

Appendix C

Biodiversity Offset Strategy



Moorebank Intermodal Terminal – Biodiversity Offset Strategy

April 2015

Moorebank Intermodal Company

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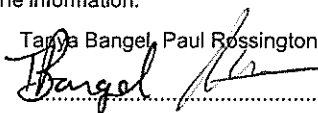
*Certified to ISO 9001, ISO 14001, AS/NZS 4801
A+ GRI Rating: Sustainability Report 2010*

Revision	Details	Date	Amended By
00	Original	September 2012	Lukas Clews
01	Rev A	02 November 2012	Tanya Bangel, Paul Rossington
02	Rev B	12 November 2012	Martin Predavec
03	Rev C(1)	21 December 2012	Paul Rossington
04	Rev C(2)	31 January 2013	Paul Rossington
05	Rev D	27 February 2013	Paul Rossington
06	Rev E	16 April 2013	Paul Rossington
07	Rev F	25 June 2013	Paul Rossington
08	Rev G	2 July 2014	Alex Cockerill
09	Rev H	11 September 2014	Alex Cockerill
10	Rev I	10 February 2015	Alex Cockerill
11	Rev J	23 March 2015	Anthea Sargeant
12	Rev K	22 April 2015	Alex Cockerill

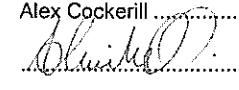
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Date: 22 April 2015

Distribution: Parsons Brinckerhoff, Department of Finance and Deregulation

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Appendix A
Framework for Biodiversity Assessment credit report

1. Introduction

The Moorebank Intermodal Terminal (IMT) Project (the Project) involves the development of approximately 220 hectares (ha) of land for the construction and operation of an IMT and associated infrastructure, facilities and warehousing. The Project includes a rail link connecting the IMT site to the Southern Sydney Freight Line (SSFL) and a single road entry and exit point at the intersection of Moorebank Avenue and Anzac Road.

An Environmental Impact Statement (EIS) and ecological impact assessment (EIA) (Technical Paper 3, EIS Volume 4) have been prepared for the Project approval under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act), as a Stage 1 State significant development (SSD).

The Department of Environment (DoE) EIS Guidelines and the revised Secretary's Environmental Assessment Requirements (SEARs) for environmental assessment of the Project, issued 2 July 2014 and 4 June 2014 respectively, include issues relating to biodiversity. The SEARs outline the need for a strategy to offset ecological impacts and native vegetation clearance, consistent with the 'improve and maintain' principle.

The proposed strategy must also demonstrate how it will achieve long term conservation outcomes; and taking into account the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999 – Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012) and the NSW Biodiversity Offsets Policy for Major Projects (Offset Policy 2014).

Since the exhibition of the EIS, the biodiversity offset strategy (BOS) has been amended in response to changes in proposed biodiversity offset areas and the submissions raised by the Office of Environmental Heritage (OEH). This revised BOS also incorporates changes in the application of the Framework for Biodiversity Assessment (FBA) assessment methodology to further consider the revised Southern rail access corridor, changes to the Version 1.03 (OEH 2014a) credit calculator used in the Technical Paper 3 – Ecological Impact Assessment in Volume 4 of the EIS) and Version 4.0 credit calculator used in January 2015. In particular, the revised BOS has incorporated:

- further assessment of the measures are taken to avoid and minimise the direct and indirect impacts of a development proposal on biodiversity values as required by Section 8 of the FBA and NSW Offset Policy 2014;
- assessment of matter requiring further consideration under the FBA;
- changes in the boundary and extent of the proposed Biodiversity offset areas;
- changes in the proposed application and flexibility of the FBA variation rules; and
- commitment to take all reasonable steps in searching for residual like for like offsets for the project in accordance with the FBA.

This revised report identifies a strategy to offset the residual biodiversity impacts of the Project. Three offset areas, suitable to partially offset the biodiversity impacts of the Project, are described and a detailed method of identifying additional residual offsets is proposed.

This includes offsets for Threatened species listed under the EPBC Act and NSW *Threatened Species Conservation Act 1995* (TSC Act) and Threatened ecological communities listed under the TSC Act.

The development of the offset strategy for the Project has been guided by the *Environment Protection and Biodiversity Conservation Act 1999 – Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012), and NSW Offset Policy 2014.

This report outlines the assessment of the measures taken to avoid and minimise the direct and indirect impacts on biodiversity in accordance with the FBA, the residual biodiversity impacts to be offset, identifies a proposed offset strategy specific to the Project, identifies the ecological values of the proposed offset areas, an approach to residual offset requirements and outlines the compliance of the offset strategy with Commonwealth and state offsetting principles.

2. Avoidance of impacts on biodiversity values

This section outlines the actions the Project must undertake to demonstrate reasonable measures are taken to avoid and minimise the direct and indirect impacts of a development proposal on biodiversity values as required by Section 8 of the FBA and NSW Offset Policy 2014.

2.1 Avoidance and minimisation of direct impacts on biodiversity

The Project has considered avoiding or minimising direct impacts to biodiversity throughout the Project lifecycle in accordance with Section 8.3.2 of the FBA guidelines. The Project is currently seeking concept approval for a Stage 1 SSD development of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals.

The Stage 1 SSD will not result in the direct impacts on vegetation, however the current concept design for the Project (at Full Build) will clear approximately 48 ha of vegetation, including Endangered Ecological Communities, plant community types (PCTs) that contain threatened species and habitats and riparian areas.

While the Project will result in unavoidable direct impacts, the Project has given significant consideration to the avoidance of impacts to sensitive biodiversity areas including:

- Endangered Ecological Communities and Critically Endangered Ecological Communities;
- PCTs that contain threatened species and habitats;
- declared critical habitat;
- riparian areas, important wetlands and estuaries; and
- state significant biodiversity links.

This is demonstrated by the incorporation of the Ecological Integrity Classification presented in Section 2.7 of the EIA (Technical Paper 3, EIS Volume 4) into early concept designs and the development of the Moorebank Conservation area.

The Project has demonstrated further avoidance in the development of the concept design (as presented in Chapter 7 – *Proposed amendments to development* in the Response to Submissions report as part of the proposed amendments to the development) with the revised southern access rail corridor being realigned to coincide with existing disturbed rail corridor crossing of the Georges River and by reducing the corridor width in general.

A summary of these include:

- a narrowing of the proposed southern access rail corridor in the vicinity of the Georges River from 60 to 25–30 m;
- a modified rail alignment utilising more cleared and disturbed lands associated with the Glenfield Waste site and the existing rail corridor; and
- a reduction in the impact to the Riparian and Alluvial vegetation associated with the southern rail access option by approximately 5 ha.

In addition the revised concept design for the Full Build option presented in the Response to Submissions Report (Chapter 7 – *Proposed amendments to the development*) has also increased the width of the onsite Moorebank conservation area, extending east of the 1% flood line and therefore increasing the future conservation and riparian corridor.

2.1.1 Site selection

The site selection for the Project was undertaken prior to the development of the FBA, however the process was generally consistent with the guidelines in Section 8.3.2 of the FBA and incorporated broad desktop assessment of the potential ecological values of the site.

The Project is required to be located close to supporting rail and road infrastructure, industry and warehouse facilities. The Project site is one of the last remaining parcels of suitable land for an Intermodal Terminal in south-western Sydney with close access to road and rail infrastructure. It is the only site within the south-western Sydney area with the capacity to provide both IMEX and interstate capacity. No other sites in south-western Sydney are considered to have the distinct advantages of the Project site, which include:

- extensive size and length of the site;
- flat topography;
- central location relative to the major employment lands;
- location within 1 km of a dedicated rail freight line;
- location adjacent to the M5 Motorway and a major arterial road network;
- potential for development of a freight precinct; and
- currently in Commonwealth Government ownership (which minimises potential acquisition costs and impacts private property).

Chapter 3 – *Strategic context and need for the project* of the EIS provides further justification for why the Moorebank site was selected, including a discussion of the Commonwealth objectives for the Project and why the selected site addresses a number of these objectives.

An assessment of the site selection process addressing matters identified in Sections 8.3.2.5 of the FBA is provided below:

2.1.1.1 Whether there are alternative sites within the property on which the proposed development is located where siting the proposed Major Project would avoid and minimise impacts on biodiversity values

Vegetation exists along the western edge of the Project site, with riparian vegetation along the banks of the Georges River, and in isolated disturbed patches scattered across the site. The site has previously been extensively developed for Defence industry and training purposes. With the exception of a cleared area that provides a viewing platform to the west, a narrow corridor of riparian vegetation on the Project site (generally 25 m wide) provides a wildlife corridor and a buffer for the protection of soil stability, water quality and aquatic habitats. A wider strip of land (up to approximately 250 m wide) along the western edge of the Project site has been identified as a proposed conservation area that would become a significantly enhanced riparian buffer between the Georges River and the Project site.

The areas of high ecological integrity to be impacted by the proposal (classed as high only because of the presence of threatened flora species and Threatened ecological communities) are restricted to narrow linear remnant adjoining Moorebank Avenue and in proximity to the SIMTA IMT site, that are considered of limited viability for conservation when considering the small fragmented size, high edge to area ratio, and surrounding land uses.

The retention of these isolated patches within an industrial development precinct would provide little long term conservation benefit to the Threatened ecological community species.

The Response to Submissions Report has identified the southern rail access option as the preferred rail access option. However the alignment of the southern rail access option has been revised in the Response to Submissions report to further avoid impacts to the Georges River corridor and associated riparian vegetation.

This revised southern rail access will utilise more of the existing disturbed rail corridor crossing of the Georges River and further minimise impacts on the corridor in general. A summary of these further reduction include:

- Narrowing of the proposed southern access rail corridor in the vicinity of the Georges River from 60 m to 40 m
- a modified rail alignment utilising more cleared and disturbed lands associated with the Glenfield Waste site and the existing rail corridor
- a reduction in the impact to the Riparian and Alluvial vegetation associated with the southern rail access option by approximately 5 ha.

In addition the changed site layout has increased the width of the onsite Moorebank conservation area, extending east of the 1% flood line and therefore increasing the future Conservation and riparian corridor.

The Early Works also include the proposed restoration of the plant and equipment operation training area (referred to as the 'dust bowl') within the proposed conservation area. This would create an additional area of Riparian Forest and/or Alluvial Woodland vegetation thereby increasing the biodiversity value of this location. The edge of the Georges River is vegetated; particularly along the eastern bank; and would become a dedicated riparian vegetation buffer between the Georges River and the Project site.

2.1.1.2 How the development site can be selected to avoid and minimise impacts on biodiversity values as far as practicable

Avoidance of vegetation was initially considered in the planning phase of the Project and was supported through the ecological integrity classification (Section 2.7 of the EIA in Technical Paper 3, EIS Volume 4) which 'classification of ecological values was used in the identification of constraints and evaluation of potential design options for the Project'. This assessment considered the full build development scenario and ensured the high conservation lands were considered for avoidance along with the range of other factors, resulting in the retention of substantial areas of vegetation and habitat contiguous with the riparian vegetation of the Georges River (refer Section 6.4.4 of the EIA in Technical Paper 3, EIS Volume 4).

The scale and type of development provides only limited possibilities for the incorporation of small isolated patches of vegetation into the design of a large industrial and warehouse layout. The EIS is for a Stage 1 SSD development approval of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals. It is acknowledged that the current proposal will clear approximately 48 ha of Threatened ecological communities; however the majority of this vegetation is made up of small, highly fragmented and disturbed patches of vegetation.

2.1.1.3 Whether an alternative development site to the proposed development site, which would avoid adversely impacting on biodiversity values, might be feasible

As identified in section 2.1.1 above the proposed site is unique in western Sydney with the specific requirements for close supporting rail and road infrastructure, existing industry and warehouse facilities.

