CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1C

APPENDIX G:
CLIMATE CHANGE RISK ASSESSMENT

Transport for NSW

CBD and South East Light Rail

Climate Change Risk Assessment

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1. Introduction

This climate change risk assessment and adaptation strategy identifies risks and risk mitigation measures associated with the predicted impacts of climate change on the design, construction and operation of the Sydney CBD and South East Light Rail (CSELR) proposal.

The objectives of this technical paper are to:

- identify significant potential impacts of climate change on the CSELR proposal including customers, physical infrastructure and service delivery
- assess the level of associated risks
- identify risk mitigation measures which are being included in the draft definition design of the project, through the application of existing design standards and good design practice
- identify additional mitigation measures which would be considered for inclusion in design, construction and operation of the CSELR proposal.

2. Methodology

2.1 Approach

This climate change risk assessment has been conducted in accordance with:

- The risk management approach set out in AS/NZS ISO 31000:2009 Risk management – Principles and guidelines and ISO/IEC 31010 Risk management – Risk assessment techniques. Both build upon AS/NZ 4360:2004 Risk management and its application to climate change risks.
- Green Infrastructure Council (AGIC) Guidelines for Climate Change Adaptation, which aim to align projects to achieve a 'Level 2' performance level, which is deemed appropriate for definition design.
- Climate Change Impacts and Risk Management: A Guide for Business and Government (AGO 2006).
- draft Australian Standard (DR AS 5334) - Climate change adaption for settlements and Infrastructure.
- NSW Office of Environment and Heritage's Guide to Climate Change Risk Assessment for NSW Local Government.

The DRAFT Australian Standard (DR AS 5334) 'Climate change adaptation for settlements and infrastructure' suggests that the following six consecutive steps should be applied to determine the climate change context that will inform the climate risk assessment and subsequent adaptation responses:

1. define the greenhouse gas emissions scenario
2. define future time slices
3. define the climate variables
4. selection of climate data
5. determine other associated impact studies required
6. obtain past meteorological record.

2.1.1 Greenhouse gas emission scenario

Internationally accepted projections used in climate change analysis are those set out in the Special Report on Emissions Scenarios (SRES) of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2007).

The two main climate change scenarios used in climate change projections for the CSELR proposal are the SRES A1B and A1FI scenarios. The SRES A1B scenario (rapid convergent economic and population growth and is fossil-fuel intensive) is the best estimate of annual warming over Australia relative to the climate of 1990.

2.1.2 Selection of timescales

The CSELR proposal is anticipated to commence operation in 2019. The design life of the various components of the project is projected to range from 15 years to 100 years and are summarised in Table 2.1 below.

Table 2.1 Approximate design life of assets/components used in the CSELR project

Structures, components, services and systems	Design life
Retaining structures, rock bolts, rock anchors and sprayed concrete to external retained structures	100 years
Masonry wall systems	50 years
Waterproofing systems in general	100 years
Permanent and inaccessible elements such as fire protection, mechanical and electrical control systems	100 years
Drainage structures and inaccessible pipe systems	100 years
Pumps, tanks and valves, pump control systems and accessible pipe systems	20–50 years
Handrails and walkways	50 years
High Voltage electrical systems and traction power systems	30 years
Low voltage systems	30 years
General cabling, conduits and fixing systems	25 years
Signalling and train control systems including trackside equipment	25 years
Rail communications systems	15 years
Passenger information systems	15 years
Security systems	15 years

2.1.3 Selection of climate variables

The location, size, extent and scope of the CSELR proposal indicate that the project may be susceptible to a variety of climatic factors and seasonal variations in climate including:

- solar radiation
- annual mean maximum temperature and summer mean maximum
- highest temperature
- temperature (heatwaves) – average number of days over 35°C, average number of days over 40°C, times per year 35°C exceeded for 3 to 5 successive days, times per year 40°C exceeded for 3 to 5 successive days
- annual mean rainfall
- seasonal mean rainfall
- extreme rainfall – indicative change in 40 year 1 day rainfall total (rainfall totals for the 40 year average recurrence interval (ARI) 1 day storm events)
- rainfall intensity – 100 year events (2 hour) and 5 year events (2 hour)
- wind speed
- relative humidity

- average annual potential evaporation
- hail
- cyclones
- bushfire risk
- sea level rise and storm surge.

2.2 Risk identification

Potential climate-change related risks to the project were identified through initial identification of potential risks based on an understanding of key project components (from the definition design report), likely vulnerabilities, work completed on similar projects, publications and case studies.

2.3 Risk assessment

For each risk identified in the climate change risk register:

- a risk owner was identified
- the cause and impact of the risk were documented
- the level of risk was determined by reviewing the current evidence (non-project specific evidence and generic, Australia-wide case studies) to inform a decision on likelihood (refer Table 2.2) and consequence (refer Table 2.3) outcomes. These outcomes were then combined to obtain an overall risk rating from the 'risk matrix' (derived from AGO's report Climate Change Impacts and Risk Management: A Guide for Business and Government (AGO, 2006)). A copy of this risk matrix is provided in Table 2.4. Each risk was allocated a risk rating based on current understanding of design measures and adaptation measures that would be employed as part of the CSELR proposal.

Table 2.2 Likelihood rating

Rating	Recurrent risks	Single events
Almost certain	Could occur several times a year	More likely than not (probability greater than 50%)
Likely	May arise about once a year	As likely as not (probability of 50%)
Possible	May arise once in ten years	Less likely than not, but still appreciable (probability less than 50% but still high)
Unlikely	May arise once in ten to 25 years	Unlikely but not negligible (probability low but noticeably greater than zero)
Rare	Unlikely during the next 25 years	Negligible (probability very small, close to zero)

Table 2.3 Consequence rating (adapted from AGO, 2007)

Rating	Success criteria				
	Service quality	Service delivery	Interactions with other providers	Administration	Community confidence
Catastrophic	Services would fall well below acceptable standards and this would be clear to all	Services would be incorrectly targeted, delivered late or not delivered at all in a large number of cases	The organisation would be in conflict with other providers and this would directly affect services	Administration of the organisation would be seen to be deficient and in need of technical review	There would be serious expressions of concern about our capacity to serve the community
Major	The general public would regard the organisation's services as unsatisfactory	There would be isolated instances of services being incorrectly targeted, delivered late or not delivered at all	The effort of managing relations with other providers would drain resources and badly degrade service delivery	Administration of the organisation and would be seen to be deficient and in need of external review	There would be serious expressions of concern about our capacity to serve the community
Moderate	Services would be regarded as barely satisfactory by the general public and the organisation's personnel	There would be isolated but important instances of services being poorly targeted or delivered late	Unnecessary overheads arising from relations with other providers would be a drain on resources but the public would be unaware of this	Administrative failings might not be widely seen but they would cause concern if they came to light	There would be isolated expressions of concern about our capacity to serve the community
Minor	Services would be regarded as satisfactory by the general public but personnel would be aware of deficiencies	There would be isolated instances of service delivery failing to meet acceptable standards to a limited extent	Unnecessary overheads in dealing with other providers would absorb some effort but the public would be unaware of this and would not be affected	There would be some administrative shortcomings demanding attention but they would not be regarded as serious failures	There would be some concern about our capacity to serve the community but it would not be considered serious
Insignificant	Minor deficiencies in principle that would pass without comment	Minor technical shortcomings in service delivery would attract no attention	Minor unnecessary overheads arising from relations with other providers but with no material effect	There would be minor areas of concern but they would not demand special attention	There would be minor concerns but they would attract no attention

*adapted from AGO, 2007

Table 2.4 Risk matrix

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	Medium

3. Climate change projections

3.1 Existing benchmark

The CSELR proposal would be situated within a region with a temperate subtropical climate, characterised by very warm summers and mild, warm winters. Mean daily temperatures are within the range of 18 to 26°C during summer and between 9 and 18°C in winter. Uniform rainfall is experienced throughout the year with an average of 1,287 millimetres received per annum, with autumn the wettest period, and spring the driest.

3.2 Projected benchmark

The Australian climate is likely to experience a greater frequency and severity of extreme weather events due to climate change. As a result, it is especially important to understand the 'most likely' and 'worst case' implications of climate change on high-value infrastructure in major Australian cities such as Sydney.

According to CSIRO (2007) and OEH (2010) research, the Sydney area is likely to become warmer, with more hot days and fewer cold nights. Detailed projections are presented in Table 3.1 and summarised as follows:

- by 2030 – approximately 0.9°C (0.6–1.3°C range) increase in temperature, with increasing frequency of hot days and warm nights. Average rainfall may range from a 9% decrease to a 3% increase, with increased likelihood and intensity of extreme rainfall
- by 2050 – further increase in temperature, with increase in frequency of hot days and warm nights, a likely increase in summer rainfall and a decrease in winter rainfall
- by 2070 – approximately 3.0°C (2.1–4.3°C range) increase in temperature, with increasing frequency of hot days and warm nights. Winter and spring rainfall patterns may range from a 25% decrease to a 10% increase with increased likelihood and intensity of extreme rainfall
- by 2100 – up to 6.4°C increase in temperature, with increasing frequency of hot days and warm nights. Winter and spring rainfall patterns to vary widely with increased likelihood and intensity of extreme rainfall
- up to 2100 – sea level is virtually certain to keep rising, with estimates of 18–59 cm, with a possible additional contribution from ice sheets of 10 to 20 cm (relative to 1990). Sea level rise, coupled with increased flooding, is virtually certain to pose an increased risk to property and infrastructure. Developments near estuary entrances and beaches and on coastal floodplains are most vulnerable.

Table 3.1 Climate change projections for Sydney region – key climate variables

Climate variable	Current	Units of change	2030 (A1B)	2050 (A2)	2070 (A1FI)	Notes (1)
Temperature – average annual	17–26	ºC increase from 1990	0.9°C (0.6–1.3)	2.3°C (1.5–3.0)	3.0°C (2.1–4.3)	2, 4
Temperature – heat waves	See in bold brackets	Average days over 35°C per year (current = 3.6)	4.6 (3.9–5.3)	Heatwaves are projected to become more intense and more frequent	9.5 (5.0–13.9)	3
		Average days over 40°C per year (current = 0.3)	0.7 (0.5–0.8)	Heatwaves are projected to become more intense and more frequent	1.9 (0.7–3.1)	3
		Times per year 35°C exceeded for 3 to 5 successive days (current = 0)	0.0	Heatwaves are projected to become more intense and more frequent	0.2 (0.1–0.3)	3
		times per year 40°C exceeded for 3 to 5 successive days (current = 0)	0.0	Heatwaves are projected to become more intense and more frequent	0.0	3
Rainfall – annual mean	1276.5 mm>	% change	-3% (-9 to +3%)	Not available	-8% (-25 to +10%)	2
Extreme rainfall (indicative change in 40 year 1 day rainfall total)	Not available	% change	+5% (-3% to +12%)	Flash flooding may increase	+2% (-7% to +10%)	4
Rainfall – intensity	Not available	100 year– 2 hr	-10% (-15% to +5%)	Not available	+10% (+5% to +15%)	5
Rainfall – intensity	Not available	5 year– 2 hr	0% (-5% to +5%)	Not available	+10% (+5% to +15%)	5

Notes (Table 3.1)

(1) 'Current' temperature and rainfall data derived from Bureau of Meteorology (http://www.bom.gov.au/) for Sydney (Observatory Hill) from mean of 1971-2000 data. Sydney (Observatory Hill) was selected as the most representative and valid site for the CSELR project location, as it was the closest weather station location with a comprehensive set of historic data for the period 1971–2000.

(2) A1B scenario for 2030 projections and A1FI scenario for 2070. Climate Change in Australia – Technical Report 2007, City Summaries - Sydney data Table B13 (10 to 90 percentile range in bracket below median (50th percentile) value).

(3) Data on extreme temperatures is data for Richmond provided by Jim Ricketts (CSIRO), 2010, personal communication. The range indicated in brackets is the range of values calculated by the four models used. This data can be downloaded by accessing http://climatechangeinaustralia.com.au/resources.php and then downloading the file 'Temperature Thresholds DCCEE with summary.xls'.

(4) Climate Change in the Sydney Metropolitan Catchments, 2007, Prepared for the New South Wales Government by the CSIRO.

(5) Impact of Climatic Variability and Climate Change on Rainfall Extremes in Western Sydney and Surrounding Areas: Component 4 – Dynamical Downscaling. Abbs, D & T Rafter, November 2008. Data is interpreted from Figures 20 and 21 (figures in brackets indicate the data range).

4. Climate change risk assessment

The draft climate change risk assessment for the CSELR proposal is shown in Table 4.1. The assessment includes key identified risks, potential controls/actions and an overall risk rating. The consequences and risks for service quality and delivery, and public safety outlined in Table 2.3 and Table 2.4**Error! Reference source not found.** are for the CSELR proposal itself, and not the wider rail transport system. If considered within the context of Sydney's overall transport system, the consequences and risks would be different, as the CSELR proposal would form a component of the overall transport system.

4.1 Assumptions

The assessment comprised a high level assessment of potential climate change risks of the CSELR proposal and, therefore, the following limitations need to be considered:

- assessment of risks and possible adaptation plans was qualitative, not quantitative
- climate change scenarios were based on publicly available projections
- the climate projections were regional rather than localised, so their accuracy is limited
- the assessment was designed to highlight risks and outline where further assessment/modelling/design is required, and did not consider implications or assessment of other related infrastructure (e.g. nearby warehouses, stations etc.)
- the consequences and risks for service quality and delivery were considered for the CSELR proposal and not the wider rail system.

Table 4.1 Climate change risk assessment

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
1a	Climate change causes increased frequency, severity and duration of extreme temperatures (days exceeding 35 ºC) leading to light rail track movement/cracking.	Temperature increases. More frequent and severe heatwaves.	Derailment, increased maintenance cost and increased travel time due to speed restrictions.	RailCorp Engineering Standard Track (ESC200) specifies a rail temperature range from –10°C to 75°C and a neutral temperature of 35°C. This correlates to an operating air temperature range of -10°C to 45°C. The rail track temperature is also affected by the environment within which the railhead sits (i.e. located near to heat sources, uncover or in a cut and cover tunnel etc.). Rail track movement is controlled by undertaking regular maintenance and inspection.	The design of track could take opportunities to minimise exposure by ensuring that the track is adequately ventilated, has low ambient temperatures and exposure to direct sunlight is avoided if possible. All critical, heat-emitting equipment should also be located away from the track to reduce contribution to ambient temperature. A strict maintenance regime should be developed, with specific requirements for extremely hot temperature events.	**Medium** (Likelihood - Unlikely, Consequence - Major)
1b	Climate change causes increased frequency, severity and duration of extreme temperatures (days exceeding 35 ºC) leading to increased difficulty/cost (incl. maintenance) to adequately ventilate and cool carriages.	Temperature increases. More frequent and severe heatwaves.	A warmer tunnel or ambient temperature environment may result in: ▪ Ill passengers. ▪ Reduced patronage. ▪ Air conditioning units on trains failing. ▪ Heat in carriages may be exacerbated by urban heat island effects.	Control would depend on what level of thermal comfort the project aspires to deliver (currently identified as ‘satisfactory environment during severe heat waves’). Potential control measures include: ▪ Ensuring that (cut and cover) tunnel is adequately ventilated ▪ Ensuring that the passenger carriages are adequately cooled/ ventilated. Use of vegetation to provide passive cooling in the surrounding areas.	The cut and cover tunnel contributes to reduced air flow (in comparison with an open alignment) and therefore ventilation and cooling design should take account of climate change risks to long-term temperature. Mixed mode ventilation - Incorporate mixed mode ventilation. This involves using natural ventilation when ambient conditions are suitable, with air conditioning only operating at peak temperature periods. Interlock A/C with windows so both cannot be used simultaneously.	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
1c	Climate change causes increased frequency, severity and duration of extreme temperatures (days exceeding 35°C) leading to more frequent interruptions to mains power supply and reduced transformer efficiency.	Temperature increases. More frequent and severe heatwaves.	More frequent and prolonged brownouts/blackouts caused by increased air conditioning demands, reduced generation, conductor and transformer efficiency.	RailCorp's electrical systems are built around the principles of 'diversity' and 'redundancy'.	The proposal should have stringent maintenance, inspection and safety protocols that enable rail systems to be managed efficiently and effectively during extreme hot weather events.	**Medium** (Likelihood - Possible, Consequence - Moderate)
1d	Climate change causes increased frequency, severity and duration of extreme temperatures (days exceeding 35°C) leading to failure of signalling and communication equipment and reduced functionality of electrical systems.	Temperature increases. More frequent and severe heatwaves.	Increased electrical resistance in conductors and transformers. Reduced lifespan and efficiency of electrical equipment. Heat-related sag in overhead powerlines. Reduced functionality of computing systems, signalling and communication equipment. All results in safety and operational impacts, and maintenance and construction costs.	Regulated tension wiring and safety screens will take account of temperature-related sag (no overhead wiring along parts of George St. from Town Hall to Circular Quay). All systems (including track circuits) have fail safe mechanisms. Overhead wiring designs are regulated by strict standards (including thermal characteristics) and are designed for ambient temperatures up to 60–65°C. The overhead wiring system will be double insulated. Substation equipment is designed to work in ambient temperatures up to 50–60°C.	The proposal should have stringent maintenance, inspection and safety protocols.	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
1e	Climate change causes increased frequency, severity and duration of extreme temperatures (days exceeding 35°C) leading to extreme heat-related impacts on materials (indoor and outdoor).	Temperature increases More frequent and severe heatwaves	Fatigue of structural materials. Accelerated degradation of external materials at surface. Movement of joints at structures.	Bridge materials and associated building infrastructure are designed to strict RailCorp and Australian standards (AS5100 for bridges, AS3600 for buildings), which have built-in tolerances to temperature and fail-safes. The use of materials in the design is such that any temperature increases would not lead to intended performance impairment.	Future-proofing of materials and the behaviour of materials subject to climatic extremes should be evaluated within concept and detailed design stages. A strict maintenance regime would be the key method to mitigate any major additional risks.	**Low** (Likelihood - Unlikely, Consequence - Minor)
2a	Climate change causes increase in annual average temperature that leads to increased movement at bearings and expansion joints.	Temperature increases	Damage to track and structures. Requirement for increased maintenance.	Bridge materials and associated building infrastructure are designed to strict RailCorp and Australian standards (AS5100 for bridges and AS3600 for buildings), which have built-in tolerances to temperature and fail-safes. The design of insulated rail joints in accordance with AS1085 is such that any temperature increases would not lead to intended performance impairment.	A strict maintenance regime should be developed to mitigate any major risks.	**Low** (Likelihood - Unlikely, Consequence - Minor)
2b	Climate change causes increase in annual average temperature that leads to greater electrical resistance in conductors.	Temperature increases	Greater losses and maintenance for electrical conductors and transformers, with consequent increases in costs.	A relatively short replacement/design life (typically 30 years) for cabling means that the consequence of extreme climate change-related events is reduced.	A strict inspection regime is the key method to mitigate any major additional risks.	**Low** (Likelihood - Unlikely, Consequence - Minor)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
3a	Climate change causes increased frequency and severity of extreme rainfall events leading to flooding of infrastructure.	Increased rainfall intensities. Increased stormwater run-off.	Flooding of tracks. Foundation instability.	All drainage systems are designed according to specific design lives and flooding levels, which correlate with the manageable level of acceptable risk. Track drainage to be designed to limit water depth to 15 mm or less where at or adjacent to the track surface during whichever event is larger of a 10 year ARI or the design ARI of the adjacent road. Similar light rail systems are designed with a maximum water level of 50mm above track level, after which it is recommended that operations should cease. The existing flood immunity in some locations along both the CBD and South East routes will be less than the current proposed design criteria. The vast majority of track is designed according to probable maximum flood level.	The drainage calculations should take account of the surrounding catchment area (i.e. changing land use over time) and future master-planning so they are essentially 'future-proofed'. Tracks and foundation drainage design levels should take account of climate change projections (e.g. those included in this chapter) and designed according to RailCorp standards of 'acceptable risk'. Water sensitive urban design should be integrated into the design wherever possible. The Sydney Metropolitan Catchment Authority commissioned a study in 2011 to review impacts of climate change on Urban Stormwater Infrastructure in Sydney. This document recommended that an additional 15% is added to peak rainfall intensities design to take account of increasing rainfall intensities due to climate change. It is recommended that the design of the CSELR drainage network includes this 15% increase to assess future impacts of climate change on the drainage network and CSELR infrastructure. Vegetated track has been proposed for a significant section of the route through Moore Park.	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
3b	Climate change causes increased frequency and severity of extreme rainfall events leading to flooding of infrastructure in some section of the CSELR alignment i.e. Alison Road in Randwick	Increased rainfall intensities. Increased stormwater run-off.	Flooding of tunnels, drainage and culverts, stabling depot and stations. Loss of access/transport. The proposed Randwick stabling site is inundated in the 1 in 5 year ARI flood event and all events beyond this. The depth of flooding across the site varies from a few mm to up to 200 mm in the 1 in 5 year ARI flood event.	Increase pump well size (and increase pump sizes as appropriate). Provide back-up pump(s). Stormwater detention sump/structure. All drainage systems are designed according to specific design lives and flooding levels, which correlate with the manageable level of acceptable risk. The vast majority of infrastructure is designed according to probable maximum flood level. The existing drainage network in some locations will not meet the CSELR criteria, and that the downstream piped network capacity in some locations will be insufficient to accept an enhanced level of stormwater collection along the CSELR route. Project-wide strategies for including Water Sensitive Urban Design (WSUD) include: ■ Tree pit bio-retention ■ Gully baskets/pit inserts ■ Bio-retention within parklands.	Infrastructure drainage design levels should take account of climate change projections (e.g. those included in this chapter) and designed according to RailCorp standards of 'acceptable risk'. Water sensitive urban design should be integrated into the design wherever possible. Raised ground levels proposed at stations and pedestrianised zones will reduce overland flow capacity and therefore reduce flood immunity/increase flood risk to neighbouring properties. Options to address drainage risks include: ■ Upsizing of the trunk network downstream of the corridor until a network of sufficient capacity is reached, or through to the outfalls to the harbour if necessary. ■ Utilising a 'surcharge pit' approach. ■ Providing other means of flood protection to the CSELR route. ■ Accepting reduced design criteria for the CSELR in areas where existing flooding issues exist. The Sydney Metropolitan Catchment Authority commissioned a study in 2011 to review impacts of climate change on Urban Stormwater Infrastructure in Sydney. This document recommended that an additional 15% is added to peak rainfall intensities design to take account of increasing rainfall intensities due to climate change. It is recommended that the design of the CSELR drainage network includes this 15% increase to assess future impacts of climate change on the drainage network and CSELR infrastructure. Develop evacuation plans for risk areas during flood events and to close areas subject to flooding.	**High** (Likelihood - Possible, Consequence - Major)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
3c	Climate change causes increased frequency and severity of extreme rainfall events leading to flooding or saturation of embankments and ground conditions.	Increased rainfall intensities. Increased stormwater run-off.	Ground stability issues, risk of landslides and embankment/slope failure. Other impacts could include groundwater percolation causing hydrostatic pressure build up behind geological structures resulting in rock-fall and landslips (ASRC 2009).	There are very few exposed areas in the proposal and slopes are designed with their own drainage systems and designed to be stable in extreme weather events.	The detailed design should take account of extreme weather events and 'worst-case scenario' risks for drainage and geotechnical elements ('Worst case' does not always relate to climate change. It may reflect flooding due to a burst water main for example. The detailed design would also require use of geotechnical materials to address extreme weather related impacts). The Sydney Metropolitan Catchment Authority commissioned a study in 2011 to review impacts of climate change on Urban Stormwater Infrastructure in Sydney. This document recommended that an additional 15% is added to peak rainfall intensities design to take account of increasing rainfall intensities due to climate change. It is recommended that the design of the CSELR drainage network includes this 15% increase to assess future impacts of climate change on the drainage network and CSELR infrastructure.	**Low** (Likelihood - Unlikely, Consequence - Minor)
3d	Climate change causes increased frequency and severity of extreme rainfall events leading to water damage to electrical circuitry.	Increased rainfall intensities. Increased stormwater run-off.	Malfunctioning power supplies. Malfunctioning signalling and associated circuitry. Malfunctioning communications and associated circuitry. Traction problems. Malfunctioning track sensors. Disruption to service and maintenance issues.	Cables are well protected, insulated and have fail-safe mechanisms built in to ensure less safety risks. Much of the electrical circuitry operates autonomously, such that one failure would not mean the failure of entire systems. Location of electrical equipment, with the exception of cables, above the 1 in 100 year ARI flood level where feasible to minimise damage and to allow prompt resumption of service when water recedes.	The proposal should have stringent maintenance, inspection and safety protocols. The Sydney Metropolitan Catchment Authority commissioned a study in 2011 to review impacts of climate change on Urban Stormwater Infrastructure in Sydney. This document recommended that an additional 15% is added to peak rainfall intensities design to take account of increasing rainfall intensities due to climate change. It is recommended that the design of the CSELR drainage network includes this 15% increase to assess future impacts of climate change on the drainage network and CSELR infrastructure.	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
3e	Climate change causes increased frequency and severity of extreme rainfall events leading to effects on passenger comfort.	Increased rainfall intensities. Increased stormwater run-off.	Impacts to customer comfort and experience whilst outdoors or exposed to extreme rainfall may result in effects on patronage.	There is limited evidence as to how extreme weather affects patronage and passenger experience worldwide.	The detailed design should take account of the entire passenger experience and certain design measures that would improve passenger comfort (This may include some shaded, covered areas and station canopy design should focus on reducing exposure to the weather).	**Low** (Likelihood - Unlikely, Consequence - Minor)
4	Climate change causes reductions in average annual rainfall leading to cracking and movement of ballast and failure of embankments.	Reduced annual rainfall.	Rail track movement, leading to increased risk of derailment, increased maintenance cost and increased travel time due to speed restrictions. Landslip risk and failure of embankments due to reductions in soil moisture.	Embankments and slopes are designed with their own drainage systems and are designed to be stable in extreme weather events. Soil stability can be moderated by using geotechnical materials and vegetation, where possible.	The proposal should have stringent maintenance, inspection and safety protocols that enable rail systems to be managed efficiently and effectively during extreme weather events.	**Low** (Likelihood - Unlikely, Consequence - Minor)
5a	Climate change causes increased frequency and severity of extreme wind events leading to debris, fallen trees and branches.	More severe storms. Increased extreme wind events.	Debris landing on trains, and any area where passengers or general public may be on the network.	RailCorp has specific standards for setback for trees and other vegetation, which are deemed to be conservative (the setbacks depend on the height and species of tree, but the minimum setback distance is generally at 40 m. The intention of these standards is to avoid vegetation debris, whilst maintaining visual aesthetics and soil stability).	The vast majority of the alignment is away from any significant sources of vegetation or in cut and cover tunnel. The alignment adjacent to Moore Park will need to consider debris and wind-blown vegetation (especially leaves) as this area is heavily vegetated with mature trees and bushes. A regulated, co-ordinated maintenance, pruning and landscaping regime will avoid many of the potential impacts from wind-blown vegetation.	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
5b	Climate change causes increased frequency and severity of extreme wind events leading to debris, fallen trees and branches and potential damage to wind-exposed infrastructure.	More severe storms. Increased extreme wind events.	Dewirements, phase conductors swinging together, snagging of overhead lines. Damage to communications. Damage to structures, signs, gantries, noise walls. Damage to station canopies or covers. Wear and tear of wind exposed infrastructure (i.e. reduced service life). All leads to service delivery impacts and safety concerns. Traction and braking problems.	The wind loading of each structural element, including station canopies, would be evaluated at the detailed design stage and extreme weather events would need to be considered. If debris does land on wires or critical equipment, the RailCorp rapid response system protects itself (e.g. circuit breakers deploy automatically). RailCorp has specific standards for setback for trees and other vegetation, which are deemed to be conservative (the setbacks depend on the height and species of tree, but the minimum setback distance is generally at 40 m. The intention of these standards is to avoid vegetation debris, whilst maintaining visual aesthetics and soil stability).	Structural engineers would need to take account of internal and external pressures. The proposal should specify increases in inspection and maintenance regime of the asset following windstorms to identify fatigue. A regulated, co-ordinated maintenance, pruning and landscaping regime will avoid many of the potential impacts from wind-blown vegetation, especially at Moore Park.	**Medium** (Likelihood - Possible, Consequence - Moderate)
5c	Climate change causes increased frequency and severity of extreme wind events leading to impacts to customer comfort.	More severe storms. Increased extreme wind events.	Impacts to customer experience whilst outdoors or exposed to weather events may result in effects on patronage.	There is limited evidence as to how extreme weather affects patronage and passenger experience worldwide.	The detailed design should take account of the entire passenger experience and certain design measures that would improve passenger comfort (this may include some shaded, covered areas and station canopy design should focus on reducing exposure to the weather).	**Low** (Likelihood - Unlikely, Consequence - Minor)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
5d	Climate change causes increased frequency and severity of extreme wind events leading to rolling stock blowing over.	More severe storms. Increased extreme wind events.	Derailment, delays, operational and safety risks.	National rail codes and standards ensure that rail cars are unlikely to be blown over by specifying a maximum height for the centre of gravity of the rail car (these rail standards define wind speed and wind loading. RailCorp standards are highly conservative and take account of extreme wind events). The majority of the alignment is within a built up area and often surrounded by other infrastructure (which can act as a wind break) and therefore there is minimal exposure to open areas where rail cars may be exposed to extreme wind events.		**Medium** (Likelihood - Rare, Consequence - Catastrophic)
6	Climate change causes increased frequency of lightning leading to damage to electrical systems.	Increased frequency of lightening.	Damage to underground cable networks - Underground cables take longer to repair than transformer damage.	All electrical assets would be protected in accordance with current standards, such as utilising a common earth system and frequent analysis and inspection by designers and maintainers to ensure the integrity of earth connections. The majority of project cabling would be buried within trenches. Long cables have sacrificial surge arresters as standard, which ensures that safety is maintained at all times. The majority of the alignment is within a built up area and often surrounded by other infrastructure (which will act as a prior lighting conductor).	Consideration should be given to consequential impacts of lightning (for example, tree strike at Moore Park leading to tree fall) and appropriate landscape/maintenance regimes.	**Low** (Likelihood - Rare, Consequence - Minor)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
7	Climate change causes increased carbon dioxide (CO2) levels in the atmosphere leading to increased carbonation.	Increased CO2 levels in the atmosphere.	Faster degradation of reinforced concrete through acidification.	There are currently no standards to address increased concrete carbonation as a result of climate change. There is no significant proposal risk from carbonation as impacts (such as cracking) are only likely to occur in the very long term.	Geopolymer and supplementary cementitious material concrete should be investigated as an alternative to ordinary Portland cement concrete, as it offers improved environmental credentials and would reduce CO_2 emissions and fly ash deposits (there is also evidence that the carbonation of geopolymer concrete does not reduce the pH as much as in Portland cement concrete, indicating that it may offer improved durability).	**Low** (Likelihood - Rare, Consequence - Insignificant)
8	Climate change causes extreme weather events leading to impacts on customer comfort.	Increased solar radiation, average temperature, rainfall intensities, extreme wind events, humidity, hail events, lightning events. More frequent and severe heatwaves. More severe storms	Disruption to station access. Discomfort at stations.	There is limited evidence as to how extreme weather affects patronage and passenger experience worldwide.	The detailed design should take account of the entire passenger experience and certain design measures that would improve passenger comfort (this may include some shaded, covered areas and station canopy design should focus on reducing exposure to the weather. Station canopy design should have a focus on reducing exposure to the weather. Station canopies could be extended at the sides to deflect wind (and rain/sun) and therefore protect passengers from extreme weather effects).	**Low** (Likelihood - Unlikely, Consequence - Minor)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
9	Climate change causes extreme weather events leading to construction impacts.	Increased solar radiation, average temperature, rainfall intensities, extreme wind events, humidity, hail events, lightning events. More frequent and severe heatwaves. More severe storms	Inundation to construction sites. Wind and water damage to construction equipment, materials and compounds. Worker comfort during extreme weather. Disruptions to schedules and delays. Changes to materials performance (e.g. concrete curing times). Impacts on groundwater levels, which may affect integrity of works. Increase in cost, higher impact on communities, reputation.	The likelihood of climate change resulting in a significant increase in extreme weather events by the construction phase (planned to end in 2019) is extremely low. Standard controls at construction sites are likely to be sufficient to minimise the risks from extreme weather events.	Potential adaptation measures should be further evaluated by the design and construction contractor. Construction works are proposed to take 5 years (2014–2019), with construction of many areas anticipated to be less than this. As such, climate change impacts during construction are considered to be minimal. However, climate-related impacts should still be considered by the construction contractor as an independent issue.	**Low** (Likelihood - Rare, Consequence - Moderate)
10	Climate change causes increased annual average ultraviolet (UV) radiation leading to accelerated degradation of external materials on station entrances at surface.	Increased solar radiation. More frequent and severe heatwaves.	Poor performance of materials resulting in additional operations and maintenance work/cost.		Consider as part of detailed design. Performance specification based solution for contractor to satisfy.	**Low** (Likelihood - Rare, Consequence - Insignificant)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
11	Climate change causes reduced average annual rainfall leading to soil movements and cracking of tunnel walls.	Reduced average rainfall. Increased evaporation.	Delay to construction, rework, potential cost increase.	Impact should only be within 5 m of surface.	Consider shrinkage as part of detailed design.	**Low** (Likelihood - Rare, Consequence - Moderate)
12a	Climate change causes incremental sea level rise and increased frequency and severity of storm surge events leading to flooding of infrastructure.	Incremental sea level rise. Increased frequency and severity of storm surge. Increased stormwater run-off.	Flooding of tracks Foundation instability	Increase pump well size (and increase pump sizes as appropriate). Provide back-up pump(s). The vast majority of infrastructure is designed according to probable maximum flood level. Including the above allowances for sea level rise, the 1% AEP event extreme still water level will increase from 1.44 m AHD to 2.34 m AHD by 2100.	It is noted that there are some areas at Circular Quay which the contour data shows to be <2.25 m AHD. Whether these are actual low points or due to data issues in the underlying topographic data should be confirmed in the subsequent stages of this assessment. Tracks and foundation drainage design levels should take account of climate change projections (e.g. those included in this chapter) and designed according to RailCorp standards of 'acceptable risk'. Water sensitive urban design should be integrated into the design wherever possible.	**Medium** (Likelihood - Possible, Consequence - Moderate)
12b	Climate change causes incremental sea level rise and increased frequency and severity of storm surge events leading to flooding of infrastructure.	Incremental sea level rise. Increased frequency and severity of storm surge. Increased stormwater run-off.	Flooding of tunnels, drainage and culverts, stabling depot and stations. Loss of access/transport.	The vast majority of infrastructure is designed according to probable maximum flood level. Given the above the NSW Sea Level Rise Policy Statement suggests that impacts of climate change are projected to result in a 0.4 m rise in sea level by the year 2050 and a 0.9 m rise by the year 2100. The 1% (1 in 100 years) AEP event extreme still water level in Sydney Harbour is 1.44 m AHD. Including the above allowances for sea level rise, the 1% AEP event extreme still water level will therefore increase from 1.44 m AHD to 2.34 m AHD by 2100.	Infrastructure drainage design levels should take account of climate change projections (e.g. those included in this chapter) and designed according to RailCorp standards of 'acceptable risk'. Increase pump well size (and increase pump sizes as appropriate). Provide back-up pump(s).	**Medium** (Likelihood - Possible, Consequence - Moderate)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
				These predicted still water levels have been converted into approximate contour data (at 1.5 m AHD and 2.25 m AHD) using digital topographic data for the study area. These contours have been evaluated (refer Figure 5.3, page 15, Volume 2) and it can be seen that, in general, there is not predicted to be widespread flooding due to sea level rise of the city area. hydrological/drainage design. It is noted that there are some areas at Circular Quay which the contour data shows to be <2.25 m AHD. Whether these are actual low points or due to data issues in the underlying topographic data should be confirmed in the subsequent stages of design and assessment.		
12c	Climate change causes incremental sea level rise and increased frequency and severity of storm surge events leading to flooding or saturation of embankments and ground conditions.	Incremental sea level rise. Increased frequency and severity of storm surge. Increased stormwater run-off.	Ground stability issues, risk of landslides and embankment/slope failure.	There are very few exposed areas in the proposal and slopes are designed with their own drainage systems and designed to be stable in extreme weather events.	Drainage design levels should take account of climate change projections (e.g. those included in this chapter) and designed according to RailCorp standards of 'acceptable risk'.	**Low** (Likelihood - Unlikely, Consequence - Minor)

