as a result of clearing activities and relocate to the pre-determined location (as above) • Carry out staged habitat removal (Guide 4) where fauna habitat features have been identified and marked.			
	B-4	Vegetation removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation • Non-woody vegetation should be incorporated into the stripping of topsoil to	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		retain any organic materials and nutrients • The staged habitat removal process is to be used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource • The Australian Standard *AS 4373 Pruning of amenity trees* should be followed for all pruning works.			
	B-5	The unexpected species find procedure is to be followed under Biodiversity Guidelines: • *Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011) if threatened ecological communities, flora or fauna not assessed in the biodiversity assessment, are identified in the project site. The procedure is as follows: • Threatened flora or fauna species unexpectedly encountered Stop work, • Notify the environment manager, • Environmental manager would arrange for an ecologist to conduct an assessment of significance of the likely	Contractor	Construction	Proven to be effective. Reporting requirements of the FFMP to be adhered to.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		impact, develop management options and notify OEH, DPI and DoEE as appropriate, • If a significant impact is not likely to occur, recommence work and maintain regular inspections, • If a significant impact is likely to occur: • Consult with OEH, DPI and DoEE as appropriate, • Obtain approvals, licenses or permits as required, • Recommence works once advice is sought and necessary approvals, licences and permits are obtained, • Include species in subsequent inductions, toolbox talks and update the CEMP.			
Removal of native vegetation, threatened species and threatened species habitat	B-6	Native vegetation would be re-established in accordance with *Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Use experienced and licensed seed	Contractor	Post construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		collectors to carry out seed collection in accordance with RTA *Seed Collection QA Specification R176* and the Florabank Guidelines and Model Code of Practice • Planting operations should be in accordance with *RTA Landscape Planting QA Specification R179* • Collect local native topsoils and leaf litter and store for use in revegetation works • Ensure areas to be revegetated have an appropriate level of natural drainage, avoid compaction of soils in those areas and ensure suitable moisture requirements are maintained • Implement planting as per the planting plan for the project, including planting during suitable conditions, spacing and diversity of plants, etc. • Inspection, monitoring and maintenance of revegetated areas should be conducted in accordance with the Landscape Management Plan.			
	B-7	Habitat removal would be minimised through detailed design.	Roads and Maritime	Detailed design	Proven to be effective if done in accordance with the Biodiversity Guidelines.
	B-8	Habitat removal would be undertaken in accordance with *Guide 4: Clearing of vegetation and removal of bushrock of the*	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Carefully clear vegetation so as not to mix topsoil with debris and to avoid impacts to surrounding native vegetation • Retain stumps in riparian zones and aquatic habitats to reduce the potential for bank erosion • Separate woody vegetation into millable timber, secondary re-use (Guide 5) or exotic (non-native) vegetation • Non-woody vegetation should be incorporated into the stripping of topsoil to retain any organic materials and nutrients • The staged habitat removal process is to be used when identified habitat is to be removed, with a licensed wildlife carer or ecologist on site • Undertake bush rock removal in a way that minimises damage to the bush rock, avoids excessive soil disturbance and avoids climatic seasons when species are utilising this resource			Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• The Australian Standard *AS 4373 Pruning of amenity trees* should be followed for all pruning works.			
	B-9	Habitat would be replaced or re-instated in accordance with *Guide 5: Re-use of woody debris and bushrock* and *Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Separate weeds from native vegetation • Carry out removal, stockpiling, transportation and relocation of woody debris and/or bush rock in a manner that minimises disturbance to native vegetation or bush rock • Engage an ecologist to provide advice on positioning woody debris and bush rock in designated relocation areas • Keep topsoil disturbance to a minimum.	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.
Aquatic impacts	B-10	Aquatic habitat would be protected in accordance with *Guide 10: Aquatic habitats and riparian zones of the Biodiversity*	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		Guidelines: Protecting and managing biodiversity on RTA projects (NSW Roads and Traffic Authority, 2011) and Section 3.3.2 Standard precautions and mitigation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (Department of Primary Industries, 2013). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Avoid activities in aquatic habitats and riparian zones as much as practicable • Establish exclusion zones and set up exclusion fencing around sensitive areas • Keep vehicles and machinery away from the banks of a waterway where possible • Refuelling of vehicles and plant, and chemical storage and decanting should not take place within 50 m of aquatic habitats • Avoid clearing within the riparian zone during periods when flooding is likely to occur • Retain the roots of trees on the bank of a waterway in order to maintain bank stability			Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• During rehabilitation, stabilise the banks of the waterway through revegetation and/or armouring according to available landscape plans • Remove all temporary works, flow diversion barriers and sediment control barriers within aquatic habitats as soon as practicable and in a manner that does not promote future channel erosion.			
Removal of woody debris	B-11	All large woody debris or snags would be relocated instream (Guide 10).	Contractor	Construction	Expected to be effective.
Changes to hydrology	B-12	Changes to existing surface water flows would be minimised through detailed design.	Roads and Maritime	Detailed design	Expected to be effective. Drainage upgrades for the project have been designed and optimised to minimise changes to existing flows as much as possible.
	B-13	Measures to mitigate potential water quality impacts during construction are outlined in Section 8.1 and Section 8.2 of the EIS.	Contractor	Construction	N/A
Fragmentation of identified biodiversity links and habitat corridors	B-14	Connectivity measures have been considered during design in accordance with the *Wildlife Connectivity Guidelines for Road Projects* (RMS in prep). In particular, design where connectivity has been considered included culvert design, lighting and fencing.	Roads and Maritime and Contractor	Detailed design, during construction and post construction	Expected to be effective if done in accordance with the Wildlife Connectivity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Edge effects on adjacent native vegetation and habitat	B-15	Exclusion zones would be set up at the limit of clearing in accordance with *Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011).These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Identify exclusion zones on a suitable plan as required to prevent damage to native vegetation and fauna habitats and prevent the distribution of pests, weeds and disease • Mark out exclusion zones on site with temporary markings such as pegs or paint and where possible use a qualified surveyor • Erect signs to inform personnel of the purpose of exclusion zone fencing • Ensure all exclusion zones are regularly inspected and repairs to fencing are made where required • Maintain exclusion fencing until the risk to disturbance within the excluded zone has been eliminated through other means. Removal of fencing should be undertaken in consultation with environmental staff	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Communicate the importance of exclusion zones, and any changes to the zones, to all site staff and visitors (eg in toolbox talks and inductions).			
Injury and mortality of fauna	B-16	Fauna would be managed in accordance with *Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Allow fauna to leave an area without intervention as much as possible • Use a licensed fauna ecologist or wildlife carer with specific animal handling experience to carry out any fauna handling • Include the procedures to follow if fauna is found or injured on site in project inductions • Release fauna into pre-determined habitat identified for fauna release • Release fauna into similar habitats, as near as possible to their capture location. Release nocturnal fauna at dusk	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Temporary fauna fencing may be required on projects to reduce the chances of road kill/injury from public traffic or construction machinery.			
Invasion and spread of weeds	B-17	Weed species would be managed in accordance with *Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Use an ecologist or person trained in weed management and identification to undertake a site weed assessment to identify and describe or map weed infested areas within the site and adjacent areas. • Develop a Weed Management Plan for the site • Map and mark areas that are infested with weeds as an exclusion zone with fencing and signage to limit access by personnel and vehicles • Minimise soil disturbance within weed infested areas	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Use mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance • Mow/slash areas infested with weeds before they seed. This may reduce the propagation of new plants • Clean machinery, vehicles and footwear before moving to a new location • Securely cover loads of weed-contaminated material to prevent weed plant material falling or blowing off vehicles • Dispose of weed-contaminated soil at an appropriate waste management facility.			
Invasion and spread of pathogens and disease	B-18	Pathogens would be managed in accordance with *Guide 7 – Pathogen Management: Protecting and managing biodiversity on RTA projects* (NSW Roads and Traffic Authority, 2011). These measures would be outlined in the FFMP and would include monitoring and review procedures to be implemented to ensure the effective implementation of these measures, including but not limited to the following: • Ensure vehicles and footwear are free of soil before entering or exiting the site (ie directed to wash down area before	Contractor	Construction	Proven to be effective if done in accordance with the Biodiversity Guidelines. Monitoring and reporting requirements of the FFMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		entering or exiting the site) • Provide vehicle and boot wash down facilities • Set up exclusion zones with fencing and signage to restrict access into contaminated areas • Restrict vehicles to designated tracks, trails and parking areas.			
General socio-economic impacts	SE-1	A Draft Community Involvement Plan would be prepared to guide community engagement during construction of the project and would be updated throughout construction. Communication would be with the local community, stakeholders and the wider region. The Draft Community Involvement Plan includes: • Guiding principles overall approach to community and stakeholder involvement • A comprehensive list of identified stakeholders • A register of specific issue communications strategies • Requirements for the project regarding access to information, complaints and inquiries procedures and community consultation	Construction contractor / Roads and Maritime	Construction	Proven to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• A range of communication tools applicable to the project • Contact names and details • Complaints procedures.			
	SE-2	Areas affected by construction would be reinstated and restored in accordance with the urban design and landscape strategy.	Construction contractor	Construction	See Chapter 8.5
Noise and vibration during construction and operation	SE-3	Mitigation measures specific to construction noise and vibration can be found in Section 7.2 of the EIS for this project.	Construction contractor/ Roads and Maritime	Pre-construction and during construction	See Chapter 7.2
Air quality during construction and operation	SE-4	Mitigation measures specific to construction air quality can be found in Section 8.6 of the EIS for this project.	Construction contractor/ Roads and Maritime	Pre-construction and during construction	See Chapter 8.6
Property acquisition	SE-5	Provide appropriate compensation in accordance with the (NSW) *Land Acquisition (Just Terms Compensation) Act 1991* for properties to be partially or fully acquired for the project.	Roads and Maritime	Pre-construction	N/A
	SE-6	Impact from the acquisition on owners' remaining holdings would be considered in the acquisition process. As required and in consultation with owners, Roads and Maritime would engage the use of appropriately qualified professionals to carry out property assessments and identify	Roads and Maritime	Pre-construction	N/A