The adjoining undeveloped properties to the south and south east of the Project site are significantly more constrained by high biodiversity values associated with other Department of Defence (Defence) owned land. If the Project did not proceed, the Project site would most likely be left vacant until some alternative use is developed, following completion of the Defence Moorebank Units Relocation Project (the MUR Project), which involves relocation of the existing School of Military Engineering (SME) to Holsworthy (due for completion in 2015).

Chapter 3 – *Strategic context and need for the project* and Chapter 6 – *Project development and alternatives* of the EIS provides further justification for why the Moorebank site was selected and what alternatives were considered. The Response to Submissions report provides further justification and analysis in response to community submissions questioning why project alternatives in Western Sydney were not selected.

Alternative locations to the proposed site would require significant additional infrastructure development to provide the required road and rail freight networks. These hypothetical alternatives are likely to require substantially greater disturbance footprints increasing the risk of additional impacts to biodiversity. Potential alternative sites on adjoining lands with available capacity to support the proposed development are restricted to sites to the south and southeast and are dominated by significant areas of remnant vegetation with significantly greater biodiversity values.

2.1.2 Planning

A detailed analysis of layout and functionality options for the Project site has been undertaken as discussed in Chapter 6 – *Project development and alternatives* and Chapter 7 – *Built form and operations* of the EIS. When considering and analysing the Project site layout, the avoidance of vegetation was initially supported through the ecological integrity classification (section 2.7 of the EIA in Technical Paper 3, EIS Volume 4) which classification of ecological values was used in the identification of constraints and evaluation of potential design options for the Project' is in accordance with sections 8.3.2.7 and 8.3.2.8 of the FBA.

In particular the following matters outlined in sections 8.3.2.8 of the FBA were considered:

2.1.2.1 Siting of the project – the Major Project should be located in areas where the native vegetation or threatened species habitat is in the poorest condition

The Project is approximately 220 ha of which only 21% (or 48 ha) will be located in areas of existing native vegetation associated with isolated disturbed patches scattered across the site and a rail corridor over Georges River riparian corridor. The poor condition of the vegetation to be impacted within the site is demonstrated by the very low site value scores under the BBAM (refer to Appendix A of this report) for each of the vegetation types below:

- 35 for the Alluvial Woodland;
- 40 for the Riparian Woodland;
- 39 for the Castlereagh Swamp Woodland; and
- 44 Castlereagh Scribbly Gum Woodland.

In contrast, the condition of the remnant vegetation within the onsite Moorebank Conservation area is better, as demonstrated by the higher site value scores for these vegetation remnants:

- 51 for the Alluvial Woodland; and
- 50 for the Riparian Woodland.

2.1.2.2 Minimise the amount of clearing or habitat loss

Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Given the scale and type of development, there are only limited possibilities for the incorporation of small isolated patches of vegetation into the design of a large industrial and warehouse development.

The Project has generally minimised the area of clearing and habitat loss to those areas of disturbed and fragmented patches of vegetation within the centre and east of the Project site, further consolidating the existing and proposed future industrial development area. Section 2.1.1.1 above demonstrates the additional design changes associated with the rail access corridor within the change in concept design (and reported in the Response to Submissions Report) that have been incorporated to further reduce impacts to the riparian vegetation along the Georges River.

2.1.2.3 Loss of connectivity – some developments can impact on the connectivity and movement of species through areas of adjacent habitat. Minimisation measures may include providing structures that allow movement of species across barriers or hostile gaps

The Project site is located within an urban area and predominantly consists of Defence land, urban development, internal road network and a golf course. The majority of development of the site currently occurs on fragmented remnant vegetation within an urban environment and will not result in change connectivity.

The site is connected to riparian vegetation along Georges River to the west which connects to extensive vegetation in the south and south east. The Project has incorporated the majority of the Georges river riparian corridor within the proposed onsite offset areas which through proposed restoration and management will result in the likely improvement of habitat quality within this corridor and further consolidate the connectivity of this corridor.

The Project will require the construction of a rail access corridor across the Georges River to connect with the SSFL to the west of the Project site. Minimising the impacts of the southern rail access corridor on the Georges River have been considered throughout the planning phase and are detailed in section 2.1.1.1 above.

The residual impacts for the Project to the Georges River riparian corridor is likely to result in a maximum gap of 25–30 m however, this is likely to incorporate a portion of the existing corridor for the East Hills Railway Line and Tarakan Road. The proposed design is currently for a bridge that would facilitate the development of fauna movement structures and not provide any barriers to terrestrial fauna or fish passage in the Georges River itself.

2.1.2.4 Other site constraints

The Project has also considered the flood planning levels, and Georges River riparian zone in the development of the Projects layout, incorporating these areas into the Moorebank and Casula conservation areas. Where possible any new services will also be located adjoining existing service areas or within disturbed areas.

2.1.3 Construction

Detailed flora and fauna mitigation measures have been developed in Section 6 of the EIA (Technical Paper 3, EIS Volume 4) and Chapter 28 – *Environmental management framework*, section 28.3 of the EIS and are in accordance with section 8.3.2.10 of the FBA. A summary of the measures to be implemented as part of the Construction Environmental Management Plan (CEMP) include:

- minimisation of clearing, to maximise vegetation retainment and utilisation of existing cleared areas for the Project;
- establishment of exclusion areas;
- methods for clearing including ecological supervision, pre-clearance surveys and daily fauna surveys;
- construction timing with threatened species torpor and breeding periods;
- environmental inductions and education for site employees; and
- weed, pest and pathogen control and management.

The success and suitability of the CEMP would be progressively reassessed to ensure the mitigation and management measures are effectively managing biodiversity impacts for the Project.

2.1.4 Operation

In accordance with Section 8.3.2.7–8.3.2.8 of the FBA the Project has assessed potential direct impacts to biodiversity that may occur during the Operational phase. Biodiversity mitigation measures for the construction phase of the project are listed in Section 6 of the EIA (Technical Paper 3, EIS Volume 4) and Chapter 28 – *Environmental management framework*, section 28.3 of the EIS.

The Project has made several key considerations applicable to the operation phase of the Project including/but not limited to:

- consideration to the selection and design of infrastructure installed by the Project as to its impact on biodiversity e.g. power lines and bridges impacts on microbats and birds;
- a long-term program of weed removal and riparian vegetation restoration in the Georges River corridor, which would include monitoring landscaped areas for the presence of noxious and environmental weeds;
- installation of nest boxes and compensatory habitat in adjacent habitat to assist displaced fauna. The project would undertake ongoing monitoring and where necessary, relocation of nest boxes to discourage and disperse unfavourable species; and
- preferred selection of species including Threatened species and Threatened species food resources for ongoing revegetation and rehabilitation areas.

2.1.5 Mitigation and avoidance measures

In accordance with section 8.3.1.3 of the FBA appropriate mitigation and management measures have been identified where the Project cannot proceed without impacting on biodiversity values despite seeking to avoid. Industry best practices and standards have been considered in preparing mitigation and management measures presented in Section 6 of the EIA (Technical Paper, 3 EIS Volume 4) and Chapter 28 – *Environmental management framework*, section 28.3 of the EIS.

2.1.5.1 Biodiversity offsetting

Biodiversity offsetting for the Project has been undertaken in accordance with sections 8.3.1.3 and 8.3.1.4 of the FBA. The proposed offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome, combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in poor condition.

2.1.5.2 Species specific mitigation

In accordance with section 8.3.1.6 of the FBA the Project will undertake species specific mitigation to minimise direct impacts to Threatened species and communities, these measures have been detailed in Chapter 28 – *Environmental management framework* of the EIS. Species specific mitigation measures for the Project include:

- hollow bearing tree surveys and staged clearing methods to accommodate Threatened hollow dwelling species;
- avoidance and establishment of environmental exclusion areas for EECs;
- potential for translocation of Threatened plant species;
- collection and other genetic material for the Project for propagation of tube stock;
- retain topsoil from seedbank for application in rehabilitation areas on site;

- selective roost box installation for Threatened microbat species such as the Large-footed Myotis;
- selection of winter-flower species in landscaped areas for nomadic and migratory species such as the Grey-headed Flying-fox; and
- as part of the CEMP the Project will prepare and implement a Threatened Species management Plan for *Persoonia nutans* and *Grevillea parviflora*.

2.2 Avoidance and minimisation of indirect impacts on biodiversity

In accordance with section 8.4 of the FBA the EIS provides a detailed assessment of all potential indirect impacts to biodiversity as a result of the Project.

Where indirect impacts could not be avoided by the Project, detailed flora and fauna mitigation measures would be developed and implemented as part of the CEMP and detailed in Section 6 of the EIA (Technical Paper 3, EIS Volume 4) and Chapter 28 – *Environmental management framework* of the EIS. These detailed measures are in accordance with Section 8.4 of the FBA and address the following:

- sedimentation and runoff;
- noise, dust and light spill;
- impacts on adjacent vegetation such as weed, pathogen, pest encroachment;
- bushfire risk management;
- tramping; and
- implementation of short-term and long-term biodiversity and rehabilitation monitoring programs.

These mitigation measures would be implemented throughout the construction and operational phases of the Project and continually reassessed during their implementation to monitor effectivity.

As discussed above, given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Given the scale and type of development, there are only limited possibilities for the incorporation of small isolated patches of vegetation into the design of a large industrial and warehouse development. The EIS is for a Stage 1 SSD development approval of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals. It is acknowledged that the current proposal will clear approximately 48 ha of TEC; however the majority of this vegetation is made up of small, highly fragmented and disturbed patches of vegetation in low condition. The retention of these isolated patches within an industrial development precinct would provide little long term conservation benefit to the TEC species.

3. Residual biodiversity impacts to be offset

The Project will have direct and indirect impacts on biodiversity during the construction and operation phases. Construction of the Project will require the clearing of vegetation and habitats and this has been identified as the key residual impact in the EIS and biodiversity technical paper.

While a phased development approach is proposed for the Project, the offset strategy has been developed with the intent to meet the ‘worst-case’ scenario in terms of the Full Build footprint, including the associated construction compounds. This is the combined development area for all Project development phases.

As identified in the Response to Submissions Report (see Chapter 7 – *Proposed amendments to the development*) the final layout and footprint of the terminal is based on the southern rail access option proposed in this EIS. The residual impacts of this option on threatened biodiversity recorded or considered likely to occur within the study area, are listed in Table 3.1, along with an estimate of residual impacts associated with habitat removal. Full details of the existing environment and biodiversity impacts have been outlined in Chapter 13 – *Biodiversity* and the EIA (Technical Paper 3, EIS Volume 4) of the EIS.

Table 3.1 Residual vegetation and habitat removal

Vegetation community/habitat/threatened species	Approx. extent (ha) within Project site	Full Build clearing (ha)
		Preferred Project Option
Vegetation		
Castlereagh Swamp Woodland ¹	0.9	0.9
Castlereagh Scribbly Gum Woodland ²	16.1	16.1
Riparian Forest (River-Flat Eucalypt Forest) ¹	16.2	3.6
Alluvial Woodland (River-Flat Eucalypt Forest) ¹	35.6	28.1
Total River-Flat Eucalypt Forest ³	51.8	31.7
Total vegetation	68.8	48.7
Fauna habitat		
Shrubby eucalypt woodland	17.0	17.0
Tall eucalypt forest	51.8	31.7
Waterbodies	2.0	2.0
Cleared land	130.1	n/a

Notes: 1 – Endangered Ecological Community as listed under the TSC Act;

2 – Vulnerable Ecological Community as listed under the TSC Act;

3 – River flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney basin and South East Corner bioregions.