Risk ID	Risk description	Cause	Impact/ consequence	Current controls and relevant information	Tasks to further reduce risk (adaptation response)	Current risk rating (definition design)
12d	Climate change causes incremental sea level rise and increased frequency and severity of storm surge events leading to water damage to electrical circuitry.	Incremental sea level rise. Increased frequency and severity of storm surge. Increased stormwater run-off.	Malfunctioning power supplies. Malfunctioning signalling and associated circuitry. Malfunctioning communications and associated circuitry. Traction problems. Malfunctioning track sensors. Disruption to service and maintenance issues.	Cables are well protected, insulated and have fail-safe mechanisms built in to ensure less safety risks. Much of the electrical circuitry operates autonomously, such that one failure would not mean the failure of entire systems. Location of electrical equipment, with the exception of cables, above the 1 in 100 year ARI flood level where feasible to minimise damage and to allow prompt resumption of service when water recedes.	The proposal should have stringent maintenance, inspection and safety protocols.	**Medium** (Likelihood - Possible, Consequence - Moderate)

5. Conclusions

This climate change impact assessment has identified 27 key climate change risks to the CSELR proposal. Many of these risks have multiple or secondary consequential impacts, and many have similar causes (for example, impacts to passenger comfort are derived from a variety of extreme weather events). The risk evaluation identified:

- one high level risk
- twelve medium risk ratings
- fourteen low risk ratings.

The CSELR proposal is expected to be constructed by 2019 and, therefore, it is not anticipated that there would be any significant climate-change related construction impacts within this relatively short period of time. However, climate-related impacts would still be considered by the construction contractor as an independent issue.

In summary, extreme weather adaptation measures employed by the CSELR proposal, either in accordance with RailCorp standards or as a project-specific innovations, would result in one high level risk for the proposal.

This high level risk is identified as 'Climate change causes increased frequency and severity of extreme rainfall events leading to flooding of infrastructure, flooding of tunnels, drainage and culverts, stabling depot and stations'. This has been determined for a number of reasons:

- The existing drainage network in some locations will not meet the CSELR design criteria.
- The downstream piped network capacity in some locations will be insufficient to accept an enhanced level of stormwater collection along the CSELR route.
- The proposed Randwick stabling site is inundated in the 1 in 5 year ARI flood event and all events beyond this. The depth of flooding across the site varies from a few mm to up to 200 mm in the 1 in 5 year ARI flood event. This is based on the existing ground levels and not the proposed stabling levels which are likely to be closer to the existing road levels in Alison Road. Inundation of the site appears to be from a break out of flood water running down Alison Road which uses an existing low point to cross the depot site.
- Raised ground levels proposed at stations and pedestrianised zones will reduce overland flow capacity and therefore reduce flood immunity/increase flood risk to neighbouring properties.
- One solution for addressing drainage risks identified in the Definition Design Report (CSELR-00WP-GN-0018) is 'accepting reduced design criteria for the CSELR in areas where existing flooding issues exist.' However, the Sydney Metropolitan Catchment Authority commissioned a study in 2011 to review impacts of climate change on Urban Stormwater Infrastructure in Sydney. This document recommended that an additional 15% is added to peak rainfall intensities design to take account of increasing rainfall intensities due to climate change. Therefore, it is considered that the collective risk of allowing reduced drainage criteria, in combination with a recommended potential 15% increase in rainfall intensity as a result of climate change poses a significantly increased likelihood and consequence to the project than would be achieved if design criteria and treatment measures were made more robust.

6. References

AGIC, September 2011, Guidelines for Climate Change Adaptation AS/NZS ISO 31000:2009 Risk management – Principles and guidelines

AS/NZ 4360:2004 Risk management, Australian Greenhouse Office, 2006

Australian Greenhouse Office 2006 *Climate Change Impacts and Risk Management: A Guide for Business and Government*

DRAFT Australian Standard (DR AS 5334) '*Climate change adaptation for settlements and infrastructure*'

IPCC 2007 *Fourth Assessment Report*

NSW Office of Environment and Heritage, 2011 *Guide to Climate Change Risk Assessment for NSW Local Government*

CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1C

APPENDIX H:
FLORA AND FAUNA TABLES

Appendix H

Flora and fauna tables

H1. Threatened species of plant

Likelihood of occurrence of Threatened species and populations of plants previously recorded, or predicted to occur within 10 km of the study area

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Acacia bynoeana	Bynoes Wattle	V	E1	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils {Harden, 2002 #5}. Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with Corymbia gummifera, Eucalyptus haemastoma, E. gummifera, E. parramattensis, E. sclerophylla, Banksia serrata and Angophora bakeri {NSW National Parks and Wildlife Service, 1999 #61}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Acacia gordonii		E	E1	Occurs in the lower Blue Mountains from Bilpin to Faulconbridge and also in the Glenorie district. Grows on sandstone outcrops and amongst rock platforms in dry sclerophyll forest and heath {Harden, 2002 #5; NSW Scientific Committee, 1997 #298}. Specifically this species occurs in Sydney Sandstone Ridgetop Communities {James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Acacia pubescens	Downy Wattle	V	V	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravely soils often with ironstones {Harden, 2002 #5;NSW National Parks and Wildlife Service, 2003 #14}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Acacia terminalis subsp. terminalis	Sunshine Wattle	E	E1	Grows in scrub and dry sclerophyll woodland between Botany Bay and the northern foreshore of Port Jackson. The locations from which several of the early collections were made no longer provide habitat, having been cleared for development of the eastern suburbs. Recent collections have been made only from Clifton Gardens, Dover Heights, Parsley Bay, Nielsen Park, Cooper Park, Chifley and Watsons Bay {NSW National Parks and Wildlife Service, 2004 #211}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Allocasuarina glareicola		E	E1	Restricted to the Sydney basin where it occurs north east of Penrith in or near Castlereagh State Forest. Grows on lateritic soil in open forest {Harden, 2000 #2}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Allocasuarina portuensis		E	E1	Known from only a single population within Sydney Harbour National Park. The single population has declined from only 10 individuals in 1986 to only a single female surviving in 2002, excluding re-introduced individuals {NSW National Parks and Wildlife Service, 2004 #212}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Amperea xiphoclada var. pedicellata		X	E4	This species is presumed extinct but previously known to occur in Central Coast region in heath, woodland and forest on low fertility sandy soils {Harden, 1993 #4}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Asterolasia buxifolia			E1	Previously known only from a collection in 1834 from the Bells Road area of the Blue Moiuntains {Royal Botanic Gardens, 2005 #404} but rediscovered in 2000, little is known about the species. Now known from a single site at a granite outcrop in the riparian zone of the Lett River {Department of Environment and Conservation, 2005 #762}. Habitat probably includes sclerophyll forest {Royal Botanic Gardens, 2005 #404}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Asterolasia elegans		E	E1	Only known to occur in one locality, north of Maroota, where it grows in wet sclerophyll forest on moist hillsides {Harden, 2002 #5}.	EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Caladenia tessellata	Thick Lip Spider Orchid	V	E1	Occurs south of Swansea where it grows on clay loam or sandy soils {Harden, 1993 #4}. Prefers low open forest with a heathy or sometimes grassy understorey {Bishop, 2000 #12}. Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas {NSW Scientific Committee, 2002 #292}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Callistemon linearifolius	Netted Bottle Brush		V	Occurs chiefly from Georges to the Hawkesbury River where it grows in dry sclerophyll forest, open forest, scrubland or woodland on sandstone. Found in damp places, usually in gullies {Robinson, 1994 #16;Fairley, 2002 #15;Harden, 2002 #5}. Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River {NSW Scientific Committee, 1999 #63}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Camarophyllopsis kearneyi			E1	Small, pale, gilled fungus and is known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney {NSW National Parks and Wildlife Service, 2002 #227}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Chamaesyce psammogeton	Sand Spurge		E1	Occurs in coastal regions of NSW where it grows on sand dunes near the sea {Harden, 2000 #2}. Grows on fore-dunes and exposed headlands, often with Spinifex (Spinifex sericeus) {Department of Environment and Conservation, 2005 #762}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats {Harden, 1993 #4; NSW National Parks and Wildlife Service, 1999 #502}.	EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Cynanchum elegans	White-flowered Wax Plant	E	E1	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes {Harden, 1992 #3}. This species typically occurs at the ecotone between dry subtropical forest/woodland communities {NSW National Parks and Wildlife Service, 2002 #70; James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Darwinia biflora		V	V	Occurs from Cheltenham to Hawkesbury River where it grows in heath on sandstone or in the understorey of woodland on shale-capped ridges {Harden, 2002 #5}. Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include Eucalyptus haemastoma, Corymbia gummifera and/or E. squamosa. The vegetation structure is usually woodland, open forest or scrub-heath {Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Deyeuxia appressa		E	E1	Occurs in the Hornsby area on wet ground. {Harden, 1993 #4; Sharp, 2002 #403}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Dichanthium setosum	Bluegrass	V	V	Grows in woodland and grassland {Harden, 1993 #4}. On the New England Tablelands and North West Slopes it grows on stony red-brown hard-setting soils over basalt, or on black soil {Department of Environment and Conservation, 2006 #1093}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Dillwynia tenuifolia		V	V	Occurs on the Cumberland Plain from the Blue Mountains to Howes Valley area where it grows in dry sclerophyll woodland on sandstone, shale or laterite {Harden, 2002 #5}. Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include Eucalyptus fibrosa, E. sclerophylla, Melaleuca decora, Daviesia ulicifolia, Dillwynia juniperina and Allocasuarina littoralis {James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Diuris arenaria			E1	Restricted to the Tomaree Peninsula north of Newcastle where it grows in coastal heathy dry sclerophyll forest on sandy flats with patches of Themeda {Bishop, 2000 #12}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Epacris purpurascens var. purpurascens	-		V	Occurs in Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps {Harden, 1992 #3}. Usually found in sites with a strong shale influence {NSW National Parks and Wildlife Service, 2002 #67}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	Camfield's Stringybark is known from Norah Head, on the NSW Central Coast, to Waterfall and the Royal National Park, south of Sydney {Fairley, 2004 #523}. Within this area it occurs in scattered locations including Peats Ridge, Mt Colah, West Head, Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites within the Royal National Park {Fairley, 2004 #523}. Camfield's Stringybark occurs in shallow sandy soils overlying Hawkesbury sandstone within coastal heath, generally on exposed sandy ridges. It occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodlands of the slightly more fertile inland areas {Department of Environment Water Heritage and the Arts, 2008 #3587}. Associated species frequently include Brown Stringybark (E. capitellata), Scribbly Gum (E. haemastoma), Narrow-leaved Stringybark (E. oblonga), Silvertop Ash (E. sieberi), Smooth-barked Apple (Angophora costata), Dwarf Apple (A. hispida), Red Bloodwood (Corymbia gummifera), Scrub She-oak (Allocasuarina distyla), Slender Tea Tree (Leptospermum trinervium), and Fern-leaved Banksia (Banksia oblongifolia) {Leigh, 1984 #3171}{Benson, 1998 #3588}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Eucalyptus fracta			V	Known only from State Forests on parts of the northern escarpment of the Broken Back Range, near Cessnock, where it is locally frequent. It is restricted to shallow soils along the upper escarpment of a steep sandstone range {Harden, 2002 #5; NSW Scientific Committee, 1999 #537}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V	V	Occurs from Niangala to Glenn Innes where it grows in grassy sclerophyll woodland on shallow relatively infertile soils on shales and slates, mainly on granite (Harden, 1991; DLWC, 2001). Endemic on the NSW Northern Tablelands, of limited occurrence, particularly in the area from Walcha to Glen Innes; often on porphyry or granite (Brooker and Kleinig 1999).	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area but a commonly planted street tree; not recorded by arborist or during ecological inspection.	No.
Eucalyptus pulverulenta	Silver-leaved Gum	V	V	Tree or mallee to 10 metres high, rare and scattered, in small stands almost in the understorey of grassy woodland on relatively poor soil; from Bathurst to Bombala {Royal Botanic Gardens, 2004 #9}. It grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum (Eucalyptus mannifera), Red Stringybark (E. macrorhynca), Broad-leafed Peppermint (E. dives), Silvertop Ash (E. sieberi) and Apple Box (E. bridgesiana) {Department of Environment and Conservation, 2005 #762}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area but a commonly planted street tree; not recorded by arborist or during ecological inspection.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Eucalyptus scoparia	Wallangarra White Gum	V	E1	Occurs in Queensland and reaches its southern limit in NSW. In NSW it is known from three locations all near Tenterfield in the far northern New England Tableland Bioregion where it grows on well drained granitic hilltops, slopes and outcrops, often as scattered trees in open forest and woodland {Royal Botanic Gardens, 2004 #9}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area but a commonly planted street tree; not recorded by arborist or during ecological inspection.	No.
Genoplesium baueri	Bauers Midge Orchid		V	Grows in sparse sclerophyll forest and moss gardens over sandstone; from the Hunter Valley to Nowra district {Royal Botanic Gardens, 2004 #9}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Grammitis stenophylla	Narrow-leaf Finger Fern		E1	Fern which occurs in coastal regions from Queensland to the NSW south coast where it grows on rocks in rainforest and in wet sclerophyll forest {Harden, 2000 #2}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Grevillea caleyi	Caleys Grevillea	E	E1	Occurs in the Terrey Hills-Belrose area north of Sydney where it grows in woodland on laterized sandstone ridgetops {Harden, 2002 #5}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales {NSW Scientific Committee, 1998 #78; Harden, 2002 #5}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Haloragodendron lucasii		E	E1	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone {Harden, 2002 #5}. Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Associated with high soil moisture and relatively high soil-phosphorus levels {Department of Environment and Conservation, 2005 #762}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hibbertia puberula			E1	Has not been seen for over 40 years. Early records of this species are from the Hawkesbury River area and Frenchs Forest in northern Sydney, South Coogee in eastern Sydney, the Hacking River area in southern Sydney, and the Blue Mountains {Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hibbertia sp. Bankstown		CE	CE	Endemic to New South Wales and is currently known to occur in only one population at Bankstown Airport in Sydney's southern suburbs, in the Bankstown local government area. The species is not known from any conservation reserves. The population comprises fewer than 50 individuals.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hibbertia superans			E1	Occurs from Castle Hill to South Maroota where it grows in ridgetop woodlands usually near Shale/Sandstone Transition Forest. It is often associated with other threatened flora including Pimelea curviflora var. curviflora, Darwinia biflora, Epacris purpurascens var. purpurascens, Leucopogon fletcheri subsp. Fletcheri, Acacia bynoeana, Eucalyptus sp. Cattai and Persoonia hirsuta (NSW Scientific Committee, 2001).	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe anomala var. ianthinomarginata			V	Small, brightly-coloured gilled fungus and has been found in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from Royal and Blue Mountains National Parks {NSW National Parks and Wildlife Service, 2002 #221}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Hygrocybe aurantipes			V	Small, brightly-coloured gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney and from the Blue Mountains National Park (Mt Wilson) and Hazelbrook and surveys in potentially suitable habitats elsewhere in the Sydney Basin Bioregion have failed to find Hygrocybe aurantipes A. M. Young. At Lane Cove the species occurs not only in leaf litter but also on mossy creek banks, under a closed canopy. The species does not produce basidiomes all year, but non-reproductive hyphal structures occur below ground {NSW National Parks and Wildlife Service, 2002 #222}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe austropratensis			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney {NSW National Parks and Wildlife Service, 2002 #223}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe collucera			E1	Small, brightly-coloured red gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney {NSW National Parks and Wildlife Service, 2002 #228}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe griseoramosa			E1	Small, buff to brown gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove local government area in Sydney {NSW National Parks and Wildlife Service, 2002 #229}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe lanecovensis			E1	Small, brightly-coloured gilled fungus and known only from its type locality in Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney {NSW National Parks and Wildlife Service, 2002 #224}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Hygrocybe reesiae			V	Small, lilac coloured gilled fungus and is known in New South Wales only from its type locality in the Lane Cove Bushland Park in the Lane Cove Local Government Area in Sydney, and from the Blue Mountains National Park (Hazelbrook Area). It is also found in Tasmania {NSW National Parks and Wildlife Service, 2002 #225}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hygrocybe rubronivea			V	Small, brightly-coloured gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove local government area in Sydney {NSW National Parks and Wildlife Service, 2002 #226}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Leptospermum deanei		V	V	Only occurs near the watershed of Lane Cove River where it grows on forested slopes {Harden, 2002 #5}.Woodland on lower hills and slopes or near creeks, sandy alluvial soil or sand over sandstone. Occurs in Riparian Scrub- e.g. Tristaniopsis laurina, Baechea myrtifolia, Woodland- e.g. Eucalyptus haemstoma and Open Forest - e.g. Angophora costata, Leptospermum trinervium and Banksia ercifolia {Department of Environment and Climate Change, #2966}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Leucopogon exolasius	Woronora Beard-heath	V	V	Restricted chiefly to the Woronora and Grose Rivers and Stokes Creek, Sydney catchments and the Royal National Park. One old record from the Grose River. Grows in woodland on sandstone {Royal Botanic Gardens, 2004 #9}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Maundia triglochinoides	-		V	Occurs north from Sydney. Grows in swamps, creeks or shallow freshwater 30 to 60 cm deep on heavy clay, low nutrients. Associated with wetland species such as Triglochin procerum {Harden, 1993 #4}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Melaleuca biconvexa	Biconvex Paperbark	V	V	Occurs as disjunct populations in coastal New South Wales from Jervis Bay to Port Macquarie, with the main concentration of records is in the Gosford/Wyong area {NSW Scientific Committee, 1998 #145}. Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects {Harden, 2002 #5; Department of Environment and Climate Change, 2008 #1913}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Melaleuca deanei	Deanes Paperbark	V	V	Occurs in coastal districts, including western Sydney (e.g. Baulkham Hills, Liverpool shires) from Berowra to Nowra where it grows in wet heath on sandstone and shallow/skeletal soils near streams or perched swamps {James, 1997 #69; Harden, 2002 #5}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Microtis angusii		E	E1	Known from few small populations at Sunny Corner near Bathurst, Ingleside and Warringah. Known to occur within Duffy's Forest {Warringah Shire Council, 2004 #233}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pelargonium sp. Striatellum (G. W. Carr 10345), syn. Pelargonium sp., Pelargonium sp. 1	Omeo Stork's-bill	E	E1	Known to occur in New South Wales and Victoria in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes and in the transition zone between surrounding grasslands or pasture and the paludal and aquatic communities. During dry periods, the species is known to colonise exposed lake beds {NSW Scientific Committee, 2010 #3826}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Persoonia hirsuta	Hairy Geebung	E	E1	Occurs from Gosford to the Royal National Park and Hill Top to Glen Davis and Putty inland where it grows in woodlands and dry sclerophyll forest on sandstone or very rarely on shale {Harden, 2002 #5}. Typically occurs as isolated individuals or very small populations {NSW Scientific Committee, 1998 #64; Royal Botanic Gardens, 2005 #404}. Often occurs in areas with clay influence, in the ecotone between shale and sandstone {James, 1997 #69}. Habitat in Castle Hill is considered to be "critical habitat" {James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Persoonia nutans	Nodding Geebung	E	E1	Confined to the Cumberland Plain where it grows in Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands {NSW National Parks and Wildlife Service, 2001 #77; Harden, 2002 #5; James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pimelea curviflora var. curviflora		V	V	Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville, but its former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Usually occurs in woodland in the transition between shale and sandstone, often on Lucas Heights soil landscape {NSW Scientific Committee, 1998 #65; James, 1997 #69; James, 1999 #68; Harden, 2000 #2}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Pimelea spicata	Spiked Rice-flower	E	E1	This species occurs in two disjunct areas: in coastal districts from Lansdowne to Shellharbour, and in Cumberland Plain Woodland inland to Penrith. In western Sydney it grows on Wianamatta Shales in Greybox - Ironbark Woodland with Bursaria spinosa and Themeda australis. In the Illawarra, it occurs on well-structured clay soils in grassland or open woodland {NSW National Parks and Wildlife Service, 2000 #75; Harden, 2000 #2; James, 1997 #69}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Prasophyllum fuscum	Slaty Leek Orchid	V	V	Occurs in the Blue Mountains and Hawkesbury Sandstone where it grows in moist heath often along seepage lines {Harden, 1993 #4}. It prefers brown silty sand on gentle slopes {Bishop, 2000 #12}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Prostanthera marifolia		CE	CE (NSW)	Thought to be extinct. Previously occurred in Mangrove Mountain and Sydney districts usually near the coast. Recorded within sclerophyll forest and woodland in sandy loamy soils on sandstone Occurs in the Springwood area where it grows in woodland on lateritic soils {Harden, 1992 #3}. The taxonomic status of this name is uncertain {Royal Botanic Gardens, 2004 #9}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Pterostylis saxicola	Sydney Plains Greenhood	E	E1	Known now only from Freemans Reach to Picton district. Grows in Sydney Sandstone Gully Forest in shallow or skeletal soils over sandstone shelves, often near streams {Harden, 1993 #4; James, 1997 #69; Department of Environment and Climate Change, 2007 #1653}	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pterostylis sp. Botany Bay		E	E1	Extremely restricted and currently known from only one small population on the Kurnell peninsula in Botany Bay National Park. The habitat of the known population is coastal heath in moist level sites, in association with Melaleuca nodosa and Baeckea imbricata, on skeletal sandy soils derived from sandstone {National Parks and Wildlife Service, 2000 #2317}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pultenaea parviflora		V	E1	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium {Harden, 2002 #5}. Locally abundant within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Also occurs in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland {NSW National Parks and Wildlife Service, 2002 #82; James, 1997 #69}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pultenaea pedunculata	Matted Bush-pea		E1	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. If grows on a variety of soils in dry sclerophyll forest and disturbed sites {Harden, 2000 #2; NSW Scientific Committee, 1999 #727; NSW National Parks and Wildlife Service, 2002 #726}. It is largely confined to loamy soils in dry gullies in populations in the Windellama area {Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Streblus pendulinus	Whalebone Tree	E		On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest {Australian Tropical Plants, 2010#3934}.On Norfolk Island, the species is found in a variety of forest types, though it is rare {Director of National Parks, 2010#3935}.	EPBC	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Syzygium paniculatum	Magenta Lilly Pilly	V	E1	Occurs between Buladelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea {Harden, 2002 #5}. On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities {Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area but a commonly planted street tree; not recorded by arborist or during ecological inspection.	No.
Tetratheca glandulosa	Glandular Pink-bell	V	V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub {Harden, 1992 #3}. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar). Common woodland tree species include: Corymbia gummifera, C. eximia, Eucalyptus haemastoma, E. punctata, E. racemosa, and/or E. sparsifolia, with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae {Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Tetratheca juncea	Black-eyed Susan	V	V	Occurs in coastal districts from Buladelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy, {Harden, 1992 #3} low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland {Payne, 2002 #296}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Species Name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data Source[3]	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Thesium australe	Austral Toadflax	V	V	Grows in grassland or woodland often in damp sites. It is a semi-parasitic herb and hosts are likely to be Themeda australis and Poa spp. {Harden, 1992 #3; Department of Environment and Climate Change, 2008 #1913}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Triplarina imbricata	Creek Triplarina	E	E1	Occurs along the coast and adjacent ranged in the Tabulum and Nymboida districts where it grows in heath often in damp areas. It has been recorded along watercourses in low open forest in association with Tristaniopsis laurina {Harden, 2000 #2; NSW National Parks and Wildlife Service, 2002 #93}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Wilsonia backhousei	Narrow-leafed Wilsonia		V	Occurs chiefly in the Sydney district but also common at Jervis Bay {Harden, 2000 #2}. A salt tolerant species, it is found in intertidal saltmarshes and sometimes on seacliffs {NSW Scientific Committee, 2000 #428}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Zannichellia palustris	-		E1	Grows in fresh or slightly saline stationary or slowly flowing water {Royal Botanic Gardens, 2005 #404}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