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		alternate opportunities for any remaining land holdings.			
Property acquisition	SE-7	Undertake property adjustments and relocation of infrastructure (for example, fencing, dams, property access) in consultation with the property owner.	Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements
	SE-8	Undertake any adjustments to the Orchard Hills golf course, in consultation with the managers of the Orchard Hills Golf Club.	Roads and Maritime/ Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements.
Business and economic activity	SE-9	On-going consultation with local business owners, including owners of agricultural businesses, located close to construction works about the timing, duration and likely impact of construction activities on their business operations would be carried out.	Construction contractor/ Roads and Maritime	Construction	Expected to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	SE-10	Relocate and/or remove farm infrastructure, including farm dams, as required and in consultation with affected land owners.	Construction contractor	Construction	Expected to be effective if carried out in accordance with consultation requirements.
	SE-11	Maintain a business impact risk register to identify and manage the specific impacts associated with construction related works for individual businesses.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting would be required to measure the effectiveness.
	SE-12	Access to existing businesses would be	Construction	Construction	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		provided on a continuous basis throughout the construction of the project.	contractor		Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for any alternative and/or temporary access arrangements would be agreed with affected property owners.
	SE-15	Roads and Maritime would undertake the project in accordance with the NSW Government Policy on Aboriginal Participation in Construction (NSW Finance and Services, 2016).	Roads and Maritime / Construction contractor	Construction	Expected to be effective. Contractors for all projects covered by this policy must provide an Aboriginal Participation Plan to the contracting agency within 60 days of the contract being awarded.
Access and connectivity	SE-16	The Traffic Management Plan would include a signage strategy (consistent with Roads and Maritime policy) to provide guidance to passing patrons on access to shops, services and businesses during construction.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
	SE-17	Access to properties would be provided on a continuous basis throughout the construction of the project Where temporary changes to property access are required, alternate access should be determined in consultation with affected property owners and tenants.	Construction contractor	Construction	Proven to be effective. Access arrangements would be outlined in the TMP, the effectiveness of those arrangements and the need for

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
					any alternative and/or temporary access arrangements would be agreed with affected property owners.
	SE-18	Access for pedestrians and cyclists near construction works would be maintained, including consideration of pedestrian access needs for elderly people, children and people with disability.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
	SE-19	Mitigation measures specific to Traffic and Transport can be found in Section 7.1 of the EIS for this project.	Construction contractor	Construction	See Chapter 7.1
Cumulative impacts	SE-20	Mitigation measures specific to cumulative impacts can be found in Chapter 9.	Refer to Chapter 9	Refer to Chapter 9	See Chapter 9
Impacts on flood behaviour during construction	FH-1	Temporary works would consider flood impacts during construction. Should construction staging require a temporary departure from the design (eg higher embankments for preloading, temporary diversions or temporary crossings), flood impacts would be assessed before finalising the approach.	Construction contractor	Construction	Expected to be effective Monitoring and reporting requirements of the Soils and Water Management Plan (SWMP) to confirm effectiveness of measures.
	FH-2	Appropriate scour protection measures would be implemented along any temporary drainage lines within the project construction area. • Scour protection would be added to the	Contractor	Pre-construction	Expected to be effective Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		outlets of the upgraded transverse drainage • Scour protection measures would also be incorporated on the inlet of the upgraded transverse drainage in order to prevent damage to the structure during major flood events. • Scour protection measures would take the form of dumped rock riprap or reno mattress.			
	FH-3	A contingency plan to be prepared to manage a potential flood event during construction that would outline procedures to reduce the likelihood, including removing plant/equipment and stabilising exposed areas. This plan would consider the likelihood of flooding, evacuation routes, warning times, and potential impacts from the site flooding.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.
General construction impacts	SWC-1	A Soil and Water Management Plan (SWMP) would be developed in accordance with the Roads and Maritime specification G38 – Soil and Water Management and the Blue Book – Soils and Construction – Managing Urban Stormwater Volume 1 (Landcom, 2004) and Volume 2D (DEC, 2008a). The SWMP would include but not be limited to: • An erosion and sedimentation control plan and maintenance schedule for ongoing maintenance of temporary	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		erosion and sediment controls • A Sediment Basin Management Plan to guide appropriate management of runoff during construction and operation • An incident emergency spill plan which would include measures to avoid spillages of fuels, chemicals and fluids onto any surfaces or into any nearby waterways. • Preparation of a wet weather rain event which includes a process for monitoring potential wet weather and identification of controls to be implemented in the event of wet weather. • Provision of a maintenance schedule for ongoing maintenance of erosion and sedimentation controls. • A review process by a soil conservationist and a process for updating the report to address any recommendations. • A farm dam dewatering plan to be prepared include: - A map showing locations of farm dams to be dewatered - Methodology for dewatering dams with consideration to aquatic ecology - Location of any offsite discharge points.			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Requirements to manage encounters of contaminated water.			
Water quality during construction	SWC-2	A water quality monitoring program would be developed during detailed design which would outline the pre-construction baseline water quality monitoring to be undertaken, as well as the ongoing construction and operational water quality monitoring requirements. The program would be updated once the construction and operational phase water quality monitoring parameters have been determined (based on the results of the baseline water quality monitoring). The program would include specific monitoring locations, frequency, parameters, and relevant procedures to be implemented. This would include a procedure to be followed in the event that monitoring results during construction or operation indicate an exceedance of the specified criteria, including any stop works requirements, relevant non-conformance, corrective and preventative actions, reporting and review procedures. This would include a requirement to review the effectiveness of control measures and identify any potential additional controls or revised work procedures or management measures that may need to be implemented. It is noted that any sample locations or access requirements within the DEOH site would be determined in	Construction contractor / Roads and Maritime	Pre-construction / construction / operation	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		consultation with DoD.			
	SWC-3	The realignment of the tributary of Surveyors Creek would be progressively stabilised to avoid potential scour and sedimentation and permanent stabilisation measures would be implemented as soon as practicable.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.
	SWC-4	50 temporary sediment basins are proposed during construction of the project (See Table 8-15).	Construction contractor	Construction	Proven to be effective Temporary basins have been designed to provide sufficient volume for settling and storage of sediments.
Soil salinity impacts	SWC-5	Durability and aggressivity samples of soil material would be collected and analysed prior to the construction phase, to determine potential impacts of soil salinity on pavement infrastructure.	Contractor	Pre-construction	Proven to be effective.
Sedimentation and Erosion	SWC-6	Erosion and sediment controls would implemented before construction starts in accordance with Blue Book requirements: • Sediment basins would be regularly serviced and maintained to comply with water quality and capacity requirements • Clearing of vegetation and site stabilisation of disturbed areas would be	Construction contractor	Construction	Proven to be effective. Monitoring and reporting built into the SWMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		undertaken progressively to limit the time disturbed areas are exposed to erosion prices • High risk soil and erosion activities such as earthworks would not be undertaken immediately before or during high rainfall or wind events • Stockpiling of topsoil separately for potential reuse in landscaping and rehabilitation works • Permanent catch drains would be installed behind cut faces to act as diversion drains during the construction phase • Erosion and sediment control measures would be maintained until the works are complete and areas are stabilised by revegetation.			
Sedimentation and Erosion	SWC-7	A soil conservationist from RMS Erosion, Sedimentation and Soil Conservation Consultancy Services would be engaged to review the erosion and sedimentation plans and conduct routine inspections of the construction works.	Roads and Maritime	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the SWMP to confirm effectiveness of measures.
Impacts to water pollution (surface water and groundwater)	SWC-8	• All fuels, chemicals, and liquids would be stored at least 50 m away from the existing stormwater drainage system and would be stored in an impervious bunded	Construction contractor	Construction	Expected to be effective. Monitoring and reporting to confirm effectiveness of

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		area within the compound site • The refuelling of plant and maintenance machinery would be undertaken in impervious bunded areas in the designated compound area • Vehicle wash downs and/or concrete truck washouts would be undertaken within a designated bunded area of an impervious surface or undertaken off-site • Disposal of dam water would be done in accordance farm dam dewatering plan.			measures. Continuous improvement to be achieved through ongoing evaluation of monitoring results.
Impacts to water pollution (surface water and groundwater)	SWC-9	It is not expected that specific controls for groundwater would be required. This is primarily due to the low to very low permeability of Wianamatta Shale and subsequently minor to negligible extent of drawdown and negligible seepage through identified road cuttings. The expected groundwater inflows are anticipated to be in the order of 0.1 L/s/km of cuttings, although probably much less. It is considered prudent that if groundwater is encountered during excavation works the groundwater monitoring plan detailed below should be implemented.	Construction contractor	Construction	N/A
Disturbance of contaminated or potentially contaminated land	SWC-10	Intrusive investigations should be undertaken in the vicinity of moderate risk areas including service stations (operational and non-operational), stockpiles and market gardens	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CLMP to confirm effectiveness of