Threatened biodiversity recorded or considered likely to occur within the study area is listed in Table 3.2 along with an estimate of residual impacts associated with habitat removal. Two EPBC Act listed flora species *Grevillea parviflora* subsp. *parviflora* (Vulnerable) and *Persoonia nutans* (Endangered) will be directly affected by the Project. Approximately 16 *Grevillea parviflora* subsp. *parviflora* and 10 *Persoonia nutans* individuals will be removed. Additionally, the soil seed bank will also be removed.

Table 3.2 Residual impacts to Threatened biodiversity

Threatened biodiversity	Status		Extent (community and habitat) to be removed by the Project (ha) Estimated number of individuals (where applicable)
	EPBC Act ¹	TSC Act ²	
Threatened ecological communities			
Castlereagh Swamp Woodland	-	E	0.9
Castlereagh Scribbly Gum Woodland	-	V	16.1
River-Flat Eucalypt Forest	-	E	31.7
Threatened flora			
<i>Acacia bynoeana</i>	V	E	17.0
<i>Acacia pubescens</i>	V	V	17.0
<i>Dillwynia tenuifolia</i>	V	V	17.0
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	V	V	17.0 (≈16 individuals)
<i>Leucopogon exolasius</i>	V	V	17.0
<i>Persoonia hirsuta</i>	E	E	17.0
<i>Persoonia nutans</i>	E	E	17.0 (≈10 individuals)
<i>Pultenaea parviflora</i>	V	E	17.0
Threatened fauna			
Barking Owl	-	V	31.7
Black-chinned Honeyeater	-	V	48.7
Eastern Bent-wing Bat	-	V	48.7
Eastern False Pipistrelle	-	V	31.7
Eastern Free-tail bat	-	V	48.7
Eastern Pygmy-possum	-	V	48.7
Flame Robin	-	V	48.7
Greater Broad-nosed Bat	-	V	48.7
Grey-headed Flying-fox	V	V	48.7
Koala	V	V	31.7
Large-footed Myotis	-	V	31.7
Little Eagle	-	V	48.7
Little Lorikeet	-	V	48.7
Powerful Owl	-	V	31.7
Regent Honeyeater	E	CE	48.7
Scarlet Robin	-	V	48.7
Spotted Harrier	-	V	48.7
Square-tailed Kite	-	V	48.7
Squirrel Glider	-	V	48.7
Swift Parrot	E	E	48.7
Varied Sittella	-	V	48.7
Yellow-bellied Sheath-tail Bat	-	V	48.7

Notes: 1 – V = Vulnerable, E = Endangered (EPBC Act).

2 – V = Vulnerable, E = Endangered, CE = Critically Endangered (TSC Act). Species in bold were recorded in the study area during the ecological assessment.

3.1 Residual Impacts under the FBA

The FBA Credit Calculator Version 4.0 (OEH 2014a) was used to provide a calculation of the number and class of biodiversity credits required to offset the biodiversity impacts associated with the Project (refer to Appendix A of this report). The FBA results are summarised below.

3.1.1 Ecosystem credits

The ecosystem credits required to offset biodiversity impacts associated with the Project based on the vegetation zones identified for the Moorebank IMT site are summarised in Table 3.3 below.

Table 3.3 Ecosystem credits required to offset biodiversity impacts associated the Project based on the vegetation zones for the Moorebank IMT site

Veg code	Vegetation name	Vegetation zone	Vegetation zone area (ha)	Development site vale loss	Number of credits
ME003	Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland – Good Condition	1	16.1	44.3	444
ME005	Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin – Good Condition	2	0.9	39.6	30
ME018	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin – Good Condition	3	28.1	35.8	844
ME044	Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin – Good Condition	4	3.6	40.1	91
TOTAL					1,409

3.1.2 Species credits

Species credits were calculated for two threatened flora and recorded during the current and previous targeted surveys (Parsons Brinckerhoff 2011).

The species credits required for development of the Moorebank Development Site are summarised in Table 3.4 below.

Table 3.4 Species credits required for development

Scientific name	Common name	No. of individuals recorded to be impacted	No. of credits required
<i>Persoonia nutans</i>	Nodding Geebung	11	770
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	16	235
Total		27	1,005

3.1.2.1 Species credit species that cannot withstand further loss in the major catchment area

In accordance with Section 6.5.1.13 of the FBA, two species, *Persoonia nutans* and *Grevillea parviflora subsp. parviflora* were identified as species that cannot withstand further loss on the Threatened species profile database. However both of these species were also identified under the Species Recovery loss sheet, as being able to sustain loss within the Catchment Management Authority (CMA) of up to 10%, for a population greater than 500 individuals.

The project impacts on 16 individual of *Grevillea parviflora subsp. Parviflora* is significantly less than the 10% of >2000 individuals considered to form a local population within the development site and adjoining offset areas. Consequently this species is considered to withstand loss.

The project impacts on 10 individual of *Persoonia nutans* is significantly less than the 10% of >120 individuals considered to form a local population within the development site and adjoining offset areas. Given that the 120 individuals on site is less than the CMA population requirement of 500 individuals, as stated above, the species is not considered able to withstand loss. It is acknowledged however, that based on the criteria in Section 9.2.5.2 of the Framework for Biodiversity Assessment (FBA), that *Persoonia nutans* is unlikely to become extinct at subregional level.

3.1.3 Impacts for further consideration by the consent authority

In accordance with Section 9 of the FBA, an assessment of impacts for further consideration by the consent authority has identified one 'landscape feature' for further consideration.

3.1.3.1 Landscape features

The Project includes the construction of a new rail access that will connect the Project site with the SSFL. The Response to Submissions Report (see Chapter 7 – *Proposed amendments to the development*) has identified a modified alignment of the southern rail access option presented in to the EIS.

The rail access will include a rail bridge that crosses the Georges River. The proposed crossing will follow but expand on the existing East Hills Railway corridor crossing over the Georges River. There is no direct impact on the Georges River as the proposed crossing is a bridge spanning the width of the river with no new pylons to be constructed in the river bed. Indirect impacts associated with sedimentation, water quality and erosion are proposed to be managed through onsite mitigation.

A small area of highly disturbed Riparian Forest vegetation corresponding with PCT (ME044) Sydney Blue Gum x Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion will be directly impacted by the crossing. The vegetation is consistent with the River-Flat Eucalypt Forest on Coastal Floodplains Endangered ecological community listed under the NSW TSC Act.

On the eastern bank of the Georges River, the southern rail access option traverses a strip of Riparian Forest, which has been previously disturbed during construction of the East Hills Railway Line and Tarakan Road and exhibits a moderate to high level of weed infestation.

The vegetation of the eastern riverbank immediately adjacent to the Georges River exhibits a high degree of weed infestation and is in poor condition. Native vegetation here consists of a canopy of mature eucalypts including *Eucalyptus saligna x botryoides* and *E.longifolia*. The understorey and groundcover layers are dominated by woody weeds (e.g. *Ligustrum sinense* and *Lantana camara*) and vine weeds (e.g. *Cardiospermum grandiflorum* and *Delairea odorata*) (Hyder Consulting Pty Ltd 2012). Vegetation further upslope on the eastern bank is less disturbed and generally dominated by native plants in all layers with the exception of some highly disturbed land associated with East Hills Railway Line and Tarakan Road. In addition to the eucalypt canopy, this vegetation contains a sub-canopy dominated by *Acacia binervia* and moderately diverse native understorey and groundcover layers.

The vegetation on the western bank of the Georges River, within and adjacent to the Glenfield Waste Services (GWS) site, is similar in structure and condition to the vegetation on the eastern bank (Hyder Consulting Pty Ltd 2012). It is mostly in poor condition and weed infested. The southern rail access also includes cleared areas within the GWS site which have been significantly disturbed by extensive sand/gravel extraction activities. Any native vegetation in the cleared areas would only be relatively recent regrowth that is likely to have low ecological conservation value.

The Project impacts to the Riparian Forest vegetation is likely to result in a maximum gap in the existing riparian corridor of 25–30 m, however this incorporates a portion of the already disturbed existing East Hills Railway Line.

The Project also conserves a significant portion of the Riparian Forest vegetation along the Georges River and adjoining the Project site under a dedicated conservation area. The management and restoration of this conservation area is likely to improve the condition of the native vegetation within this corridor, resulting in improvement in water quality and erosion.

4. Proposed offset package

Offset strategies may include both on and off site or local area schemes that contribute to the long term conservation of Threatened species and communities. The offset strategies chosen for the Project include a combination of:

- on-site offsets – securely conserving and improving the condition of existing riparian habitat or providing a buffer to an area of existing habitat within the Project site;
- off-site offsets – securing and improving the condition of existing habitats at other sites in the immediate locality of the Project site; and
- purchase of biodiversity credits under the NSW BioBanking Scheme.

The currently proposed direct land offset areas that have been identified as part of the offset strategy are on land owned by the Australian Government and therefore, state and local legislative obligations do not apply to these lands.

4.1 Identification of off-site offset areas

The offset strategy has identified the need for off-site offsets to supplement the existing on site offset. In identifying these offsets the following criteria has been considered:

4.1.1 Biodiversity and landscape characteristics

The following biodiversity and landscape characteristics will be important considerations in the identification of additional offsets:

- presence of relevant Threatened biodiversity;
- distance from the Project;
- current condition and potential for improvement; and
- connectivity.

These criteria are described in further detail below.

4.1.1.1 Presence of relevant Threatened biodiversity

When determining offsets, they must be targeted and offset the impacts on a 'like for like or better' basis. Given that the Project includes clearing of Threatened ecological communities, and threatened species the offsets should where possible include these species and communities.

4.1.1.2 Distance from the Project

Biodiversity offsets should be located appropriately and offset the impact in the same region. Ideally, offset habitat areas should be located within the region of the Project.

Choosing offsets within the region of the Project is also consistent with the need to provide compensatory habitat of similar type and quality to that being removed. The integrity of the habitat network and biodiversity values of the locality are retained and habitat is secured and existing corridors consolidated for local flora and fauna populations.

In addition to the ecological benefits, by choosing offsets located within the region of the Project, conservation planning can be integrated with development planning and this is also likely to benefit the reputation of the proponent, particularly with local stakeholders.

4.1.1.3 Current condition and potential for improvement

Habitat condition gives an indication of its quality for flora and fauna habitat and long-term viability. The condition of a remnant is a result of a number of factors including weed invasion, fragmentation, pollution and disturbances including clearing, fire and grazing. The condition provides an index of a site's potential to support Threatened species, populations and communities. Although it is preferable that the condition/habitat quality of offset areas exceeds or matches that of habitat removed, this is not always achievable. Where the condition or quality of the offset is not equivalent to that of the area being cleared, a greater area of offset may be required.

Where the condition of habitats can be improved through changes in management (for example cessation of grazing, weed control), this improvement in condition can be used to offset a development.

4.1.1.4 Connectivity

Connectivity of habitats is essential to the long-term survival of many species because it facilitates movement on a local scale, for foraging and sheltering, as well as on a regional or even national scale as a wildlife corridor for dispersal and migration. Remnants with habitat linkages are more likely to maintain their biodiversity in the long-term because wildlife corridors:

- provide increased foraging area for wide-ranging species;
- provide cover for movement between habitat patches, particularly for cover-dependent species and species with poor dispersal ability and enhance the movement of animals through sub-optimal habitats;
- reduce genetic isolation;
- facilitate access to a mix of habitats and successional stages to those species which require them for different activities (for example, foraging or breeding);
- provide refuge from disturbances such as fire;
- provide habitat in itself; and

- link wildlife populations and maintain immigration and re-colonisation between otherwise isolated patches. This in turn may help reduce the risk of population extinction (Wilson & Lindenmayer 1995).