H2. Threatened species of animals

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Amphibians							
Crinia tinnula	Wallum Froglet		V	Occurs along coast from south-eastern Queensland to Sydney. Mostly associated with swamps, dams and flooded roadside ditches, usually in heathland, where it is confined to acid, paperbark swamps and sedge swamps of the 'wallum' country. Males call any time of year. Breed in late winter {Anstis, 2002 #540; NSW National Parks and Wildlife Service, 2002 #320}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Heleioporus australiacus	Giant Burrowing Frog	V	V	Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks {Cogger, 2000 #20; NSW National Parks and Wildlife Service, 2001 #47}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Litoria aurea	Green and Golden Bell Frog	V	E1	Has a fragmented distribution of mainly near coastal locations from Lakes Entrance (Victoria) to south of the NSW-Queensland border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral locations that are more often dry than wet. It is found in small pockets of habitat in otherwise developed areas and has the	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
				tendency of often turning up in highly disturbed sites. Fast flowing rivers and streams appear to be one of the few types of water body not utilized for breeding purposes. Habitat attributes associated with the species' presence include that the water body is shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. Permanent waterbodies are also known to be used and there is historical evidence of occupation of large, often deep and permanent bodies of water. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes that favour the species include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used for this purpose is not yet well understood {Department of Environment and Conservation, 2004 #397; Department of Environment and Conservation, 2005 #398}.			
Litoria brevipalmata	Green-thighed Frog		V	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain {Department of Environment and Climate Change, 2009 #2829} Breeding occurs following heavy rainfall in late spring and summer, with frogs aggregating around grassy semi-permanent ponds and flood-prone grassy areas. The frogs are thought to forage in leaf-litter. Isolated localities along the coast and ranges from the NSW central coast to south-east Queensland.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Mixophyes iteratus	Giant Barred Frog	E	E1	Terrestrial species which occurs in rainforests, Antarctic beech or wet sclerophyll forests. Feeds on insects and smaller frogs {Cogger, 2000 #20}. The species is associated with permanent flowing drainages, from shallow rocky rainforest streams to slow-moving rivers in lowland open forest. It is not known to utilise still water areas {NSW Scientific Committee, 1999, #48}. More prevalent at lower altitudes and in larger streams than its congeners, although has been recorded up to 1000 metres asl. {NSW National Parks and Wildlife Service, 1999 #502}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Pseudophryne australis	Red-crowned Toadlet		V	Occurs within 160 km of Sydney where it is restricted to Hawkesbury Sandstone. It breeds in deep grass and debris adjacent to ephemeral drainage lines. When not breeding individuals are found scattered on sandstone ridges under rocks and logs {Cogger, 2000 #20}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Birds							
Anseranas semipalmata	Magpie Goose		V	Occurs in shallow wetlands such as large swamps and dams, especially with dense growth of rushes or sedges, and with permanent lagoons and grassland nearby. Feeds on seeds, tubers and green grass. Form large nesting colonies during the wet season. During the dry season this species migrates hundreds of kilometres to perennial swamps {Garnett, 2000 #21; NSW National Parks and Wildlife Service, 2002 #320}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Anthochaera phrygia (syn. Xanthomyza phrygia)	Regent Honeyeater	EM	CE	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with Casuarina cunninghamiana and Amyema cambagei are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include Eucalyptus sideroxylon (Mugga Ironbark), E. albens (White Box), E. melliodora (Yellow Box) and E. leucoxylon (Yellow Gum) {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Apus pacificus	Fork-tailed Swift	M		Breeds in the northern hemisphere, wintering south to Australia. It is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. It mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. It also occurs over towns and cities. It mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. It sometimes occurs above forests. It probably roosts aerially, but has occasionally been observed to land {Higgins, 1999 #531}.	Atlas of NSW Wildlife	Moderate. Marginal habitat in the study area. Only likely to occasionally fly over the study area.	No General assessment only.
Ardea ibis	Cattle Egret	M		Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands and very rarely in arid and semi-arid regions. High numbers may occur in moist, poorly drained pastures with high grass; it avoids low grass pastures but has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora {Marchant, 1990 #3649}{Morton, 1989 #3648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Arenaria interpres	Ruddy Turnstone	M		Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs and wave platforms {Morcombe, 2003 #992}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Botaurus poiciloptilus	Australasian Bittern	E	E1	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. {Garnett, 2000 #21; NSW National Parks and Wildlife Service, 2002 #320}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Burhinus grallarius	Bush Stone-curlew		E1	Inland habitat consists of open forest and woodlands with few, if any, shrubs, and short, sparse grasses of less than 15cm in height, with scattered fallen timber, leaf litter and bare ground present {Department of Environment and Conservation NSW, 2006 #3631}. In coastal areas, structurally similar elements of tidal and estuarine communities (Casuarina woodlands, saltmarsh and mangroves) provide suitable habitat {Price, 2004 #3630}. Nesting sites are frequently located in relatively open areas, where ground cover is extremely low and/or sparse including native vegetation and mown lawns, ploughed paddocks and paddocks cut for hay, dirt and gravel roads, seaweed on sand beach, playing fields, vacant lots {Department of Environment and Conservation NSW, 2006 #3631}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris acuminata	Sharp-tailed Sandpiper	M		Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris alba	Sanderling	M	V	A coastal species found on low and open sand beaches exposed to open sea-swells. A migratory species, it has been recorded in NSW from September to May {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris bairdii	Baird's Sandpiper	M		Baird's Sandpiper is a vagrant to Australia, with five accepted records in WA, NT, Tas., Vic. and SA and unverified reports from Qld., NSW, Vic. and SA. It is widespread in North, Central and northern South America. In Australia it has been recorded on sandy beaches and mudflats, at saltponds, sewage ponds and shores of lakes and lagoons {Department of Sustainability Environment Water Population and Communities, 2013 #4064}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Calidris canutus	Red Knot	M		In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps {Higgins, 1996 #648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris ferruginea	Curlew Sandpiper	M	E1	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes {Morcombe, 2003 #992}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris melanotos	Pectoral Sandpiper	M		In Australasia, the Pectoral Sandpiper prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. The species is usually found in coastal or near coastal habitat but occasionally found further inland. It prefers wetlands that have open fringing mudflats and low, emergent or fringing vegetation, such as grass or samphire. The species has also been recorded in swamp overgrown with lignum. They forage in shallow water or soft mud at the edge of wetlands {Higgins, 1996 #648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris ruficollis	Red-necked Stint	M		Mostly found in coastal areas, including sheltered inlets, bays lagoons and estuaries. They also occur in shallow wetlands near the coast or inland, including lakes, waterholes and dams {Higgins, 1996 #648}. They forage in mudflats, shallow water, sandy open beaches, flooded paddocks and in samphire feeding along the edges. The species roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle. Occasionally they roost on exposed reefs or shoals {Higgins, 1996 #648} and amongst seaweed, mud and cow-pats {Hobbs, 1961 #3663}. During high tides they may also use sand dunes and claypans.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calidris tenuirostris	Great Knot	M	V	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Callocephalon fimbriatum	Gang-gang Cockatoo		V	Occurs in wetter forests and woodland from sea level to an altitude over 2000 metres, timbered foothills and valleys, coastal scrubs, farmlands and suburban gardens {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Calyptorhynchus lathami	Glossy Black-Cockatoo		V	Occurs in eucalypt woodland and forest with Casuarina/Allocasuarina spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key Allocasuarina species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows {Garnett, 2000 #21; NSW National Parks and Wildlife Service, 1999 #55}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Charadrius leschenaultii	Greater Sand Plover	M	V	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Charadrius mongolus	Lesser Sand Plover	M	V	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Charadrius veredus	Oriental Plover	M		Oriental Plovers are found in coastal habitats, including estuarine mudflats and sandbanks, on sandy or rocky ocean beaches, nearby reefs, or near-coastal grasslands {Bigg, 1981 #3664}{Bransbury, 1985 #3666}{Crawford, 1972 #3671}{Murlis, 1988 #3675}{Serventy, 1976 #3679}{Storr, 1977 #3680}{Storr, 1980 #3681}{Storr, 1984 #3682}. They also disperse further inland inhabiting flat, open, semi-arid or arid grasslands, where the grass is short and sparse, and interspersed with hard, bare ground, such as claypans, dry paddocks, playing fields, lawns and cattle camps {Boekel, 1980 #3665}{Carruthers, 1968 #3667}{Close, 1982 #3669}{Fletcher, 1980 #3672}{Pedler, 1982 #3678}{Storr, 1980 #3681}, or open areas that have been recently burnt {Boekel, 1980 #3665}{Chatto, 2003 #3668}{Crawford, 1972 #3671}{Garnett, 1986 #3673}{Storr, 1977 #3680}. Oriental Plovers may move to lightly wooded grasslands in wet season {Storr, 1977 #3680} and sometimes roost on soft wet mud or in shallow waters of ocean or mudflats {Bransbury, 1985 #3666}{Close, 1982 #3669}{Cox, 1988 #3670}{McCrie, 1984 #3674}{Serventy, 1976 #3679}, and also occasionally in dry, open habitats, such as saltmarsh or paddocks {McCrie, 1984 #3674}{Park, 1983 #3676}{Patterson, 1983 #3677}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Chlidonias leucopterus	White-winged Black Tern	M		In Australia, and elsewhere in their non-breeding range, the species mostly inhabits fresh, brackish or saline, and coastal or subcoastal wetlands. It frequents tidal wetlands, such as harbours, bays, estuaries and lagoons, and their associated tidal sandflats and mudflats. Terrestrial wetlands, including swamps, lakes, billabongs, rivers, floodplains, reservoirs, saltworks, sewage ponds and outfalls are also inhabited. They rarely occur on inland wetlands in Australia {Chan, 2007 #3655}{Chan, 2008 #3656}{Chatto, 2006 #3657}{Cramp, 1985 #3658}{Dening, 2003 #3659}{Gochfeld, 1996 #3660}{Higgins, 1996 #648}{Johnstone, 1998 #3661}{Urban, 1986 #3662}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Chthonicola sagittata (syn. Pyrrholaemus sagittatus)	Speckled Warbler		V	Occurs in a wide range of eucalypt dominated vegetation with a grassy understorey and is often found on rocky ridges or in gullies. It feeds on seeds and insects and builds domed nests on the ground {Garnett, 2000 #21}. The species has been shown to decrease in abundance as woodland area decreased, and it appears to be extinct in districts where no fragments larger than 100ha remain {Barrett, 1994 #3628}. Isolation of Speckled Warbler populations in small remnants increases their vulnerability to local extinction as a result of stochastic events and decreases their genetic viability in the long term {NSW Scientific Committee, 2001 #245}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Circus assimilis	Spotted Harrier		V	The Spotted Harrier occurs throughout the Australian mainland in grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods) {Marchant, 1993 #534}. It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. The diet of the Spotted Harrier includes terrestrial mammals, birds and reptiles, occasionally large insects and rarely carrion {Department of Environment Climate Change and Water, 2010 #3228}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)		V	Found in eucalypt woodlands and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly in habits woodlands dominated by stringybarks or other rough-barked eucalypts. Nesting occurs in tree hollows {Department of Environment and Conservation, 2005 #3051}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Daphoenositta chrysoptera	Varied Sittella		V	The Varied Sittella inhabits most of mainland Australia except the treeless deserts and open grasslands. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. The Varied Sittella feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years {Department of Environment Climate Change and Water, 2010 #3226}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Dasyornis brachypterus	Eastern Bristlebird	E	E1	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is though that few individuals survive the passage of fire, survival is dependant on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region {NSW National Parks and Wildlife Service, 1997 #148}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Diomedea antipedensis	Antipodean Albatross	VM	V	A nomadic marine species that occasionally breeds off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Diomedea chrysostoma	Grey-headed Albatross	M		An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Diomedea dabbena	Tristan Albatross	E		Breeding range now restricted to Inaccessible and Gough Island., having been eliminated from the main island of Tristan de Cunha by 1907. Current global population estimated to contain about 1,000 breeding pairs. There is only one record from Australian waters. Breed biennially in colonies among grass tussocks on isolated subantarctic islands and feed pelagically on squid, fish and crustaceans {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Diomedea exulans	Wandering Albatross	VM	E1	Nomadic marine species that breeds in small loose colonies among grass tussocks, using a large mud nets, sometimes off the coast of NSW {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Diomedea gibsoni	Gibson's Albatross	VM	V	A nomadic marine species that forages off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Ephippiorhynchus asiaticus	Black-necked Stork		E1	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Epthianura albifrons	White-fronted Chat		E2	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level (North 1904; Higgins et al. 2001; Barrett et al. 2003). In New South Wales the White-fronted Chat occurs mostly in the southern half of the state, occurring in damp open habitats along the coast, and near waterways in the western part of the state (Higgins et al. 2001). Along the coastline, White-fronted Chats are found predominantly in saltmarsh vegetation although they are also observed in open grasslands and sometimes in low shrubs bordering wetland areas. (North 1904; Higgins et al. 2001; Barrett et al. 2003). The population in the Sydney Metropolitan Catchment Management Authority region is listed as Endangered {Office of Environment and Heritage, 2012 #3712}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Erythrotriorchis radiatus	Red Goshawk	VM	CE	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 meters which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Esacus neglectus	Beach Stone-curlew		CE	Found on beaches within species range, including short stretches of muddy sand among mangroves, coralline sands on atolls and prime surf beaches. Does not occupy long stretches of continuous mangroves or cliffs though beaches associated with estuaries or near mangroves are favoured {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Fregetta grallaria	White-bellied Storm-Petrel		V	Marine species, breeding on Lord Howe Island (Department of Environment and Climate Change 2007).	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Gallinago hardwickii	Latham's Snipe	M		Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Glossopsitta pusilla	Little Lorikeet		V	The Little Lorikeet is a small green lorikeet with black bill and red patch on forehead and throat. The underside is yellow-green. Immatures are duller with less red on face and brown bill. Found in forests, woodland, treed areas along watercourses and roads. Forages mainly on flowers, nectar and fruit. Found along coastal east Australia from Cape York in Queensland down east coast and round to South Australia. Uncommon in southern Victoria {Higgins, 1999}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Grantiella picta	Painted Honeyeater		V	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus Amyema, though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees. Less likely to be found in in strips of remnant box-ironbark woodlands, such as occur along roadsides and in windbreaks, than in wider blocks {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Gygis alba	White Tern		V	Occurs on oceanic islands, tropical and subtropical seas. Eggs are laid and incubated in depression on branch of forest tree or palm frond up to 10 metres above ground {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Haematopus fuliginosus	Sooty Oystercatcher		V	The Sooty Oystercatcher is found on rocky headlands, rock shelves, exposed reefs with rock pools, beaches and muddy estuaries {Marchant, 1993 #534}. The species forages on exposed intertidal rocky shorelines at low tide {Garnett, 2000 #21}. It breeds almost exclusively on offshore islands, and occasionally on isolated promontories during spring and summer. They nest on the ground in amongst rocks, seaweed, shells and pebbles {Marchant, 1993 #534}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Haematopus longirostris	Australian Pied Oystercatcher		E1	Occurs in undisturbed beaches, sandspits, sandbars, tidal mudflats, estuaries and coastal islands. Occasionally found on rocky reefs, shores, rock stacks, brackish or saline wetlands and also in grassy paddocks, golf courses or parks near coast. Eggs are laid in shallow scrape in sand on open beach or among low growth behind beach {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Haliaeetus leucogaster	White-bellied Sea-Eagle	M		Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hieraaetus morphnoides	Little Eagle		V	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring. Prey includes birds, reptiles and mammals, with the occasional large insect and carrion. Most of its former native mammalian prey species in inland NSW are extinct and rabbits now form a major part of the diet {Marchant, 1993 #534}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Hirundapus caudacutus	White-throated Needletail	M		Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Moderate. Marginal habitat in the study area. Only likely to occasionally fly over the study area.	No General assessment only.
Hydroprogne caspia (syn. Sternia caspia)	Caspian Tern	M		The Caspian Tern is found in sheltered coastal embayments preferring sandy or muddy margins. Also found in near-coastal or inland terrestrial wetlands. It forages in open wetlands, preferring sheltered shallow water near the margins. It usually breeds in low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks and occasionally among beachcast debris above the high-water mark or at artificial sites, including islands in reservoirs, or on dredge-spoil. Generally roosting occurs on bare exposed sand or shell spits, banks or shores. {Higgins, 1996 #648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Ixobrychus flavicollis	Black Bittern		V	Usually found in dense vegetation in and fringing streams, swamps, tidal creeks and mudflats, particularly amongst swamp she-oaks and mangroves. Feeds on aquatic fauna along streams, in estuaries and beside billabongs and pools. Breeding occurs in summer in secluded places in densely vegetated wetlands. It nests in trees that overhang the water {NSW National Parks and Wildlife Service, 2002 #320; Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Lathamus discolor	Swift Parrot	E	E1	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering Acacia pycnantha, is indicated. Sites used vary from year to year. {Garnett, 2000 #21},{Swift Parrot Recovery Team, 2001 #396}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Limicola falcinellus	Broad-billed Sandpiper	M	V	A migratory species that breeds in the northern hemisphere between June and August. Individuals feed both on exposed mudflats and while wading in water {NSW National Parks and Wildlife Service, 1999 #22}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Limosa lapponica	Bar-tailed Godwit	M		Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds {Morcombe, 2003 #992}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Limosa limosa	Black-tailed Godwit	M	V	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Macronectes giganteus	Southern Giant-Petrel	EM	E1	A partly nomadic marine species that forages off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Macronectes halli	Northern Giant-Petrel	VM	V	Nomadic marine species that nest as dispersed pairs, often amidst tussocks in dense vegetation. Forages in inshores waters of southern Australia and occasionally visits the coast of NSW {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Melanodryas cucullata cucullata	Hooded Robin (South-Eastern)		V	Found in south-eastern Australia, generally east of the Great Dividing Range. Found in eucalypt woodland and mallee and acacia shrubland. This is one of a suite of species that has declined in woodland areas in south-eastern Australia {Traill, 2000 #42; Garnett, 2000 #21}. The species appears unable to survive in remnants smaller than 100-200ha {NSW Scientific Committee, 2001 #3627}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)		V	Occurs within areas of annual rainfall between 400–700 mm. Feed on insects, nectar and lerps {Garnett, 2000 #21}. It occupies mostly upper levels of drier open forests or woodlands dominated by box and ironbark eucalypts, Blakely's Red Gum and Forest Red Gum. Also inhabits open forests of smooth-barked gums, stringybarks, river sheoaks (nesting habitat) and tea-trees. Feeding territories are large making the species locally nomadic. It tends to occur in the largest woodland patches in the landscape as birds forage over large home ranges of at least 5 hectares (Office of Environment and Heritage 2012b).	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Neophema chrysogaster	Orange-bellied Parrot	ZM	E1	Orange-bellied Parrot breeds in the south-west of Tasmania and migrates in autumn to spend the winter on the mainland coast of south-eastern South Australia and southern Victoria. Typical winter habitat is saltmarsh and strandline/foredune vegetation communities either on coastlines or coastal lagoons. Spits and islands are favoured but they will turn up anywhere within these coastal regions. The species can be found foraging in weedy areas associated with these coastal habitats or even in totally modified landscapes such as pastures, seed crops and golf courses. Diet mainly comprises seeds and fruits of sedges and salt-tolerant coastal and saltmarsh plants. Occasionally, flowers and stems are eaten. Orange-bellied Parrots are known to forage among flocks of Blue-winged Parrots {Higgins, 1999 #531}. It is expected that NSW habitats	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
				may be being more frequently utilised than observations suggest {Department of Environment and Conservation, 2005 #762}.			
Nettapus coromandelianus	Cotton Pygmy-Goose		E1	Found on freshwater lakes, swamps, and large water impoundments. Congregates in flocks on permanent water bodies during the dry season. Lays eggs in the hollow of trees that stand in or beside water. Principal foods are Pondweed Potamogeton seeds and other aquatic vegetation {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Ninox connivens	Barking Owl		V	Occurs in dry sclerophyll woodland. In the south west it is often associated with riparian vegetation while in the south east it generally occurs on forest edges. It nests in large hollows in live eucalypts, often near open country. It feeds on insects in the non-breeding season and on birds and mammals in the breeding season {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Ninox strenua	Powerful Owl		V	A sedentary species with a home range of approximately 1000 hectares it occurs within open eucalypt, Casuarina or Callitris pine forest and woodland. It often roosts in denser vegetation including rainforest of exotic pine plantations. Generally feeds on medium-sized mammals such as possums and gliders but will also eat birds, flying-foxes, rats and insects. Prey are generally hollow dwelling and require a shrub layer and owls are more often found in areas with more old trees and hollows than average stands {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Moderate. Marginal habitat in the form of urban trees present in the study area. The species is known to utilize habitats in inner Sydney the Royal Botanic Gardens and Centennial Park.	Yes
Numenius madagascariensis	Eastern Curlew	M		Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and whatever else it can dig out of the mud with its long, downward-turned bill. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Numenius minutus	Little Curlew	M		On passage the species shows a preference for foraging and resting in swampy meadows near lakes and along river valleys. It overwinters on dry inland grassland, bare cultivation, dry mudflats and coastal plains of black soil with scattered shallow pools of freshwater, swamps, lakes or flooded ground. It shows a preference for short grass swards of less than 20 cm tall, and occasionally occurs in dry saltmarshes, coastal swamps, mudflats or sandflats in estuaries, or on the beaches of sheltered coasts {BirdLife International, 2009 #3690}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pandion cristatus (syn. P. haliaetus)	Eastern Osprey	M	V	Generally a coastal species, occurring in estuaries, bays, inlets, islands and surrounding waters, coral atolls, reefs, lagoons, rock cliffs and stacks. Sometimes ascends larger rivers to far inland. Builds nests high in tree, on pylon or on ground on islands. Feeds on fish {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Petroica boodang	Scarlet Robin		V	In NSW, the Scarlet Robin occupies open forests and woodlands from the coast to the inland slopes. Some dispersing birds may appear in autumn or winter on the eastern fringe of the inland plains. It prefers an open understorey of shrubs and grasses and sometimes in open areas. Abundant logs and coarse woody debris are important structural components of its habitat. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. It forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris {Higgins, 2002 #649}{Department of Environment Climate Change and Water, 2010 #3229}. The species has been found to be absent from remnants surrounded by cereal cropping, less common in isolated patches of 30 ha or less (where there was no tree cover within 200 m and less than 20% cover within 1 km), less common in sites surrounded by cattle grazing and more common in sites with native versus exotic grasses if ungrazed for more than 10 years {Barrett, 2003 #3591}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Petroica phoenicea	Flame Robin		V	In NSW the Flame Robin breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats {Higgins, 2002 #649}. The Flame Robin forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other woody debris. The robin builds an open cup nest of plant fibres and cobweb, which is often near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank {Department of Environment Climate Change and Water, 2010 #3227}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Pezoporus wallicus	Ground Parrot		V	Lives in low heathland and sedgeland. Nests are made on ground beneath dense vegetation. Heathland becomes unsuitable immediately after fire. Seeds are eaten from a wide range of herbs, graminoids and heath, the diet reflecting range of available plants, but excludes seeds that need removal of woody husks. Patchy distribution throughout east coast of NSW {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Phaethon lepturus	White-tailed Tropicbird	M		Marine species.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Phoebetria fusca	Sooty Albatross	VM	V	An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pluvialis fulva	Pacific Golden Plover	M		Prefers sandy, muddy or rocky shores, estuaries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, including offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and occasionally rock shelves, or where these substrates intermingle; harbours, estuaries and lagoons {Higgins, 1993 #534}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pluvialis squatarola	Grey Plover	M		In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes {Marchant, 1993 #534}. They usually forage on large areas of exposed mudflats and beaches and occasionally in pasture and on muddy margins of inland wetlands {Marchant, 1993 #534}. They usually roost in sandy areas, such as on unvegetated sandbanks or sand-spits on sheltered beaches or other sheltered environments {Jaensch, 1988 #3692}{Pegler, 1983 #3693}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Polytelis swainsonii	Superb Parrot	V	V	Mainly found in the Riverina where they nest in loose colonies in riparian woodland on River Red Gum. On the inland slopes, Superb Parrots both forage and feed within box woodland, mostly nesting in dead trees {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Procelsterna cerulea	Grey Ternlet		V	A marine species. It breeds on Lord Howe Island on seacliffs of northern hills and southern mountains, and also on offshore islands including Admiralty Islets, Muttonbird Island and Ball's Pyramid. This species makes a rough nest of seaweed and grass in pockets and hollows along cliff faces {Department of Environment and Conservation, 2005 #762}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pterodroma leucoptera	Gould's Petrel	EM	V	A marine species, it nests on islands among rocks and debris of Cabbage Tree Palms. It feeds on fish, cephalapods and other marine animals {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Pterodroma neglecta	Kermadec Petrel	V		An oceanic species that forages in the tropical and subtropical pacific ocean {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Pterodroma nigripennis	Black-winged Petrel		V	A marine species. Nests at numerous sites on Lord Howe Island: North Head, New Gulch, Dawson's Ridge, Malabar, Ned's Beach, Jim's Point, Transit Hill, adjacent to Muttonbird Point, Red Point and Ball's Pyramid. Nest in a burrow, up to a metre long in sandy soil but shorter in stony volcanic soil. The burrow is located on higher ground, and the entrance is usually hidden amongst bushes {Department of Environment and Conservation, 2005 #762}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Pterodroma solandri	Providence Petrel	M	V	A marine species that breeds at Norfolk island and breeds within earth burrows often within rainforest. Occurs across the western Tasman Sea and the entire north Pacific Ocean {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Ptilinopus superbus	Superb Fruit-Dove		V	Occurs in rainforests and fringes, scrubs, mangroves and wooded stream-margins, lantana thickets, isolated figs, pittosporums, lily pillies and blackberries {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Puffinus assimilis	Little Shearwater		V	A marine species that occurs over the Tasman Sea and possibly the Coral Sea. The species breeds on island in burrows dug in soft soil among mats of succulents or among loose rocks and they forage far out to sea {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Puffinus carneipes	Flesh-footed Shearwater	M	V	An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Puffinus pacificus	Wedge-tailed Shearwater	M		Return from the North Pacific to their burrows on islands off the coast of NSW. Marine nomadic species that visits land to breed. Known breeding colony at Muttonbird island near Coffs Harbour {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Rostratula australis (syn. R. benghalensis)	Australian Painted Snipe (Painted Snipe)	VM	E1	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as Eucalyptus camaldulensis (River Red Gum), E. populnea (Poplar Box) or shrubs such as Muehlenbeckia florulenta (Lignum) or Sarcocornia quinqueflora (Samphire). Feeds at the water's edge and on mudlflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Stagonopleura guttata	Diamond Firetail		V	Distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas {Blakers, 1984 #376}{Schodde, 1999 #3629}. Occurs in a range of eucalypt dominated communities with a grassy understorey including woodland, forest and mallee. Most populations occur on the inland slopes of the dividing range {Garnett, 2000 #21}. Firetails nest in trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects {Blakers, 1984 #376}{Read, 1994 #3632}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Stercorarius pomarinus	Pomarine Jaeger	M		Marine species.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Sterna albifrons	Little Tern	M	E1	A coastal species found along the coast of New South Wales. They nest between the high tide mark and shore vegetation on undisturbed and unvegetated sites near estuaries and adjacent freshwater lakes. They feed on fish taken from inshore waters {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Sterna fuscata	Sooty Tern		V	Occurs in tropical and subtropical seas, islands and cays. Nests in scrape in sand or coral debris, often in large colonies {Simpson, 1996 #587}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Sterna hirundo	Common Tern	M		A non-breeding migrant to Australia, occurring mainly on the east coast and inhabiting marine, pelagic and coastal habitats. Mostly oceanic but often recorded in bays, harbours and estuaries and occasionally in coastal wetlands. Roosting occurs on unvegetated intertidal sandy ocean beaches, shores of estuaries, lagoons and sand bars {Higgins, 1996 #648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Sternula nereis nereis	Fairy Tern (Australian)	V		Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake islands, wetlands, beaches and spits. The subspecies may migrate within southern Western Australia and Tasmania, where they are seen less frequently during the winter months. They are more sedentary in the north of Western Australia, and in South Australia and Victoria {Hill, 1988 #3584}. Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches {Hill, 1988 #3584}{Higgins, 1996 #648}. They nest above the high water mark often in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse. Colonies tend to occupy areas rather than specific sites, and nest sites are often abandoned after one year, even if they have been successful {Saunders, 1985 #3585}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Stictonetta naevosa	Freckled Duck		V	In most years this species appear to be nomadic between ephemeral inland wetlands. In dry years they congregate on permanent wetlands while in wet years they breed prolifically and disperse widely, generally towards the coast. In inland eastern Australia, they generally occur in brackish to hyposaline wetlands that are densely vegetated with Lignum (Muehlenbeckia cunninghamii) within which they build their nests {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Thalassarche bullei	Buller's Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Thalassarche cauta	Shy Albatross	VM	V	An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Thalassarche impavida	Cambells Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Thalassarche melanorphis	Black-browed Albatross	VM	V	Nomadic marine species that breeds on subantarctic island outside Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds {Garnett, 2000 #21}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Thalassarche salvini	Salvin's Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Thalassarche steadi	White-capped Albatross	VM		An oceanic species that has been recorded off the coast of New South Wales {Garnett, 2000 #21}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Tringa glareola	Wood Sandpiper	M		Found in well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees and often with fallen timber. They also inhabit inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops. This species uses artificial wetlands, including open sewage ponds, reservoirs, large farm dams, and bore drains and occasionally found in stony wetlands. The species forages on mud at the edges of wetlands, either along shores, among open scattered aquatic vegetation, or in clear shallow water {Higgins, 1996 #648}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Tringa nebularia	Common Greenshank	M		Occurs in a range of inland and coastal environments. Inland, it occurs in both permanent and temporary wetlands, billabongs, swamps, lakes floodplains, sewage farms, saltworks ponds, flooded irrigated crops. On the coast, it occurs in sheltered estuaries and bays with extensive mudflats, mangrove swamps, muddy shallows of harbours and lagoons, occasionally rocky tidal ledges. It generally prefers wet and flooded mud and clay rather than sand {Morcombe, 2003 #992}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Tringa stagnatilis	Marsh Sandpiper	M		Occurs in coastal and inland wetlands (salt or fresh water), estuarine and mangrove mudflats, beaches, shallow or swamps, lakes, billabongs, temporary floodwaters, sewage farms and saltworks ponds {Morcombe, 2003 #992}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Tyto novaehollandiae novaehollandiae	Masked Owl (southern mainland)		V	Occurs within a diverse range of wooded habitats including forests, remnants and almost treeless inland plains. This species requires large-hollow bearing trees for roosting and nesting and nearby open areas for foraging. They typically prey on terrestrial mammals including rodents and marsupials but will also take other species opportunistically. Also known to occasionally roost and nest in caves {Garnett, 2000 #21}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Xenus cinereus	Terek Sandpiper	M	V	Found on tidal mudflats and estuaries and on shores and reefs of offshore islands {Pizzey, 1997 #24}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Fish							
Epinephelus daemelii	Black Cod		V	Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. Black cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in just a few seconds. They are usually black in estuaries and banded around clear water reefs. Black cod are apparently slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100-110 cm in length. {Department of Primary Industries Fishing and Aquaculture, 2011 #3439}	EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Pristis zijsron	Green Sawfish		E4	In Australia the species occurs mainly in the tropics from Broome to southern Queensland, with individuals found as far south as Sydney and a single record from Glenelg, South Australia(Last & Stevens, 1994).The last recorded museum specimen from NSW was in 1972 {NSW Fisheries Scientific Committee, 2006 #3582}. The Green Sawfish inhabits muddy bottom habitats and enters estuaries. It has been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches {Threatened Species Scientific Committee, 2008 #3583}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Prototroctes maraena	Australian Grayling	V		It is a mid-water, freshwater species that occurs most commonly in clear, gravelly streams with a moderate flow. Prefers deep, slow flowing pools {NSW Fisheries, 2004 #213}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Invertebrates							
Meridolum corneovirens	Cumberland Plain Land Snail		E1	Restricted to the Cumberland Plain and Castlereagh Woodlands of Western Sydney and also along the fringes of River Flat Forest, especially where it meets Cumberland Plain Woodland. It is typically found under logs and other debris, amongst leaf litter and bark around bases of trees. It is also sometimes found under grass clumps and where possible it will burrow into loose soil {NSW National Parks and Wildlife Service, 1999 #41}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Mammals							
Aepyprymnus rufescens	Rufous Bettong		V	Distribution: From Cooktown in north Queensland, to north-east NSW, where it occurs east of the Dividing Range. In Queensland, it still occurs on both sides of the Great Divide. Macrohabitat: Found in a variety of forest types from wet sclerophyll to dry open woodland, where grass tussocks or fallen timber are present. Also known to occupy a mosaic of open forest and grasslands. Microhabitat: It appears to prefer a more open forest structure, with an sparse shrub layer and a diverse ground cover. Builds nests in grass tussocks and under logs. Strongly associated with dry sclerophyll forest particularly those dominated by Spotted Gum {NSW National Parks and Wildlife Service, 1999 #502}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Cercartetus nanus	Eastern Pygmy-possum		V	Found in a range of habitats from rainforest through sclerophyll forest to tree heath. It feeds largely on the nectar and pollen of banksias, eucalypts and bottlebrushes and sometimes soft fruits. It nests in very small tree holes, between the wood and bark of a tree, abandoned birds' nests and shredded bark in the fork of trees {Turner, 1995 #25}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins {Churchill, 1998 #26}{Office of Environment and Heritage, 2011 #3424}. Breeding habitat (maternity roosts) is located in roof domes in sandstone caves {Office of Environment and Heritage, 2011 #3424}. Thought to forage below the forest canopy for small flying insects {Churchill, 1998 #26}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Dasyurus maculatus maculatus	Spotted-Tailed Quoll (Southern Subspecies)	E	V	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold {NSW National Parks and Wildlife Service, 1999 #502}. Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods {NSW National Parks and Wildlife Service, 1999 #27; NSW National Parks and Wildlife Service, 1999 #502}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Dasyurus viverrinus	Eastern Quoll		E1	Found in a variety of habitats including dry sclerophyll forest, scrub, heathland and cultivated land. Lives in dens which consist of several chambers including underground burrows, hollow logs, rock piles and hay sheds {Strahan, 1995 #185}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Falsistrellus tasmaniensis	Eastern False Pipistrelle		V	Usually roosts in tree hollows in higher rainfall forests. Sometimes found in caves (Jenolan area) and abandoned buildings. Forages within the canopy of dry sclerophyll forest. It prefers wet habitats where trees are more than 20 metres high {Churchill, 2008 #2904}	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Isoodon obesulus	Southern Brown Bandicoot	E	E1	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire {NSW National Parks and Wildlife Service, 1999 #23}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Micronomus norfolkensis (syn. Mormopterus norfolkensis)	Eastern Freetail-bat		V	Thought to live in sclerophyll forest and woodland. Small colonies have been found in tree hollows or under loose bark. It feeds on insects above the forest canopy or in clearings at the forest edge {Churchill, 1998 #26}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Miniopterus australis	Little Bent-wing Bat		V	Feeds on small insects beneath the canopy of well timbered habitats including rainforest, Melaleuca swamps and dry sclerophyll forests. Roosts in caves and tunnels and has specific requirements for nursery sites. Distribution becomes coastal towards the southern limit of its range in NSW. Nesting sites are in areas where limestone mining is preferred {Strahan, 1995 #185}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat		V	This species is found along the east coast of Australia from Cape York in Queensland to Castlemaine in Victoria. Habitat includes rainforest, wet and dry sclerophyll forest, monsoon forest, open woodland, Melaleuca forests and open grasslands. Roosts in caves, old mines, stormwater channels and sometimes buildings with populations centred on maternity caves that are used annually for the birth and development of young {Churchill, 2008 #2904}.	Atlas of NSW Wildlife	Moderate. Marginal habitat in the form of large remnant trees and large open spaces are present within the study area. Recorded previously within proximity of the study area.	Yes.
Myotis macropus	Southern Myotis		V	Found in most habitat types in association with streams and permanent waterways usually at low elevations in flat or undulating landscapes from northern areas of Western Australia, and the Northern Territory, down the entire east coast and the southern coast of Australia to just west of the Victoria/South Australia border and inland along the Murray River. Roosts in caves, tree hollows, in clumps of dense vegetation (e.g. Pandanus), mines, tunnels, under bridges, road culverts and stormwater drains often in abandoned, intact Fairy Martin nests. Roost sites are strongly associated with bodies of water where this species commonly feeds on aquatic insects, shrimp and small fish at the water surface, however, aerial	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
				foraging for other insects is also known {Churchill, 2008 #2904}. Breeding habitat likely to coincide with roosting habitat {Office of Environment and Heritage, 2011 #3424}.			
Petaurus norfolcensis	Squirrel Glider		V	The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. In NSW it is found in dry sclerophyll forest and woodland but not found in dense coastal ranges, inhabits mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range and Blackbutt-Bloodwood forest with heath understorey in coastal areas. It is associated with mixed tree species stands with a shrub or Acacia midstorey. It requires abundant tree hollows for refuge and nest sites and feeds on gum of acacias, eucalypt sap and invertebrates {NSW National Parks and Wildlife Service, 1999 #39}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Petrogale penicillata	Brush-tailed Rock-wallaby	V	E1	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres {NSW National Parks and Wildlife Service, 2003 #49}.	EPBC	Low. No preferred habitat recorded in the study area.	No.
Phascolarctos cinereus	Koala (NSW, ACT & QLD - excluding SE QLD)	V	V	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum Eucalyptus tereticornis, Grey Gum E. punctata, Monkey Gum E. cypellocarpa and Ribbon Gum E. viminalis. In coastal areas, Tallowwood E. microcorys and Swamp Mahogany E. robusta are important food species, while in inland areas White Box E. albens, Bimble Box E. populnea and River Red Gum E. camaldulensis are favoured {NSW National Parks and Wildlife Service, 1999 #43; NSW National Parks and Wildlife Service, 2003 #31}. Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available {Johnston, 1995 #30; NSW National Parks and Wildlife Service, 1999 #502}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Pseudomys novaehollandiae	New Holland Mouse	V		The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (Mus musculus), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes {Threatened Species Scientific Committee, 2010 #3296}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves {NSW National Parks and Wildlife Service, 2001 #56; Churchill, 2008 #2904}	Atlas of NSW Wildlife, EPBC	High. Foraging habitat in the form of Ficus trees is present within the study area. Habitat in the study area is unlikely to be suitable for roosting.	Yes.