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• A Contaminated Land Management Plan would be prepared in accordance with the Contaminated Land Management Act 1997, relevant EPA Guidelines and *Roads and Maritime Guideline for Management of Contamination* (Roads and Maritime,2013) and would include at a minimum: - Contaminated land legislation and guidelines including any relevant licences and approvals to be obtained - Identification of locations of known or potential contamination and preparation of a map showing these locations - Identification of rehabilitation requirements, classification, transport and disposal requirements of any contaminated land within the construction footprint - Measures to manage stockpiled potentially contaminated soil in accordance with the requirements of NSW EPA Waste Guidelines - Contamination management measures including waste classification and reuse procedures and unexpected finds procedures for unanticipated discovery of			measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		contaminated material during construction - Asbestos handling and disposal requirements in accordance with NSW EPA guidelines Excavated material that is not suitable for on-site reuse or recycling would be transported to a site that may legally accept that material for reuse or disposal.			
Encountering UXO	SWC-11	For UXO's, an investigation should be undertaken to confirm the likelihood of UXO's being present within the areas of the project within DEOH. The investigation should be undertaken prior to construction activities by a suitably qualified consultant registered on the Commonwealth Department of Defence UXO Panel (DUXOP) now subsumed into the Defence Environment and Heritage Panel (DEHP).	Construction contractor	Construction	Proven to be effective
Aboriginal construction heritage management plan	AH-1	A Construction Cultural Heritage Management Plan (CCHMP) would be prepared prior to construction and implemented as part of the CEMP. The CHMP would include details on: • The policy basis for management measures • The erection of any temporary fencing for the protection of heritage sites being	Construction Contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CHMP to confirm effectiveness of measures. Specific measures carried out in accordance with agreed guidelines and by qualified archaeologists.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		partially impacted • Unexpected finds procedures • Responsibilities for heritage management • Salvage excavation methodologies • Consultation requirements • Procedures for monitoring and reporting on the effectiveness of measures.			
Archaeological sites partially impacted by the project	AH-2	The location of the portions of these sites to be conserved would be identified in the CHMP, Construction Heritage Sites Map and project inductions to ensure they are not inadvertently damaged as a result of construction works The portion of the site outside the project boundary would be fenced off prior to the commencement of construction works in accordance with the management procedures outlined in the CHMP Archaeological salvage excavation would be undertaken for the impacted portion of the following sites in accordance with the salvage excavation methodology detailed in Appendix M: – B6 – TNR AFT 08 – TNR AFT 11 – TNR AFT 12 – TNR AFT 13 – TNR AFT 14	Construction contractor	Construction	Expected to be effective. Salvage excavation activities would be carried out in accordance with the methodology outlined in the CHAR by a qualified team and in consultation with relevant stakeholder groups. The salvage methodology is considered bot efficient and effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		– TNR AFT 20 – TNR AFT 22 – TNR AFT 24 – TNR AFT 26 – TNR AFT 27 – TNR AFT 29 – TNR AFT 30 – TNR AFT 31 – TNR AFT 33			
Archaeological sites wholly impacted by the project	AH-3	• Archaeological salvage excavation would be undertaken for the following wholly impacted sites in accordance with the management procedures outlined in Appendix M: – TNR AFT 06 – TNR AFT 07 – TNR AFT 16 – TNR AFT 17 – TNR AFT 19 • Archaeological salvage excavation must be completed prior to any activities which may harm Aboriginal objects in accordance with the management procedures outlined in Appendix M • No construction activities would occur on lands to be salvaged until the relevant archaeological excavations at the nominated site have been completed	Roads and Maritime	Pre-Construction	Expected to be effective. Salvage excavation activities would be carried out in accordance with the methodology outlined in the CHAR by a qualified team and in consultation with relevant stakeholder groups.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Unexpected identification of skeletal remains	AH-4	In the event of the unexpected discovery of suspected archaeological Aboriginal human remains during the proposed works, in addition to the procedures outlined in the Roads and Maritime Unexpected Heritage Items Procedure (2015a), the CHMP would require that Roads and Maritime immediately notify the identified knowledge holders of the discovery. If the material is confirmed to be archaeological Aboriginal human remains that consultation would occur with the identified knowledge holders. Procedures for Handling Human Remains are detailed in Appendix M and summarised below: • As soon as remains are exposed, all work is to halt at that location immediately and the Project environmental manager on site is to be immediately notified to allow assessment and management: – Stop all activities and – Secure the site. • Contact police as the discovery of human remains triggers a process which assumes that they are associated with a crime. The NSW Police retain carriage of the process until such time as the remains are confirmed to be Aboriginal or historic • The relevant approval authority(s) will be notified when human remains are found • Once the police process is complete and if remains are not associated with a	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHAR.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		contemporary crime contact the relevant approval authority(s) who will determine the process in consultation with OEH and/or the Heritage Office as appropriate: – If the remains are identified as Aboriginal, the site is to be secured and the approval authority(s) and all Aboriginal stakeholders are to be notified in writing. The approval authority(s) will act in consultation with OEH as appropriate. OEH will be notified in writing according to the approval authority(s) instructions or – If the remains are identified as non-Aboriginal (historical) remains, the site is to be secured and the approval authority(s) is to be contacted, who will act in consultation with the Heritage Division as appropriate. The Heritage Division will be notified in writing according to the approval authority(s) instructions • Once the police process is complete and if the remains are identified as not being human work can recommence once the appropriate clearances have been given.			
Unexpected identification of Aboriginal objects	AH-5	Where there is a proposed change to the project (once approved), this change will be considered in the context of potential impact to Aboriginal cultural heritage, whether increased or reduced. Where a proposed	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHAR.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		change to the approved project occurs outside of the project boundary, further heritage assessment will be required in consultation with the appointed Archaeologist to determine if there would be an impact on Aboriginal cultural heritage. Where the change is considered to have a neutral or lesser significant impact on Aboriginal cultural heritage than that identified for the approved project (as per this assessment), it would be considered a consistent impact. Where the change to the approved project is considered to have a more significant impact on Aboriginal cultural heritage than that identified in the EIS, it would be considered an inconsistent impact. In this case, Roads and Maritime would require a modification to the approved project, and further consultation with Aboriginal stakeholders would be required to be undertaken.			
Construction impacts to non-Aboriginal heritage items and places	NAH-1	A Construction Cultural Heritage Management Plan would be prepared as part of the CEMP prior to construction in consultation with the NSW Heritage Division of OEH. As a minimum, the plan would include the following: • Induction protocols for staff and project personnel to undertake a cultural heritage induction, to assist them in understanding and complying with their legal obligations	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CHMP to confirm effectiveness of measures. Specific measures carried out in accordance with agreed guidelines and by qualified

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		under the Heritage Act 1977 • A list, plan and GIS layer showing the location of identified heritage items • A significance assessment and statement of significance for each item • Detail the mitigation measures identified and when the measures are to be implemented • Provide protocols and procedures to be enacted during construction to ensure the protection of items of heritage significance • An unexpected finds procedure in the event that further sites are identified during works • The separate procedure for the discovery of skeletal remains (highly effective).			archaeologists.
Orchard Hills Cumberland Plain Woodland (Chaffey Brothers Irrigation Scheme Canal)	NAH-2	Archival photographic recording in accordance with the Heritage Division of the OEH guidelines. This would include: • Report (paper), thumbnails, CD-R and prints (10.5x14.8cm) to NSW Heritage Office • Report (paper), thumbnails and CD-R to State Library of NSW • Report (paper), thumbnails and CD-R to	Construction contractor	Construction	Proven to be effective. An archival photographic recording would be made of the extent of the canal, including the section outside the project area, in accordance with the Heritage Division of the OEH guidelines (Heritage Council of NSW 2006) prior to its demolition