Connectivity of habitats creates larger remnants that are likely to be of higher quality and support higher biodiversity.

Offsets are likely to be of greater biodiversity value where they are located adjacent to remnant vegetation creating a larger remnant or where they provide linkages within otherwise fragmented landscapes. Compensatory habitat should act to consolidate existing corridors or, occur adjacent to existing areas of native vegetation in order to maintain or increase their habitat quality and long-term viability.

4.1.2 Preliminary desktop identification of possible sites

The first step in identifying potential offsets is to undertake a desktop assessment. This includes a review of readily available information for the western Sydney region including but not limited to:

- vegetation mapping; e.g. *The native vegetation of the Cumberland Plain, western Sydney* (Tozer 2003);
- land use zone mapping;
- other relevant mapping; e.g. Cumberland Plain priority conservation lands mapping (Department of Environment Climate Change and Water 2010);
- regional land management plans and policies;
- broad-scale biodiversity survey reports; e.g. *Threatened and pest animals of Greater Southern Sydney*, (Department of Environment and Climate Change 2007b), *Terrestrial Vertebrate Fauna of the Greater Southern Sydney Region* (Department of Environment and Climate Change 2007a); and
- wildlife databases; e.g. Bionet Atlas of NSW Wildlife (Office of Environment and Heritage 2013).

These data sources would be used to locate areas that:

- Contain the biodiversity values to be offset i.e.:
 - ▶ known occurrences of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora*
 - ▶ potential habitat for the other Threatened species of animals and plants considered likely to occur in the Project area (refer Table 4.3)
 - ▶ the same Threatened ecological communities affected by the Project.
- Are not currently protected from development by existing legislation or binding conservation arrangements.
- Exhibit appropriate biodiversity and landscape characteristics (refer section 2).

- Consultation with the OEH and relevant local councils would also be used to identify priority lands for conservation and potential use as offsets.
- These sites would require further refinement, as described below, to identify a short list of potential offset sites.

4.1.3 Assessment and ranking of potential sites

The sites identified during the desktop review would require refinement based on more detailed investigation of issues including:

- tenure and zoning of the potential offset sites;
- current land ownership and availability of land for purchase;
- likelihood of loss without protection as an offset; considering factors such as physical constraints on land use and proposed developments;
- potential interaction with adjacent land uses; e.g. required fire regimes with regard to bushfire hazard reduction and biodiversity conservation; and
- size, shape and connectivity with other vegetation/habitat.

The outcome of the refinement process would be a short list of potential offset sites for detailed investigation ranked in terms of their suitability based on the above criteria.

4.1.4 Site inspection and identification of preferred site/s

Field investigations have been undertaken for the short-listed sites verifying their suitability as offsets with regard to:

- *population estimates of Persoonia nutans and Grevillea parviflora subsp. parviflora;*
- habitat suitability for the other Threatened species of animals and plants considered likely to occur in the Project area;
- presence and distribution of the Threatened ecological communities affected by the Project;
- current vegetation/habitat condition and potential for improvement; and
- long-term management issues.

The results of the inspections have been used to further refine the offset sites and for adequacy assessment (refer section 4.1 of this report).

4.1.5 Assessment against offsetting principles

- The sites will also need to be assessed against the *Principles for the use of environmental offsets under the EPBC Act* and *NSW Biodiversity Offsets Policy for Major Projects* (Offset Policy 2014) to determine their suitability for offsetting the impacts of the Project.

4.2 Proposed offset sites

Three areas are currently proposed for direct land offsets (refer Figure 4.1). These areas are described below and detailed in Table 4.5.

4.2.1 Moorebank Conservation area

Moorebank offset area – Georges River riparian zone: restoration and management of the Georges River riparian zone (approximately 32.8 ha) including the eastern side of the river corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line (refer Figure 4.2). This offset conserves a corridor extending from the Georges River to the boundary of the full build scenario. Restoration and management of this zone is proposed. This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure – Defence) under the *Liverpool Local Environmental Plan 2008*. As such, this land is zoned and reserved for Defence development. A planning proposal has been prepared to rezone this area as E3 which will provide greater environmental protection and improve its conservation value.

4.2.2 Casula Offset area

Management and restoration of vegetation within Lot 4 DP 1130937 (Casula Offset Area) is proposed (refer Figure 4.2). The Casula Offset Area (also referred to as the 'hourglass land') is an irregular shaped allotment of approximately 3.2 ha on the western side of the Georges River opposite the Project site.

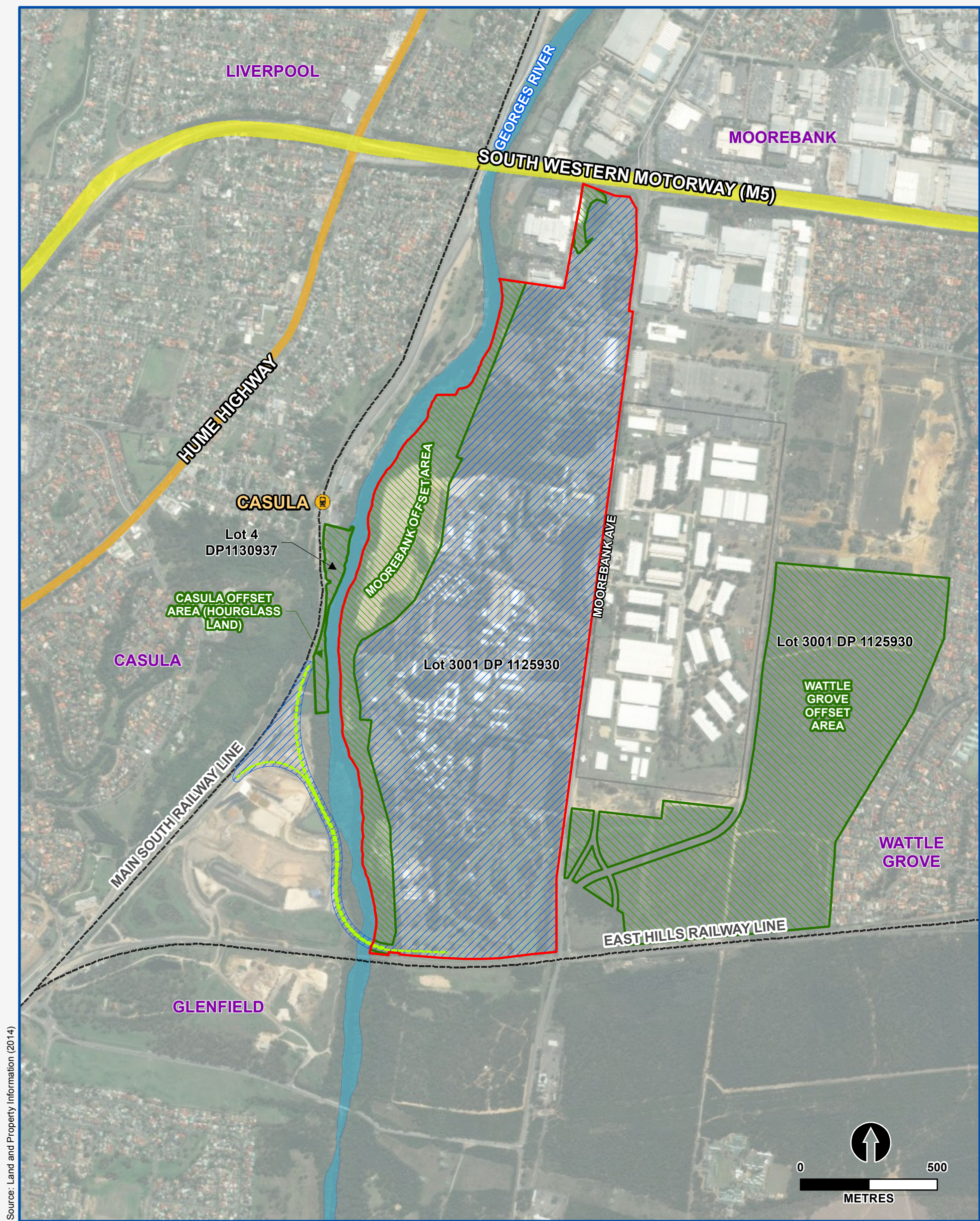
This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure – Defence) under the *Liverpool Local Environmental Plan 2008*. As such, this land is zoned and reserved for Defence development.

The site contains native vegetation that would require active management, including weed removal and supplementary planting with native species, in order to improve the condition of the vegetation and habitats contained therein. It also contains a large patch of vegetation dominated by weeds which would require clearing and revegetation with native species. A planning proposal has been prepared to rezone this area as E3 which will provide greater environmental protection and improve its conservation value.

4.2.3 Wattle Grove Offset area

Part of the eastern portion of Lot 3001 DP 1125930 (east of Moorebank Avenue) contains native vegetation that is proposed to be used to offset vegetation to be cleared for the Project (refer Figure 4.3). This area of approximately 83.0 ha of vegetation adjoins the East Hills Railway Line to the south, land owned by the SIMTA consortium to the northwest, and the residential area of the suburb of Wattle Grove to the east. This area is currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure – Defence) under the *Liverpool Local Environmental Plan 2008* and is currently owned by Department of Defence. This land would need to be actively managed in order to maintain or improve the condition of the vegetation and habitats.

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIODIVERSITY OFFSET STRATEGY



Source: Land and Property Information (2014)

- Land subject of planning proposal
- Rail line & station
- Development footprint
- Offset area

Figure 4.1 Location of proposed biodiversity offset areas

4.3 Ecological values of the proposed offset areas

The ecological values of the proposed offset areas are outlined in terms of known occurrence of threatened species of plant, fauna habitat potential and vegetation condition.

Detailed ecological surveys and assessments of these offset sites have been undertaken in accordance with the NSW BioBanking Assessment Methodology (BBAM). These surveys included ecological vegetation mapping and preliminary threatened flora surveys and built on previous ecological surveys within the Casula offset area and Wattle Grove Offset Area (GHD 2014) and (Hyder 2014). The general conditions, fauna habitats and vegetation communities of the proposed offset areas are summarised in Table 4.1 below.

Table 4.1 Summary of general conditions, fauna habitat and vegetation communities of the offset areas

Offset areas	General condition of offset sites	Fauna habitat	Vegetation communities	Threatened biodiversity
Moorebank offset area	The mapped vegetation of the site varies from patches with native species dominant in all vegetation layers to patches with the understorey and ground layer dominated by introduced vines and shrubs (e.g. <i>Lantana camara</i>).	The fauna habitat of the Georges River riparian corridor consists of a tall eucalypt forest with an understorey varying in its structure and understorey composition. Large mature hollow-bearing trees, potentially hollow-bearing trees and fallen woody debris are moderately abundant in this area. Overall, the fauna habitat in the site is in moderate condition.	Riparian Forest Alluvial Woodland (For list of dominant species refer to Table 4.2).	TSC Act listed Endangered ecological community: <ul style="list-style-type: none"> River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.
Casula offset area	The vegetation of the site is mapped as Riparian Forest (Tozer 2003). Most of the site is covered by disturbed Riparian Forest with the exception of an area in the north which is dominated by the woody weeds <i>Ligustrum lucidum</i> , <i>Ligustrum sinense</i> and <i>Lantana camara</i> . The Riparian Forest of the site has a largely intact canopy layer with an understorey varying from a mixture of native species to areas dominated by <i>Lantana camara</i> . Overall, the native vegetation mapped in the site is in moderate condition.	The fauna habitat of the Casula Offset Area (refer Figure 4.2) consists of a tall eucalypt forest with an understorey varying in its structure and composition. Hollow-bearing trees and fallen woody debris are present in these areas which provide potential microhabitat. Habitat in this area is connected via the riverbank underneath the East Hills railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve.	Riparian Forest (For list of dominant species refer to Table 4.2).	TSC Act listed Endangered ecological community: <ul style="list-style-type: none"> River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions.