Scientific name	Common Name	EPBC Act Status[1]	TSC Act Status[2]	Habitat	Data source	Likelihood of occurrence[4]	Significant Impact Assessment?[4]
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat		V	This species is widespread through tropical Australia and migrates to southern Australia in summer. Occurs in eucalypt forest where it feeds above the canopy and in mallee or open country where it feeds closer to the ground. Generally a solitary species but sometimes found in colonies of up to 10. It roosts and breeds in tree hollows but has also been recorded roosting under exfoliating bark, in burrows of terrestrial mammals, in soil cracks and under slabs of rock and in the nests of bird and sugar gliders {Churchill, 2008 #2904}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Scoteanax rueppellii	Greater Broad-nosed Bat		V	The preferred hunting areas of this species include tree-lined creeks and the ecotone of woodlands and cleared paddocks but it may also forage in rainforest. Typically it forages at a height of 3-6 metres but may fly as low as one metre above the surface of a creek. It feeds on beetles, other large, slow-flying insects and small vertebrates. It generally roosts in tree hollows but has also been found in the roof spaces of old buildings {Churchill, 2008 #2904}	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.
Reptiles							
Hoplocephalus bungaroides	Broad-headed Snake	V	E1	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer {Webb, 1994 #51; Webb, 1998 #52}.	Atlas of NSW Wildlife, EPBC	Low. No preferred habitat recorded in the study area.	No.
Varanus rosenbergi	Heath Monitor (Rosenberg's Goana)		V	Found in coastal heaths, humid woodlands, wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices {Cogger, 2000 #20}.	Atlas of NSW Wildlife	Low. No preferred habitat recorded in the study area.	No.

H3. Significance assessments

Significance assessments

The proposed works will be assessed under Part 5 of the *Environmental Planning & Assessment Act* 1979 (EP&A Act). Section 5A of the EP&A Act requires that a 7 part test is undertaken to assess the likelihood of significant impact upon Threatened species, populations or ecological communities under the *Threatened Species Conservation Act 1995* (Department of Environment and Climate Change 2007).

For Threatened biodiversity under the *Environment Protection and Biodiversity Conservation Act 1999* significance assessments have been completed in accordance with the *Matters of National Environmental Significance, Significant Impact Guidelines 1.1* (NSW Scientific Committee 2009). Species listed under both the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999* have been assessed using both assessment guidelines separately.

The following assessments were undertaken for the Threatened ecological communities recorded and the species with a moderate or higher likelihood of occurrence within the study area. The definitions used in determining the likelihood of occurrence are outlined in Section 2.2.4 of the main report.

Significants assessments

Contents

1. Powerful Owl

1.1 Status

The Powerful Owl (Ninox strenua) is listed as vulnerable under Schedule 2 of the Threatened Species Conservation Act 1995.

1.2 Species and habitat description

The Powerful Owl is endemic to eastern and south-eastern Australian, predominantly on the coastal side of the Great Dividing Range. In NSW, the Powerful Owl is widely distributed throughout the eastern forests from the coast to the tablelands. Records of the species distribution are scattered on the western slopes and plains. The Powerful Owl is now uncommon throughout its range where is occurs in low densities.

The Powerful Owl occurs in a variety of habitats including woodland, open sclerophyll forest, open wet forest and rainforest. However, the species generally requires large intact forests or woodlands but may occur in fragmented landscapes also.

The Powerful Owl breeds and hunts in open or closed sclerophyll forest or woodlands and occasionally in open habitats. During the day the species roosts in dense vegetation generally such as Turpentine Syncarpia glomulifera, Black She-oak Allocasuarina littoralis, Blackwood Acacia melanoxylon, Rough-barked Apple Angophora floribunda, Cherry Ballart Exocarpus cupressiformis and a number of eucalypt species.

Powerful Owls prey on medium-sized marsupials such as Brush-tailed Possums and Flying Foxes, depending on the prey in their region.

Breeding pairs of Powerful Owls require hollow-bearing trees, in large eucalypts (diameter at breast height of 80–240 cm) that are at least 150 years old and have a home range of 400-1450 ha.

Powerful Owls mate for life, nesting from late autumn to mid-winter. In north-eastern NSW the breeding is slightly earlier from late summer to mid-autumn (Office of Environment and Heritage 2013).

1.3 Specific impacts

The vegetation within the study area is considered to be marginal habitat for the Powerful Owl, due to its heavily modified nature. The project will modify an approximate 9 km length of road. This will involve the removal of approximately 100 potential foraging and roosting trees (predominantly large street trees) for the Powerful Owl. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages.

1.4 TSC Act significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The study area consists predominantly of individual street trees (both exotic and native) that provide potential marginal foraging and roosting habitat for the Powerful Owl. Although the study area extends approximately 9 km, it is linear in nature, with vegetation clearing comprising the removal of street trees only. Similar and higher quality foraging and roosting habitat exists in the broader locality and as such it is considered that the project is unlikely to have an adverse effect upon the lifecycle of the species to the extent that a viable local population would be placed at risk of extinction.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

iii) the extent to which habitat is likely to be removed or modified as a result of the action proposed

The project will modify an approximate 9 km length of road. This will involve the removal of approximately 100 potential foraging and roosting trees (predominantly large street trees) for the Powerful Owl. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages. The Powerful Owl would not be restricted to habitat resources within the study area, as it would likely use similar and potentially more significant habitat resources within the locality.

iv) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

Habitat connectivity is not likely to be significantly affected by the project. Approximately 100 foraging and roosting trees, located in linear isolated patches, will be affected within the study area and vegetation removal will be largely limited to linear widening in sections over an approximate distance of 9 km. Given the mobility of the Powerful Owl and the existing level of habitat fragmentation, it is considered unlikely that habitat would become significantly further isolated or fragmented.

v) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality.

Areas of potential habitat to be removed are predominately located adjacent to existing roads, and as is subject to significant human disturbance effects and not considered significant habitat for these species. Due to the mobility of these species and the linear nature of the project, potential habitat occurring in the subject site would likely be used as part of a larger home range. Although, it is recognised that vegetation likely to be affected will add incrementally to the loss of habitat for this species.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat has been listed for the Powerful Owl to date. It is estimated that approximately 100 potential foraging and roosting trees would be affected by the project: much of which is linear in nature, and thus avoiding excessive clearing in any one area. Suitable habitat occurring in the study area is not considered critical to the survival of these species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plan or priority action statements have been prepared for the Powerful Owl under the TSC Act. The project is not likely to affect any recovery measures proposed for these species by the Office of Environment and Heritage.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project is unlikely to contribute to any Key Threatening Processes (KTP) under the EPBC Act or the TSC Act of relevance to the species (see section 5.8 of the main report).

Conclusion

Vegetation removal associated with the project will be linear in nature, predominately clearing individual planted street trees adjacent to the existing roads. The area of potential habitat to be removed is relatively small and greater quality habitat is available in the surrounding landscape. As such, the project is unlikely to have a significant impact on the Powerful Owl.Eastern Bent-wing Bat

2. Eastern Bent-wing Bat

2.1 Status

The Eastern bent-wing Bat (*Miniopterus schreibersii oceanensis*) is listed as vulnerable under Schedule 2 of the *Threatened Species Conservation Act*.

2.2 Species and habitat description

The Eastern Bent-wing Bat has a wide distribution, occurring along the east and north-east coasts of Australia.

Eastern Bent-wing bats primary roosting habitat is in caves however they have been known to use derelict mines, storm-water tunnels, buildings and other man-made structures. This species forms discrete populations that centre on maternity caves usually in the spring or summer for the birth and rearing of their young. These haves have specific temperature and humidity regimes required for breeding.

During non-breeding seasons the Eastern Bent-wing Bat disperses within a 300 km range of their maternity cave. Breeding and roosting colonies reach up to 100–150,000 individuals hibernating in cold caves in southern Australia.

The Eastern Bent-wing Bat hunts in forested areas, catching moths and other flying insects above the tree tops (Office of Environment and Heritage 2012).

2.3 Specific impacts

The air spaces within and around all native and exotic vegetation within the study area provide foraging opportunities for the Eastern Bent-wing Bat. No caves or artificial structures potentially suitable as habitat for cave-dwelling bats would be affected.

The project would include the clearing of individual street trees (along an approximate 9 km length including 100 potential foraging trees (subject to change during further design stages)) that constitute potential marginal habitat for the Eastern Bent-wing Bat. The suitability of the study area as foraging habitat for the species is unlikely to be significantly reduced.

2.4 TSC Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

The Eastern Bentwing-bat breeds in communal maternity caves migrating long distances between these and summer foraging habitat and is highly unlikely to breed in the study area.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

(a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The Eastern Bentwing-bat migrates over large distances between maternity and hibernation caves and summer foraging habitat where it uses a variety of natural caves and artificial structures for roosting (Department of Environment Climate Change and Water 2010).

The project will modify an approximate 9 km length of road. This will involve the removal of approximately 100 potential foraging and roosting trees (predominantly large street trees) for the Powerful Owl. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages. Potential marginal foraging habitat for the Eastern Bent-wing Bat is considered to be relatively abundant in the broader locality. The foraging habitat for the species which would be modified is likely to be of only low importance to local populations of the Eastern Bent-wing Bat. This habitat is also likely to remain suitable for foraging after the project is complete.

As the species is highly mobile it is considered unlikely to be significantly affected by the minor habitat fragmentation that would occur as a result of the project.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat has been listed for the species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

No recovery plans have been developed for the species however priority actions have been identified for its recovery. Most of these actions relate to research, education and policy development and are of limited relevance to the project. The project is not considered likely to interfere with the implementation of any of the other recovery actions of relevance to the species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project is unlikely to contribute to any Key Threatening Processes (KTP) under the EPBC Act or the TSC Act of relevance to the species (see section 5.8 of the main report).

2.5 Conclusion

Habitat modification as a result of the project is unlikely to have a significant impact on any local population of the Eastern Bent-wing Bat due to the loss only a small proportion of potential foraging habitat in the locality.

3. Grey-headed Flying-fox

3.1 Status

The Grey-headed Flying-fox is listed as vulnerable under Schedule 2 of the Threatened Species Conservation Act.

3.2 Species and habitat description

The Grey-headed Flying-fox is found in a variety of habitats including subtropical and temperate rainforest, mangroves, paper bark swamps, heathland, sclerophyll forests, urban gardens and cultivated areas. It forages on blossoms and fruits of over 80 species of plants (Parry-Jones & Augee 1991). The major foraging resource for Grey-headed Flying-fox includes the nectar and pollen of a variety of native plants including Eucalyptus, Melaleuca and Banksia, and fruits of rainforest trees and vines, and native figs (Ficus spp.). They have also been found to chew leaves and appear to eat the salt glands from mangroves (Parry-Jones & Augee 1991).

Grey-headed Flying-foxes congregate in camps of up to 200,000 individuals with camp size influenced by the availability of the local blossom, with the camps being located close to water, in vegetation within a dense canopy. These bats have nightly feeding ranges of up to 20 to 50 km from their daytime camp (Eby 1991).

Individual camps may have tens of thousands of animals and are used for mating, birth and the rearing of young. Annual mating commences in January and a single young is born each October or November. For the first three weeks females carry their young when they forage, after this, the young are left together in the camp when they forage (Churchill 2008).

Site fidelity to camps is high with some camps being used for over a century. Individuals are highly mobile and regularly move between camp sites in response to local food availability (Parry-Jones & Augee 1991; Parry-Jones & Augee 1992; Spencer et al. 1991).

3.3 Specific impacts

The project will modify an approximate 9 km length of road. This will involve the removal of approximately 100 potential foraging and roosting trees (predominantly large street trees) for the Powerful Owl. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages.

3.4 TSC Significance assessment

In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

No camp sites (roosting and breeding habitat) for the Grey-headed Flying-fox are located within or immediately adjacent to the study area and winter-flowering eucalypts, an important foraging resource, are scarce in the study area. The life cycle of the species is hence unlikely to be significantly affected.

In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(a) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(b) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction

Not applicable.

In relation to the habitat of a threatened species, population or ecological community:

(a) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(b) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(c) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

The approximately 100 trees which would be cleared are likely to be used as marginal foraging habitat by this species, chiefly on a seasonal basis when the Ficus species and Eucalypt species are flowering heavily.

As this species is highly mobile it is considered unlikely to be significantly affected by the minor habitat fragmentation that would occur as a result of the project.

Potential foraging habitat for this species is considered to be relatively abundant in the locality. The foraging habitat in the study area is considered to be of only moderate importance to the local occurrence of this species and only a small area of this habitat would be lost.

Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat has been listed for this species.

Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The project is not considered likely to substantially contribute to or interfere with the implementation of recovery strategies for this species.

Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The project is unlikely to contribute to any Key Threatening Processes (KTP) under the EPBC Act or the TSC Act of relevance to the species (see section 5.8 of the main report).

3.5 Conclusion

The Grey-headed Flying-fox is listed as a vulnerable species under the Threatened Species Conservation Act 1995. The Grey-headed Flying-fox is unlikely to be significantly impacted by the project.

3.6 EPBC Act significance assessment – Vulnerable species

The Grey-headed Flying-fox is listed as vulnerable under the Environmental Protection and biodiversity Conservation Act 1999.

Will the action lead to a long-term decrease in the size of an important population of the species?

All Grey-headed Flying-fox individuals within Australia form a national population which is separated into colonies centred around camps. Due to the constant genetic exchange and movement patterns between camps throughout the species geographic range there are no distinct or separate populations. Therefore, only one single interbreeding population is recognised (Webb N & Tidemann C 1995, Parry-Jones K, 2004 #3524). All Grey-headed Flying-foxes are therefore considered to be part of an important population.

Grey-headed Flying-foxes occur within a variety of habitats foraging mainly within Eucalypts, other plant species with abundant nectar or fleshy-fruited trees such as figs. Although nectar-producing and flesh-fruited tree species occur on site these are predominantly summer flowering/fruiting species which are abundant at a local and regional scale.

The study area contains a number of flowering and fruiting trees that may potentially be used as marginal foraging habitat. The project may lead to a decrease in suitable habitat, however, any such decrease is likely to be minor and limited to street trees, and unlikely to decrease the size of an important population.

Will the action reduce the area of occupancy of an important population?

The project will modify an approximate 9 km length of roadside and park edge habitat in an urban setting. This will involve the removal of approximately 100 potential foraging trees (predominantly large street trees) for the Grey-headed Flying-fox, slightly reducing the area of occupancy of the species. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages.

Will the action fragment an existing population into two or more populations?

No increase in fragmentation is expected from the project as the ‘breaking apart’ of single areas of habitat into many smaller areas of habitat will not occur. Some small increase to isolation of habitat patches will occur. As it is a very mobile species, capable of traversing large expanses of cleared land, the species is unlikely to be affected by such a minor increase in habitat fragmentation.

Will the action adversely affect habitat critical to the survival of a species?

No critical habitat has been listed for the species under the EPBC Act. Habitat critical to the survival of a species may also include areas that are not listed on the Register of Critical Habitat if they are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community.

The habitat that would be affected as a result of the project is unlikely to be important for the long-term maintenance of the species, important for genetic diversity, or important for re-introductions as it is highly fragmented and disturbed.

Will the action disrupt the breeding cycle of an important population?

The Grey-headed Flying-fox breed within large exposed branches of canopy trees within large camps. There are no Grey-headed Flying-fox camps adjacent to the study area. The project will remove approximately 100 potential foraging and roosting trees for the Grey-headed Flying-fox. It is unlikely to interfere with the lifecycle of any local population as it is unlikely to result in the loss of any breeding habitat in the locality.

Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The project will modify an approximate 9 km length of roadside and park edge habitat in an urban setting. This will involve the removal of approximately 100 potential foraging trees (predominantly large street trees) for the Grey-headed Flying-fox. The number of trees to be directly and indirectly impacted upon by the project is subject to change during further design stages. Whilst the project will decrease the potential habitat available for this species it is unlikely to lead to the decline of the species as a whole as the habitat affected is unlikely to be important habitat.

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the endangered or critically endangered species' habitat?

Construction has the potential introduce to plant diseases which could affect habitat for the species. Implementation of soil, equipment and materials management measures will, however, minimise the likelihood of disease introduction such that the project would be unlikely to result in the introduction of any invasive species that would be harmful to the Grey-headed Flying-fox becoming established in the species' habitat.

Will the action introduce disease that may cause the species to decline?

No, the project is unlikely to introduce or spread any diseases likely to cause the species to decline.

Will the action interfere with the recovery of the species?

A national recovery plan has not been prepared for the Grey-headed Flying-fox, however, recovery actions have been identified by Office of Environment and Heritage. The project will not interfere significantly with any of the identified recovery actions.

Conclusion

Based on the degraded habitat to be impacted, this species is unlikely to be significantly affected by the project. Overall, the potential impact from the project on the species is not considered significant with regard to its context and intensity.

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CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 1C

APPENDIX I: PROPOSED MITIGATION MEASURES

I. Mitigation measures

Detailed design and pre-construction

Environmental management measures to be implemented during the detailed design and pre-construction phase of the CSELR proposal are listed in Table I.1.

Table I.1 Detailed design and pre-construction phase environmental management measures

ID No.	Environmental management measure – detailed design and pre-construction phase
Traffic, transport and accessibility	
A.1	Opportunities to consolidate the existing taxi zones along Devonshire Street (between Chalmers Street and Elizabeth Street) and Chalmers Street (adjacent to the Foveaux Street and Elizabeth Street intersection) into one location adjacent to Central Railway Station in Chalmers Street (south of Devonshire Street, as per the functional road network changes proposed for the operational phase of the CSELR proposal) would be investigated during detailed design in consultation with the City of Sydney.
A.2	The detailed streetscape design of the George Street pedestrian zone would include defined areas for pedestrians and light rail vehicles through visual cues, such as changing pavement types.
A.3	The key actions specified in the detailed access plans for each of the proposed light rail stops, included in section 7.3 of Technical Paper 1 — *Transport Operations Report* (addressing potential multimodal access, customer safety, or to improvements to access) would be further considered during detailed design.
A.4	Opportunities to relocate impacted loading and taxi zones from George Street to the additional kerb provided at the cross streets (for example, converting obsolete turning bays for movements onto George Street into parking) would be further investigated during detailed design (consistent with other changes proposed as part of the Sydney City Centre Access Strategy), in consultation with City of Sydney.
A.5	Parking management measures to improve the future balance between car parking supply and demand and to maintain effective spare capacity to meet varied demands would be investigated during detailed design. Transport for New South Wales would work through implementation of these measures to manage kerbside activity with City of Sydney and Randwick City Council.
A.6	For the Kingsford sub-precinct, controls on remaining parking spaces (to restrict parking to key uses and removing unrestricted parking) would be investigated during detailed design with the aim of maximising the benefit of available parking capacity for high priority users (including disabled, servicing and loading, short stay parking for local business and long stay for residents). Transport for New South Wales will work through implementation of these measures to manage kerbside activity with Randwick City Council.
A.7	Opportunities to relocate existing disabled parking space on High Street (between Clara Street and Hospital Road) to Clara Street (at the intersection with High Street) would be investigated during detailed design, in consultation with Randwick City Council.
A.8	Permanent changes to access arrangements and local traffic movement would be minimised during the detailed design phase, including the maintenance of existing accesses where possible. Any access restrictions required for the CSELR proposal would be subject to further consultation between the affected parties, Transport for NSW and the appropriate local council (City of Sydney or Randwick City Council). A case by case consideration of each affected property access would be undertaken during detailed design (in consultation with the affected parties) to determine the access restrictions required along the proposed CSELR route.
A.9	Parking permit schemes would be considered, particularly in predominately residential precincts surrounding the CSELR corridor. These would be designed to afford priority to local residents to park in the vicinity of their home with an allowance for short-term parking for visitors and for vehicle access to commercial land uses and other short-stay trip generators.
A.10	Opportunities to stage construction works on the Anzac Parade and Alison Road corridors would be investigated during detailed design to provide additional capacity during construction and reduce increases to travel time.
A.11	Opportunities to signpost and promote alternative road corridors in the south-eastern suburbs of Sydney would be investigated during detailed design and/or construction phases with the aim of lowering traffic volumes along the proposed construction corridor.