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		Owner/client • Report (paper), thumbnails and CD-R to Local Council • Report (paper), thumbnails and CD-R to Local Council Library.			
Miss Lawson's guesthouse site	NAH-3	Detailed salvage archaeological investigation of the site.	Roads and Maritime	Pre - construction	Expected to be effective. Salvage excavation would be carried out in accordance with the Heritage Division of OEH guidelines including an appropriate research design and methodology in order to best realise the research potential of this area of the site. Salvage excavation would be undertaken under the supervision of an appropriately qualified and experienced historical archaeologist in accordance with the Heritage Division of OEH criteria.
Lawson's Inn site	NAH-4	Detailed salvage archaeological investigation of the site.	Roads and Maritime	Pre - construction	
Unexpected impacts on heritage values	NAH-5	The project's Construction Environmental Management Plan would include 'unexpected finds' procedures to guide the management of any archaeological sites identified during construction. The management response would vary depending on the nature of the find, its significance and likely impacts.	Construction contractor	Construction	Expected to be effective if carried out in accordance with procedures outlined in CHMP.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Urban design	UD-1	The urban design and landscape concept developed for the project would be adopted during detailed design. This would include design treatments for: • location and identification of existing vegetation and proposed landscaped areas, including species to be used • built elements including retaining walls and Adams Road Bridge • design' treatments for stormwater quality measures and infrastructure • pedestrian and cyclist elements including footpath location, paving types and pedestrian crossings • fixtures such as seating, lighting, fencing and signs • details of the staging of landscape works taking account of related environmental controls such as erosion and sedimentation controls and drainage • procedures for monitoring and maintaining landscaped or rehabilitated areas.	Contractor	Detailed Design / Construction / Operation	Expected to be effective. Urban design outcomes have been incorporated into concept design and would be further refined during detailed design of the project in consultation with a range of stakeholders including State Government agencies, Penrith City Council, Liverpool City Council and the local community.
Lighting impacts	UD-2	The design of temporary lighting must avoid unnecessary light spill on adjacent residents or sensitive receivers and be designed in accordance with AS 1158.1-1986.	Contractor	Detailed Design / Construction	Proven effective if carried out in accordance with AS 1158.1-1986.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Visual impacts from construction sites	UD-3	Consider the provision of barriers to screen views from visually sensitive nearby areas such as rural dwellings, residential and recreational areas.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts from construction sites	UD-4	Contain construction activities within the construction works zone boundary and occupy the minimum area practicable for limiting impacts on adjoining areas, including the extent of native vegetation clearing.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-5	Construction programming must show how progressive rehabilitation of disturbed areas would be undertaken to minimise the duration and extent of temporary visual and landscape character impacts and to minimise soils exposure and the potential for erosion and dust generation.	Contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Visual impacts as a result of vegetation loss	UD-6	Existing trees to be retained within construction areas are to be identified, protected and maintained in accordance with AS4970 Trees on Development Sites, or as otherwise directed by a qualified ecologist or arborist.	Contractor	Construction	Proven effective if carried out in accordance with AS4970 Trees on Development Sites.
Excessive exhaust emissions arising from plant and equipment	AQ-1	• Plant and equipment would be operated in a proper and efficient manner by: – Inspecting the plant/equipment prior	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		to commencement of works on site – Conducting routine servicing and maintenance, and subsequent inspections to ensure that equipment continues to operate efficiently.			confirm effectiveness of measures.
Dust generation and emissions at compound locations	AQ-2	• Installation of perimeter screening around compound sites • Impose low speeds limits around compound sites to limit the generation of dust from vehicle movements • Apply wheel-wash or rumble grid facilities at access points to limit the tracking of materials beyond the site boundary • Ensure that compound area surfaces are well compacted or sealed to limit the potential for dust generation • Regularly water stockpiles and limit the amount of materials stockpiled around the site. • Position stockpiling areas as far as possible from surrounding receivers • Limit stockpiling activities during conditions where winds are blowing strongly in the direction(s) from the stockpiling location to nearby receivers. • Consultation would be carried out consistent with the Community	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		Consultation Framework in relation to air quality near ancillary sites and relevant incident management process during construction.			
Dust generation and emissions from construction activities and materials haulage	AQ-3	• Impose low speeds limits across all site haulage routes • Ensure that all loads are covered when materials are being hauled to and from site • Wherever possible, position internal haulage routes away from surrounding receivers • Regular watering of exposed and disturbed areas especially during inclement weather conditions. • Wherever possible, minimise the extent of disturbed and exposed surfaces, and restore as soon as possible • Adjust the intensity of activities based on measured dust levels, weather forecasts and the proximity of and direction of the works in relation to the nearest surrounding receivers • Ensure that any material exposed areas are secured during project shutdown periods to prevent any dust emanating over adjacent roads	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Install depositional dust gauges to quantify dust levels and determine whether control measures are adequate or whether further actions are required. • These gauges should be installed at regular intervals along the project alignment at representative receiver locations. Gauges should also be installed around major construction compound and stockpiling locations.			
Windborne dust emanating from non-vegetated surfaces	AQ-4	• Stage work to ensure that finished areas are revegetated as soon as possible • Regularly maintain and water revegetation areas to aid the establishment of adequate vegetation cover.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Odours arising from uncovered contaminated and/or hazardous materials.	AQ-5	Application of odour supressing agents to materials as necessary to minimise related impacts should any contaminated or hazardous materials be uncovered during the works.	Construction contractor	Construction	Expected to be effective. Monitoring and reporting requirements of the CEMP to confirm effectiveness of measures.
Cumulative dust impacts arising from con-current construction of the	AQ-7	• Develop construction program in consultation with the contractor(s) developing the Western Sydney Airport site. Maintain consultation through the course of both projects to plan activities in	Construction contractor	Prior to and during construction	Expected to be effective. Monitoring and reporting requirements of the OEMP to confirm effectiveness of

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
proposed upgrade and the Western Sydney Airport		a manner which limits potential air quality-related impacts. • Wherever possible and practical, co-ordinate activities with a high potential to generate dust so that they do not occur at the same time. • Stop activities if dust is observed to be emanating from the airport			measures.
Inappropriate handling and/ or disposal of waste	WR-1	The waste minimisation hierarchy principles of avoid/reduce/reuse/ recycle/dispose would be used	Construction contractor	Construction	Proven to be effective
	WR-2	A project-specific *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented	Construction contractor	Pre-Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		• Measures to be applied where waste is required to be handled and stored onsite prior to onsite reuse or offsite recycling/disposal • Specific measures to manage vegetation waste • Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			
Inappropriate handling and/ or disposal of waste	WR-3	All wastes, including contaminated wastes, would be identified and classified in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste*.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
					measures.
	WR-4	Disposal of any non-recyclable waste would be in accordance with the POEO Act and *Waste Classification Guidelines: Part 1 Classifying Waste*.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-5	Trees and plant material would be mulched or chipped on-site and used in landscaping where practicable to stabilise disturbed soils where possible.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
Inappropriate disposal of excavated material that cannot be reused in the project	WR-6	Where possible and fit for purpose, spoil would be beneficially reused within the project before off-site reuse of disposal options is pursued.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-7	Excavated material that is not suitable for on-site reuse or recycling would be transported to a site that may legally accept that material for reuse or disposal.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
	WR-8	Before being transported from construction sites, excavated spoil would be classified in accordance with the *Waste Classification*	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		Guidelines: Part 1 Classifying Waste (EPA, 2014) to ensure appropriate reuse of disposal.			requirements of the CWEMP to confirm effectiveness of measures.
	WR-9	A Spoil Management Strategy would be developed prior to the commencement of construction and implement during construction. The strategy would identify spoil disposal site(s) and describe the management of spoil on-site and during off-site transport.	Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.
Resource use	WR-10	Wherever feasible and reasonable, construction material would be sourced from within the Sydney region.	Construction Contractor	Construction	Proven to be effective.
Emissions of greenhouse gases during construction	GHGC-1	Identify recycled materials (such as recycled aggregates in road pavement and surfacing; steel with recycled content) for use in construction or operation of the project where they are cost, quality and performance competitive.	Construction contractor	Detailed design	Expected to be effective if carried out in accordance with the project-specific *Construction Waste and Energy Management sub-plan* (CWEMP)
	GHGC-2	Use of modern diesel engine equipment, to ensure highest fuel efficiency ratings.	Construction contractor	Construction	Proven to be effective.
	GHGC-3	Specification of the use of biofuels, or biofuel blends in construction plant and equipment.	Construction contractor	Pre-construction	Proven to be effective
	GHGC-4	Provision of clear guidance to construction staff on equipment start up and shut down	Construction contractor	Pre-construction	Proven to be effective.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		procedures to ensure that they are not left idling when not in use.			Induction and training requirements of the CEMP to confirm effectiveness of measures.
	GHGC-5	Review of cut and fill balances for earthworks to ensure material is transported the least possible distances.	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design
	GHGC-6	Review of local options for import and export of fill materials as needed to reduce excess fuel used during transport.	Construction contractor	Construction	Expected to be effective. To be confirmed during detailed design
	GHGC-7	Specification and certification of steel from recycled sources where suitable for offsetting virgin steel	Construction contractor	Construction	Proven to be effective.
Emissions of greenhouse gases during construction	GHGC-8	Specification of materials with low embodied energy / embodied GHG content, such as: Replacement of Portland cement in concrete mixes with low carbon alternatives such as fly-ash Use of warm mix asphalt versus hot mix.	Construction contractor	Detailed design	Proven to be effective.
	GHGC-9	A project-specific *Construction Waste and Energy Management sub-plan* (CWEMP) would be prepared before construction. The plan would adopt the Resources Management Hierarchy principles of the WARR Act and include: • The major construction related waste	Construction contractor	Pre-construction	Proven to be effective. Monitoring and reporting requirements of the CWEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		streams expected to be generated from the project • The major sources of construction related energy consumption (fuel and power) • Classification of waste streams • Waste orders and exemptions • Re-use and recycling practices to be implemented • Specific measures to manage vegetation waste • Energy conservation best practice and the reduction of greenhouse gases by adopting energy efficient work practices • A resource management strategy detailing beneficial reuse options for surplus and/or unsuitable material • Procedures for the identification, handling and disposal of hazardous materials including potential asbestos waste • Protocols for engaging with and notifying residents of any work processes that may impact them • A complaints mechanism so that residents may contact the project manager • A protocol to enable the project to respond quickly to non-compliances.			