Offset areas	General condition of offset sites	Fauna habitat	Vegetation communities	Threatened biodiversity
Wattle Grove Offset Area	<p>Mapped areas of native vegetation in this site are generally dominated by native species with only minor weed invasion. Sporadic weed occurrences also exist along track edges in the core of the site.</p> <p>Overall, the native vegetation mapped in the site is in moderate to good condition. Areas with no vegetation mapped generally consist of regrowth native trees and large shrubs with an understorey dominated by introduced species.</p>	<p>The fauna habitat of the Wattle Grove Offset Area consists of eucalypt woodland with an understory varying in its structure and composition. Large mature hollow-bearing and potentially hollow-bearing trees occur. Fallen woody debris generally occurs at low density.</p> <p>* Due to its size (83 ha), it is likely to have potential to support viable populations of a variety of fauna species under appropriate management. Overall, the fauna habitat in the site is in moderate to good condition.</p>	<p>Riparian Forest Alluvial Woodland Shale/Gravel Transition Forest Castlereagh Swamp Woodland Castlereagh Scribbly Gum Woodland (For list of dominant species refer to Table 4.3).</p>	<p>TSC Act listed Vulnerable ecological community:</p> <ul style="list-style-type: none"> ▪ <i>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion.</i> <p>TSC Act listed Endangered ecological community:</p> <ul style="list-style-type: none"> ▪ <i>Castlereagh Swamp Woodland Community</i> ▪ <i>Cooks River Castlereagh Ironbark Forest</i> ▪ <i>River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i> ▪ <i>Shale Gravel Transition Forest in the Sydney Basin Bioregion</i> <p>EPBC Act listed Critically endangered ecological community</p> <ul style="list-style-type: none"> ▪ <i>Shale Gravel Transition Forest in the Sydney Basin Bioregion</i> <p>EPBC Act listed species</p> <ul style="list-style-type: none"> ▪ <i>Acacia pubescens</i> ▪ <i>Persoonia nutans</i> ▪ <i>Grevillea parviflora subsp. parviflora</i>

4.3.1 General condition of offset sites

4.3.1.1 Moorebank Offset area

The mapped vegetation of the site varies from patches with native species dominant in all vegetation layers to patches with the understorey and ground layer dominated by introduced vines and shrubs (e.g. **Lantana camara*). Dirt/gravel vehicle paths, small patches of bare ground with minimal vegetation and concrete pads are also found here. Larger areas of bare ground and introduced grassland are included in the site but are not included in native vegetation mapping (refer Figure 4.2). Overall, the vegetation of the site is considered to be in moderate condition.

Without intervention, it is likely that the condition of vegetation and fauna habitats would continue to decline due to the ongoing reduction of the native shrub layer and lack of tree recruitment due to competition with woody weeds, particularly **Lantana camara*. Under present conditions there is little light pollution affecting the vegetation along the Georges River. Light pollution is likely to be substantially higher during the construction and operation of the Project due to fixed lighting within the facility and lighting from trucks and trains. The proposed vegetation restoration within the riparian corridor and landscape planting in the interior of the site is, however, likely to mitigate light pollution through the screening effects of increased vegetation. The proposed lighting for the site would also be designed to minimise light spill (as explained in the main EIS document), thereby minimising ecological light pollution impacts. With the proposed vegetation restoration, significant ecological light pollution impacts on the offset site are unlikely.

4.3.1.2 Casula Offset area

The vegetation of the site is mapped as Riparian Forest (Tozer 2003). Field verification of the site on 18 February 2013 revealed that most of the site is covered by disturbed Riparian Forest with the exception of an area in the north which is dominated by the woody weeds **Ligustrum lucidum*, **Ligustrum sinense* and **Lantana camara*. The Riparian Forest of the site has a largely intact canopy layer with an understorey varying from a mixture of native species (e.g. *Breynia oblongifolia*) to areas dominated by **Lantana camara*. Overall, the native vegetation mapped in the site is in moderate condition.

Without intervention, it is likely that the condition of vegetation and fauna habitats would continue to decline due to the ongoing reduction of the native shrub layer and lack of tree recruitment due competition with woody weeds, particularly **Lantana camara*.

Existing ecological light pollution is likely to affect the Casula Offset Area due to its location immediately adjacent to the Southern Freight Rail Line. The light conditions here may limit the suitability of the site for some nocturnal animal species; however, some nocturnal species are likely to be habituated to increased light levels and to persist in utilising this habitat.

4.3.1.3 Wattle Grove Offset area

Mapped areas of native vegetation in this site are generally dominated by native species with only minor weed invasion. Areas of more intense weed invasion, where introduced species are dominant in the ground layer, are limited to the periphery of the site and patches of regrowth vegetation in the south-west of the site (refer to areas with no vegetation mapped in Figure 3.5). Sporadic weed occurrences also occur along track edges in the core of the site.

The site is subject to periodic hazard reduction burning for the protection of the adjacent suburban area of Wattle Grove. The frequency and intensity of burning of the vegetation on the site is likely to influence its suitability as habitat for threatened species.

Overall, the native vegetation mapped in the site is in moderate to good condition. Areas with no vegetation mapped generally consist of regrowth native trees and large shrubs with an understorey dominated by introduced species.

4.3.2 Vegetation community composition and condition

Vegetation community composition and condition in the offset areas is described in Tables 4.2 and 4.3. Figures 4.2 and 4.3 outline the distribution of vegetation communities in each offset area.

Table 4.2 Moorebank Conservation Area and Casula Offset area vegetation composition and condition

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity ²
		Canopy	Understorey ¹	Ground cover ¹		
Riparian Forest	25–30 m	<i>Eucalyptus bosistoana</i> , <i>Eucalyptus botryoides</i> x <i>saligna</i> , <i>Angophora floribunda</i> , <i>Casuarina cunninghamiana</i>	<i>Tristaniopsis laurina</i> , <i>Backhousia myrtifolia</i> , <i>Stenocarpus salignus</i> , <i>Jacksonia scoparia</i> , <i>Polyscias sambucifolia</i> , <i>Westringia longifolia</i> , <i>Santalum obtusifolium</i> , <i>Acacia binervia</i> , <i>Acacia decurrens</i> , <i>Callistemon salignus</i> , <i>*Arundo donax</i> , <i>Melia azedarach</i> , <i>*Ligustrum sinense</i> , <i>Phebalium squamulosum</i>	<i>Microlaena stipoides</i> , <i>*Eragrostis curvula</i> , <i>*Cardiospermum grandiflorum</i> , <i>Leucopogon juniperinus</i> , <i>Morinda jasminoides</i> , <i>Pteridium esculentum</i> , <i>*Araujia sericifera</i> , <i>*Verbena bonariensis</i> , <i>*Asparagus</i> spp., <i>Gahnia aspera</i> , <i>Pratia purpurascens</i> , <i>Austrostipa ramosissima</i>	TSC Act listed Endangered ecological community <i>River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>	Moderate to High
Alluvial Woodland	20–25 m	<i>Eucalyptus tereticornis</i> , <i>Eucalyptus botryoides</i> x <i>saligna</i> , <i>Eucalyptus baueriana</i> , <i>Angophora floribunda</i>	<i>Acacia decurrens</i> , <i>Acacia binervia</i> , <i>Ozothamnus diosmifolius</i> , <i>Kunzea ambigua</i> , <i>*Lantana camara</i>	<i>Microlaena stipoides</i> , <i>*Eragrostis curvula</i> , <i>*Senecio madagascariensis</i> , <i>*Conyza bonariensis</i> , <i>Tricoryne elatior</i> , <i>Pratia purpurascens</i> , <i>*Bidens pilosa</i> , <i>*Sida rhombifolia</i> , <i>Cynodon dactylon</i>	TSC Act listed Endangered ecological community <i>River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions</i>	Moderate to High

Notes: 1. Asterisk (*) denotes an introduced species.

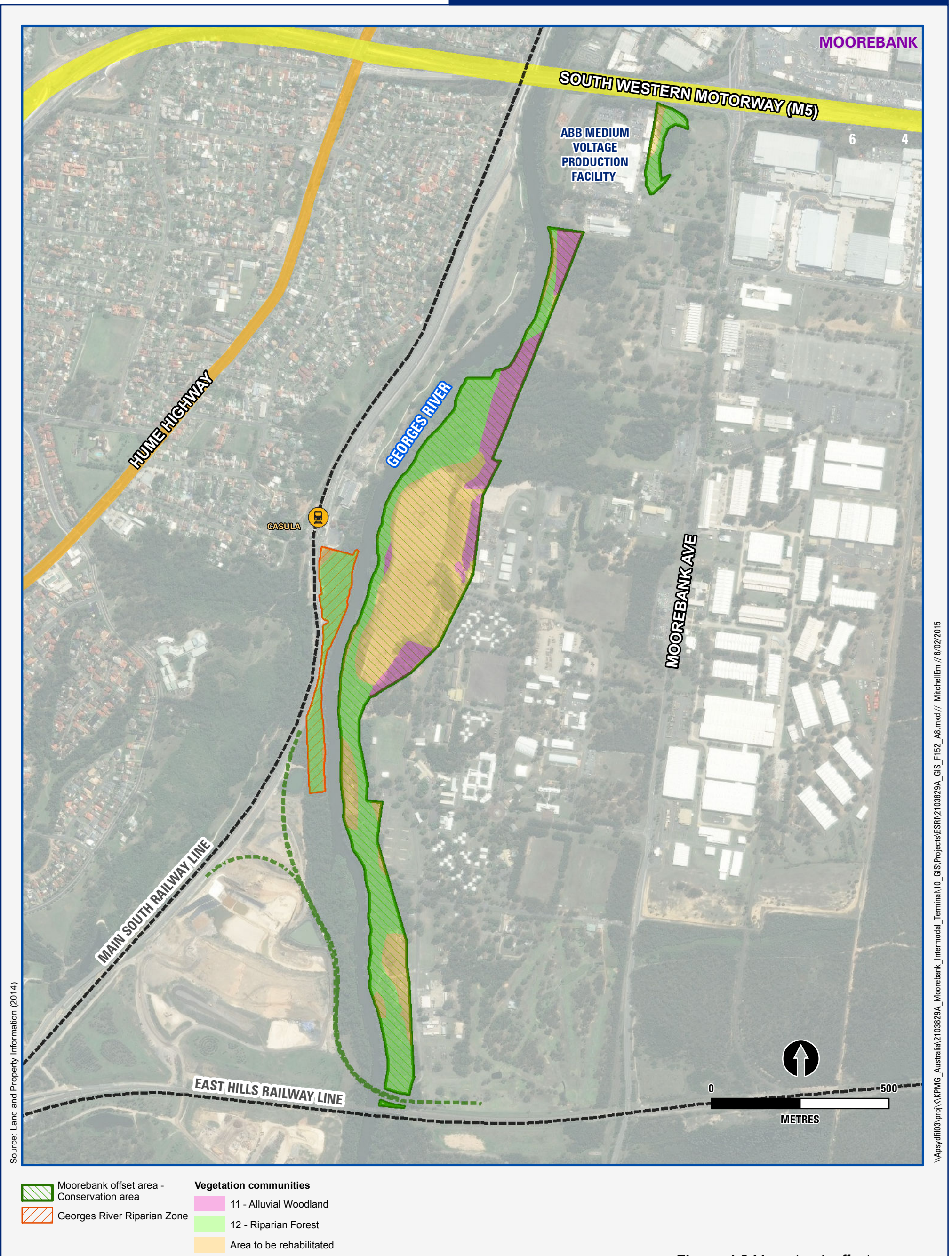
2. Refer to Section 2.4.2 of the *Moorebank Intermodal Freight Terminal – Ecological Impact Assessment* for Ecological Integrity definitions