ID No.	Environmental management measure – detailed design and pre-construction phase
A.12	Tidal flow operation on Anzac Parade during construction would be considered, to provide a bus priority lane in the peak direction and protect bus journey time reliability along the corridor during construction works. This would involve further review by RMS, including traffic modelling, to assess the impacts and feasibility in more detail. The final bus priority measures to be implemented would be determined in consultation with Randwick City Council and Roads and Maritime Services.
A.13	A single lane would be retained along the entire length of the existing Anzac Parade Busway and complementary bus priority measures on Alison Road. Potential mitigation measures would be developed to allow bus priority lanes in the peak direction during peak hours together with bus priority measures at the intersection of Anzac Parade and Alison Road. These priority measures would be explored as part of the Traffic Management Plans in consultation with the bus operators and the relevant Road Authority.
A.14	Opportunities to implement time-restricted loading zones on Holt Street, Waterloo Street and Riley Street would be investigated during detailed design, in consultation with the City of Sydney, to facilitate access to the adjacent retail and commercial businesses.
A.15	Opportunity to relocate the existing taxi rank from Anzac Parade (south of the Nine Ways intersection and adjacent to the South Sydney Junior Leagues Club) to the Wallace Street frontage of the South Sydney Juniors Club would be investigated during detailed design, in consultation with Randwick City Council.
Noise and vibration	
B.1	The predicted noise and vibration levels in the EIS, and the determination of as-required noise and vibration mitigation, would be verified during the detailed design phase of the proposal.
B.2	Where exceedances of 'other' (non-residential) sensitive receiver noise trigger levels have been predicted in the EIS (refer Table 14 in Technical Paper 11 – *Noise and Vibration Impact Assessment*), this would be verified in the detailed design stage, including further investigation of whether these receivers have fixed glazing and do not rely on open windows for ventilation.
B.3	The final trackform design and associated operational groundborne noise and vibration mitigation measures would be addressed in the detailed design of the track. Standard trackform would be employed through the majority of the George Street pedestrian zone and at other locations removed from particularly sensitive receptors. High-resilience trackform may be required to minimise groundborne noise impacts at locations where sensitive receptors line the alignment. Very high attenuation track may be required at some locations, such as near the Randwick health precinct. Consultation with the receptors identified in Table 23 in Technical Paper 11 – Noise and Vibration Impact Assessment would be required during the detailed design phase to confirm the sensitivity of these locations to ground-borne operational noise. Investigations would establish the internal noise level achieved by these buildings at present, the location of sensitive spaces within each building and the level to which any theatres or recording studios are isolated. More detailed investigations would be conducted including measurement of existing internal and external noise and vibration levels, including ground-borne noise and vibration levels due to the existing road traffic and light and heavy rail in the CBD. These investigations would inform the required resilient trackform design in these locations and confirm the appropriateness of the ground-borne operational noise design goals.
B.4	Where potential exceedances of groundborne operational vibration criteria have been identified in the EIS at locations with vibration sensitive equipment (refer Chapters 12, 13, 15 and 16), ongoing consultation and collaboration with the owners and operators of vibration sensitive equipment along the proposed CSELR alignment would be undertaken throughout the detailed design stage to achieve appropriate vibration outcomes at the affected facilities.
B.5	Operational noise from new electrical substations would be controlled by inclusion of shielding or enclosures to comply with the NSW *Industrial Noise Policy* at all locations.
B.6	The detailed design of public address (PA) systems at light rail stops would include noise mitigation measures to minimise potential noise impacts at the nearest receptors to the stops to comply with the NSW *Industrial Noise Policy.*
B.7	During the detailed design stage, alternative noise mitigation options would be investigated for the Randwick stabling facility (refer measure AI.4 in Table I.3) before determining the final solution to meet the NSW *Industrial Noise Policy* noise criteria.
B.8	The design of the maintenance building/workshop and mechanical equipment at the Rozelle maintenance depot would include noise mitigation measures (as required) to comply with the NSW *Industrial Noise Policy* criteria at the nearest noise sensitive receptors.

ID No.	Environmental management measure – detailed design and pre-construction phase
B.9	At the Rozelle maintenance depot, all audible alarm systems would be designed to be non-tonal and maintenance hard stand areas and turning spaces would be designed such that vehicles do not need to reverse unnecessarily. Alarm systems would be designed to meet the noise goals for the facility.
B.10	During the detailed design stage, construction ground-borne noise impacts would be revisited during preparation of the more detailed site-specific Construction Noise and Vibration Impact Statement for locations listed in Table 64 of Technical Paper 11 – *Noise and Vibration Impact Assessment*. This would include further assessment of the likely construction noise levels at the most affected recording rooms of all recording studios along the CSELR alignment and to establish receiver-specific noise goals, taking into account the type of recordings undertaken, and the existing external to internal noise insulation. Consultation with the owners/operators of these facilities would be undertaken as part of this process.
B.11	Additional assessment of construction road traffic noise impacts of night-time truck movements (if required) would be undertaken at detailed design stage when the finalised traffic plan is determined.
Visual and landscape	
C.1	Detailed design would consider opportunities for siting mature Fig trees within the Royal Randwick racecourse grounds in the vicinity of the intersection of Wansey Road and Alison Road, and in the Wansey Road nature strip (between Arthur and High streets) to recreate the canopy of the lost street trees on the western side of Wansey Road in consultation with the Australian Turf Club.
C.2	Detailed design would consider the opportunity for a central pole catenary system to minimise visual impacts.
C.3	Detailed design would consider opportunities to incorporate substations into other uses (such as seating and shade structures or built development), as well as opportunities to locate and/or design the substations to reduce their visual prominence and amenity impacts, in consultation with City of Sydney and Randwick City Council. Impacts would be minimised by: ▪ Identifying opportunities to locate substations below ground level would be investigated (where appropriate) during detailed design ▪ locating the substations away from sensitive receivers where possible (e.g. within existing buildings) ▪ planting appropriate vegetation around the above ground substations to minimise visual impacts for adjoining properties.
C.4	The Surry Hills stop would be designed to incorporate a new frontage to Devonshire Street for Ward Park to replace the existing landscaped seating area and new tree planting that would be removed by the CSELR proposal. More detailed concepts for this interface would be developed during detailed design in conjunction with the City of Sydney.
C.5	Detailed design would consider opportunities for incorporation of public art into treatment of the site hoarding and enclosure, in collaboration with relevant stakeholders.
C.6	The light rail tracks and paving near the Federation Place forecourt, located south of Lang Road, would be designed to integrate with the existing paving.
C.7	Design of UNSW Anzac Parade stop to maintain clear lines of sight from the University Mall.
C.8	Opportunities to minimise the impact on significant trees at UNSW would be further investigated during detailed design (e.g. rationalising the design of the UNSW Anzac Parade stop to move it away from the significant trees). Where trees are required to be removed, detailed design would investigate opportunities for siting semi mature Fig trees within the UNSW grounds (in the vicinity of the proposed CSELR stop) to recreate the perimeter planting along the Anzac Parade frontage and reinforce campus boundaries in consultation with the University of NSW.
C.9	Detailed design would consider urban design and public domain improvements for the alignment and areas that would be impacted by construction of the CSELR. This would include reinstatement of parks and open space, for example Wimbo Park and High Cross Park and the associated war memorial, as well as creation of new open spaces where available, including at Olivia Gardens.
C.10	Ongoing consultation with the City of Sydney Council, Randwick City Council and other relevant stakeholders would continue to be undertaken throughout the detailed design phase to identify opportunities for revitalisation of existing public spaces and the public domain and to determine the most appropriate form or revitalisation for these areas.
Built and non-indigenous heritage	
D.1	The detailed design of the proposed construction worksite in Circular Quay would minimise potential visual impacts on the setting of the Sydney Opera House.
D.2	The detailed design of works in Regimental Square would aim to retain and conserve the memorial and associated significant plantings.

ID No.	Environmental management measure – detailed design and pre-construction phase
D.3	The design of the proposed above ground Parker Lane substation would be further investigated during detailed design with the aim of avoiding adverse impact on views of the lower section of the Palace Hotel from Parker Lane (which could include the consideration of a below ground substation option at this location).
D.4	The proposed shelter at the Rawson Place stop would be designed to minimise impacts on key views of the façade of Daking House and would be set back as far as possible from its awning. The regrading of the road and pavement levels would be detailed to avoid adverse impacts on the fabric of Daking House at ground level, and maintain the integrity of entry doors and shopfronts.
D.5	Detailed design of the Eddy Avenue alignment would retain and conserve the significant fabric of Central Railway Station and its underbridges.
D.6	Any fixings proposed to be attached to the underbridges of Central Railway Station would be to the concrete structure, not the sandstone.
D.7	Where feasible, service poles would be rationalised and services grouped to minimise clutter and minimise impacts on surrounding visually sensitive receivers.
D.8	The section of the CSELR alignment between Eddy Avenue and Chalmers Street would aim to minimise impacts on the Elizabeth Street Gardens.
D.9	The location and design of the Rawson Place stop would aim to minimise impact on key views of Central Railway Station east along Rawson Place.
D.10	The following measures would be implemented for the Randwick Precinct Heritage Conservation Area: ▪ Where possible, detailed design of the CSELR alignment and the associated Royal Randwick racecourse stop would aim to retain (if possible) and avoid or minimise impacts on the significant built elements including the former racecourse gates and landscaping of the Racecourse Precinct Heritage Conservation Area. ▪ Detailed design of the light rail stabling facility in the north-western corner of the racecourse would investigate retention of remnant historic tram infrastructure to be integrated into the new stabling facility, where feasible. ▪ A photographic archival recording of the Alison Road and Wansey Road boundaries, the north-western area and the Swab Building would be undertaken prior to works commencing. Significant trees and structures to be demolished or altered would be recorded.
D.11	The detailed design of the CSELR would aim to retain as many as practicable of the significant trees along the route, where feasible without compromising rail safety, in particular at the Royal Randwick racecourse.
D.12	The following measures would be implemented for High Cross Park, including the High Cross Heritage Conservation Area and Significant Trees within High Cross Park: ▪ Detailed design of the proposed stop, especially the large scale elevated canopy, substation and associated infrastructure, would aim to minimise the land take in the reserve. The detailed design would aim to retain significant trees, where possible, and the war memorial. ▪ Where feasible, the proposed above ground substation would be changed to a below ground facility to reduce the extent of additional built infrastructure. ▪ Reinstatement of the remnant reserve landscaping. ▪ A photographic archival recording of the reserve would be undertaken prior to works commencing.
D.13	The following measures would be implemented for Tay Reserve: ▪ Detailed design of the CSELR proposal would minimise the area of Tay Reserve to be removed for the cross over at Anzac Parade. ▪ A photographic archival recording of Tay Reserve would be undertaken prior to works commencing.
D.14	The impact on the Rozelle maintenance depot Historical Archaeological Management Units (HAMU) would be revised during detailed design once more detailed information on the proposed Rozelle Maintenance Depot has been determined.
Safety and security and hazard and risk	
E.1	Detailed design would incorporate the principles of Crime Prevention through Environmental Design (CPTED).
E.2	Targeted consultation with identified sensitive receivers for EMF (e.g. UNSW and Prince of Wales Hospital) would be undertaken to inform the detailed design. Any issues identified would be resolved on a case by case basis with solutions such as monitoring and, if necessary, protective screening at the site of the sensitive equipment.

ID No.	Environmental management measure – detailed design and pre-construction phase
Regional land use and community outcomes and property acquisition	
F.1	Where property acquisition is required, it would be acquired in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*. A Property Acquisition Plan would be prepared as part of detailed design.
F.2	Transport for NSW would consult with directly affected land owners during the detailed design of the CSELR proposal.
Hydrology, drainage and surface water quality	
G.1	For flood affected locations, the CSELR would be designed to ensure compliance with the *NSW Floodplain Development Manual* which includes a requirement to not increase flood levels above existing levels. Flood mitigation measures that could be considered include: ▪ increasing downstream drainage capacity ▪ diverting upstream flows around or under the track formation ▪ providing stormwater detention under or adjacent to the track formation.
G.2	All additional flow diversions and new drainage would not exceed the capacity of the existing downstream drainage network and receiving environments. This would be achieved by a range of the following methods: ▪ diverting the existing drainage and crossing the track formation at a location that allows it at a point up slope of the alignment ▪ providing new drainage parallel to the CSELR alignment and crossing the track formation at a location that allows it at a point down slope of the alignment ▪ providing new drainage to discharge to an alternative outlet downstream without crossing the track formation ▪ recycling of wash-down water at the Rozelle maintenance depot and Randwick stabling facility. These measures would aim to prevent increased flood risk and hazard for property and infrastructure.
Groundwater	
H.1	Additional investigation/assessment of dewatering requirements for the construction of the Moore Park tunnel would be undertaken during detailed design and in consultation with the NSW Office of Water. Groundwater modelling would be undertaken to determine the potential impacts from the permanent interruption of groundwater flow, including the extent of the drawdown and the potential for settlement.
H.2	A dewatering system for excavations proposed in the Botany Sands aquifer would be developed. This could comprise the reinjection of groundwater back into the same aquifer to minimise the spatial extent of drawdown (and therefore settlement).
H.3	A field survey would be undertaken to confirm the existence, usage and condition of any bore located within the construction footprint of the CSELR proposal, or potentially affected by the CSELR proposal (e.g. those located in the vicinity of proposed excavations). This would cover an area appropriate to identify potential dewatering impacts.
H.4	The design of embankments would incorporate adequate drainage to reduce compaction and/or sealing of the underlying aquifer.
H.5	Adequate drainage and runoff management would be incorporated into the design of the Rozelle maintenance depot and the Randwick stabling facility.
H.6	A condition assessment of existing buildings and infrastructure along and within the immediate vicinity of the Moore Park tunnel would be undertaken to monitor the risk of settlement from groundwater drawdown.
Aboriginal heritage	
I.1	Information gathered from geotechnical investigations would be reviewed to further refine the areas of potential Aboriginal archaeological deposits identified in this EIS and the extent of impact on such deposits. This review would be undertaken for all areas of the CSELR corridor that have been designated as archaeological potential zones 1, 2 and 3.
I.2	A program of targeted test excavations would be undertaken for all areas of the CSELR corridor that have been designated as archaeological potential zones 1 and 2. This would follow on from the desktop review and site inspections of the CSELR proposal area which were completed for this EIS to assist in accurately determining areas of Aboriginal archaeological potential, and more accurately inform the impact assessment. This in turn would refine the nature and distribution of further mitigation measures, such as salvage excavation.
I.3	Where the allocation of archaeological potential zones is altered from those designated in this EIS, mitigation measures would be employed as relevant to the updated zoning.
I.4	Where required, local Aboriginal stakeholders would be involved and consulted with during Aboriginal archaeological works.

ID No.	Environmental management measure – detailed design and pre-construction phase
Greenhouse gas	
J.1	Transport for NSW would revise and update the greenhouse gas assessment undertaken for the CSELR proposal as part of this EIS during the detailed design phase. This would include the further identification of mitigation measures to reduce the volume of emissions generated during the construction and operational phases of the CSELR proposal. Evaluation and reporting on the feasibility of these mitigation measures would also be undertaken during detailed design as part of the greenhouse gas assessment.
J.2	Opportunities to reduce operational greenhouse gas emissions would be investigated during detailed design. These opportunities could include purchasing electricity derived from a renewable energy source (where available), the use of regenerative braking on rolling stock, promoting the selection of energy efficient rolling stock, the use of photovoltaic powered lighting at stops and undertaking a traction power assessment. The sustainability initiatives documented in Table 7.5 (refer to Chapter 7) would be regularly reviewed, updated and implemented throughout the design development, construction and operational phases.
J.3	Undertake AS14064-2 (greenhouse gases – project level) compliant carbon footprinting exercise in accordance with Greenhouse Gas Inventory Guide for Construction Projects (TfNSW). The carbon footprint would be used to inform decision-making in design and construction. Use standard carbon coefficient values for construction material and fuel usage. Monitor and report the carbon footprint every six months during construction.
Utilities	
K.1	The proposed 12 substations for the CSELR proposal would be located so that they minimise amenity impacts along the CSELR alignment.
K.2	The extent of utility impacts and any works required to protect, relocate or replace services (including funding arrangements) would be confirmed during detailed design in consultation with the relevant utilities providers, including the City of Sydney and Randwick City Council. This consultation would also ensure that appropriate measures are taken regarding the potential integration of future utilities requirements along the alignment and to ensure that the CSELR proposal does not preclude the development or installation of these proposed utilities.
K.3	Should the location of any utilities be identified to be in conflict with the proposal, a review of the proposed works at these location(s) would be undertaken in consultation with the construction contractor. An alternative design or arrangements would then be determined to provide the most feasible and beneficial outcome for the community, service provider and proposal in terms of safety and constructability.
Sustainability	
L.1	The detailed design of the CSELR proposal would aim to achieve an 'excellent' rating under the Infrastructure Sustainability Council of Australia (ISCA) infrastructure rating tool. Table 7.5 in Chapter 7 outlines initiatives applicable to achieve a rating level of 'excellent'.
L.2	Sustainable design and construction of the project would be in accordance with the *Sustainable Design Guidelines V3.0* (Transport for NSW 2013b). Table 7.5 in Chapter 7 outlines applicable initiatives to achieve a rating level of 'Gold'.
Climate change	
M.1	Climate change risk and opportunity assessments would be undertaken during detailed design and would include identification and mitigation of the key climate change risks for the proposal.
Planted trees	
N.1	Proposed construction methods would be reviewed to reduce the construction footprint, where feasible.
N.2	The large mature Figs adjacent to Alison Road, Wansey Road and within George Dan Reserve would be reviewed by a suitably qualified arborist during detailed design to confirm if these trees could be retained. This review could include root zone mapping of potentially impacted Figs to determine the likely extent of their tree roots adjacent to and beneath the road surface (This would be undertaken in conjunction with the mitigation measure identified in mitigation measure C.1).

Construction

Environmental management measures to be implemented during the construction phase of the CSELR proposal are listed in Table I.2.

Table I.2 Construction environmental management measures

ID No.	Environmental management measure – construction phase
General environmental management measures	
O.1	Construction would be undertaken in accordance with Transport for NSW's ISO 14001 accredited environmental management system.
O.2	A construction environmental management plan (CEMP) would be prepared prior to construction, which would outline the construction conditions and temporary environmental protection measures to manage the impact of construction activities. The CEMP would be consistent with the environmental management measures documented in this EIS, conditions of approval and the conditions of any licences or permits issued by government authorities.
O.3	The CEMP would identify the auditing and inspection requirements and determine the framework for the management of key environmental issues for construction. To address site specific conditions, the CEMP would delegate particular management measures to be incorporated in discrete Environmental Control Maps.
O.4	The location of sensitive areas (e.g. heritage items and trees to be retained) would be clearly identified on Environmental Control Maps, which would be supplied to construction managers and workers.
O.5	All workers would be provided with an environmental induction prior to commencing work on-site. This induction would include information on the following: ▪ Environmental protection measures to be implemented to protect the quality of the surrounding environment, including weed control, erosion and sediment control, and water quality management and penalties for breaches. ▪ Noise and vibration management, including good working practices and measures for reducing the source noise levels of construction equipment by construction planning and equipment selection where practicable. ▪ Basic training in the recognition of Aboriginal cultural heritage material. This training would include information such as the importance of Aboriginal cultural heritage material and places to the Aboriginal and non-Aboriginal community, as well as the legal implications of removal, disturbance and damage to any Aboriginal cultural heritage material and sites.
O.6	A waste management plan would be prepared as part of the CEMP. Construction waste would be managed through the waste hierarchy established under the *Waste Avoidance and Recovery Act 2001*. All waste requiring off-site disposal would be classified in accordance with the OEH's (2009) *Waste Classification Guidelines* prior to disposal.
O.7	Procurement of materials would be undertaken on and 'as needed' basis to reduce over-ordering and wastage, and exploring opportunities to reuse materials, where applicable.
O.8	The CSELR proposal would aim to achieve a diversion rate for construction waste from landfill of 95 per cent of waste by volume, with a minimum target of 90 per cent of waste by volume. The proposal would also aim to reuse 100 per cent of paving and other reusable materials or facilitate reuse of such materials.
O.9	Opportunities to minimise the use of potable water would be investigated during construction planning. These opportunities could include the use of alternative water sources, such as recycled water and/or rainwater capture.
O.10	The CEMP would include measures to manage the potential impacts of construction compound operations. This would include inputs into the traffic management plan to minimise impacts associated with vehicle movements to and from construction compounds on surrounding receivers.
O.11	The following environmental management measures would be implemented for the Circular Quay construction compound: ▪ No trees within First Fleet Park would be removed by the proposed construction compound. Exclusion fencing would be established around the drip lines of each tree to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting the underlying tree roots, in accordance with Australian Standard AS 4970.

ID No.	Environmental management measure – construction phase
	▪ Only light structures such as site sheds and light loads would be used in this area to prevent damage to subsurface archaeology. Where appropriate, ground surface protection measures such as geotextile would be considered. The advice of an appropriately qualified archaeologist would be sought in relation to measures to protect subsurface archaeology. ▪ No excavation would be undertaken within First Fleet Park to minimise the risk of impacting on potential subsurface archaeology. ▪ Potential opportunity to temporarily remove plantings under the Cahill Expressway to facilitate construction vehicle access to the construction compound would be further investigated during detailed design, in consultation with relevant stakeholders. Any removed plantings would be reinstated at the completion of construction. ▪ Adequate measures would be implemented to minimise the visual amenity impact of the construction compound on the surrounding area. ▪ Adequate water quality controls would be implemented to reduce the risk of chemical spills/leaks reaching Sydney Harbour (due to the small offset distance to this waterway).
O.12	The following environmental management measures would be implemented for the Belmore Park construction compound: ▪ No trees within Belmore Park would be removed by the proposed construction compound. Exclusion fencing would be established around the drip lines of each tree to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable buildings) above the ground level would be investigated so as to avoid impacting on underlying tree roots, in accordance with Australian Standard AS 4970. ▪ Pedestrian access through Belmore Park would be maintained for the duration of construction.
O.13	The following environmental management measures would be implemented for the Ward Park construction compound: ▪ The layout of the construction compound would be designed to minimise impacts to significant trees within Ward Park. Exclusion fencing would be established around the drip lines of each tree to be retained to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting on underlying tree roots, in accordance with Australian Standard AS 4970. ▪ Vehicle access to the construction compound would be provided from Devonshire Street via the southern side of Ward Park. This vehicle access would be designed so as to avoid significantly impacting on trees that would not already be impacted by the proposed permanent works (e.g. light rail stop and substation).
O.14	The following environmental management measures would be implemented for the Wimbo Park construction compound: ▪ The proposed construction vehicle access to Wimbo Park would be designed to avoid impacts to significant street trees along Bourke Street that would not already be removed to accommodate the proposed permanent works (e.g. light rail track and associated overhead wires). ▪ Opportunity to provide construction vehicle access to Wimbo Park via South Dowling Street (rather than via an extension of Devonshire Street) would be investigated during detailed design, in consultation with Roads and Maritime Services. ▪ The construction compound boundary would be rationalised to allow for the early provision of alternative car parking provisions for the Langton Centre along the southern side of Nobbs Lane (to mitigate impacts associated with the acquisition of the Langton Centre car park). ▪ The community mural would be preserved and relocated within the redesigned Wimbo Park, where feasible.
O.15	The following environmental management measures would be implemented for the associated construction facilities east and west of Anzac Parade (at Moore Park): ▪ The final layout of the construction compound would be configured so as to retain as many of the sporting fields as possible. ▪ The construction compound boundary would be rationalised to avoid impacts to significant trees within Moore Park that would not already be impacted by the proposed permanent works (i.e. the cut-and-cover tunnel). Exclusion fencing would be established around the drip lines of each tree to be retained to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting on underlying tree roots, in accordance with Australian Standard AS 4970.

ID No.	Environmental management measure – construction phase
	▪ Where feasible, the Moore Park construction compound would be located to the north of the proposed cut-and-cover tunnel to minimise impacts to the bottom grounds (which are currently being used by the adjacent schools). ▪ The Moore Park construction compound would not impact on the Korean War memorial or children's play area, located towards the north-western corner of Moore Park. ▪ A temporary footpath would be provided through Moore Park, to maintain current pedestrian access during the construction of the Moore Park tunnel. ▪ Exclusion fencing would be installed around the drip lines of any tree fringing the proposed staff car park (with the potential to be adversely impacted) to avoid impacts to the viability of these trees. ▪ Where feasible, staff car parking at the site would not be permitted during special events at Moore Park, to avoid impacting on special event parking at this venue.
O.16	The following environmental management measures would be implemented for the High Cross Park construction compound: ▪ The construction compound boundary would minimise impacts to significant trees within High Cross Park that would not already be impacted by the proposed permanent works (i.e. the Randwick stop). Exclusion fencing would be established around the drip lines of each tree to be retained (and with the potential to be adversely affected) to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting on underlying tree roots, in accordance with Australian Standard AS 4970. ▪ Where possible, the construction compound at High Cross Park would be constrained to the northern portion of the park to maintain access to public open space and the war memorial. ▪ The High Cross Park construction compound would not impact on the war memorial. ▪ The opportunity to remove on-street parking on Belmore Road would be investigated during detailed design to reduce the extent of High Cross Park that would be required for the construction compound.
O.17	Opportunities to reduce the size of the construction compound required at High Cross Park would be investigated during the detailed design the accommodation of a smaller satellite construction compound the vicinity of the Wansey Road light rail stop.
O.18	The Randwick stabling facility temporary construction compound would be configured so as to retain the large Moreton Bay Fig at the western end of the site, where feasible.
O.19	The following environmental management measures would be implemented for the UNSW construction compound: ▪ The construction compound boundary would be rationalised to avoid impacts to significant trees within UNSW site that would not already be impacted by the proposed permanent works (i.e. the UNSW Anzac Parade stop). Exclusion fencing would be established around the drip lines of each tree to be retained (and with the potential to be adversely affected) to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting on underlying tree roots, in accordance with AS 4970.
Stakeholder engagement	
P.1	A Community and Stakeholder Involvement Plan would be established prior to construction commencing. The Plan would identify: ▪ key stakeholders ▪ methods to inform the community of the progress and performance of the proposal and issues of interest to the community ▪ processes to receive and manage complaints ▪ processes to consult with affected property owners, including property inspections, where appropriate ▪ protocols to notify stakeholders of relevant activities (e.g. out of hours work and traffic disruptions) and any incidents should they occur (e.g. unscheduled service interruptions).
P.2	Newsletters and other communication tools would be distributed to keep the community informed of construction progress, activities and impacts. This would especially outline the need to undertake out of hours works and the process for the community to register complaints and enquiries in relation to the works.
P.3	A 24 hour toll free complaints and enquiries number would be established for the duration of construction.