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
General	HR-1	Hazard and risk management planning would be incorporated throughout the CEMP, which may include items such as: • Details of the hazards and risks associated with construction activities • Risk management measures, including those identified in Chapters 7 and 8 of this EIS • Procedures to comply with all legislative and industry standard requirements • Contingency plans, as required • Site-specific Work, Health and Safety plans and activity specific Safe Work Method Statements • Training for all personnel (including subcontractors) in site inductions, including the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
Storage of dangerous goods and hazardous substances	HR-2	Storage of dangerous goods and hazardous materials would occur in accordance with suppliers' instructions and relevant Australian Standards and may include bulk storage tanks, chemical storage cabinets / containers or impervious bunds.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
					and life safety systems.
	HR-3	Storage, handling and use of dangerous goods and hazardous substances would be in accordance with the *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).	Construction contractor	Construction	Proven to be effective if carried out in accordance with *Work Health and Safety Act 2011* and the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW, 2005).
Storage of dangerous goods and hazardous substances	HR-4	Secure, bunded areas would be provided around storage areas for oils, fuels and other hazardous liquids.	Construction contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire and life safety systems.
	HR-5	Material Safety Data Sheets would be obtained for dangerous goods and hazardous substances stored onsite prior to their arrival.	Construction contractor	Construction	Proven to be effective.
Contamination from transportation of hazardous goods	HR-6	Transport all hazardous substances in accordance with relevant legislation and codes, including the Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998 and the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (National Transport Commission, 2008).	Construction Contractor	Construction	Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace practices, and regular testing and monitoring of any fire

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
					and life safety systems.
Bushfire	HR-7	Measures to mitigate and manage bushfire would be developed and included as part of site-specific hazard and risk management measures within the CEMP	Construction Contractor	Construction	
Cumulative impacts	CI-1	Consultation would be undertaken with local communities potentially affected by the impacts of multiple projects in addition to the project.	Roads and Maritime / Construction Contractor	Construction	Expected to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
Cumulative impacts	CI-2	Where relevant, consultation would be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. To ensure flexibility in the communications approach to the project, communications and engagement activities would be monitored, assessed and reported regularly.
	CI-3	Construction traffic management plans for this project should be developed in consultation with plans for these projects so that increased traffic on the local road network would be spread over the road network to ensure that construction traffic is not concentrated on any one particular route if there are alternatives available	Roads and Maritime / Construction Contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.

12.4 Operational environmental management

Once construction on the Northern Road upgrade has been completed, the responsibility for ongoing operational management would be handed back to Roads and Maritime from the construction contractor.

The maintenance and management of the Roads and Maritime road asset network in the Sydney region has been vested to private organisations that carry out all operational aspects of the network on behalf of Roads and Maritime in the form of Stewardship Maintenance Contracts. The obligations under the *Roads Act 1993*, the *Environmental Planning and Assessment Act 1979* and the State Infrastructure Planning Policy (Infrastructure) 2007 and all other relevant legislation is the responsibility of the private organisations as an agent of Roads and Maritime. In addition, organisations contracted to provide operational maintenance for Roads and Maritime are bound to address any operational requirements provided by the Minister through the Conditions of Approval for the project.

Roads and Maritime manage their legislative and environmental management obligations through the use of a number of procedures, guidelines, guidance notes, and technical notes to provide guidance and set expectations in environmental planning and management of the road network and assets. Specifications, including, but not limited to Routine Services Specification (M3); General Specification – Environmental Protection (Management Systems) Maintenance (G36M); General Specification – Soil and Water Management (G38) are used to outline the environmental planning and management expectations and requirements of the Stewardship Maintenance Contractors. The Stewardship Maintenance Contractors are also required to operate under an Environmental Management System, have a program Environmental Management Plan and have specific Construction Environmental Management Plans activities that are undertaken on the network.

The iterative design and EIS process has enabled Roads and Maritime to avoid and minimise environmental impacts from the project where possible. Where environmental controls have been incorporated into the design there is a program of monitoring and review including independent auditing, to ensure the controls comply with stated objectives (refer Table 12-5).

Specific monitoring that would be considered during operation of the project may include:

- Noise monitoring to compare actual noise performance of the project against predicted noise performance
- Monitoring and maintaining landscaped or rehabilitated areas
- Monitoring of surface water quality in order to:
  - Assess and manage impacts on the receiving waters as the site stabilises
  - Assist in deciding when the site has stabilised
  - Identify water quality conditions after development.

Table 12-5 Summary of operational environmental safeguards and management measures

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Operational noise impacts	NV-4	Where noise barriers and/or low noise pavements are not considered feasible and/or reasonable, noise impacts at affected dwellings would be mitigated by at-property treatments.	Roads and Maritime	Operation	Proven to be effective To be carried out in consultation with affected residents
	NV-5	Within 12 months of the commencement of operation of the project an operational noise review would be undertaken. This would include: • Monitoring to compare actual noise performance of the project against predicted noise performance • An assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all feasible and reasonable mitigation measures • Identification of any additional feasible and reasonable measures that would be implemented with the objective of meeting the criteria in the *NSW Road Noise Policy* (DECCW, 2011), when these measures would be implemented and how their effectiveness would be measured and reported.	Roads and Maritime	Operation	Proven to be effective

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Noise, light and vibration	B-19	Shading and artificial light impacts would be minimised through detailed design. Measures to mitigate potential noise and vibration impacts are provided in Section 7.2 of the EIS.	Roads and Maritime	Detailed design	Expected to be effective.
Operational socio-economic impacts	SE-13	Appropriate road signage would be provided in accordance with the Roads and Maritime Services guidelines Tourist Signposting (2012) to provide guidance to passing patrons on access to shops and services, including within Luddenham town centre.	Construction contractor	Construction	Proven to be effective. Monitoring and reporting requirements of the TMP to confirm effectiveness of measures.
Operational socio-economic impacts	SE-14	Roads and Maritime will, in consultation with Liverpool Council, provide appropriate support for preparation of plans to revitalise Luddenham town centre, for the purpose of encouraging motorists to continue to pass through or visit the town. Any streetscape and landscape treatments would be determined after finalisation of any town centre revitalisation plans.	Roads and Maritime	Pre-construction and construction	Expected to be effective. Roads and Maritime have experience with similar by-pass projects in NSW.
Impacts on flood behaviour during operation	FH-4	The transverse drainage and flood mitigation strategy would continue to be refined during detailed design. If the properties are still impacted, and if mitigation is required, this would be investigated in consultation with the landowners. It would include but not be limited to: • Identification of potential flood impacts to	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
		the project and adjoining areas, including consideration of local drainage catchment assessments and climate change implications on rainfall, drainage • Design and mitigation measures to protect proposed operations and not worsen existing flooding characteristics during construction and operation, including soil erosion and scouring • Drainage system upgrades and preparation of a Flood and Emergency Management Plan.			
	FH-5	The 100 year ARI flood level is to be adopted in the assessment of measures which are required to mitigate any adverse impacts attributable to the project. Changes in flood behaviour under PMF conditions would also be assessed in order to identify impacts on critical infrastructure and substantial changes in flood hazards as a result of the project.	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties
	FH-6	A floor level survey would be undertaken in affected areas to determine whether the project would increase flood damages in adjacent developments (ie in properties where there is a potential for increases in peak flood levels for events up to the 100 year ARI flood).	Roads and Maritime	Detailed design	Proven to be effective. Further design development would be carried out at detailed design stage to reduce the potential for flood attributable to the project in the affected properties

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Reductions in water volumes	FH-7	Consultation would be carried out with each affected landholder where reductions in the volume of flow would cause existing dams to fill less frequently, reducing the available yield.	Roads and Maritime	Detailed design	Expected to be effective if carried out in accordance with consultation requirements
Operational water quality	SWC-12	24 water quality swales are proposed, including those upstream of identified sensitive receiving waterways.	Roads and Maritime	Operation	Expected to be effective. The proposed swales have been optimised by increasing their base width to provide additional water quality treatment Monitoring and reporting requirements of the WQMP to confirm effectiveness of measures and if any additional measures are required.
Roadside air quality during operations	AQ-6	• Post-construction traffic measurements should be collected to verify that traffic volumes and characteristics are not materially different from the forecast numbers considered in this assessment. • Where material differences are identified, further assessment should be completed to confirm that the level of impacts remain consistent with the predictions of this study.	Roads and Maritime Services	Operation	Expected to be effective. Monitoring and reporting requirements of the OEMP to confirm effectiveness of measures.

Potential impact	Ref #	Environmental management measure	Responsibility	Timing	Effectiveness of measures
Emissions of greenhouse gases during operation	GHGC-10	Opportunities to use renewable energy for road operation would be investigated.	Roads and Maritime	Detailed design	Expected to be effective. To be confirmed during detailed design
Incident response	HR-8	An Incident Response Management Plan would be developed and implemented. The response to incidents within the motorway would be managed in accordance with the memorandum of understanding between Roads and Maritime and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services. An incident response facility has been provided for the project.	Roads and Maritime	Operation	Proven to be effective Proven to be effective. Monitoring of safety measures would occur daily as part of routine site management procedures, for movement of hazardous goods, safe workplace, and regular testing and monitoring of any fire and life safety systems.

13 Project justification and conclusion

This chapter presents a justification of the project and a conclusion to the environmental impact statement (EIS). The justification considers how the project balances strategic and project needs against the protection of the environment and planning outcomes outlined in the objects of the EP&A Act and EPBC Act.

Table 13-1 sets out the Secretary's Environmental Assessment Requirements (SEARs) and Commonwealth EIS Guidelines as they relate to the project's justification and conclusion.

Table 13-1 SEARS and Commonwealth EIS Guidelines for cumulative impacts

Environmental assessment requirements	Where addressed in the EIS
Secretary's Environmental Assessment Requirements	
a statement of the objectives of the proposal, including a description of the strategic need, justification, objectives and outcomes for the proposal, and as relevant the outcomes and objectives of relevant strategic planning and transport policies, including, but not limited to, *NSW 2021, NSW Government State Infrastructure Strategy, NSW Long Term Transport Master Plan* (December 2012), *A Plan for Growing Sydney* (December 2014) and any other relevant plans.	Section 3.6 Section 13.1
an analysis of feasible alternatives to the carrying out of the proposal and proposal justification, including: • justification for the preferred proposal taking into consideration the objects of the *Environmental Planning and Assessment Act 1979*	An analysis of the alternatives and options considered for the project is presented in Chapter 4 (Project development and alternatives) An analysis of how the project meets the objects of the EP&A Act is presented in Section 13.1 and Table 13.3
Commonwealth EIS Guidelines	
An overall conclusion as to the environmental acceptability of the proposal on protected matters must be provided, including: (a) Discussion on how consideration has been given to the objects of the EPBC Act, principles of ecological sustainable development and the precautionary principle (b) Justification for undertaking the proposal in the manner proposed, including the acceptability of the avoidance and mitigation measures (c) A discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on protected matters, and the relative degree of compensation and acceptability.	Table 13.3 Table 13.4 Chapter 10 Section 13.1 Section 13.2

13.1 Justification

The project is located within the western Sydney region with a current population of about two million people. The population of the Sydney metropolitan area is expected to grow by around 1.6 million people by 2031 with the majority of this growth expected to be in western Sydney, which is expected to experience a population increase of around one million people (DPE, 2014).