Table 4.3 Wattle Grove Offset area – eastern bushland area vegetation community composition and condition

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity
		Canopy	Understorey	Ground cover		
Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland	8–12 m	<i>Eucalyptus sclerophylla</i> , <i>Angophora bakeri</i> <i>Eucalyptus globoidea</i> , <i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> , <i>Melaleuca decora</i>	<i>Kunzea capitata</i> , <i>Melaleuca nodosa</i> , <i>Acacia brownei</i> , <i>Banksia spinulosa</i> , <i>Banksia oblongifolia</i> , <i>Hakea sericea</i> , <i>Astroloma humifusum</i> , <i>Daviesia acicularis</i> , <i>Petrophile sessilis</i> , <i>Hakea dactyloides</i> , <i>Acacia linifolia</i> , <i>Isopogon anethifolius</i> , <i>Leptospermum polygalifolium</i> , <i>Dillwynia parvifolium</i> , <i>Leptospermum parvifolium</i> , <i>Leptospermum trinervium</i> , <i>Pimelea linifolia</i> , <i>Pultenaea villosa</i> , <i>Callistemon linearis</i> , <i>Pultenaea elliptica</i> , and <i>Acacia falcata</i> .	<i>Lomandra multiflora</i> , <i>Cyathochaeta diandra</i> , <i>Dianella revoluta</i> , <i>Cheilanthes sieberi</i> , <i>Themeda australis</i> , <i>Laxmannia gracilis</i> , <i>Billardiera scandens</i> , <i>Pratia purpurascens</i> , <i>Eragrostis brownei</i> , <i>Goodenia hederacea</i> var. <i>hederacea</i> , <i>Aristida vagans</i> , <i>Trachymene incisa</i> , <i>Entolasia stricta</i> , <i>Xanthorrhoea minor</i> , <i>Stylidium graminifolium</i> , <i>Microlaena stipoides</i> , <i>Panicum simile</i> , <i>Dampiera stricta</i> , <i>Lepyrodia scariosa</i> , <i>Leptocarpus tenax</i> , <i>Cassytha pubescens</i> and <i>Hardenbergia violaceae</i> .	TSC Act listed Vulnerable ecological community <i>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion.</i>	High
Parramatta Red Gum woodland	8–10 m	<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> , <i>Angophora floribunda</i> , <i>Melaleuca linariifolia</i> , <i>Melaleuca decora</i> , <i>Angophora bakeri</i> , <i>Eucalyptus sclerophylla</i>	<i>Melaleuca thymifolia</i> , <i>Melaleuca erubescens</i> , <i>Leptospermum polygalifolium</i> , <i>Callistemon linearis</i> and <i>Pultenaea villosa</i> .	<i>Lomandra longifolia</i> , <i>Hakea sericea</i> , <i>Gahnia</i> sp., <i>Pteridium esculatum</i> , <i>Dianella revoluta</i> , <i>Juncus usitatus</i> , <i>Aristida vagans</i> , <i>Pratia purpurascens</i> , <i>Ranunculus inundatus</i> , <i>Imperata cylindrica</i> , <i>Centella asiatica</i> , <i>Goodenia paniculata</i> , <i>Lepidosperma quadrangulatum</i> , <i>Lepyrodia muelleri</i> , <i>Carex appressa</i> <i>Typha orientalis</i> , <i>Leptocarpus tenax</i> , <i>Isolepis inundata</i> , <i>Isolepis cernua</i> , <i>Schoenus brevifolius</i> , <i>Baumea articulata</i> , and <i>Chorizandra cymbaria</i> .	TSC Act listed Endangered ecological community <i>Castlereagh Swamp Woodland Community.</i>	High

Vegetation community	Canopy height	Dominant species			Conservation significance	Ecological integrity
		Canopy	Understorey	Ground cover		
Broad-leaved Ironbark – Melaleuca decora grassy open forest	16–20 m	<i>Eucalyptus fibrosa</i> , <i>Eucalyptus tereticornis</i> , <i>Melaleuca decora</i> , <i>Allocasuarina littoralis</i> , <i>Exocarpus cupressiformis</i> and <i>Acacia decurrens</i> .	<i>Ozothamnus diosmifolium</i> , <i>Bursaria spinosa</i> , <i>Acacia falcata</i> , <i>Pultenaea villosa</i> , <i>Daviesia ulicifolia</i> , <i>Olearia microphylla</i> , <i>Lissanthe strigosa</i> , <i>Hakea sericea</i> , <i>Dillwynia parvifolia</i> , <i>Melaleuca nodosa</i> , <i>Leucopogon juniperinus</i> , <i>Persoonia linearis</i> , and <i>Pomax umbellata</i> .	<i>Lissanthe strigosa</i> , <i>Entolasia stricta</i> , <i>Themeda australis</i> , <i>Aristida vagans</i> , <i>Austrodanthonia tenuior</i> , <i>Lomandra longifolia</i> , <i>Lomandra multiflora</i> , <i>Dianella revoluta</i> , <i>Hibbertia obtusifolia</i> , <i>Lepidosperma laterale</i> , <i>Cheilanthes sieberi</i> , <i>Gonocarpus tetragynus</i> , <i>Dichondra repens</i> , <i>Centella asiatica</i> , <i>Einadia hastata</i> , <i>Billardiera scandens</i> , <i>Hardenbergia violaceae</i> and <i>Glycine clandestina</i> .	TSC Act listed Endangered ecological community. <i>Shale Gravel Transition Forest in the Sydney Basin Bioregion</i> . EPBC Act listed Critically endangered ecological community.	High
Broad-leaved Ironbark – Melaleuca decora shrubby open forest	16–20 m	<i>Eucalyptus fibrosa</i> , <i>Eucalyptus tereticornis</i> , <i>Melaleuca decora</i> , and <i>Melaleuca nodosa</i> .	<i>Melaleuca nodosa</i> , <i>Bursaria spinosa</i> , <i>Acacia falcata</i> , <i>Pultenaea villosa</i> , <i>Notelaea longifolia</i> , <i>Daviesia ulicifolia</i> , <i>Lissanthe strigosa</i> , <i>Lissanthe strigosa</i> , <i>Leucopogon juniperinus</i> , <i>Persoonia linearis</i> , and <i>Pomax umbellata</i> .	<i>Lomandra filiformis</i> , <i>Lissanthe strigosa</i> , <i>Themeda australis</i> , <i>Entolasia stricta</i> , <i>Aristida vagans</i> , <i>Lomandra longifolia</i> , <i>Lomandra multiflora</i> , <i>Dianella revoluta</i> , <i>Lepidosperma laterale</i> , <i>Pratia purpurascens</i> , <i>Einadia hastata</i> , <i>Hardenbergia violaceae</i> and <i>Glycine clandestina</i> .	TSC Act listed Endangered ecological community <i>Cooks River/ Castlereagh Ironbark Forest in the Sydney Basin Bioregion</i> .	High

PROPOSED MOOREBANK INTERMODAL TERMINAL BIODIVERSITY OFFSET STRATEGY



PROPOSED MOOREBANK INTERMODAL TERMINAL BIODIVERSITY OFFSET STRATEGY



Wattle Grove offset area

Threatened species records

- *Grevillea parviflora* subsp. *parviflora*
- *Persoonia nutans*
- *Grevillea parviflora* subsp. *parviflora* - larger sub-populations

Persoonia nutans - larger populations

Vegetation communities

- 103 - Shale/Gravel Transition Forest,
- 3 - Cooks River Castlereagh Ironbark Forest,

4 - Castlereagh Swamp Woodland,

6 - Castlereagh Scribbly Gum Woodland (High condition)

6 - Castlereagh Scribbly Gum Woodland (Moderate condition)

Figure 4.3 Moorebank offset area -
Wattle Grove offset area - vegetation communities and threatened plants

4.3.3 Fauna habitat of offset sites

4.3.3.1 Moorebank Offset area

The fauna habitat of the Moorebank Offset Area consists of a tall eucalypt forest with an understorey varying in its structure and composition including areas with dense weed thickets, diverse native shrubbery and sparse understorey consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing, potentially hollow-bearing trees and fallen woody debris are moderately abundant in this area.

Habitat in this area is connected via the riverbank below the railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation.

Overall, the fauna habitat on the site is in moderate condition.

4.3.3.2 Casula Offset area

The fauna habitat of the Casula Offset Area consists of a tall eucalypt forest with an understorey varying in its structure and composition including areas with dense weed thickets and native shrubbery. Hollow-bearing trees and fallen woody debris are present in these areas which provide potential microhabitat features for a variety of species of animal.

Habitat in this area is connected via the riverbank underneath the railway line to larger areas of vegetation to the south which extend into the Georges River Nature Reserve. Connectivity to substantial areas of fauna habitat to the north is less pronounced due to the presence of intervening areas with only very narrow bands of riparian vegetation. Recent weed removal and replanting with indigenous species in Riparian Forest areas immediately to the north of the site is likely, however to result in a minor improvement in connectivity to the north in the medium term.

4.3.3.3 Wattle Grove Offset area

The fauna habitat of the Wattle Grove Offset Area consists of eucalypt woodland with an understorey varying in its structure and composition including areas with dense thickets of native shrubbery and areas of sparse understorey consisting mainly of grasses, leaf litter and scattered shrubs. Large mature hollow-bearing and potentially hollow-bearing trees occur at low density in this site. Fallen woody debris generally occurs at low density, likely as a result of fuel reduction burning activities in the northern portion of the site. The southern area of the site contained a moderate density of fallen timber debris providing habitat for reptiles and small terrestrial mammals.

Swamp Forest in the form of Parramatta Red Gum Woodland contained sedges and small areas of aquatic habitat such as small wetlands and areas of open water. This contained habitat for reptiles, amphibians and birds.

The site is fenced on the north, east and south of the site, and maintains connectivity to a small area of native bushland to the west. A rail corridor and the fence separate this area from a large area of habitat to the south limiting connectivity for terrestrial and arboreal fauna. Due to its size (83 ha) and proximity to very large remnant patches >1000 ha, it is likely to have potential to support viable populations of a variety of fauna species under appropriate management. If populations of less mobile animal species (i.e. non-flying species) are lost, however, there is limited scope for natural repopulation of this habitat due to its limited connectivity. Overall, the fauna habitat in the site is in moderate to good condition.

4.3.4 Threatened species of plant

Targeted surveys for *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans* were conducted on the Wattle Grove offset area on 29 November 2012 and May 2014 and to provide further detail regarding the population size and distribution of these species in the offset area. In addition the results of surveys of the Wattle Grove Offset by (Hyder 2014) and (GHD 2014) have been incorporated into the local population estimates in Table 4.4 below.

Table 4.4 Threatened flora populations recorded within the offsets

Offset area	Threatened species population information		
	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	<i>Persoonia nutans</i>	Other species
Wattle Grove offset area	A minimum population of 2000 individual's recorded but total number likely to be higher as surveys did not cover entire site and count estimates were conservative. Larger concentrations (>50 stems) mostly in the southern half of the site and scattered individuals elsewhere.	Approximately 120 individuals recorded within the offset area. The largest concentration was recorded along the boundary of the offset area between Anzac Creek and the southern boundary of the Defence National Storage and Distribution Centre site (refer Figure 3.3). Scattered individuals recorded elsewhere. A further four individuals were recorded within the perimeter fence but outside the mapped offset boundary.	Three clumps comprising > 300 stems of <i>Acacia pubescens</i> recorded.