ID No.	Environmental management measure – construction phase
Traffic, transport and accessibility	
Q.1	A construction network management plan would be developed during detailed design to identify key management measures during construction to minimise impacts to journey times and congestion levels. The plan would also establish a framework for coordinating the implementation of such management measures during the construction of the CSELR proposal. The construction network management plan would seek to align the peak period travel demand with the traffic capacity available during construction. The construction network management plan would comprise a live document that would be updated as a greater understanding of the required construction staging is developed and as new management measures are identified in response to unforseen events during construction and light rail operations.
Q.2	Site specific traffic management plans would be prepared for the construction of the CSELR in accordance with RMS construction specifications and RMS *Traffic Control at Work Sites Manual Version 4.0*.
Q.3	The contractor would comply with the relevant roads authority procedures in applying for road occupancy licences.
Q.4	An application to the NSW Roads and Maritime Services would be made for any proposed adjustment to speed limits whether they are temporary (such as those required for short-term road occupancies), longer term (such as for the duration of a construction stage) or permanent. No adjustments to speed limits would be undertaken without an approved speed zone authorisation.
Q.5	The indicative planned traffic management measures described in section 3.9.4 of Technical Paper 2 (*Construction Traffic and Transport Management Plan*) would be considered and, where appropriate, implemented to manage a reduction in traffic capacity along the CSELR corridor. The traffic, transport and access management strategies described in section 6.10 of the EIS would also be adopted during the construction of the CSELR proposal.
Q.6	Where possible, existing longitudinal pedestrian movements (i.e. pedestrian movements running parallel to the CSELR alignment) would be maintained along the footpaths. Similarly, where possible, transverse pedestrian movement (i.e. pedestrian movements crossing the CSELR alignment) would be maintained at existing pedestrian crossing facilities either at signals or controlled by traffic controllers. Clearly defined pedestrian paths and fencing would be provided to separate the pedestrian path from the worksite and prevent random crossings.
Q.7	Where appropriate, traffic controllers would be used when undertaking construction works adjacent to footpaths with high volumes of construction vehicle movements to manage the conflict between construction vehicles and pedestrians.
Q.8	*Disability Discrimination Act 1992* requirements would be adopted (e.g. with drop kerbs, etc. provided at crossings). Footpath widths would allow two-way pedestrian traffic, with sufficient space provided to accommodate pushchairs and wheelchairs. Where high numbers of vulnerable users utilise a footpath, special provision and design consideration would be undertaken to minimise impacts to these pedestrians.
Q.9	Consideration would be given in design to the layout of any hoarding/fence lines to maximise sight lines for pedestrians, and design out hiding places and blind spots to improve pedestrian personal security. Any gantry arrangements or tunnels would have internal lighting. Any hoardings, or other fixed site boundaries would have lighting if required by current standards.
Q.10	Consideration would be given to relocating or supplementing existing closed-circuit television (CCTV) cameras if the worksite creates unacceptable blind spots.
Q.11	Footway lighting would be provided, where required. Any barriers and pedestrian screens adjacent to pedestrian footways would be designed so as to permit observation from the worksite and opposite footway.
Q.12	Emergency evacuation requirements would be agreed with emergency service providers (Fire Brigade). Depending on the stage of work this may require: ▪ temporary road plates to permit crossing of the work zone ▪ assistance of traffic controllers in restricting public access to the street block and facilitating access for emergency service vehicles ▪ protocols for managing emergency response, which would need to be agreed with service providers prior to the start of work ▪ protocols to manage the evacuation of occupants adjacent to the worksite, which would need to be agreed with the building owners and service providers prior to the start of work.
Q.13	Where required, alternative cycle routes would be reviewed by the local authority with input from local bicycle user groups.

ID No.	Environmental management measure – construction phase
Q.14	Existing cycle paths located within the construction corridor but not occupied by the worksite would be maintained during construction, where feasible.
Q.15	Access for emergency vehicles would be maintained at all construction-sites and emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes.
Q.16	During project inductions, all heavy vehicle drivers would be provided with the emergency response plan for construction traffic incidents. An emergency response plan would also be developed for construction traffic incidents and provided to drivers as part of the induction. In the event of an emergency occurring during the construction of the CSELR proposal, Roads and Maritime Service's *Incident Response Plan Manual* would be consulted to determine the appropriate procedure and responses required to address the emergency.
Q.17	Heavy vehicles would be restricted to specified routes, with the aim of avoiding local streets, high pedestrian areas and school zones. Where feasible, route markers would be installed for heavy vehicles along designated routes.
Q.18	Off-site construction vehicle parking would be limited to designated areas. Areas of temporary on-street parking during peak construction events would be identified in the traffic management plans to minimise the impact on surrounding properties and businesses.
Q.19	The queuing and idling of construction vehicles in residential streets would be minimised.
Q.20	A pre and post construction assessment of road pavement assets would be conducted in areas likely to be used by heavy construction vehicles.
Q.21	Public communications would advise the community and local residents of vehicle movements and anticipated effects on the local road network relating to site works in accordance with the CEMP. Affected stakeholders, such as local government authorities, emergency services, utility providers, local schools, public transport operators, public transport users, road users, local businesses, local employees and residents, would receive advance notification of scheduled construction works to allow for planning of required journeys.
Q.22	Construction vehicle traffic movements would be undertaken outside of peak road traffic periods and outside of school peak periods where feasible.
Q.23	Appropriate information, road and traffic signage, pavement markings and line markings would be implemented to advise commuters, pedestrians and road users of changed conditions.
Q.24	The end state transport arrangements for the City Centre Precinct (e.g. traffic environment during the operational phase of the project, as described in section 12.3.3) would be implemented prior to construction, where appropriate and compatible with construction requirements. This could include the diversion of bus services in accordance with the Sydney City Centre Access Strategy, closure of minor side road junctions and laneways (where access is proposed to be permanently removed), and enhancements to the east-west capacity of cross streets within the CBD (where possible).
Q.25	Intersection works within the City Centre Precinct would be undertaken on weekends and at night during weekdays.
Q.26	Works at major intersections within the City Centre Precinct would be staged to maintain key traffic movements (e.g. Grosvenor Street/Bridge Street and Pitt Street/Eddy Avenue). Works at other intersections would be undertaken during weekend and weekday night intersection closures, with traffic diverted to alternative routes. The closure of these intersections would be conditional on the alternate route remaining open (e.g. Hunter Street westbound would remain open while Bridge Street westbound is closed).
Q.27	Major disruptive works would be scheduled to occur during times of lower traffic movement (e.g. during the Christmas/New Year period). Measures required to manage pedestrian movements during such works would be reviewed to determine their adequacy in coping with increased pedestrian activity during the public holiday period.
Q.28	Property access within the City Centre Precinct would be maintained, based on the following hierarchy (corresponding to the current frequency of use) and subject to agreement with the affected property owners and business operators: ▪ properties with infrequent access requirements would be managed through the use of traffic controllers on an ad hoc basis and/or the scheduling of deliveries to occur outside of work hours ▪ access to properties with frequent deliveries (e.g. the Westfield loading dock) would be maintained via an access track ▪ where feasible, a lane would be retained for 24 hour property access. Where this is not feasible, a 24-hour traffic controller would manage property access.

ID No.	Environmental management measure – construction phase
Q.29	The local road network changes outlined in Table 12.17 of the EIS would be implemented to manage impacts to traffic.
Q.30	The coordination of construction activities at redevelopment sites without access to alternate street frontages to George Street would also need to be negotiated with the building owners and contractors prior to the start of work.
Q.31	Local bus diversions outlined in Table 12.19 of the EIS would be implemented to manage the CSELR proposal's impact on bus operations at Chalmers Street, Eddy Avenue, Rawson Place, and the Park Street/Druitt Street/George Street intersection. An assessment of bus stop capacity would be undertaken for those stops located on high-activity corridors to confirm that they do not exceed capacity during construction.
Q.32	Access to the key heavy rail interchange hubs of Wynyard, Town Hall and Central would be retained, with existing controlled crossing points through worksites being maintained.
Q.33	Traffic signal operation would be reviewed to identify turning movement conflicts with pedestrians crossing at intersections and vehicles on access lanes and accessing worksites.
Q.34	The number of traffic changes would be minimised (where possible) to maintain the legibility of the network for the public, businesses and emergency services to simplify network operations.
Q.35	Access corridors for emergency services would be maintained along the George Street worksite. Pull-off areas (between gaps in barriers) would be provided to allow construction vehicles to stand clear of the access lane. Where this is not feasible and delivery requirements dictate vehicles to stand for an extended time (e.g. while unloading track sections) these deliveries would be made outside business hours. Through traffic would be discouraged by public education, signs, traffic controllers and enforcement.
Q.36	The Elizabeth Street, Crown Street and Bourke Street intersections with Devonshire Street would remain open to traffic for the duration of construction. Construction works at these intersections would be staged to allow traffic to pass adjacent to the worksites and thus ensure property and network accessibility is maintained.
Q.37	Construction across South Dowling Street and the Eastern Distributor would be undertaken as staged night works and night works with some road closures.
Q.38	Vehicles access to all adjacent properties would be maintained during the closure of Devonshire Street. Waterloo Street and Riley Street would remain open during the closure of Devonshire Street. Traffic controllers would be used to guide private vehicles between their driveway and Waterloo Street when works are undertaken adjacent to Waterloo Street.
Q.39	Where feasible, all construction vehicles would be contained within the Ward Park worksite, while staff would utilise potential parking facilities located within designated construction compounds at Moore Park and the proposed Randwick stabling facility.
Q.40	Existing pedestrian footpaths along Devonshire Street would be retained and protected from the worksite with barrier protection, with the exception of during works undertaken adjacent to Ward Park, where pedestrians may need to be diverted to the northern footpath.
Q.41	During intersection staging works, pedestrian crossing facilities would be maintained either by providing an alternate crossing opportunity adjacent to the work zone or maintaining the existing pedestrian facilities.
Q.42	During construction, the reconfiguration of Randle Street would allow for two-way cycle movements, providing a connection from Cooper Street through to Prince Alfred Park (inner south) and Belmore Park (southern CBD).
Q.43	Construction of the CSELR proposal across Lang Road would be undertaken during night works over an approximate two week period. The proposed construction activities would avoid periods when major events are scheduled within Moore Park. Construction of the CSELR proposal across Lang Road would be undertaken during complete closure of the Anzac Parade/Lang Road intersection with traffic directed to the alternate access point of Driver Avenue and Moore Park Road, as shown in Figure 14.4 of the EIS.
Q.44	The proposed construction compound, bentonite plants and laydown facility proposed within the Moore Park Precinct would be positioned so as to minimise the effect on land use and parking provisions during special events, as negotiated with the Centennial Park and Moore Park Trust.
Q.45	Construction activities and traffic movements to and from the staff car park at the Moore Park construction compound would be minimised during major events to ensure that there is minimal construction traffic within the local area, to minimise the impact on the road network and in particular the localised congestion within the Moore Park Precinct.
Q.46	To ensure safety of the workers on-site, separation barriers would be installed along the borders of the worksites in the vicinity of the off-road busway, in locations where there is high speed traffic on adjacent lanes.

ID No.	Environmental management measure – construction phase
Q.47	Construction at the southern Gregory Avenue intersection with the busway would be undertaken in a staged manner to facilitate one directional bus movements at this location at all times, as far as practicable.
Q.48	An alternate path would be provided for pedestrians and cyclists at the location where the proposed CSELR route crosses over the existing shared pedestrian and cycle path located adjacent to the busway within Moore Park. This alternate path would be provided within the same segment of the intersection and would not require crossing of Anzac Parade or Alison Road.
Q.49	During intersection works at Lang Road, all existing pedestrian and bicycle crossing facilities would be maintained either by providing an alternate crossing opportunity adjacent to the work zone or maintaining the existing pedestrian facilities.
Q.50	A single traffic lane would be maintained in each direction along High Street within the Randwick Precinct at all times.
Q.51	The construction of the CSELR across Alison Road in the Randwick Precinct would be undertaken in stages to maintain a minimum of two lanes of travel in each direction during each works stage. A minimum of two traffic lanes would be retained along Anzac Parade in each direction within the Kensington/Kingsford Precinct. Where achievable, an additional city-bound lane would be provided which would operate as a peak period bus only lane and off-peak parking zone.
Q.52	Construction works at the Alison Road/Doncaster Avenue intersection would be staged, with works scheduled to occur during weekends when no major events are planned at Royal Randwick racecourse.
Q.53	Works at the intersections of High Street with Wansey Road and Botany Street would be undertaken in stages during off-peak periods (i.e. either during weeknights and/or weekends).
Q.54	The Belmore Road intersection works within the Randwick precinct would be staged during the weekend and nights.
Q.55	Where possible, only on-street parking spaces that would be permanently removed to accommodate the CSELR proposal would be impacted during the construction phase (other than those spaces required for construction compounds).
Q.56	Bus priority measures would be explored during detailed design at the intersection of Anzac Parade and Alison Road.
Q.57	A permanent bus diversion would be established for the bus routes 357, 400 and 410 via Blenheim Street, as shown in Figure 15.8 of the EIS. As part of this diversion, the affected High Street bus stops would be relocated to Clara Street (north of Blenheim Street), consistent with the changes proposed as part of the operational phase of the CSELR proposal. The existing taxi zone on High Street (outside of Prince of Wales Hospital) would be relocated to Clara Street, opposite the existing taxi zone (and adjacent to the bus stops), in consultation with Randwick City Council.
Q.58	Temporary passenger set-down and pick-up areas for special event buses and coaches accessing Royal Randwick racecourse would be established along Darley Road, adjacent to the TAFE Randwick campus, as shown in Figure 15.10 of the EIS, or nearby as feasible
Q.69	During events scheduled at Royal Randwick Racecourse, construction activities adjacent to the main entrance to the racecourse on Alison Road would be reviewed so as to not significantly impact on the roundabout operation at the intersection of Ascot Street and Doncaster Avenue, and to maintain safe pedestrian access across the worksite.
Q.60	The proposed signalisation of the Wansey Road/Alison Road intersection would be implemented as part of the early works so that pedestrians can safely cross Alison Road during the construction phase.
Q.61	During construction, to reduce any conflict between the bus operations associated with the bus stops outside the UNSW, adjacent to Gate 9, and construction activities, a westbound bus stop would be provided west of Wansey Road, as shown in Figure 15.9, as required.
Q.62	The existing bus stops located adjacent to Central Railway Station that currently service the university express services would remain operational throughout the construction phase.
Q.63	Alternate on-road cycle routes would be signposted during the construction phase to maintain suitable cycle access to UNSW and the southern Randwick Precinct. Existing Randwick City Council on-road cycle routes would be encouraged through signposting and line marking. Furthermore, directional signs would be installed at key locations to direct cyclists to the cycle route.
Q.64	Pedestrian crossing opportunities would be maintained during intersection works at Botany Street and Belmore Road either by maintaining the existing pedestrian facilities or providing alternate crossing opportunities at adjacent locations.

ID No.	Environmental management measure – construction phase
Q.65	A minimum of two lanes of traffic would be maintained along Anzac Parade (within the Kensington/Kingsford Precinct) in both directions during the day time.
Q.66	CSELR construction works at the Alison Road/Anzac Parade intersection and within the wider Kensington/Kingsford Precinct would be undertaken during week nights and weekends to minimise the impact on adjacent properties and the road network.
Q.67	Construction works at locations with proposed light rail stops in the Kensington/Kingsford Precinct would be undertaken during staged night and weekend works (where required) with traffic controls. Traffic controls would be removed before the morning peak.
Q.68	The closure of the median gaps at Abbotford Street, Carlton Street and Ascot Street in the Kensington/Kingsford Precinct would be implemented during the construction phase.
Q.69	Multiple construction activities occurring concurrently at multiple sites along Anzac Parade would be managed so that accesses to adjacent properties are maintained.
Q.70	The High Street intersection works in the Kensington/Kingsford Precinct would be staged during the weekend and nights. Construction activities at the intersection would be avoided, wherever possible, during special events at the racecourse or the university during the weekends. The staging of the High Street intersection would maintain all existing movements at the intersection; however, the existing dual right turn from High Street would need to be restricted to a single lane during these weekend closures.
Q.71	The right-turn movement from Anzac Parade south to Rainbow Street would be permanently banned at the commencement of construction. Right turn movements would be accommodated at the downstream intersection at Barker Street or earlier upstream at adjoining roads and accessing Avoca Street.
Q.72	Overhead wiring works and changeovers between the intersection layouts at the Nine Ways intersection (to facilitate installation of signals, linemarking, removal of kerb blisters and paving) would be undertaken during nightshifts and weekends to minimise the impact on traffic.
Q.73	End-state (i.e. during the operation of the CSELR proposal) right-turn opportunities along Anzac Parade intersections would be maintained wherever possible. Where such opportunities cannot be maintained during construction, alternative access routes would be provided, in conjunction with Roads and Maritime Services, to ensure sufficient capacity is maintained.
Q.74	Construction activities at Todman Avenue and Doncaster Avenue would be undertaken at separate times to minimise impacts to access.
Q.75	Intersection works at Strachan/Middle Streets and Borrodale/Meeks Streets in the Kensington/Kingsford Precinct would not coincide with works at Barker Street to minimise impacts to access.
Q.76	During construction, suitable alternative parking for the Langton Centre would be provided within the general vicinity of the Langton Centre. Access to this facility would be maintained at all times.
Property and land use	
R.1	Consultation would be undertaken with agencies such as the City of Sydney, utilities providers and other potential stakeholders (such as stakeholders associated with future developments within the vicinity of the CSELR proposal) throughout construction of the proposal to identify measures to minimise potential conflicts, potential land use impacts to community facilities such as Ward Park and Wimbo Park and opportunities for minimising impacts to existing land uses.
R.2	Consultation would be undertaken with the Centennial and Moore Park Trust as the key land holder for a majority of the land uses impacted by the CSELR proposal within the Moore Park Precinct.
R.3	For the Randwick precinct, consultation would be undertaken with agencies such as Randwick City Council, utilities providers and other potential stakeholders such as the UNSW, the ATC and the Prince of Wales Hospital throughout construction of the proposal to minimise ongoing impacts to existing land uses.
Noise and vibration	
S.1	A Construction Noise and Vibration Management Plan would be developed to document all necessary measures to manage and mitigate potential noise and vibration levels during standard daytime and out of hours construction activities. In general this would include some or all of the following measures: ▪ For construction concentrated in a single area, such as at the stops, worksites, substation construction-sites, bridge sites and stabling / maintenance facility locations, temporary acoustic fencing/barriers around the site perimeter should be considered where feasible and reasonable to mitigate off-site noise levels. ▪ Given the potentially high noise levels at residential receptors, adherence to daytime construction hours is recommended for excavation, demolition or rock breaking activities, and for activities concentrated in a single area (i.e. activities that do not move along the alignment, and do not require out of hours activities for safety reasons or to minimise disruption to road networks).

ID No.	Environmental management measure – construction phase
	▪ Noise generating night works should be programmed to minimise the number of consecutive nights work impacting the same receptors. ▪ Consultation would be undertaken with nearby local schools prior to noise intensive works to ensure impacts are minimised during examination periods and/or other critical periods in the school calendar (where works are predicted to exceed the relevant construction noise management level for this receiver). Consultation with nearby childcare centres to be undertaken to potentially avoid noisy works during rest periods at the centres. ▪ Where feasible, simultaneous operation of noisy plant in close proximity to sensitive receptors would be avoided. ▪ Equipment which is used intermittently is to be shut down when not in use. ▪ Where possible, the offset distance between noisy plant items and nearby noise sensitive receptors should be as great as possible. ▪ Where possible, equipment with directional noise emissions should be oriented away from sensitive receptors. ▪ Regular compliance checks on the noise emissions of plant and machinery regularly used to determine whether such plant comply with predicted noise emissions or are higher than predicted. Compliance checks would also be used to identify defective silencing equipment on the items of plant. ▪ Ongoing noise monitoring during construction at sensitive receptors during critical periods to identify and assist in managing high risk noise events. ▪ Reversing of equipment should be minimised so as to prevent nuisance caused by reversing alarms. ▪ Loading and unloading should be carried out away from sensitive receptors, where practicable. ▪ Work should be scheduled to provide respite periods from the noisiest activities, and impacted residents should be communicated with to clearly explain the duration and noise levels for the works. ▪ Where all feasible and reasonable practices have been applied and noise would be more than 5 dB above the noise affected level, the proponent should negotiate with the community to determine the schedule for the works or provide respite to occupants where sleep disturbance is likely to occur.
S.2	Wherever reasonable and feasible, construction work on the proposal would be undertaken in the recommended standard hours for construction work: ▪ Monday to Friday 7.00 am to 6.00 pm ▪ Saturday 8.00 am to 1.00 pm ▪ No work on Sundays or public holidays.
S.3	Site specific construction noise and vibration management plans (CNVMPs) would be developed. These would provide a detailed assessment of potential noise levels and site specific measures to control potential noise impacts and minimise the potential for disturbance at affected receptors. A range of feasible and reasonable construction noise mitigation measures would be provided. Within the Randwick Precinct, the CNVMP would include communication with the owners of the horse stables near the proposed works to clearly explain the timing, duration and likely noise levels for the works.
S.4	In the event of predicted exceedances of the noise goals (particularly during out of hours works), additional noise mitigation measures in the Transport for NSW *Construction Noise Strategy* would be included in the CNVMPs where reasonable and feasible. As noted in section 12.5.1 of this EIS, the option of alternative accommodation during highly intrusive noise impacts at night-time is unlikely to be reasonable and feasible in the City Centre Precinct. For other precincts, offers of alternative accommodation would only be considered in the event that more than two consecutive nights of highly intrusive noise works are required in any particular location.
S.5	For sensitive receptors that operate outside standard construction hours, for example hospitals which operate on a 24 hour basis, reasonable and feasible noise mitigation options and measures would be developed in consultation with the receptor.
S.6	During construction, attended measurements would be undertaken at the commencement of rockbreaking activities in the vicinity of the premises listed in Table 64 of Technical Paper 11 – *Noise and Vibration Impact Assessment*, to assist in evaluating and managing construction ground-borne noise impacts in conjunction with the premises operators. Alternative construction methods such as smaller rockbreakers, rock saws or respite periods would be considered if required to minimise noise impacts. In the event that lower impact equipment cannot be substituted, all efforts would be made to reschedule work to less sensitive times in consultation with affected communities.

ID No.	Environmental management measure – construction phase
S.7	Where vibration intensive construction activities are proposed within 100 metres of sensitive receptors, these works would be confined to the less sensitive daytime period where possible. The potential impacts from vibration are to be considered in the site-specific CNVMPs. In general, mitigation measures that would be considered include: ▪ Relocate vibration generating plant and equipment to areas within the site in order to lower the vibration impacts. ▪ Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment. ▪ Use lower vibration generating items of excavation plant and equipment (e.g. smaller capacity rockbreaker hammers). ▪ Minimise consecutive works in the same locality (if applicable). ▪ Use dampened rockbreakers and/or 'city' rockbreakers to minimise the impacts associated with rockbreaking works. ▪ If vibration intensive works are required within the safe working distances, vibration monitoring or attended vibration trials would be undertaken to ensure that levels remain below the cosmetic damage criterion. ▪ Building condition surveys would be completed both before and after the works to identify existing damage and any damage due to the works. ▪ Measurements of existing ambient vibration levels would be undertaken at receptors with vibration sensitive equipment during the detailed design phase. This information would be used to inform the site-specific CNVMPs for works near these locations.
Planted trees	
T.1	Trees that would not be directly impacted by the proposed CSELR permanent works (e.g. overhead wires, substations, light rail stops, kerb realignments, service relocations, etc.) — or significantly impinge on required clearances to such infrastructure, such that the tree would need to be removed to allow for the safe operation of the CSELR — would be retained. All trees to be retained would be protected prior to the commencement of construction in accordance with AS4970 the Australian Standard for Protection of Trees on Development Sites and Adjoining Properties. Some trees would require one-off or ongoing maintenance, for example pruning of low branches that would interfere with the overhead wiring. Where pruning of trees is required, a qualified arborist would be engaged to assess the health and condition of the tree and to plan and undertake any pruning works.
T.2	Exclusion fencing would be established around the drip lines of each tree to be retained to minimise the risk of impact to the viability of the trees. Where impact to the drip line area cannot be avoided (due to space constraints), opportunities to raise construction facilities (e.g. demountable) above the ground level would be investigated so as to avoid impacting on the underlying tree roots, in accordance with Australian Standard AS 4970 Protection of Trees on Development Sites.
T.3	Where the loss of trees is unable to be mitigated, trees removed as a result of the CSELR would be offset in accordance with the Transport for NSW *Vegetation Offset Guide* (TfNSW 2013b), which includes a principle of replacing 'the amenity/visual landscape value of vegetation removed' even if the vegetation may not have significant ecological value. Replacement plantings would be agreed in accordance with the CSELR Landscape Strategy (Appendix F) and consultation with relevant stakeholders.
T.4	The use of low impact construction techniques (on existing tree roots) for installation of new services would be considered, where appropriate and feasible.
T.5	The trees in Martin Place would not be impacted during the construction of the CSELR proposal. Design and siting of the underground substation in Martin Place would be undertaken so as to provide adequate clearance of the structure from the root zone of these trees. Exclusion fencing would be erected around these trees during construction.
T.6	Opportunities to translocate the four mature trees on Rawson Place to a suitable new location would be investigated during detailed design, where feasible. *Lophostemon confertus* (Brush Box) trees are also proposed in Rawson Place.
T.7	Where feasible semi-mature Figs directly impacted by the construction of the CSELR proposal would be transplanted to an alternative suitable location, in consultation with Moore and Centennial Parks Trust and Roads and Maritime Services (where Fig trees are proposed to be planted within the Anzac Parade road corridor). A detailed relocation and maintenance strategy for the impacted trees would be developed during detailed design, in consultation with Moore and Centennial Parks Trust, Randwick City Council and the Australian Turf Club where required. Fig species (consistent with existing plantings) and *Lophostemon confertus* (Brush Box) would generally be used along Anzac Parade as replacement trees.

ID No.	Environmental management measure – construction phase
T.8	Potential impacts to the large mature Figs adjacent to Anzac Parade would be reviewed by a suitably qualified arborist during detailed design, once the final tunnel construction technique has been determined. To minimise the potential impacts associated with dewatering activities on the viability of the surrounding Figs, an irrigation strategy would be developed for any Fig that is deemed to be at risk of being affected by a potential lowering of the water table.
T.9	The health of Fig trees within Moore Park would be monitored by a suitable qualified arborist both during and post construction. Appropriate management responses would be developed by a suitably qualified arborist, in consultation with Moore and Centennial Parks Trust so as to minimise impacts to any potentially affected trees.
T.11	Planted trees within George Dan Reserve and trees adjacent to the section of the CSELR route along the busway between Robertson Road and Doncaster Avenue would be retained.
T.12	The impacts associated with the Randwick stop would be managed through the development of a detailed landscape strategy for High Cross Park, which would incorporate improvements such as new tree planting, a public plaza and new landscaping. New trees would provide shade and would partly compensate for the loss of existing trees.
Visual and landscape	
U.1	Where feasible and reasonable, the elements within construction-sites would be located to minimise visual impacts e.g. materials and machinery would be stored back behind fencing.
U.2	Lighting of compounds and works sites would be restricted to agreed hours and security needs and in accordance with the CEMP.
U.3	Visual mitigation would be implemented as soon as feasible and reasonable, and remain for the duration of the construction period.
U.4	Minimise light spill from the light rail construction corridor into adjacent visually sensitive properties by directing construction lighting into the construction areas and ensuring the site is not over-lit. This includes the sensitive placement and specification of lighting to minimise any potential increase in light pollution.
U.5	Regular maintenance of site hoarding and perimeter site areas would be undertaken, including the prompt removal of graffiti.
U.6	On completion of construction, work sites and other land occupied temporarily would be reinstated to their existing condition.
U.7	Work sites and site access would be away from the forecourt of the Museum of Contemporary Art (MCA) and the Circular Quay area, where possible.
U.8	Avoid any negative impacts to the heritage listed Tank Stream Fountain in Alfred Street plaza.
U.9	Schedule works to minimise impacts on special events, such as Anzac Day, New Year's Eve and Vivid Festival events, where possible. This should include staging works to minimise impacts on areas including Circular Quay, Martin Place (Cenotaph), High Cross Park and Belmore Park where those works would clash with special events, where feasible.
U.10	Identify opportunities for an artistic approach or colours and materials that complement the surroundings as appropriate (for example parkland or University of NSW surroundings) to treatment of the site hoarding and enclosure, in consultation with councils and potentially local community groups and schools. This should include consideration of day and night time activation of the exterior of the site. Privacy considerations for adjacent residential properties or other sensitive receivers as a result of site hoardings would also considered.
U.11	At Circular Quay identify opportunities for an artistic/historic harbour side narrative approach to the treatment of the site hoardings and enclosures, in collaboration with Customs House.
U.12	Position-site compounds and construction areas to avoid direct impacts on the structure or use of the Martin Place Cenotaph.
U.13	Position equipment and site access away from the Queen Victoria statue and Ibero-American Statue Plaza as far as practicable.
U.14	Consolidate site equipment and facilities to maximise the area of useable public green space, and maintaining pedestrian permeability where reasonable and feasible.
U.15	Maintain permeability or identify an alternative pedestrian route within Moore Park (to replace the key pedestrian route between Parkham Street and Driver Avenue affected by construction) by minimising encroachment onto the existing playing fields.
U.16	Reinstate planting, where removed for construction purposes, on the periphery of Centennial Park in the Randwick Precinct in accordance with the Centennial Parklands Conservation Management Plan.