The upgrade of The Northern Road is part of the Australian and NSW government funded Western Sydney Infrastructure Plan (WSIP). The WSIP is a 10 year, $3.6 billion plan which involves major road and transport linkages that will capitalise on the economic gains from developing the Western Sydney Airport at Badgerys Creek, the Western Sydney Priority Growth Area (WSPGA) and the South West Priority Growth Area (SWPGA) whilst boosting the local economy and liveability of western Sydney.

These major land use changes, together with natural growth in the regional centres of Penrith and Campbelltown, will drive a dramatic increase in traffic demand in the region. The pressures placed on the surrounding road network by the planned development in the region as well as the associated passenger and freight traffic generated by the Western Sydney Airport will exceed the capacity of the current The Northern Road, particularly at existing priority intersections along the corridor

Traffic modelling carried out for the project indicates that traffic volumes along The Northern Road (north of Bringelly Road) are anticipated to reach and exceed carrying capacity in peak hours by 2021. This is consistent with The Northern Road Corridor Strategy (RTA 2009), which forecast the majority of intersections to provide inadequate service by 2026, resulting in severe local congestion.

This forecast indicated the need for substantial upgrades along The Northern Road to provide sufficient capacity to serve the forecast traffic demand. In addition to the need to serve increased traffic demand, the construction of both the Western Sydney Airport and the proposed M12 Motorway create the need for a high-capacity route to and from the Sydney Motorway Network for construction traffic generated by these developments.

Additionally, a three kilometre section of the existing The Northern Road alignment bisects the Western Sydney Airport site south-east of the Luddenham town centre. This section of road requires realignment around land identified by the DIRD as required for operation of the Western Sydney Airport. The realignment would allow for the construction of the airport, while ensuring the road maintains north–south connectivity for communities in western Sydney.

As a key component of overall upgrade of The Northern Road Upgrade and the WSIP, the project would provide greater connectivity within the region and cater for future traffic from planned residential and commercial developments in time for the Western Sydney Airport.

The project also supports the implementation of a number of other key transport and infrastructure plans in NSW, such as NSW 2021, the State Infrastructure Strategy 2012–2032, the NSW Long Term Transport Master Plan and A Plan for Growing Sydney. Broadly, the project supports these plans by enhancing western Sydney's sustainable transport network to support jobs growth in the area, the Western Sydney Airport and directly improving transport connections to key development and growth areas.

Overall, the project is considered to be in the public interest because it would provide the following benefits:

- Facilitate the construction and ongoing operation of the Western Sydney Airport
- Address existing road safety and intersection performance
- Accommodate future traffic growth and improve accessibility for road users accessing the WSPGA, SWPGA and other development projects in western Sydney
- Develop new infrastructure for public and active transport modes
- Support regional benefits related to the broader program of upgrades proposed under WSIP, such as the provision of high capacity traffic and freight links

- Support the development and operation of the Western Sydney Airport and WSPGA
- Support the potential benefits and operational viability of the Western Sydney Airport and WSPGA.

13.1.1 Project justification

Program objectives for the WSIP were developed in February 2015 by representatives of Roads and Maritime, Transport for NSW and the Department of Infrastructure and Regional Development (DIRD). As a key part of the WSIP, the project would deliver a combination of new, additional and renewed infrastructure. In consideration of the broader objectives for WSIP, specific objectives were developed for the project. The project and WISP objectives are listed in Section 3.4 of this EIS. A summary of how the project complies with the WSIP and project objectives is provided in Table 13-2.

Table 13-2 Project compliance with WSIP and project objectives

WSIP and project objectives	Response
WSIP program objectives	
Development and demand – Support the Western Sydney Airport, and land use change and residential growth; balancing functional, social, and environmental and value for money considerations	The project would meet this objective by: • Providing a safe modern high capacity road corridor to support future increased traffic generation from the construction and operation of a Western Sydney Airport at Badgerys Creek, and land use changes in the region • Linking with other proposed road upgrades in the region to provide a high capacity integrated road network • Minimising environmental and social impacts through design and development of appropriate environmental management measures • Providing value for money by servicing both a Western Sydney Airport and land use changes in the region.
Connectivity to airport – Provide a resilient connection to the Western Sydney Airport site for freight and people	The preferred alternative would meet this objective by: • Linking with other proposed road upgrades in the region (eg the proposed M12 Motorway) to provide a high capacity link to a Western Sydney Airport at Badgerys Creek • Providing high capacity freight access to the south-west section of the Western Sydney Airport site • Providing dedicated bus lanes, which would form part of the initial main public transport link to a Western Sydney Airport at Badgerys Creek.
Integrated network – Provide road	The preferred alternative would meet this objective by:

WSIP and project objectives	Response
improvements to support and integrate with the broader transport network	• Integrating with other planned road upgrades (including The Northern Road upgrades to the south of Mersey Road, Bringelly and to the north of Glenmore Parkway, Glenmore Park and the proposed M12 Motorway) • Providing dedicated bus lanes which would integrate with existing and new bus routes in the region.
Customer focus – Provide meaningful engagement with customers and stakeholders throughout the program life	• All project development activities have and would be undertaken to comply with this objective. For example, substantial and meaningful engagement with customers, the community and other stakeholders has been undertaken to identify the route for the section of The Northern Road that needs to be realigned – refer to Section 6 for further detail. Engagement activities would continue throughout the EIS, design, construction and operational phases.
The Northern Road Upgrade project objectives	
Realignment of The Northern Road around the Western Sydney Airport site to allow construction and facilitation of a Western Sydney Airport at Badgerys Creek	The preferred alternative would meet this objective by: • Realigning the section of The Northern Road that currently bisects the Western Sydney Airport site • Providing a high capacity road corridor and direct links to the Western Sydney Airport site to support airport related construction.
Cater for future traffic demand to improve the flow of traffic to provide reliable journeys	The preferred alternative would meet this objective by: • Providing three lanes northbound and southbound (two general traffic lanes and one bus lane each way) between Mersey road and Bradley Street and upgrading to four lanes (three general traffic lanes and one bus lane) between Bradley Street and Glenmore Parkway to cater for future traffic demand. In some sections, the provision of four lanes may be staged to occur after 2019 • Upgrading intersections and associated traffic controls to provide more reliable journeys and reduce crashes • Providing Intelligent Transport Systems (ITS) infrastructure to provide information on traffic conditions and incidents to road users.
Improve the transport connections from	The preferred alternative would meet this objective by:

WSIP and project objectives	Response
the Penrith region and M4 Western Motorway to the Western Sydney Airport and surrounding developments including the SWPGA and WSPGA	• Integrating with other planned road upgrades (including The Northern Road upgrades to the south of Mersey Road, Bringelly and to the north of Glenmore Parkway, Glenmore Park and the proposed M12 Motorway) • Providing new or upgraded intersections with other arterial and local roads.
Improve facilities for public and active transport to promote sustainable and efficient journeys	The preferred alternative would meet this objective by: • Providing dedicated southbound and northbound bus lanes • Providing upgraded bus stops and supporting possible new bus routes • Providing a shared path along the western side of the upgrade and a footpath along the eastern side as required.

13.1.2 Objects of the EP&A Act

The objects of the EP&A Act provide a framework within which the justification of the project can be considered. A summary of how the project relates to these objectives is provided in Table 13-3.

Table 13-3 Objectives of the EP&A Act

EP&A Act objective	Comment
To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, waters, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	The project would manage, develop and conserve natural and artificial resources appropriately and result in social and economic benefits to the community. The project would promote social and economic welfare by reducing congestion and improving transport efficiency along The Northern Road corridor for both people and freight. The project would also make efficient use of land by utilising an existing transport corridor where possible, minimising acquisition of private properties and maximising use of government land. Where new road corridor is proposed, the route options process has sought to minimise the impacts of the project on residential and agricultural land and ecologically sensitive areas. A range of safeguards and management measures are proposed to address potential environmental impacts, including biodiversity offsets under the NSW Government Framework for Biodiversity Assessment.
To encourage the promotion and	The project promotes the orderly development of the

EP&A Act objective	Comment
coordination of the orderly and economic use and development of land.	region through being an integral element in the many changes either planned or already under way, in western Sydney. The upgrade of The Northern Road is needed to support not only the development of the Western Sydney Airport at Badgerys Creek, but also to support the planned expansion of the South West Priority Growth Area (SWPGA) and the Western Sydney Priority Growth Area (WSPGA). In doing so, the project would help to capitalise on the economic gains from developing surrounding land uses.
To encourage the protection, provision and coordination of communication and utility services.	The project is designed to minimise impacts on communication and utility services within the corridor. Where relocation is required this would preferably be undertaken within the footpath or shared user path to enable greater access for maintenance activities wherever possible. However some relocation in the road corridor may be required, including on local side streets, in order to minimise disruption. The required works would be confirmed during detailed design in consultation with utility providers, taking into consideration tie in with local streets as required.
To encourage the provision of land for public purposes,	The project would provide a public road.
To encourage the provision and coordination of community services and facilities.	The project would improve the transport network of the area providing improved access and connectivity to community services and facilities within western Sydney region and locally within Luddenham.
To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The process of selecting the preferred route alignment considered ways to avoid and minimise impacts to the environment. In particular, maximising the use of existing road corridor in the northern segment of the project and undertaking environmental assessments during concept design development has reduced the potential impact of the project where possible. In accordance with the requirements of the Framework for Biodiversity Assessment, the process for identifying and evaluating biodiversity offsets has been documented in the Biodiversity Offset Strategy appended to the Biodiversity Assessment Report. A range of management measures have been developed to further minimise impact on biodiversity through the detailed design and construction phases of the project.
To encourage ecologically sustainable development.	Ecologically sustainable development has been considered throughout project planning, including

EP&A Act objective	Comment
	alternatives and route options development as detailed in Chapter 4. The way the four tenets of ESD have been recognised and applied during the development and assessment of the project is considered in detail in Chapter 10.
To encourage the provision and maintenance of affordable housing.	Not relevant to the project.
To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Not relevant to the project.
To provide increased opportunity for public involvement and participation in environmental planning and assessment.	The project development process has involved extensive consultation with relevant stakeholders and the community. Consultation carried out to date and proposed ongoing consultation is outlined in Chapter 6. Additionally, the route options development process involved community and stakeholder consultation (Chapter 4).