4.4 Management of currently proposed offset areas

The existing management of the currently proposed offset areas and proposed management are outlined below.

4.4.1 Existing management

The proposed offset sites are currently managed by the Department of Defence (Defence). A Weed Management Plan (WMP) has been prepared for Defence Maintenance Management Pty Ltd (DMM) on behalf of the Defence (AECOM Australia 2010). The scope of the plan was to develop and implement all works related to the management and control of weeds on Liverpool Military Area (LMA) for a period of three years (from 1 February 2010–31 January 2013) (AECOM Australia 2010). The WMP also included an Annual Works Schedule (AWS) providing a framework against which specialist sub-contractors, DMM and Defence personnel, can identify the target weeds, define their priority for control, and implement a cost effective and environmentally sustainable program of control aligned to the

implementation of the required Defence activities at each site (AECOM Australia 2010). The goal of the WMP is to effectively manage weeds so that the site can be fully utilised within legislative responsibilities and sustain the Defence training activities over the long term (AECOM Australia 2010). Current and proposed management of biodiversity values on Defence lands in the LMA primarily involves weed management, with a focus on minimising the spread of environmental weeds (AECOM Australia 2010). The primary goal of weed management in the LMA is to manage the African Lovegrass (**Eragrostis curvula*) population as part of the ongoing management of Threatened flora species and native vegetation. Priority has been given to control of African Lovegrass on access routes to the less disturbed sections of the LMA (AECOM Australia 2010). The control of other environmental and noxious weeds such as Blackberry (**Rubus* spp.) and Green Cestrum (**Cestrum parqui*) is also a key consideration (AECOM Australia 2010).

African Lovegrass is also present at low density in the Moorebank Conservation Area and Casula Offset Area.

The current management regime appears to be focussed on containing the further spread of weeds rather than large scale reduction in existing weed infestation. While possibly sufficient to maintain the current condition of native vegetation and associated Threatened species habitat, current management is unlikely to result in a long-term improvement in biodiversity values without a substantially higher resource investment.

The proposed management described below includes an intensification of weed management and other measures to actively improve the biodiversity values of the offset sites.

4.4.2 Proposed management

4.4.2.1 Restoration and management of the Moorebank Offset area and Casula Offset area

The Moorebank Offset Area restoration site includes the eastern side of the River corridor from approximately 300 m south of the M5 Motorway for a length of approximately 2.5 km south to the East Hills Railway Line. The Casula Offset Area is located on the western side of the Georges River opposite the Project site (refer Figures 4.1 and 4.2).

A riparian restoration plan for this area has been developed (refer Appendix E in Technical Paper 3, EIS Volume 4). The purpose of this restoration plan is to guide the restoration of the riparian landform, vegetation and fauna habitat of the site and to improve the quality of water entering the Georges River. The objectives of the plan include:

- restoration and revegetation of the riparian zone of the site to be consistent with, and complementary to, areas of remnant indigenous vegetation within the Georges River Corridor (approximately 15.5 ha of land to be revegetated);
- long-term eradication and suppression of the most detrimental weed species on the site including vine and woody weeds (approximately 20.7 ha of land to undergo a weed control program);
- consolidation and widening of the existing vegetation corridor of Georges River where feasible. It is currently proposed to revegetate and conserve a corridor extending from the riverbank to the proposed development area;

- improved habitat values for native animals and plants, particularly threatened species; and
- management of undesirable animal species including introduced animal species and some Australian native animals which may be detrimental to the biodiversity of the Project site.

Successful implementation of this strategy would require detailed planning, monitoring and adaptive management.

The detailed planning stage may include management actions involving project management, sourcing of soil and obtaining plants and seeds. A variety of issues may arise in the implementation of the plan which would require actions to be modified or additional actions to be implemented. A monitoring program is thus required to detect issues at an early stage such that appropriate adaptations may be made to strategies to ensure that the relevant objectives can be met. Adaptive management actions may include trial treatments (such as trial weed-control) and subsequent modified and/or substitute actions to find alternative methods to achieve the same outcomes if the proposed actions are unsuccessful.

4.4.2.2 Wattle Grove offset area

The management and restoration of the Wattle Grove offset area will be established under a BioBanking agreement as the area is located offsite.

4.4.2.3 Management of undesirable animal species

Successful management of undesirable animal species requires an integrated approach including habitat manipulation and/or culling programs. Culling of undesirable species over a small spatial area is likely to result in constant re-invasion from adjacent lands and is unlikely to be effective in substantially reducing the impact of these species. Proposed measures to manage undesirable animal species include:

- Monitoring of undesirable animal species. Monitor the site for the presence of introduced and undesirable animal species as part of fauna monitoring;
- Co-operate with government bodies, interest groups and adjacent landowners in regional pest management programs including the NSW Department of Primary Industries, the OEH, and the Invasive Animal Cooperative Research Centre interest groups (e.g. Australasian Pest Bird Network and local landowners);
- Manage the use of nest boxes by undesirable species by removing the eggs and/or young of introduced animals (e.g. Black Rat and Common Myna) found utilising nest boxes under appropriate permit conditions;
- Remove any insect colonies (bees, wasps, termites, ants found in nest boxes); and
- Modify or move nest boxes to discourage use by undesirable species.

4.4.2.4 Proposed ecological rehabilitation requirements in accordance with the FBA

The Project's ecological impacts and the proposed biodiversity offsets have been reassessed and quantified using the BioBanking credit calculator and with reference to the FBA.

The area of proposed rehabilitation within the Moorebank and Casula offset areas adjoining the Georges River contain limited vegetation and are highly disturbed. The proposed revegetation of this area will strengthen the existing riparian corridor and will contribute to long term ecological gain of the Moorebank and Casula offsets. OEH have accepted that these areas may contribute the Projects biodiversity offsets and therefore the quantum of ecosystem credits provided by any such rehabilitation should be calculated using Chapter 12 of BBAM 2014 (in particular Table 6, Equation 7 and, where appropriate, Appendix 7).

There is currently only limited survey data available to adequately assess the potential credits generated from these 'low condition' rehabilitation areas. As such the rehabilitation areas have been temporally excluded from credits generated in the FBA credits calculations for the Moorebank and Casula offsets presented in the BOS.

It is proposed that further surveys incorporating the formal assessment of the Moorebank and Casula offsets under the BioBanking scheme will be undertaken as part of the development of the BOS. These surveys and assessment will determine the quantum of ecosystem credits generated from rehabilitation areas in accordance with Chapter 12 of BBAM 2014. Once the quantum of ecosystem credits generated by the rehabilitation of these 'low condition' areas has been determined they will contribute in part to the residual biodiversity credit requirements identified in this BOS.

4.5 Security of offset lands

Offsets sites need to demonstrate ongoing conservation of land in perpetuity for the benefit of future generations. Offset sites must be enduring and must offset the impact of the development for at least the period that the impact occurs. The security of land tenure and ongoing management of offset site(s) is critical to the long-term viability of offsets and must be carefully considered:

To ensure the conservation of lands in-perpetuity, the offset strategy will require the dedication of any identified offset sites under a secure conservation arrangement. The preferred option for the conservation of these lands is through the establishment of a BioBanking agreement in accordance with the requirements of the FBA.

4.6 Comparison of vegetation and habitat removal to the extent provided in currently proposed offset areas

Offsets must be proportionate to the impact, in terms of size, scale and habitat type (SEWPaC 2012). The proposed biodiversity offset strategy is based around a dual direct offset approach to achieve an improved conservation outcome by combining the long-term protection of existing habitat in good condition at the IMT site with the restoration, rehabilitation and re-establishment of habitat in poor condition along the Georges River riparian corridor. A ratio (offset: clearing) of 2.5:1 would be achieved through the securing of the currently proposed offsets.

A comparison is provided in Table 4.5 below between the extent of vegetation and habitat removal with that provided in the currently proposed offset areas.

Table 4.5 Comparison of vegetation and habitat removal for the southern rail option

Vegetation community/ habitat type	Extent to be removed by the Project (ha) ¹	Extent provided in offset areas (ha)						Ratio (offset: clearing)
		Moorebank Offset Area – Georges River Riparian Zone		Casula Offset area		Wattle Grove Offset	Combined offset areas	
		Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Revegetation	Weed control – habitat restoration	Area	
Vegetation								
Castlereagh Swamp Woodland ¹	0.9	-	-	-	-	23.5	23.5	26:1
Castlereagh Scribbly Gum Woodland ²	16.1	-	-	-	-	33.6	33.6	2.1:1
Riparian Forest (River-Flat Eucalypt Forest) ¹	3.6	12.9	-	3.0	1.1	-	17.0	4.7:1
Alluvial woodland (River-Flat Eucalypt Forest) ¹	28.1	4.9	16.7	-	-	-	21.6	0.8:1
Shale/Gravel Transition Forest	-	-	-	-	-	12.9	13.35	12.9:1
Cooks River Castlereagh Ironbark Forest	-	-	-	-	-	13.0	13.23	13.0:1
Total area	48.7	17.7	16.7	3.0	1.1	83.0	121.5	2.5:1
Shrubby eucalypt woodland	17.0	-	-	-	-	83.0	83	4.9:1
Tall eucalypt forest	31.7	17.7	16.7	3.0	1.1	-	38.4	1.2 : 1
Total area	48.7	17.7	16.7	3.0	1.1	83	121.5	2.5:1

Notes: 1 - Endangered Ecological Communities as listed under the NSW *Threatened Species Conservation Act 1995*;

2 – Vulnerable Ecological Community as listed under the TSC Act. 3) Critically endangered ecological community as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

5. Compliance with offsetting principles

This section provides a comparison of the Projects biodiversity offset strategy against the principles for the use of environmental offsets as outlined in the current Environment Protection and Biodiversity Conservation Act 1999 Environmental Biodiversity Offsets Policy (Department of Sustainability Environment Water Population and Communities 2012), and the NSW Biodiversity Offsets Policy for Major Projects.

5.1 Principles for the use of environmental offsets under the EPBC Act

DoE has developed principles for the use of environmental offsets under the EPBC Act which assess any proposed environmental offsets for matters of National Environmental Significance (including Threatened species and communities). This is done to ensure consistency, transparency and equity under the EPBC Act. The applicable principles are as follows:

- suitable offsets must deliver an overall conservation outcome that improves or maintains the viability of the protected matter;
- suitable offsets must be built around direct offsets but may include other compensatory measures;
- suitable offsets must be in proportion to the level of statutory protection that applies to the protected matter;
- suitable offsets must be of a size and scale proportionate to the residual impacts on the protected matter;
- suitable offsets must effectively account for and manage the risks of the offset not succeeding;
- suitable offsets must be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs;
- suitable offsets must be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- suitable offsets must have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The eight principles are addressed below in relation to the potential impacts of the Project and the proposed offsets.

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development

Offsets must deliver an overall conservation outcome that *improves or maintains* the viability of the aspect of the environment that is protected by national environment law and affected by the proposed development (Department of Sustainability Environment Water Population and Communities 2012). As the Project involves the Commonwealth and actions that affect

Commonwealth areas, offsets must be targeted to the aspect of the environment that is being impacted. An improved conservation outcome may be achieved by:

- improving existing habitat for the protected matter;
- creating new habitat for the protected matter;
- reducing threats to the protected matter;
- increasing the values of a heritage place; and/or
- averting the loss of a protected matter or its habitat that is under threat (Department of Sustainability Environment Water Population and Communities 2012).