ID No.	Environmental management measure – construction phase
U.17	Locate site equipment and facilities to minimise impact to the Parklands Sports Centre, maintaining access or providing alternative access to the existing sports facilities.
U.18	Where possible site equipment and facilities would be consolidated to minimise the intrusion into the University campus grounds.
U.19	Maintain access or provide alternative pedestrian access to all existing University campus facilities.
Built and non-Indigenous heritage	
V.1	The mitigation measures for Historical Archaeological Management Units (HAMUs) listed in section 6.2.2 of Technical Paper 5 (Heritage Impact Assessment) would be implemented, in accordance with the HAMU zones documented in Figures 4.4 to 4.12 of Technical Paper 5 (Heritage Impact Assessment).
V.2	The following mitigation measures would be implemented for the Tank Stream: ▪ Physical protection would be provided through construction of bridging structure to retain integrity of the Tank Stream, as required. ▪ Management would be implemented in accordance with policies in Sydney Water's Tanks Stream Conservation Management Plan. ▪ Consultation would be undertaken with Sydney Water, City of Sydney and NSW Heritage Division of OEH.
V.3	The following mitigation measures would be implemented for Alfred Street/Herald Square: ▪ Implementation of an archaeological testing program. ▪ Open area excavation and archival recording during site works.
V.4	The proposed construction compound in part of First Fleet Park would be planned to retain significant elements of the park, including plantings, monuments and landscape features and to minimise impacts on the setting of the Sydney Opera House.
V.5	The following mitigation measures would be implemented for First Fleet Park: ▪ The potential historical archaeological resource would be managed in accordance with the policies outlined in the *First Fleet Park Conservation Management Strategy*. ▪ Consultation would be undertaken with the Sydney Harbour Foreshore Authority. ▪ Ground disturbance works within First Fleet Park HAMU would be avoided, where feasible. ▪ Services, if required, would be above ground or installed within existing service trenches. ▪ The subsurface archaeological remains within First Fleet Park would be protected from compaction or movement of vehicles over the park's ground surface. ▪ The scope of appropriate ground works within First Fleet Park HAMU would be developed in consultation with a suitably qualified archaeologist and Sydney Harbour Foreshore Authority to ensure the impact on the archaeological resource is as minor as possible. ▪ A photographic archival recording of First Fleet Park would be undertaken prior to works commencing.
V.6	Works in George Street north HAMU, Ward Park HAMU, Devonshire Street Central HAMU (particularly in the location of the proposed substation), Devonshire Street East HAMU, Kensington/Kingsford HAMU and the University of NSW HAMU are likely to require some open area excavation and archival recording during site works, and post-excavation analysis and reporting. The nature and intactness of the archaeological resource may warrant interpretation. Advice from an archaeological specialist would be obtained where these areas are affected.
V.7	In respect of HAMUs within the Surry Hills Precinct, in the unlikely event that remains associated with unrecorded activities of early land grants and estates are identified and assessed as of State significance, this archaeology would be managed in accordance with Zone 1 mitigation measures
V.8	Within the Olivia Gardens HAMU, mitigation measures for areas outlined as Zone 3 within the basement footprint of the Olivia Gardens building would apply.
V.9	The following mitigation measures would be implemented for the Moore Park West HAMU and Moore Park East HAMU: ▪ Works in this HAMU where air raid shelters were located are likely to require some open area excavation and archival recording during site works, as well as post excavation analysis and reporting (limited to the extent of the area affected by the CSELR proposal). The nature and intactness of the archaeological resource may warrant interpretation. ▪ Areas with nil archaeological potential would be managed in accordance with the outlined Zone 4 mitigation measures.
V.10	Mitigation measures, as outlined for Zone 2 in section 12.8.4, would be implemented for the Rozelle maintenance depot HAMU.

ID No.	Environmental management measure – construction phase
V.11	If skeletal remains are identified at Town Hall, Eddy Avenue or Chalmers Street they would be managed in accordance with Zone 1 strategies and, at a minimum, managed in accordance with the Heritage Division guideline *Skeletal Remains: Guidelines for Management of Human Skeletal Remains*, and exhumed and reinterred at an appropriate location. If identified, consultation with the NSW Heritage Division of OEH would be required.
V.12	The following mitigation measures would be implemented for Belmore Park: ▪ The subsurface archaeological remains within Belmore Park would be protected from compaction or movement of vehicles over the park's ground surface. ▪ Significant trees and landscaping to be retained within Belmore Park would be protected from damage by vehicular or machinery movement. ▪ Significant landscape elements (such as sandstone kerbing) that is to be removed from Belmore Park for the construction compound, would be salvaged, catalogued and stored for reinstatement following completion of construction works. ▪ A photographic archival recording of Belmore Park would be undertaken prior to works commencing.
V.13	The following mitigation measures would be implemented for Martin Place, the Cenotaph and General Post Office: ▪ The detailed design of any works in Regimental Square would retain and conserve the memorial and associated significant plantings. ▪ The memorial and significant associated landscaping would be retained and protected during construction works. ▪ A photographic archival recording of Regimental Square would be undertaken prior to any works commencing in this area. ▪ No new permanent above ground structures would be introduced into Martin Place, particularly in the vicinity of the Cenotaph. ▪ The size and material of any required access hatches for the below ground substation in Martin Place would minimise visual impacts on the ground plane of Martin Place. ▪ The design of necessary substation ventilation shafts, access hatches, and other infrastructure would minimise visual impacts on the Cenotaph. ▪ The condition of the Cenotaph would be assessed prior to commencement of construction works for the proposed substation and monitored during construction. ▪ The planning of the works compound would ensure that access is provided to the Cenotaph for the groups who use the memorial.
V.14	A photographic archival recording of the principal elevations of Daking House would be undertaken prior to works commencing.
V.15	Significant fabric of the Elizabeth Street Gardens that is to be removed, such as the edging and the palms, would be salvaged, catalogued and stored for possible reinstatement (or partial reinstatement) following completion of construction works.
V.16	A photographic archival recording of the parts of Central Railway Station to be affected by the CSELR works, including the Elizabeth Street Gardens and the Chalmers Street boundary wall, would be undertaken prior to works commencing.
V.17	Replanting of trees would be undertaken along Devonshire Street where possible following completion of construction works in accordance with the Landscape Strategy (Appendix F).
V.18	The mosaic mural and sandstone monument in Wimbo Park would be retained where feasible and conserved. If they cannot be retained in situ, relocation of these elements within the proposed new landscaping would be undertaken in accordance with a management plan or other approved document.
V.19	The design of necessary substation ventilation shafts, access hatches, and other infrastructure in Ward Park would minimise impacts on the spatial quality of Ward Park.
V.20	The following mitigation measures would be implemented for Centennial Park, Moore Park, Queens Park and the Moore Park Conservation Area: ▪ The area required for excavation would be minimised to reduce the impact of the works on Moore Park. ▪ The size and form of the tunnel portal structures would be as recessive as possible to reduce permanent visual impacts on the landscape of Moore Park. Any new structures/infrastructure would be recessive and allow the broader landscape to remain the dominant feature. ▪ The location and design of the Moore Park stop would minimise impacts on significant views of the Sydney Cricket Ground and former RAS buildings from Anzac Parade and within Moore Park.

ID No.	Environmental management measure – construction phase
	▪ Where feasible, areas excavated for construction of the CSELR would be reinstated to the current condition on completion of construction. This includes areas to be used for construction compounds/laydown areas.
	▪ A photographic archival recording of the areas of Moore Park that would be subject to impacts from construction of the CSELR, including the Anzac Parade avenue of trees, would be undertaken prior to works commencing.
V.21	Where significant trees must be removed in the Martin Road Conservation Area suitable replacements would be made, where possible, to screen the conservation area from the CSELR.
Socio-economic	
W.1	Alternate routes to public areas and open spaces areas and community facilities impacted by the construction of the proposal would be identified including The Rocks, Belmore Park, the Sydney Dental Hospital and other community services (churches, schools etc.).
W.2	The following mitigation measures would be implemented regarding safety and security: ▪ The CEMP would identify risks to safety and security on a site-by-site basis and provide appropriate mitigation measures. ▪ Detailed design would incorporate the principles of CPTED. ▪ *Disability Discrimination Act 1992* requirements would be adopted. ▪ Construction lighting standards would be met with the aim of minimising lighting impacts outside the construction corridor. ▪ Hoarding/fence lines would be erected to maximise sight lines for pedestrians and avoid hiding places and blind spots to improve pedestrian personal security. ▪ Any gantry arrangements would have internal lighting. ▪ Safety and security impacts would be addressed as part of the CEMP.
W.3	The following mitigation measures would be implemented regarding health and wellbeing, in addition to measures to manage noise impacts (refer measures S.1–S.7) and air quality impacts (refer measures AC.1–AC.24): ▪ The CEMP is to identify risks to health and wellbeing on a site-by-site basis and would include appropriate mitigation measures. ▪ The CEMP would account for cumulative impacts of construction given concurrent works in the precinct. ▪ Health impacts would be addressed as part of the CEMP, including watering exposed areas to minimise dust impacts, using non-tonal reversing indicators, and fitting construction machinery with appropriate muffling devices.
W.4	Access management plans would be prepared in liaison with businesses and landowners to understand their servicing and delivery requirements. These plans would then identify and implement means of maintaining (and where possible enhancing) access to businesses for deliveries and servicing during both the construction and operational phases of the CSELR proposal.
W.5	A business landowner and engagement management plan would support the preparation and effective implementation of the access management plans. It would also identify and implement means by which to keep businesses informed of the CSELR proposal and methods to proactively support businesses through the construction phase.
W.6	Place managers would assist with ensuring needs of disadvantaged residents are accounted for, particularly as some residents may not have access to telephone or email facilities or may not speak English comfortably or as a first language.
Hydrology, drainage and surface water quality	
X.1	During construction any water collected from the worksites would be treated and discharged in accordance with current guidelines to avoid any potential contamination or local stormwater system impacts. These guidelines would include the Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Guidelines for Fresh and Marine Water Quality* and Landcom's (2004) *Managing Urban Stormwater: Soils and Construction*.
X.2	Where existing longitudinal pit and pipe drainage exists and needs to be reinstated or repaired, appropriate scour protection measures would be reinstated or improved at outlets to watercourses or drainage lines. Typical scour protection might include concrete energy dissipating structures or dumped stone rip rap.
X.3	During construction, the potential for localised flooding of excavation-sites would need to be managed. Water pumping facilities may be required at specific locations along the alignment to remove any water that would pool within or adjacent to construction areas. Temporary drainage pipes or channels would also be provided to drain any open excavation areas.

ID No.	Environmental management measure – construction phase
Land stability, soils and contamination	
Y.1	Construction of the cut-and-cover tunnel across Moore Park would employ construction techniques aimed at minimising the risk of settlement.
Y.2	Precondition surveys of building and structures in the vicinity of the Moore Park tunnel would be undertaken prior to the commencement of construction of the structure. Monitoring would continue for identified baseline buildings and structures throughout the construction period.
Y.3	As part of the detailed design, a Phase 2 Environmental Site Assessment (ESA) would be undertaken to further characterise the nature of potential contamination along the proposed CSELR alignment. The Phase 2 ESA would focus on the following: ▪ General contamination along the route. This would be assessed through a program of conventional field testing involving groundwater wells, soil cores and test pits and lab testing of collected samples. Test locations would be derived from a Sampling, Analysis and Quality Plan (SAQP) which would be developed based on the Phase 1 ESA discussed in Section 10.3.2 of the EIS. ▪ Building contamination (including asbestos and lead paint). This would include areas where demolition works are proposed (e.g. Olivia Gardens and at the Rozelle maintenance depot). ▪ Contamination from existing underground services (e.g. pits, pipes and substations). This would involve a review of existing detailed utilities data including 'Dial-Before-You-Dig', survey and data provided by asset owners (e.g. hazard logs) to categorise the likelihood of contamination, followed by field testing to confirm the presence of contaminated materials.
Y.4	A remediation strategy would be developed (as part of the CEMP) based on the results of the Phase 2 ESA. This strategy would outline any measures required to manage contaminated materials during construction. The strategy would also include a protocol to manage any unexpected disturbance of potentially contaminated material (which was not identified during the Phase 2 ESA). The remediation strategy would identify opportunities for remediation of affected areas prior to or during construction where the Phase 2 ESA confirms the presence of contaminated materials in concentrations above the intended land use criteria, as specified in the following guidelines: ▪ *Contaminated Site Guidelines for Assessing Service Station Sites* (EPA 2004) ▪ *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* (NEPM) (National Environment Protection Council (NEPC, 2013) ▪ *Waste Classification Guidelines* (DECCW 2009).
Y.5	All contaminated materials disturbed during construction would be managed and either re-used or disposed of appropriately in accordance with all relevant legislation and guidelines, including the *Protection of the Environment Operations Act 1997*, the *Waste Avoidance and Resource Recovery Act 2001*, the NSW Department of Environment and Climate Change (DECC 2009a) *Waste Classification Guidelines* and the National Environment Protection Council (NEPC, 2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)* (NEPM).
Y.6	Segregated materials would be inspected and sampled, with samples submitted for analytical testing for contaminants of concern. Results would be compared to relevant assessment criteria to assess whether there is any potential health or environmental risk posed by re-using the material on-site. Where concentrations of contaminants are above the intended land or appropriate human/ecological health criteria, the assessment would identify opportunities for remediation of affected areas.
Y.7	Attempts would be made to re-use material on-site where assessment indicates that there is no risk, or where materials can reasonably and feasibly be remediated.
Y.8	Areas requiring remediation would be validated to confirm that the surrounding soil meets site land use criteria requirements.
Y.9	In the event of any previously unidentified contaminated materials being identified on-site during construction, works in the affected area would cease and would not recommence until sampling and remedial actions are instigated. This would be undertaken in accordance with the applicable EPA guidelines and statutory requirements. Work health and safety requirements and appropriate management measures would be followed for works that have the potential to contain contaminated soil.
Y.10	Fill material would remain on-site where possible and where contaminant concentrations meet the site assessment criteria.
Y.11	All material requiring off-site disposal would be appropriately tested and classified against the *Waste Classification Guidelines* (DECC 2009).

ID No.	Environmental management measure – construction phase
Y.12	A hazardous material inspection would be undertaken of any areas where historical infrastructure is to be disturbed and/or demolished to assess the material to be disturbed for the presence of asbestos and/or lead paint. Appropriate management plans would be developed (such as an Asbestos Management Plan) to outline the management and handling of hazardous materials during construction.
Y.13	Where there is a potential for the presence of hazardous materials to be disturbed, for example during demolition activities or excavation of underground services, the works would be monitored by an occupational hygienist.
Y.14	An Asbestos Management Plan would be developed in accordance with the *Guidelines for the Assessment, Remediation and Management of Asbestos Contaminated Sites in Western Australia* (Western Australia Department of Health 2009) and included as part of the CEMP.
Y.15	Where suspected asbestos and/or lead paint containing materials are identified, work in the affected area would cease, and an investigation would be undertaken to determine the nature, extent and degree of contamination. A report would be prepared which would include a methodology for the removal, handling and disposal of the contaminated material. Works would only recommence upon receipt of a validation report from a suitably qualified occupational hygienist that the contaminated materials had been removed.
Y.16	Erosion and sediment control plans would be prepared for each worksite in accordance with Volume 2D of *Managing Urban Stormwater: Soils and Construction* (DECC 2008). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase.
Y.17	Stabilised surfaces would be reinstated as quickly as practicable after construction.
Y.18	All stockpiled materials would be stored in bunded areas and kept away from waterways to avoid sediment entering the waterways.
Y.19	Sediment would be prevented from moving off-site and sediment laden water prevented from entering any watercourse, drainage line or drainage inlet.
Y.20	Clean water would be diverted around the work site in accordance with Landcom's (2004) *Managing Urban Stormwater: Soils and Construction*.
Y.21	Erosion and sediment control measures would be regularly inspected (particularly following rainfall events) to ensure their ongoing functionality.
Y.22	Erosion and sediment control measures would be left in place until the works are complete and areas are stabilised.
Y.23	Works would be avoided during rainfall (or whilst the ground remains sodden) to minimise vehicle disturbance to the topsoil.
Groundwater	
Z.1	A construction groundwater management plan will be prepared prior to construction, and will detail the control measures that aim to minimise potential impacts to groundwater resources and receiving environments during construction. The purpose of the plan is to provide practical impact mitigation principles and measures for the design and construction of the proposal consistent with relevant legislation and standard guidelines.
Z.2	The construction groundwater management plan will include details of a groundwater monitoring program, which will be implemented prior to construction to identify changes in groundwater quality and levels during the construction. The monitoring program will be developed in consultation with the NSW Office of Water.
Z.3	Excavation techniques would be adopted to minimise impacts on aquifers.
Z.4	Groundwater encountered during the construction of the proposal would be tested, managed and disposed of in accordance with the *Waste Classification Guidelines* (DECC 2009) and Transport for NSW's (2012a) *Water Discharge and Re-use Guideline*. Groundwater will be disposed to ensure it does not cause the pollution of waters in accordance with Section 120 of the *Protection of the Environment Operations Act 1997*.
Z.5	Hazardous material procedures (including procedures for managing spills and refuelling and maintaining construction vehicles/equipment) would be developed and implemented as part of the CEMP to minimise potential for groundwater quality impacts due to chemical spills.

ID No.	Environmental management measure – construction phase
Z.6	The following construction sequence may be used to reduce the volume of dewatering required at the deeper sections of the tunnel: ▪ Extend alternate diaphragm wall panels to form a groundwater cut-off in the swamp deposits underlying the Botany Sands. The other panels would be founded at a shallower depth to allow continued groundwater flow towards Botany Bay. ▪ Construct bentonite slurry cross walls at approximately 50 metre centres to confine the extent of drawdown. ▪ Excavate the entire tunnel to the underside of headstock level (excluding Anzac Parade), which is expected to be above groundwater level. ▪ Dewater one bay at a time with a line of wells at the centre of the excavation. ▪ Deep excavation of one bay at a time and construct the base slab.
Aboriginal heritage	
AA.1	All contractors would receive a Heritage induction advising and informing them of the archaeological potential and actions to be implemented in the event of any unexpected remains.
AA.2	A qualified archaeologist would be nominated and available to attend in the event that unidentified archaeological remains are discovered during construction.
AA.3	Where required, local Aboriginal stakeholders would be involved and consulted with during Aboriginal archaeological works.
AA.4	Should Aboriginal objects or other archaeological evidence be identified in these areas during works, works would cease in the immediate area and the archaeologist contacted to assess the evidence. Additional investigation, such as salvage excavation, may be required.
AA.5	If human remains were to be discovered during any phase of works associated with the CSELR proposal, works would cease immediately in the surrounding area. Any finding would need to be reported immediately to the NSW Coroner's Office and/or the NSW Police. If the remains are suspected to be Aboriginal, the Office of Environment and Heritage would also need to be contacted. A specialist would also be consulted to determine the nature of the remains.
Biodiversity	
AB.1	The location of the hollow-bearing trees identified in this EIS would be confirmed to inform and plan procedures for the removal of these habitat features.
AB.2	Nearby suitable habitat would be identified for the release of any fauna that may be encountered during the pre-clearing or habitat removal processes.
AB.3	The presence of flora and fauna species and habitat on-site would be checked before clearing begins such as the presence of bird nests or trees that contain hollows.
AB.4	An appropriate level of emergence survey would be undertaken to confirm absence of microbats in any buildings or structures likely to be directly impacted by the works.
AB.5	Prior to construction, site personnel would be adequately informed of environmental management procedures including, but not limited to, issues related to flora and fauna management, disease prevention, erosion and sediment control.
AB.6	Implementation of mitigation measures (refer measures T.1 to T.11) to ensure protection and management of all trees identified to be retained.
AB.7	Clearing of vegetation would be restricted to vegetation that is absolutely required to be removed in order to undertake work.
AB.8	Noxious weeds within the study area would be managed in accordance with the *Noxious Weeds Act 1993*.
AB.9	The potential for the introduction or spread of plant diseases would be managed. Management techniques may include ensuring that equipment is clean prior to commencement of earthworks, disease free certification of landscaping materials, and disposal of pathogen-contaminated soils at appropriate weed disposal facilities.
Air Quality	
AC.1	Dust minimisation measures would be developed and implemented prior to commencement of construction.
AC.2	Methods for management of emissions would be incorporated into project inductions, training and pre-start talks.
AC.3	Activities with the potential to cause significant dust emissions (such as bulk earthworks or demolition works) would be identified in the CEMP. Work practices which minimise emissions during these activities would be investigated and applied where reasonable and feasible.

ID No.	Environmental management measure – construction phase
AC.4	Vehicle movements would be limited to designated site entrances/exits, haulage routes and parking areas. Site exits would be fitted with hardstand material, rumble grids or other appropriate measures to limit the amount of material transported off-site (where required). Site speed limits of 20 kilometres per hour would be imposed on all construction vehicles at the site.
AC.5	Work sites and exposed areas would be screened to assist in capturing airborne particles and reduce potential entrainment of particles from areas susceptible to wind erosion.
AC.6	Visually monitor dust and where necessary implement the following measures: ▪ Apply water (or alternative measures) to exposed surfaces that are causing dust emissions. Surfaces may include any stockpiles, hardstand areas and other exposed surfaces (for example recently graded areas and those areas recently scraped). Regular watering would ensure that the soil is moist to achieve 50 per cent control of dust emissions from scrapers, graders and dozers. ▪ Appropriately cover loads on trucks transporting material to and from the construction-site. Securely fix tailgates of road transport trucks prior to loading and immediately after unloading. ▪ Prevent where possible or remove mud and dirt from sealed road surfaces. ▪ Apply water to internal unsealed access roadways and work areas. Application rates would be related to atmospheric conditions (e.g. prolonged dry periods) and the intensity of construction works. Paved roads would be regularly swept and watered when necessary.
AC.7	Dust generating activities (particularly clearing and excavating) would be avoided or minimised during dry and windy conditions. Street sweeping of the CSELR alignment would be undertaken where an excessive build-up of material has occurred.
AC.8	Minimise drop heights during loading and unloading of bulk materials.
AC.9	Exposed areas and stockpiles would be limited in area and duration. For example, stage vegetation stripping or grading where possible, cover unconsolidated stockpiles, or apply hydro mulch or other revegetation applicant to stockpiles or surfaces left standing for extended periods.
AC.10	Revegetation or rehabilitation activities would proceed once construction activities are completed within a disturbed area.
AC.11	Onsite monthly dust deposition monitoring would be undertaken to measure dust fallout at selected sensitive receivers during construction.
AC.12	Real time dust monitoring would be undertaken during significant dust generating activities close to sensitive receivers.
AC.13	Construction plant and equipment would be well maintained and regularly serviced so that vehicular emissions remain within relevant air quality guidelines and standards.
AC.14	Emissions from trucks would be regulated in accordance with the requirements prescribed in National Environment Protection Council's (2001) *In Service Emission Testing – pilot study, fault identification and effect of maintenance* (diesel vehicle emissions).
AC.15	All construction vehicles would be tuned so as to not release excessive level of exhaust smoke, and would be compliant with the NSW Office of Environment and Heritage's Smokey Vehicles Program under the NSW *Protection of the Environment and Operations Act 1997* and associated regulations.
AC.16	All on-road trucks would comply with the latest emission standards.
AC.17	All new off-road construction equipment would meet, at a minimum, the United States Environmental Protection Agency's Tier 3 emission standards for non-road diesel engines.
AC.18	All chemicals and fuels would be stored in sealed containers as per appropriate regulations and guidelines.
AC.19	The onsite storage of fuel would be kept to a minimum.
AC.20	Unloading of fuels (diesel or liquefied nitrogen gas) would be vented via return hoses that recirculate vapours from delivery to receiver.
AC.21	Chemical/fuel storage tanks would be fitted with a conservation vent (to prevent air inflow and vapour escape until a pre-set vacuum or pressure develops).
AC.22	Strategies would be investigated to reduce the usage of chemical and fuels in addition to using alternative fuel technologies as recommended in the NSW Office of Environment and Heritage's *Action for Air – 2009 Update* (DECCW 2009a). Particular focus would be on those products with the potential to release high levels of air toxics.

ID No.	Environmental management measure – construction phase
Utilities	
AD.1	Services or utilities that may be impacted by the CSELR would be protected and/or relocated using the following hierarchy: ▪ Utilities within Zone 1 (as shown in Figure 10.8 of the EIS) are likely to require relocation due to the physical clash with the structural rail slab (including its construction). ▪ Utilities crossing Zone 2 (as shown in Figure 10.8 of the EIS) would be protected where feasible. ▪ Utilities crossing Zone 3 (as shown in Figure 10.8 of the EIS) may require protection but have the potential to remain undisturbed, subject to accurate identification and consultation with the relevant utility authorities.
AD.2	All appropriate service utility providers (e.g. electricity, communication, water and other utility services) would continue to be consulted throughout construction.
Greenhouse gas	
AE.1	Methods for management of greenhouse gas emissions would be incorporated into site inductions, training and pre-start talks.
AE.2	Activities with the potential to cause substantial greenhouse gas emissions (such as material delivery and loading and bulk earthworks) would be identified. Work practices which minimise greenhouse gas emissions during these activities would be investigated and applied where reasonable and feasible. These would potentially include: ▪ the use of biodiesel and other low carbon fuels in vehicles and equipment ▪ the use of fuel-efficient construction equipment with the latest technology.
AE.3	Construction services and materials would be procured locally, where practicable, to minimise the distance travelled and therefore greenhouse emissions from vehicles accessing the site.
AE.4	During construction planning, deliveries would be managed in an efficient manner to minimise the number of trips required and therefore reduce the amount of greenhouse gas emissions.
AE.5	Energy-efficient work practices would be implemented, such as switching off construction plant, vehicles and equipment when not in use to minimise idling.
AE.6	Regularly monitoring, auditing and reporting on energy, resource use and associated greenhouse gas emissions would be undertaken as part of the environmental reporting requirements specified within the CEMP.
AE.7	Selection of materials during construction planning to ensure products that reduce embodied carbon are considered and used.
Hazards and risks	
AF.1	Hazards and risks associated with construction activities would be identified prior to construction. Management measures for each identified hazard/risk would be developed. A process for regularly reviewing work practices/procedures would be implemented throughout construction to identify, report and respond to any new environmental hazards/risks.
AF.2	Construction worksites located adjacent to public areas would be screened (where required) to minimise risks of injury as a result of unsecured debris, tools and other objects.
Regional cumulative impacts	
AG.1	The following construction management plans would incorporate measures, where required, to manage cumulative construction impacts: ▪ construction traffic management plan ▪ construction noise and vibration management plan ▪ air quality and dust management plan ▪ construction compounds and ancillary facilities management plan ▪ earthworks management plan – which would include measures to manage water quality.

Operation

Environmental management measures to be implemented during the operational phase of the CSELR proposal are listed in Table I.3.

Table I.3 Operational environmental management measures

ID No.	Environmental management measure – operational phase
Traffic, transport and access	
AH.1	A network management plan would be developed for the CSELR proposal during detailed design to identify key management measures that would be implemented to minimise impacts to journey times and congestion levels. Transport for NSW would be responsible for developing and maintaining the network management plan in consultation with stakeholders.
AH.2	Transport for NSW would work alongside the relevant road authorities to develop appropriate demand management strategies for the construction and operational phases of the CSELR proposal. These demand management strategies would be integrated with network optimisation measures being developed as part of the Sydney City Centre Access Strategy, to ensure their maximum effectiveness.
AH.3	In conjunction with the demand management measures, targeted traffic management upgrades would be undertaken to improve general traffic circulation in the vicinity of the CSELR proposal. Within the CBD, these measures would also form part of the Sydney City Centre Access Strategy which identifies the priority traffic routes shown in Figure 9.12 of the EIS and the redesign of the city centre bus network. Outside of the CBD, Transport for NSW would continue to work with local councils and the Roads and Maritime Services to mitigate the local traffic impacts and potential increased traffic flows that may occur on local roads as a result of the CSELR proposal.
AH.4	Key road network changes to accommodate the introduction of light rail within the CBD and South East, as described in section 5.2.7, section 9.2 and the relevant sections of the precinct chapters (sections 12.3.2, 13.3.2, 14.3.2, 15.3.2, 16.3.2) would be implemented as part of the CSELR.
AH.5	Transport for NSW would continue to work with City of Sydney, Randwick City Council and Roads and Maritime Services to mitigate the local traffic impacts and potential increased traffic flows that may occur on the road network as a result of the CSELR proposal.
AH.6	The following intersections would be signalised as part of the CSELR to manage light rail conflicts with pedestrian and traffic movements: ▪ Devonshire Street/Marlborough Street intersection. ▪ Devonshire Street/Bourke Street intersection. ▪ South Dowling Street southbound and northbound traffic lanes at the CSELR crossing point. ▪ Wansey Road/Alison Road intersection would be signalised (on all arms) to provide pedestrian access from the residential catchments in the north and east to the Wansey Road stop. ▪ High Street/Wansey Road intersection would be signalised to accommodate pedestrians and the light rail turning movements between Wansey Road and High Street. Pedestrian crossings would be provided across Wansey Road and the eastern arm of High Street as a minimum, which would replace the existing zebra crossing on High Street. ▪ High Street/Hospital Road intersection. ▪ High Street/Clara Street intersection. ▪ The existing Nine Ways roundabout would be reconstructed and upgraded to incorporate traffic signals.
AH.7	All existing property accesses along the CSELR would be maintained during the operational phase of the CSELR proposal; however, certain restrictions are likely to apply which would be implemented by the relevant road authority and could include: ▪ Access restrictions on George Street implemented by the City of Sydney to provide for appropriate safety and amenity for pedestrians. These measures would be determined by City of Sydney, in consultation with Transport for NSW. ▪ Left-in, left out-out limitations on driveway access along the proposed CSELR corridor, where feasible. ▪ Property accesses along Devonshire Street would be maintained; however, access arrangements to some properties may change. Ongoing consultation will be undertaken with owners of properties with direct access onto the CSELR corridor to determine specific access arrangements.