13.1.3 Objects of the EPBC Act

The objectives and principles of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are outlined in Sections 3 and Section 3A of the EPBC Act. A summary of how the project relates to these objectives is provided in Table 13-4.

Table 13-4 Objectives of the EPBC Act

EPBC Act objective	Comment
(a) To provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance	The process of selecting the preferred route alignment considered ways to avoid and minimise impacts to the environment, including matters of national environmental significance. Project impacts on matters of national environmental significance relate to listed species and ecological communities. All practicable steps to avoid or minimise impacts to biodiversity would be implemented during the detailed design phase to reduce the scope of the overall impact. This would include the application of measures such as road design refinements to reduce the project footprint and incorporating design features to minimise impacts, where practical. The EIS also considers the impacts to the environment of Commonwealth land. In accordance with the requirements of the Framework for Biodiversity Assessment, the process for identifying and evaluating biodiversity offsets has been documented in the Biodiversity Offset Strategy appended to the Biodiversity Assessment Report. A range of management measures have been developed to further minimise impact on biodiversity through the detailed design and construction phases of the project.
(b) To promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources	Ecologically sustainable development has been considered throughout project planning, including alternatives and route options development as detailed in Chapter 4. The way the four tenets of ESD have been recognised and applied during the development and assessment of the project is considered in detail in Chapter 10.
(c) To promote the conservation of biodiversity	The implementation of mitigation measures outlined in this EIS and the Biodiversity Offset Package would support the viability of threatened species and communities that are impacted by the project.
(d) To promote a cooperative approach to the protection and management of the environment involving governments, the community, land-holders and indigenous peoples	The project development process has involved extensive consultation with relevant stakeholders, indigenous groups and the community. Consultation carried out to date and proposed ongoing consultation is outlined in Chapter 6. Additionally, the route options development process involved community and stakeholder consultation (Chapter 4).
(e) To assist in the cooperative implementation of Australia's	The EPBC Act provides a framework for protection of the Australian environment, including its biodiversity and its

EPBC Act objective	Comment
international environmental responsibilities	natural and culturally significant places. Through assessing potential impacts and developing appropriate mitigation measures or offset strategies, the project supports Australia's international environmental responsibilities.
(f) To recognise the role of indigenous people in the conservation and ecologically sustainable use of Australia's biodiversity	Roads and Maritime is committed to effective consultation with Aboriginal communities regarding their activities and their potential for impact on Aboriginal cultural heritage. The Roads and Maritime PACHCI was developed to provide a consistent means of effective consultation with Aboriginal communities regarding activities which may impact on Aboriginal cultural heritage and a consistent assessment process for Roads and Maritime activities across NSW. The aim of consultation is to integrate cultural and archaeological knowledge and ensure registered stakeholders have information to make decisions on Aboriginal cultural heritage. Consultation with Aboriginal people has also been carried out in accordance with the OEH Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010 (OEH 2010a) and the requirements of Clause 80C of the National Parks and Wildlife Regulation 2009. Roads and Maritime invited Aboriginal people who hold knowledge relevant to determining the cultural heritage significance of Aboriginal objects and Aboriginal places in the project area to register an interest in a process of community consultation
(g) To promote the use of indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.	

13.2 Conclusion

This environmental assessment has addressed the key issues identified in the Secretary's environmental assessment requirements (SEARs) issued under Part 5.1 of the EP&A Act and the Commonwealth EIS Guidelines issued under Part 8 of the EPBC Act. A checklist showing where the SEARs and Commonwealth EIS Guidelines are addressed in this environmental assessment is provided in Appendix B and Appendix C respectively.

The merits of the project were considered in the context of other alternatives and a detailed route options development process was carried out early in project planning to avoid or minimise potential environmental impacts from the project where possible. The preferred option outlined in this EIS was deemed to be in the public interest by providing the best outcome of supporting the Western Sydney Airport and catering for the growth in travel demand as a result of the planned land use changes in the region.

Notwithstanding, the project would result in impacts during construction and operation.

During construction, key adverse outcomes expected include:

- Up to 39.6 ha of remnant native vegetation as assessed under the Framework for Biodiversity Assessment (FBA) would be cleared, including about:
  - 29.14 ha of the Threatened Species Conservation Act (TSC Act) listed, critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community
  - 4.29 ha of the TSC Act listed River-Flat Eucalypt Forest on Coastal Floodplains

- About 16.37 ha of the critically endangered EPBC Act listed Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community
- Removal of about 39 threatened plants consisting of:
  - Four individuals of *Pultenaea parviflora* (EPBC Act and TSC Act)
  - 35 individuals of *Marsdenia viridiflora* subsp *viridiflora (Endangered population under TSC Act)*
- Removal of about 9.68 ha of native vegetation associated with the Orchard Hills Cumberland Plain Woodland Commonwealth Heritage Place (this is equivalent to 1.3 per cent of the native vegetation on the Heritage Place). However, these impacts would be limited to areas of low to moderate natural heritage significance with a reasonable to low tolerance for change. No areas of high natural heritage significance would be impacted by the project
- Removal of threatened fauna species habitat and habitat features, minor edging effects and the potential for the spread of weeds, pests, pathogens and disease.

During construction, the other key adverse outcomes expected include:

- Generation of additional traffic to support construction of the project. Based on arrivals to and departures from site at peak periods each working day, traffic generation is likely to be in the order of 230 additional light vehicle movements per day and about 12-13 truck movements per hour in the peak hours. The likely increase in average daily traffic volume as a result of construction activities would be less than five per cent, which is likely to have a negligible impact on the LoS along The Northern Road and Elizabeth Drive
- Temporary adverse changes to traffic conditions such as active traffic controls and temporary lane closures reducing traffic speeds and increasing travel times
- Access to some properties may be temporarily affected by the construction activities, particularly in areas where construction would be occurring along the existing The Northern Road corridor. Where access is affected, alternative arrangements would be made in consultation with land owners
- Temporary, adverse changes to local amenity from construction related air emissions such as dust from stockpiles and construction plant and vehicle emissions
- The NML will not be exceeded at any time for most receivers (>60 per cent) within NCAs 1, 6 and 8
- Across the entire study area, noise from even the loudest works will comply with the NML at 80 per cent of all residences
- Across the entire study area, noise from even the loudest works will comply with the NML at 80 per cent of all residences
- At 29 residences within the study area (2 per cent) the worst case exceedance may be more than 20 dB(A). At such times of peak impact, construction noise would be highly intrusive
- Temporary leases of land would be required during construction to accommodate ancillary construction facilities such as worksites, compounds and laydown areas. Properties identified for temporary lease mainly comprise areas of rural or vacant land, but also includes residential and commercial uses. Use and access to those areas affected by temporary leases would be temporarily disrupted during construction
- Impact to 28 Aboriginal archaeological heritage sites (20 sites assessed as having moderate significance to be salvaged and the remaining eight sites assessed as having low significance to be destroyed)
- Direct impacts to three Non-Aboriginal heritage sites including Miss Lawson's Guesthouse, Lawson's Inn and the Chaffey Brothers Irrigation Scheme Canal.

During operation, adverse impacts would include:

- The acquisition of 10 houses, and the partial acquisition of land from 83 owners across 142 lots. Generally, affected properties would be partially acquired by Roads and Maritime where only part of the property would be directly impacted by the project. In some instances Roads and Maritime would give consideration to total acquisition (dual offer) or acquisition of any residual parcels created by the location and design of the project
- Changes to some land-use including the transfer of about 45 ha of land currently owned by the Commonwealth consisting of:
  - About 25 ha of land within the Defence Establishment, Orchard Hills (DEOH)
  - About 20 ha of land purchased for the Western Sydney Airport
- The project would include a wide central median that would remove existing right turns at some intersections and property accesses. In general, the removal of right turns would increase some travel times in the order of two to three minutes
- The bypassing of Luddenham town centre may impact on local businesses that rely on passing trade
- At-property treatments are considered the most reasonable form of noise mitigation for the 77 receivers (housed within 74 buildings) for which exceedances of operational noise criteria have been predicted by this assessment
- The project would result in an increase in both the rate and volume of runoff discharging to a number of receiving drainage lines. Changes in catchment hydrology are attributable to:
  - the increase in impervious area associated with the construction of the new northbound and southbound carriageways
  - the provision of an efficient pavement drainage system which would control runoff discharging from the new carriageways
  - the diversion of surface runoff toward adjacent drainage lines
- While peak flood levels would be increased as a result of the project for events up to 100 year ARI, affected areas are limited to undeveloped pastoral land

Impacts to MNES and Commonwealth land

In accordance with the requirements of the EPBC Act and the Commonwealth EIS Guidelines, impacts to MNES and Commonwealth land have been assessed. The potential construction and operational impacts to MNES and Commonwealth land is discussed throughout Chapter 7 and Chapter 8.