ID No.	Environmental management measure – operational phase
AH.8	General traffic access to the pedestrianised section of George Street (between Bathurst Street and Hunter Street) would be restricted through the introduction of appropriate vehicle restrictions. However, exceptions to this control would be provided for local access, service delivery and emergency vehicles to access driveways and loading zones (at a maximum speed of 10 kilometres per hour).
AH.9	Within the George Street pedestrian zone, signalised pedestrian crossing facilities would be provided on all arms of existing signalised intersections to provide controlled crossing points of the light rail alignment.
AH.10	Pedestrian access to the proposed Eddy Avenue coach station island platform would be provided via the existing Eddy Square pedestrian crossing at the eastern end. A new crossing at the western end would be provided to allow pedestrian movement between the existing coach booking office and the coach platform.
AH.11	The existing access to the Sydney Trains car park located opposite Devonshire Street would be integrated with the new traffic signals proposed at this location.
AH.12	Loading dock access on the southern side of Eddy Avenue would require management across the light rail alignment through time restricted access and/or audio visual warnings. Suitable treatment measures to address this issue would be identified during detailed design.
AH.13	Access for emergency vehicles would be maintained at all times along the length of the CSELR.
AH.14	Existing City of Sydney bicycle routes crossing George Street would be maintained, however George Street would no longer be promoted as a bicycle route, with cyclists being directed to alternate existing north-south corridors such as Pitt, Castlereagh and York Streets.
AH.15	The existing provision of short and long stay parking available along Chalmers Street south of Devonshire Street would be retained.
AH.16	Replacement parking to offset parking spaces removed at the Langton Centre as a result of the CSELR would be provided nearby, most likely along the northern side of the new open space on the site of the Olivia Gardens apartment complex.
AH.17	The existing pedestrian/cyclist bridge and associated crossings located adjacent to Parkham Street would be relocated to the proposed light rail bridge structure.
AH.18	The existing pedestrian and cycle crossing linking Arthur Street to Moore Park would be retained to provide a continuous cycle link between Moore Park and Central Railway Station through Surry Hills. Appropriate signposting would be provided to direct cyclists from the crossing location at Devonshire Street and Bourke Street.
AH.19	Light rail vehicles would be given priority over other traffic along Devonshire Street to ensure traffic and pedestrians are not adversely affected by the queuing of longer light rail vehicles at traffic signals during special events (which could block adjacent intersections).
AH.20	Adoption of appropriate parking management measures (parking controls) to balance supply and demand would be considered. Transport for New South Wales would work through implementation of these measures to manage kerbside activity with the City of Sydney in the City Centre and Surry Hills precincts.
AH.21	Transport for NSW will work with Randwick City Council to identify any parking management measures that would be required to manage kerbside activity within the Randwick and Kensington/Kingsford precincts.
AH.22	The following changes to bus stops would be implemented as part of the CSELR to allow for bus services to service the Prince of Wales Hospital, Children's Hospital and University of NSW: ▪ An indented bus bay for westbound buses on High Street would be introduced adjacent to the adult wing of the Prince of Wales Hospital. ▪ The westbound bus stop on High Street adjacent to the Children's Hospital emergency entrance would be relocated to Clara Street, with access to the hospital via a signalised intersection. ▪ An indented bus bay for westbound buses would be provided on High Street between Botany Street and Wansey Road (within the UNSW site).
AH.23	The off-road shared pedestrian and cyclist path between Darley Road and Wansey Road would be reinstated between the proposed CSELR route and Royal Randwick racecourse.
AH.24	Sufficient car parking provisions would be provided at the proposed Randwick stabling facility, so that there would be no requirement for CSELR employees to use existing on-street parking when accessing this facility.
AH.25	A 3.5 metre wide shared bus and light rail running lanes would be provided on Anzac Parade between the Kingsford interchange and High Street for normal bus services in the Kensington/Kingsford precinct. This would include an additional short bus only lane adjacent to the proposed light rail track on approach to Meeks Street (southbound).
AH.26	One existing signalised pedestrian crossing of Anzac Parade south of Goodwood Street would be relocated to be adjacent to the Carlton Street stop.

ID No.	Environmental management measure – operational phase
AH.27	Within the Kensington/Kingsford Precinct, physical separation would be provided between light rail and general traffic, particularly at locations where right turns off Anzac Parade were previously permitted but would be prohibited in the future.
AH.28	The existing on-road shared path along the eastern kerb of Anzac Parade between Moore Park Road and Alison Road in the Kensington/Kingsford Precinct would be retained.
AH.29	Cycle storage facilities would be provided at key bus interchanges such as Rawson Place, Randwick and the Kingsford stop, providing opportunities for cyclists to change mode onto the light rail.
AH.30	Pedestrian crossing facilities across Anzac Parade would be provided to permit safe access to the proposed light rail stops situated within the central median of Anzac Parade.
AH.31	Pedestrian access to the Kingsford stop would be provided via signalised crossings on all approaches to the Nine Ways intersection.
AH.32	To mitigate the impacts that the introduction of the CSELR proposal would have to existing bus priority along Anzac Parade (due to a reduced cross section available for general traffic and bus priority lanes) the following measures are proposed: ▪ A dedicated city-bound bus only lane would be provided in locations where the cross-section permitted five traffic lanes. ▪ The Kingsford stop would provide direct platform interchange for bus and light rail passengers. ▪ Shared running of bus and light rail movement through the proposed signalised Nine Ways intersection.
AH.33	The Operator would develop detailed contingency measures to address issues such as flooding, fallen trees/branches and LRV breakdowns which could impact on the operation of CSELR services, LRVs, customers, infrastructure and/or other modes of transport. These contingency measures would be developed prior to the commencement of CSELR operations.
AH.34	At the Rozelle maintenance depot site, vehicle access to the facility and adjacent commercial properties within the rail corridor would be maintained via the existing driveway located on Lilyfield Road, east of Catherine Street, and the existing internal site access road.
AH.35	Parking for staff vehicles at the Rozelle maintenance depot would be accommodated internally, with approximately 50 parking spaces provided for both staff and visitors. Parking provisions at the depot would be sufficient to accommodate all traffic generated by the maintenance depot to minimise impact on adjacent on-street parking provisions.
AH.36	The existing Langton Centre off-street and on-street parking affected by the CSELR proposal would be replaced with a similar number of spaces within the vicinity of the Langton Centre. The final location and number of replacement parking spaces would be determined in consultation with the Langton Centre and City of Sydney. Access to this facility would be maintained at all times.
Noise and vibration	
AI.1	For the Surry Hills Precinct, at locations where the *Rail Infrastructure Noise Guideline* (RING) (EPA 2013) operational noise trigger levels are predicted to be exceeded by more than 2 dB, a detailed investigation of feasible and reasonable noise mitigation measures would be undertaken to minimise the worst-case predicted noise levels. As detailed further in Chapter 13 of the EIS and Technical Paper 11, potential measures to be considered include: ▪ more stringent specification of LRV noise emissions in the procurement process, which would only be recommended following consultation with rolling stock providers to establish whether more stringent noise specifications could feasibly be achieved ▪ higher absorption track forms, including those described in the EIS ▪ speed restrictions to 30 kilometres per hour during the night-time between the Central Railway Station and the Surry Hills stops (with the exception of during special events) ▪ minimising wheel and rail roughness through specifications for CSELR operations, such as maintaining the rail surface (via rail grinding) and train wheel conditions (via a wheel lathe) in accordance with defined acceptance standards ▪ individual property treatments, in the event that the above alternatives are determined as not feasible or reasonable. The final form of the proposed mitigation measures would be determined during detailed design.
AI.2	Warning bells on LRVs would only be used in the event of emergencies or where the driver considers there is a danger to public safety. Warning bells would not form part of normal rail operations (i.e. they would not be used on approach or departure from stations, or at level crossings).

ID No.	Environmental management measure – operational phase
AI.3	Noise from PA systems at the light rail stops would be controlled to minimise potential impacts at the nearest receptors to the stops. The need for announcements at stops in residential areas would also be reviewed, particularly during the more sensitive night-time period.
AI.4	For the Randwick stabling facility, operational noise mitigation measures would be implemented to meet the NSW *Industrial Noise Policy* criteria. The range of alternative measures to be considered would include: ▪ an acoustic shed across the site, including a six metre noise barrier at the site boundary – which would only be implemented if considered feasible considering potential cost, visual and overshadowing implications ▪ operational measures, such as changes to pre-start practices ▪ changes to times of use of areas/noise sources, for example the wash plant ▪ increased noise attenuation targeting particular sources, for example the wash plant ▪ use of barriers within the site (not just at the site boundary), for example between stabling roads or nearer to other noise sources, such as the site access roads, wash plant and sand plant ▪ use of a partial roof enclosure, potentially in conjunction with a combination of other options.
AI.5	At the Rozelle maintenance depot, the LRV entry doors would be closed at night-time to mitigate operational noise during the night-time period.
Visual and landscape	
AJ.1	Consider the opportunity to combine several above-ground street elements (lighting, traffic signals, overhead wiring etc.) on common use poles to reduce visual clutter and to reduce potential impacts on existing awnings and footpaths, in consultation with the City of Sydney or Randwick City Council as appropriate.
AJ.2	Where possible, catenary should be located with consistent pole types and even spacing.
AJ.3	Use semi-mature to mature tree specimens, in accordance with the Transport for NSW '*Vegetation Offset Guide*' (2013d) and the Landscape Strategy (Appendix F) to replace the character of those lost on a 'like for like' basis, in consultation with the City of Sydney and Randwick City Council.
AJ.4	Reconstruct the Ibero-American Statue Plaza to incorporate all statues and restore its setting in consultation with the City of Sydney.
AJ.5	Incorporate tree planting within the Northcott Estate's northern boundary to reinforce the green edge and filtering effect of trees lost in consultation with Housing NSW.
AJ.6	Redefine the northern edge of Ward Park through a new plaza and tree planting in consultation with the City of Sydney and in accordance with the Transport for NSW '*Vegetation Offset Guide*' (Transport for NSW 2013d) and the Landscape Strategy (Appendix F).
AJ.7	Enhance the northern edge of Devonshire Street with tree planting (to mitigate the character of those lost within the Devonshire Street road corridor) in consultation with the City of Sydney and in accordance with the Transport for NSW '*Vegetation Offset Guide*' (Transport for NSW 2013d).
AJ.8	Recreate Wimbo Park, together with the new Olivia Gardens, as a high quality open space. Enhance these areas with mature tree specimens to mitigate the character of those trees proposed to be removed, in consultation with the City of Sydney.
AJ.9	Provide appropriate landscape treatment to the surroundings of the Moore Park tunnel portal in consultation with the Centennial and Moore Parks Trust and City of Sydney.
AJ.10	Provide a boulevard of street trees along Anzac Parade to improve the streetscape and extend the ceremonial avenue of street trees.
AJ.11	At night the strategy for lighting is to ensure the project contributes to a safe and legible streetscape. In particular, the lighting required for the proposal would be mitigated as follows: ▪ all lights would be located at a similar level to the overhead catenary system so to minimise the light spill onto adjacent areas ▪ all lights would be directed downwards, with the exception of feature lighting that would always be capped by a surface material ▪ light colour would be designed in response to the surrounding context and be selected to complement the surrounding lighting colour ▪ Australian Standard levels for public safety and CCTV would be used, so no unnecessary lighting would be required to be provided.
AJ.12	▪ Where possible any areas of direct light intrusion (glare and spill) from LRV headlights should be identified and managed.

ID No.	Environmental management measure – operational phase
AJ.13	▪ At stops and stabling areas, cut off and directed light fittings (or similar techniques) should be used to minimise glare and light spill onto private property.
Air Quality	
AK.1	Ancillary maintenance service vehicles and equipment would be maintained and operated in accordance with the manufacturers requirements.
AK.2	Unnecessary release of air pollutants from the Rozelle maintenance depot and Randwick stabling facility would be avoided.
Hazards and risks	
AL.1	Targeted road safety campaigns would be used in the lead up to the opening of the CSELR and during operation to raise awareness around the operation of LRVs and to promote the safe operation of the proposal. This would focus on raising awareness and promoting safe behaviours in shared zones and at key CSELR crossings.
AL.2	All cables would be buried within ducts and would adhere to all International and Australian electrical standards in terms of distances from surrounding cables (i.e. adjacent high voltage cables require minimum separation in accordance with industry standards).
AL.3	Hazardous material procedures (including procedures for managing spills, and the refuelling and maintenance of vehicles/equipment) would be developed and implemented during the operation of the CSELR proposal to minimise potential for impacts associated with chemical spills and leaks. These procedures would adequately address activities at the proposed Rozelle maintenance depot and Randwick stabling facility, as well as other general maintenance facilities that would occur along the CSELR alignment (such as storage of chemicals for operation and maintenance of LRVs in line with EPA guidelines and legislative requirements).
Socio-economic	
AM.1	Light rail stops would incorporate a high quality urban design that would reflect the precinct in which they would be located to assist in minimising impacts to visual amenity resulting from the provision of the CSELR proposal.
AM.2	Transport for NSW would continue to work with stakeholders to identify potential opportunities to integrate CSELR public domain improvements with other city planning strategies (such as the City of Sydney's other public square projects) to improve access to local community services and further enhance the public domain along the route.
AM.3	Where feasible, the CSELR would incorporate features to maintain the safety of passengers, CSELR employees and the general public. Stops would be designed to be safe and attractive places to wait for CSELR services and would (where feasible and appropriate) incorporate light emitting diode (LED) lighting technology, emergency calling capabilities and CCTV.
AM.4	Within the George Street pedestrian zone, the light rail tracks would be highlighted by either a different material colour, finish, texture or size of paving, so that pedestrians can visually and texturally distinguish between the pedestrian zone and the light rail track zone.
AM.5	Special event organisers would be consulted to determine the nature and extent of existing and planned future events that would require the use of George Street and, thus, would be affected by CSELR operations.
AM.6	Access to local community services and open spaces would be maintained during operation of the CSELR proposal. Consultation with the operators of community services (including local childcare centres and places of worship) would be undertaken to minimise impacts to the access of these facilities.
AM.7	Public open spaces directly affected by the CSELR proposal would be reinstated as soon as possible after construction.
AM.8	Revegetation of the CSELR corridor through the Moore Park Precinct would be undertaken (where required) to assist with integrating the light rail into the parkland vista. Visual connectivity would be maintained across the Anzac Road corridor and the existing AFL training field.
AM.9	Pedestrian movements, signage for passengers, and changes to intersection signalisation associated with accessing the Moore Park stop would be considered during detailed design. This would be undertaken in consultation with relevant property owners and stakeholders.
AM.10	Parks and playing fields within Moore Park would be reinstated to their former condition as soon as possible after construction to minimise disruptions to community activities.
AM.11	CCTV would be used to monitor the Moore Park tunnel.

ID No.	Environmental management measure – operational phase
AM.12	Where possible, urban design measures, such as revegetation along the corridor, would be adopted to neutralise or enhance any impacts to the existing median strips and reinstate the visual amenity characteristic of Anzac Parade.
AM.13	A targeted communication strategy would be developed for University of NSW staff and students to allow for a smooth transition to light rail operations.
AM.14	A targeted communication strategy would be developed to maintain access for businesses in the Kensington and Kingsford town centres.
AM.15	The light rail and stops would be designed to promote interaction with, and facilitate access to/from, neighbouring areas.
AM.16	Informational material advertising the commencement of CSELR operations would be prepared in multiple languages widely spoken by the affected community.

CBD AND SOUTH EAST LIGHT RAIL PROJECT

ENVIRONMENTAL IMPACT STATEMENT

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APPENDIX J: PRELIMINARY CONTINGENCY MEASURES

J. Preliminary contingency measures

Preliminary operational contingency measures that would be implemented during a range of incidents on the CSELR are outlined in Table J.1. It is noted that these contingency measures would be further refined and developed by the Operator, in consultation with all relevant stakeholders (including the Transport Management Centre (TMC) and the NSW Roads and Maritime Services (RMS)).

Table J.1 Preliminary operational contingency measures to manage incidents on the CSELR

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
Road traffic accident (collision between LRV and motor vehicle or pedestrian)	LRV driver; operations control centre; CCTV; LRV passenger; member of the public	LRV drivers; operations control centre; duty manager; operations manager; engineering manager; emergency service (ambulance, fire brigade, police), TMC and RMS as required	Establish severity of collision from LRV driver (any injured passengers, crew or others, any overturned or trapped vehicles or people, any infrastructure or overhead damage, any blockage to other tracks or road traffic) Alert other LRV drivers heading towards collision site to stop at next stop and hold until further notice. Drivers of services approaching termini can continue to end stops (unless collision site blocks path) De-energise overhead wire, if required Alert ambulance and/or fire brigade, if require Alert RMS, TMC and Police Alert duty manager and engineering manager Despatch breakdown crew Implement degraded mode operations as required	***Driver or Supervisor*** If it is safe to do so, direct and assist passengers to evacuate the LRV. Provide first aid as required ***Police*** Manage the incident and road traffic around collision if required ***Fire brigade and ambulance*** Rescue trapped people and provide emergency assistance ***Breakdown crew*** Make LRV safe, re-rail vehicle if needed ***Track engineer*** Assess and report infrastructure damage ***Traffic supervisors*** (for degraded mode operation)	First aid kit; LRV recovery vehicle (Unimog); re-railing equipment (hydraulic jacks, skates, wooden blocks)

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
LRV major fault or failure Police attendance will likely be required to divert traffic during preparation for towing operation	Faults on the vehicles will usually be observed by the LRV driver either via fault annunciator within the cab or by observing the mis-operation of an LRV subsystem (e.g. doors). Some faults may be observed by a LRV passenger (e.g. faulty passenger information display) and advised to the Driver. Depending upon the nature of the fault the LRV driver will report the fault to the operations control centre via onboard radio	If a fault occurs that has an operational impact, the LRV driver will report it to the operations control centre via the onboard radio Duty Manager	The operations control centre will determine from the LRV driver the criticality of the fault (totally disabled, rectifiable) If the driver is able to isolate the fault and continue in service (e.g. door fault) operations control centre will record details of fault for further attention. If required operations control centre will request a vehicle technician to provide diagnostic/rectification advice to driver via radio If the LRV is unable to proceed under its own power: ▪ dispatch a tow vehicle and supervisor to scene ▪ advise passengers via public address onboard and at stops ▪ advise RMS and TMC ▪ implement degraded mode operations if required	***Driver*** If the LRV is totally disabled, direct passengers to vacate the LRV when safe to do so If the LRV fault is able to be isolated, inform passengers of delay if required Isolate/rectify fault with advice from operations control centre/vehicle technician, as required If LRV can move, off-load passengers when safe to do so, place LRV out of service and run to stabling facility at reduced speed ***Supervisor*** If LRV is in a shared area, supervise passenger disembarking ***Tow vehicle operator/technician*** Attend the LRV, couple tow vehicle, prepare LRV for recovery and coordinate recovery of LRV with operations control centre	***Total disablement*** Tow or push vehicle to a safe location ***Fault can be isolated*** Vehicle diagnostic manual/Train control management system. Onboard radio/mobile phone
Vehicle fire	A fire on the LRV will usually either be observed directly by the driver (by alarm) or by a passenger and advised to the driver via the passenger intercom A fire emanating from the LRV's exterior (e.g. in roof-mounted equipment) may be observed and reported by a member of the public The driver will report the fire to the operations control centre via onboard radio	Driver; operations control centre; duty manager; operations manager; fire brigade; police	The operations control centre will determine from the driver the nature of the fire (i.e. small fire manageable with onboard fire extinguisher or significant fire requiring fire brigade attendance) as well as the location of the LRV Operations control centre will alert the fire brigade as a mandatory response Operations control centre will advise All LRVs in vicinity to hold at their nearest stops unless near scene of fire – in which case stop well clear of incident if possible	***Driver*** Immediately stop the LRV. If the LRV is within the tunnel (and so not readily accessible by the fire brigade) operate LRV until outside tunnel Once stopped, open all doors/doors on side away from opposing traffic and advise passengers via PA to evacuate LRV with caution Once doors are open, lower pantograph and power down LRV	***Manageable fire*** Onboard fire extinguisher Fire fighting training for drivers ***Serious fire*** Training for fire brigade in making LRV safe for fire fighting (power isolation)

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
			Advise passengers via public address onboard and at stops and advise RMS and TMC If fire is in roof-mounted equipment the overhead will need to be de-energised to allow ready access for fire brigade. De-energisation may be achieved either via local isolation switches (if equipped) or via SCADA system In event of overhead de-energisation, operations control centre will advise all affected LRV drivers. If they can proceed to next stop using stored energy and hold After the fire has been extinguished, dependent upon severity of any damage, LRV will likely require towing back to stabling facility	Based on judgement attempt to extinguish fire using onboard fire extinguisher otherwise fire brigade will assume control of situation ***Fire brigade*** Attend to fire	
Infrastructure fault – track points	If facing track points do not respond to control, driver will advise operations control centre and attempt manual operation using points bar carried onboard	Track engineer; operations control centre; engineering manager; other LRV drivers	Dispatch track engineer to inspect fault Advise other drivers of fault and need to use manual points operation If time to rectify is excessive, instigate degraded mode operations	***Track engineer*** Inspect faulty points and attempt rectification, advise operations control centre of diagnosis ***Duty officer*** Supervise LRV operation through points until rectified ***Drivers*** Utilise manual point control (points bar) as required until fault rectified	Points diagnostic equipment; tools; speed restriction signage; repair gang; points bar (onboard)
Infrastructure fault – track	Driver report; track engineer inspection; member of the public	Other drivers; operations control centre; engineering manager; track engineer	Dispatch track engineer to establish if fault is trafficable at reduced speed until repaired and advise operations control centre Operations control centre to impose temporary speed restriction, if applicable, and advise all drivers If track fault is not trafficable, operations control centre to advise all drivers and implement degraded mode operations if required	***Engineering manager/track engineer*** Inspect track fault and ascertain if fault is trafficable at reduced speed until repaired, advise operations control centre of determination ***Track engineer*** Arrange repair ***Repair gang*** Implement repair	Track repair equipment (jack hammer, welder, replacement rail, rail clips); speed restriction signage; repair gang

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
Infrastructure fault – overhead wire (excluding power supply failure; i.e. tree fall on OHW)	Driver report; member of public; operations control centre; operations control system; SCADA system	Other drivers; operations control centre; engineering manager; RMS and TMC (if required)	Establish nature of fault from reporting driver (e.g. loose components, broken insulator, low contact wire, contact wire break) Dispatch engineer to diagnose fault in detail and advise operations control centre if fault is trafficable at reduced speed until repaired Operations control centre to impose temporary speed restriction, if applicable, and advise all drivers If overhead fault is not trafficable, operations control centre to advise all drivers and implement degraded mode operations, as appropriate	***Overhead repair crew*** Repair overhead fault ***Traffic supervisors*** Manage shuttle operations ***Police*** Manage road traffic in vicinity of incident	Overhead repair truck with insulated elevating platform; overhead components/contact wire/insulators; earthing cables
Infrastructure fault – signals	Driver report; operations control centre; operations control system/SCADA	Drivers; operations control centre; engineering manager; RMS and TMC (if required)	Establish nature of fault from reporting driver (e.g. failed light, incorrect indication, damaged or inoperative signal) Operations control centre to impose temporary speed restriction, if applicable, and advise all drivers Operating rules may require driver to receive authority from operations control centre to pass a failed signal If a RMS-traffic signal fault, operations control centre will advise all drivers	***Signal repair crew*** Repair failed signal ***Police*** Manage incident for a failed RMS-traffic signal. LRV drivers will respond to police directions	Signals diagnostic equipment; replacement LED units; replacement signal heads
Derailment If vehicle becomes insulated as a result of derailment, follow insulated vehicle procedure	Driver report; operations control centre operations; SCADA/CCTV; passenger; member of the public	Drivers; operations control centre; operations manager; engineering manager	Establish severity of derailment from Driver (any injured passengers or crew, any overturned vehicles, any infrastructure or overhead damage, any blockage to other tracks or road traffic) Alert other LRV drivers heading towards derailment site to stop at next stop and hold until further notice. Drivers of services approaching termini can continue to end stops (unless derailment site blocks path) Alert ambulance and fire brigade (if required)	***Driver or Supervisor*** If it is safe to do so, direct and assist passengers to evacuate the LRV. Provide first aid as required ***Breakdown crew*** Re-rail vehicle ***Traffic supervisors*** (for shuttle operation) ***Police*** Manage road traffic around derailment if required ***Track engineer*** Establish cause of derailment	LRV recovery vehicle (Unimog); re-railing equipment (hydraulic jacks, skates, wooden blocks); first aid kit

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
			Alert duty manager and engineering manager Alert RMS, TMC and Police Despatch breakdown crew		
Overhead power supply failure	Driver report; operations control centre via SCADA	All drivers; duty manager; engineering manager; RMS and TMC (if appropriate)	Determine extent of supply failure from SCADA system if possible. Establish from SCADA cause of supply failure: substation trip, loss of external supply Alert duty manager and engineering manager. Alert RMS, TMC and Police Alert all drivers of supply failure and extent Alert passengers of expected delay Contact electricity supplier if fault is external to CSELR to establish timeframe for restoration of supply If cause is confirmed as substation trip, attempt remote reset when safe to do so Despatch linesmen crew to affected substation Implement degraded mode operations if required	***Drivers*** If LRVs have adequate stored energy, drivers should switch to stored energy operation (as required) and run through to next stop At next stop, advise passengers of delay and open doors to enable passengers to disembark LRV if desired ***Linesmen crew*** Diagnose fault at affected substation and rectify.	***Drivers*** Training in operation without overhead supply – (e.g. should HVAC be shut down?) ***Linesmen crew*** Diagnostic equipment and tools
Insulated vehicle/live vehicle Vehicle becomes insulated from track due to: ▪ derailment ▪ poor electrical conductivity (e.g. sand build up, leaf debris)	Driver (loss of traction power, observation); operations control centre	Operations control centre; duty manager; other drivers	Advise driver to: ▪ lower pantograph; keep passengers inside vehicle (close doors if required) ▪ advise passengers intending to board (if a stop) to stay clear of LRV ▪ attempt to move vehicle to clean rail using onboard energy storage Advise other drivers of poor conductivity in area Despatch crew to clean track, remove debris	***Driver*** Follow insulated vehicle procedure ***Track crew*** Establish cause of insulation and remove/clean ***Recovery crew*** Use tow vehicle to move LRV to clean track	Track cleaning equipment; tow vehicle

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
Excessive dwell times at stops (unanticipated passenger numbers/ wheelchair passengers)	Driver report; operations control centre operations control system	Other drivers; duty manager	If incident is of a transient nature (e.g. wheelchair passengers boarding/disembarking), advise driver to attempt to recover delay in running If incident is longer-term (e.g. large crowds at a specific stop), dispatch traffic supervisor to manage boarding, alert drivers of crowds at affected stop	***Drivers*** Attempt to recover delays in running within operating rules ***Traffic supervisor/CSO*** Manage passenger boarding	Two way radio (traffic supervisor); loudhailer/megaphone; tablet computer (remote access to operations control system)
Road traffic congestion	Driver report; operations control centre operations control system/CCTV system; RMS CCTV; SCC CCTV	Other drivers; operations control centre via operations control system/CCTV	Alert drivers Record circumstances of congestion for reporting purposes Hold LRVs at some stops temporarily to maintain gaps/prevent bunching	***Drivers*** Attempt to recover delays in running within operating rules ***Controller*** Manage holding of LRVs at stops	Automatic vehicle location system (AVLS)
Unruly passenger(s)	Passengers (via PEI to driver); driver report	Operations control centre; duty manager; police (via operations control centre)	Establish nature of incident from driver Advise driver to hold LRV at nearest stop Contact police and advise nature of incident and location of affected LRV Advise other drivers of stopped LRV Dependent upon expected length of delay implement degraded mode operations Despatch security staff	***Driver*** Make appropriate PA announcement to passengers as per procedures ***Police*** Remove unruly passenger(s) ***Controller*** Manage shuttle services	CCTV; PA
Ill passenger(s)	Passengers (via PEI to driver); driver report	Operations control centre; ambulance (via operations control centre)	Establish severity of incident from driver Advise driver to hold LRV at next stop Alert ambulance Alert other drivers Dependent upon expected length of delay implement degraded mode operations Record circumstances of delay for reporting purposes	***Ambulance*** Attend to ill passenger ***Controller*** Manage shuttle services	First aid kit
Trespasser(s) on track in hazardous area (e.g. tunnel)	Driver report; member of public	Operations control centre; other drivers; duty manager	Alert all drivers Implement speed restriction in affected area Despatch security staff	***Drivers*** Proceed through affected area at reduced speed keeping lookout for trespasser(s) Advise operations control centre of observations	CCTV

Incident	Who will identify and report the incident?	Who will be informed of the incident?	Operations Control Centre's response to the incident	Who will be responsible for on-site management of the incident?	Equipment required to manage the incident
				Traffic supervisor Manage reduced speed operation through affected area; Advise operations control centre when area clear ***Police*** Search affected area from trespassers and remove	
Loss of adhesion/ severe wheel slip/stalled LRV	Driver report	Operations control centre; other drivers; duty manager	Advise all drivers of location of adhesion problem Provide permission for driver to set back if safe to do so and reattempt to pass affected track Alert track engineer If LRV remains stranded arrange for assistance by following LRV or tow vehicle Implement degraded mode operation as required	***LRV driver*** Set back and reattempt to pass affected track with sand ***Other drivers*** Attempt to modify driving technique to avoid stalling at location ***Track engineer*** Inspect location to establish cause of poor adhesion Arrange track crew attendance if required ***Track crew*** Clean track/remove contamination, as appropriate	Tow bar (if not incorporated in LRV); track cleaning equipment; traction sand