During construction, key impacts to MNES and Commonwealth land include:

- Traffic switches and temporary changes to access would be managed in accordance with the overall staging of construction, with DEOH access being maintained continuously through each stage of construction. Overall, the project's construction would have little or no impact on traffic and transport on Commonwealth land, over and above the impacts already described and assessed
- Predicted worst case construction noise levels from out-of-hours work would exceed night-time NMLs at most receivers within Commonwealth land. During worst case night-time works, exceedances of night-time NMLs of up to 15-28 dB(A) may result for many receivers. These worst case impacts would occur for only limited periods while works passed at their nearest point to these receivers
- Up to 13.34 ha of remnant native vegetation on Commonwealth land, including about:
  - 10.51 ha of the Threatened Species Conservation Act (TSC Act) listed, critically endangered Cumberland Plain Woodland in the Sydney Basin Bioregion ecological community
  - 2.84 ha of the TSC Act listed River-Flat Eucalypt Forest on Coastal Floodplains

- About 10.07 ha of the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest ecological community
- Potential impact to aquatic ecosystems due to potential temporary changes in water quality, habitat loss and instream barriers associated with works in and around waterways identified as Key Fish Habitat
- Localised fragmentation of local wildlife corridors between The Northern Road and Willowdene Avenue where some intact habitat patches would be fragmented and a new barrier introduced by the project would restrict fauna movement. The widening of the existing The Northern Road in the north of the study area would further the barrier effects of the road where it bisects Regional Corridor 17 as identified in the OEH BIOMAP, although this is already occurring through the via the existing fence that borders the DEOH site
- Potential injury or death of fauna on Commonwealth land, for example during vegetation clearing
- Potential for the invasion and spread of weeds, pests, pathogens and disease which would potentially impact on the environment of Commonwealth land
- General construction and operational related impacts associated with noise, vibration, dust, light and contaminants as outlined above where they impact the environment of Commonwealth land
- Disturbance of around 20.27 ha of the CHP including clearing of around 9.15 ha of a particularly outstanding example and unusually long-term (~50 years) unburned extent of the Cumberland Plains Woodland (critically endangered EPBC Act). As well as modification of particularly outstanding examples of little-disturbed creek lines and riparian habitat of the Cumberland Plain region (within the Blaxland Creek catchment). As well as potential degradation of ecological condition by proliferation of weed species, introduction / disturbance of pathogen and/or disease vectors, and potential light pollution (during construction and operation).

During operation, key impacts to MNES and Commonwealth land include:

- The project's long-term operational impacts on traffic and transport on Commonwealth land would be positive. Access to the DEOH site would be improved through the upgrading and signalising of the intersection at the site's main entrance. Further, the project's design includes formalising access to the site of the Western Sydney Airport, which would facilitate access for service vehicles and deliveries
- Six receivers located on Commonwealth land have been identified as being eligible for mitigation of the project's operational noise impacts. Of the six receivers, five are located on Commonwealth owned land at the Western Sydney Airport site. One other receiver is located on Commonwealth land located west of Willowdene Avenue. At-property treatments are considered the most reasonable form of mitigation for all six receivers
- During the project's operation, acquisition of Commonwealth land within the DEOH (including the Orchard Hills Golf Club) and the site of the Western Sydney Airport would result in permanent change to the use of the affected land, most of which is currently used for either rural or recreational (golf club) purposes. Within the DEOH land, land acquisition would comprise strips of land of varying width. In the long-term the project's operation would result in little or no impact to the socio-economic environment of Commonwealth land, as the current uses (Defence, recreation) would continue and the planned future use of land for the Western Sydney Airport would not be affected or compromised
- The project would increase the scour potential in the drainage lines which run through DEOH site on Commonwealth land. The increase in scour potential would extend only a short distance from the corridor as the increase in peak flow attributable to the project as a percentage of the total flow reduces in the downstream direction due to the discharge of additional catchment runoff to the affected drainage line

- About 9.15 ha of the Orchard Hills Cumberland Plains Woodland Commonwealth Heritage Place (CHP) would be removed by the project at the western edge of the DEOH site. The total area of the listing is on the CHP is 610.60 ha. As such, the area removed would be equivalent to 1.5 per cent of the total amount within the CHP. The vegetation clearance would permanently remove some of the structural elements upon which the Orchard Hills Cumberland Plain Woodland Listed Place is based. However the impacted areas have been identified as being of moderate to low natural heritage value being regenerating patches of vegetation occurring within largely cleared grasslands with a mixture of native and introduced species (Godden Mackay Logan, 2013).

Acceptability of residual impacts

Due to the design and nature of the project, total avoidance and mitigation of some impacts cannot be reasonably achieved. Key residual impacts of the project, post implementation of the environmental mitigation measures are related to the clearing of vegetation, disturbance to heritage items and changes to the socio-economic environment of Luddenham from the bypassing of the town. This Environmental Impact Statement / draft Environmental Impact Statement has identified and assessed the impacts of the project on the environment as detailed in chapters 7 and 8. Throughout this EIS (and summarised in Chapter 12), a proposed framework of Construction Environmental Management Plans and sub-plans is outlined which set out specific impact mitigation measures managing the potential impacts of the project. Each of the plans would establishes the system for implementation, monitoring and continuous improvement to increase the effectiveness of the actions within the plans. The implementation of these plans in conjunction with individual, comprehensive environmental management measures to avoid, manage, mitigate, offset and/or monitor impacts to an acceptable level of residual impact. With the implementation of the identified comprehensive environmental management measures to avoid, manage, mitigate, offset and/or monitor impacts to an acceptable level of residual impact.

The bypass of Luddenham would also result in adverse impacts that would require ongoing management once the project is operational. The project may have a negative impact on some local businesses, particularly in Luddenham, where businesses in the town would no longer be exposed to passing trade. Additionally, there is likely to be impacts on local businesses and employment, resulting from acquisition of land that is currently used for business purposes.

To minimise these potential impacts, Roads and Maritime will, in consultation with Liverpool Council, provide appropriate support for preparation of plans to revitalise Luddenham town centre, for the purpose of encouraging motorists to continue to pass through or visit the town. Any streetscape and landscape treatments would be determined after finalisation of any town centre revitalisation plans.

The predicted impacts to ecological values such as the critically endangered Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest, threatened species and their habitat, is considered likely to contribute to the residual impacts of the project. All practicable steps to avoid or minimise impacts to biodiversity would be implemented during the detailed design phase to reduce the scope of the overall impact. This would include the application of measures such as road design refinements to reduce the project footprint and incorporating design features to minimise impacts, where practical. Specific outcomes that would be achieved through the implementation of environmental management measures include:

- Minimising the removal of vegetation, in particular native vegetation
- Ensuring the appropriate re-establishment of native vegetation after the project
- Minimising the removal of habitat and protection of surrounding habitat
- Reinstatement of habitat after the project
- Development and implementation of appropriate offsets for the project.

The Biodiversity Offset Strategy (BOS) developed for the project includes details of offsets to be implemented to compensate for residual significant impacts associated with the project in

accordance with the Biodiversity Offsets Policy for Major Projects (BOPMP) and Framework for Biodiversity Assessment (FBA) which have been endorsed by the Commonwealth.

The Northern Road upgrade funded by the Australian and NSW governments to enable the development of a Western Sydney Airport at Badgerys Creek, and employment zones and growth centres in the western and south-western regions. Western Sydney is expected to experience record growth with around one million additional people living in the region by 2031. This significant population and economic growth needs to be supported by a number of significant urban and infrastructure developments including the SWPGA and WSPGA.

The project would provide connectivity to the Western Sydney Airport through the provision of high capacity traffic and freight links between the airport and the M4 Western Motorway (via The Northern Road Upgrade) and south-western Sydney including Campbelltown and the proposed M12 Motorway. The project would also improve road safety and provide improvements to public and active transport facilities, promoting sustainable and efficient journeys.

The upgraded corridor would cater for the substantial traffic growth forecast along The Northern Road arising from increased residential and commercial development in the SWPGA and WSPGA, and nearby areas by improving road and intersection capacity.

Additionally, this EIS has assessed documents the assessment of the potential direct and indirect impacts of the project during construction and operation, in consideration of the scale, intensity, duration, timing and frequency of the potential impacts. Additional beneficial outcomes of the project would be:

- Socio-economic benefits such as:
  - Improved access and connectivity to community services and facilities within or near the project area
  - Improved access and connectivity to employment areas in the project area and the western Sydney region
  - Increases in the amenity of the Luddenham town centre through the removal of heavy vehicles relating to reduced traffic noise and increased air quality
  - The creation of direct and indirect employment opportunities through the construction phase
  - Increased expenditure by construction workers on local goods and services.
- New and upgraded drainage infrastructure.
- Improved active transport (walking and cycling paths.

On balance The Northern Road Upgrade between Mersey Road and Glenmore Parkway is considered justified and in the public interest as the residual impacts of the project are considered acceptable and are outweighed by the longer term benefits of the project.

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