The proposed offset strategy consists of a dual direct offset approach, including offsets both within and outside of the Project site, to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in poor condition.

The proposed BOS is committed to providing a BOS that meets its residual offset requirements in accordance with the NSW FBA Methodology; which provides a transparent and repeatable methodology for assessing impacts on biodiversity through a modified credit calculator, similar to the existing credit calculator used under the BioBanking Assessment methodology (BBAM).

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to **1,409** ecosystem credits or approximately 140 ha and **1,004** species credits (refer to Table 5.3 and Appendix A of Technical Paper 3 in Volume 4 of the EIS).

The potential ecosystem and species credits generated from the proposed offsets have been quantified using FBA credit calculator and meet some of the Projects ecosystem credit requirements in accordance with the FBA and NSW Offset Policy 2014.

A residual offset requirement of 610 ecosystem credits (approximately 61 ha) of Alluvial woodland and 143 (approximately 14.3 ha) of Castlereagh Scribbly Gum Woodland is required.

MIC is committed to providing an offset that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offsets for Alluvial Woodland and Castlereagh Scribbly Gum Woodland.

2. Be built around direct offsets but may include other compensatory measures

The proposed offset strategy consists of a dual direct offset approach by combining the long-term protection of existing habitat at the IMT site and two other locations in the locality with restoration, rehabilitation and re-establishment of the degraded habitats along the Georges River riparian corridor. The offset strategy also provides for the conservation of a large area of existing habitat with locally important populations of the threatened plants species impacted by the project.

The maximum offset requirements of the Project under the NSW *Offset Policy 2014* has been quantified using FBA calculator as up to **1,409** ecosystem credits or approximately 140 ha and **1,004** species credits (refer to Table 5.3 and Appendix A of Technical Paper 3 in Volume 4 of the EIS).

MIC is committed to providing a offset package that adequately meets the quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offsets for Alluvial Woodland and Castlereagh Scribbly Gum Woodland.

3. Be in proportion to the level of statutory protection that applies to the protected matter

Offsets required for protected matters with higher conservation (threat) status must be greater than those with a lower status (Department of Sustainability Environment Water Population and Communities 2012).

4. Be of a scale and size proportionate to the residual impacts on the protected matter

Offsets must be proportionate to the impact, in both size and scale (Department of Sustainability Environment Water Population and Communities 2012). The proposed offset strategy is based around a dual direct offset approach to achieve an improved conservation outcome by combining the long-term protection of existing habitat in good condition at the Wattle Grove and Casula offsets with the restoration, rehabilitation and re-establishment of habitat in moderate condition along the Georges River riparian corridor. The offsets are proportionate to the impact in both size and scale, providing between 90% and 209% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.5:1 has been secured under the currently proposed offsets with additional offsets still yet to be determined. No clearing will take place until the additional offsets have been secured.

5. Effectively manage the risks of the offset not succeeding

The proposed offset strategy addresses risk by directly accounting for the residual biodiversity impacts associated with the Project. Direct replacement and management of the same vegetation and habitat types that are to be impacted will occur. The proposed offset areas identified to date are located directly adjacent to the impact site. Using direct offsets to account for the residual biodiversity impacts of the Project in a positive ratio situated, at least in part, adjacent to the Project area should minimise the risks of the offset not succeeding. The biodiversity offset strategy will be implemented as part of the EIS process which minimises the risks of the strategy not being implemented.

Perverse outcomes (environmental, social or economic) are unlikely to occur with the implementation of the proposed offset strategy.

6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or projects (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action)

The current planning controls for the Project biodiversity offset areas have been investigated. This investigation concluded that the lands are currently mapped as Environmentally Significant Land and zoned SP2 (infrastructure – Defence under the *Liverpool Local Environmental Plan 2008*. As this land is zoned and reserved for Defence infrastructure, it is not currently protected from development. The proposed offset areas are not agreed to under any other schemes or Projects.

7. Be efficient, effective, timely, transparent, scientifically robust and reasonable

The proposed offset strategy is as follows:

- efficient – the proposed offset areas are close to the development site and are capable of achieving the desired result with the minimum use of resources, time, and effort;
- effective – will result in the intended result (i.e. an improved conservation outcome);
- timely – will be secured and functional prior to vegetation clearing within the Project area;
- transparent – clearly recognisable as to what the offset strategy is trying to achieve;
- scientifically robust – the proposed offset strategy is straightforward and conforms to current thinking in conservation science and ecological restoration; and
- reasonable – the proposed offset strategy does not promise more than is possible or achievable.

8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced

The currently proposed offset areas and additional offset areas identified (as described in section 3.5) will be protected by an agreement that will place legal restrictions on the future use and management of the land that would exist within the title for the land in perpetuity. This will ensure that the offsets are enduring and that they will offset the impact of the development for the period that the impact occurs.

MIC is currently proposing to establish BioBanking agreements over the proposed offsets as the preferred method of providing enduring, enforceable and auditable conservation areas.

The proponent or its contractors will report on the success of the offsets to ensure that the offsets are delivering an improved conservation outcome. Annual reports on the success of the offset strategy will be provided to the DoE and the OEH and will be made publicly available. All establishment costs of the proposed offsets will be borne by MIC or a future developer under contractual requirements specified by MIC.

5.1.1 Adequacy assessment of Biodiversity offsets under the EPBC Act

The *Offsets Assessment Guide* (Department of Sustainability Environment Water Populations and Communities 2012) provides the biodiversity offset requirements and decision-making framework for DoE to assess the suitability of biodiversity offsets. The guide assesses the appropriateness and adequacy of the proposed offsets, in alignment to the principles and offset requirements under the EPBC Act, for Threatened species and ecological communities (Department of Sustainability Environment Water Population and Communities 2012).

The key steps in the process under this policy (once impacts have been avoided as far as practicable) are to:

- identify the residual impacts to threatened species, their habitats or threatened ecological communities;

- determine likely offsets required via use of the Offsets Assessment Guide calculator; and
- develop an offset strategy and subsequent offset package to formalise appropriate offsets in consultation with DoE.

The Project biodiversity offsets areas identified to date, has been assessed using the *Offsets Assessment Guide*. The assessment is based on habitat of Threatened biodiversity known and predicted to occur within the Project area. The areas and condition of habitat within the Project will be based on the habitat assessments completed during field surveys for the EIS.

For the Project the following approach was taken:

- current known direct impacts of the northern rail option to threatened species, habitats and ecological communities were confirmed; and
- a flora offset calculation and a fauna habitat calculation were undertaken to determine sufficient offset areas in hectares.

Assumptions for the calculation included:

- The impacts of the project (that will require offsetting) are assumed to be those as identified in Technical Paper 3 – *Ecological Impact Assessment* in EIS Volume 4.
- The flora offset calculation was based on habitat for the endangered *Persoonia nutans* and the vulnerable *Grevillea parviflora*, as the endangered status for *Persoonia* results in the maximum offset requirement for threatened flora overall.
- The fauna offset calculation was based on fauna habitat for recorded species such as the Grey-headed Flying Fox, which is listed as vulnerable under the EPBC Act and potential habitat for endangered species like the Regent Honeyeater and Swift Parrot. These species would utilise any of the forested habitats on the site for potential foraging. The calculation was based on these species likely presence and the assumption that all native forested habitats formed habitat for this fauna species.
- No threatened vegetation communities listed under the EPBC Act were recorded on the site, although the use of fauna habitat for all native forested vegetation impacts ensures that all vegetation impacts are considered for offsetting, whether they are listed as threatened under the EPBC Act or not.

These assessments will also account for the value of habitat to to State-listed Threatened species, populations and ecological communities.

During the assessment a conservative approach will be adopted to ensure adequacy due to information limitations. The assumptions listed in Table 5.1 below have been made when assessing offsets.

Table 5.1 Assumptions of protected matter attributes when assessing adequacy of biodiversity offsets

Protected matter attributes	Assumption	Score
EPBC Act status	<p>The highest status of EPBC Act Threatened species considered likely to occur within the Project area will be used in determining the annual probability of extinction.</p> <p>Three separate assessment have been completed for the Project (refer to Attachment A of this document):</p> <ul style="list-style-type: none"> ▪ vulnerable plant species; ▪ endangered plant species; and ▪ vulnerable fauna species. 	<ul style="list-style-type: none"> ▪ Vulnerable plant species ▪ Endangered plant species ▪ Vulnerable fauna species
Protected matter attributes	<p>While detailed counts of the two recorded threatened flora species exists for the projects impacts, given the potential for a soil seed bank for the species and absence of viable population data within the project for the threatened fauna, a precautionary approach was taken and the presence of habitat was used as the key attribute for assessment.</p>	Habitat
Quality of site habitat	<p>The condition of the sites habitats has been assessed through detailed surveys and assessment in accordance with the NSW BioBanking methodology. These surveys collected data on a range of site condition variables specifically relevant to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.</p> <p>Site condition</p> <p>The site specific date identified condition scores for the vegetation to be impacted between 36–44/100.</p> <p>Site context</p> <p>The Project is situated on land in the suburb of Moorebank in a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Defence land. Much of the vegetation of the Project site has been cleared and replaced with roads, buildings, playing fields and exotic grassland, or substantially thinned, leaving only scattered remnant trees. Substantial areas of vegetation remain, however, in the west of the site within the riparian zone of the Georges River and in patches along the eastern boundary of the site adjacent to Moorebank Avenue.</p> <p>Species stocking rate</p> <p>The two threatened flora species, <i>Persoonia nutans</i> and <i>Grevillea parviflora</i> were recorded in relatively low numbers within the development site (10 and 16 respectively) when compared to the significant number (40 and 360 respectively) recorded from the adjoining better quality habitats associated with the Wattle Grove Offset area immediately to the south east of the development.</p>	5
Time over which loss is adverted	<p>It is assumed that the offset areas will be secured for at least 20 years for conservation purposes. It is likely that the offset would be secured in perpetuity, however, the <i>Offsets Assessment Guide</i> allows for a maximum of 20 year for offset assessment purposes.</p>	20 years

Protected matter attributes	Assumption	Score
Time until ecological benefit	<p>The proposed biodiversity strategy involves the restoration and rehabilitation of the disturbed areas of the Casula Offset Area and Georges River Riparian Zone as part of the Projects early works program well before any proposed vegetation clearing activities with the Project site (refer to Attachment E of the Biodiversity Technical report, EIS Volume 4).</p> <p>The Wattle Grove Offset area is a large area of relatively undisturbed vegetation and habitats and as such will require very little time before the ecological benefit is made.</p>	2
Risk of loss (%)	<p>The risk of the habitat within the proposed offset sites being completely lost will be assessed based on the following aspects:</p> <ul style="list-style-type: none"> Physical constraints – topography and flooding. Land use zoning. Surrounding Infrastructure. Existing development applications. <p>The Casula Offset Area and Georges River Riparian Zone is currently disturbed and subject to significant development pressures from the neighbours industrial, urban development and transport land uses. It is considered these areas are likely to be subject to >50% risk of loss.</p> <p>The Wattle Grove Offset area is currently impacted by only periodic defence developments and edge effects from the adjoining transport corridors. It is considered these areas are likely to be subject to <20% risk of loss.</p> <p>A precautionary approach has been taken to the combined weighting and while the Casula Offset Area and Georges River Riparian Zone are considered to be significantly greater risk of loss a combined weighting of 25% has been applied.</p>	25%

Protected matter attributes	Assumption	Score
Start quality of offset	<p>The condition of the sites habitats has been assessed through detailed surveys and assessment in accordance with the NSW BioBanking methodology. These surveys collected data on a range of site condition variables specifically relevant to the ecological requirements of a threatened species or ecological community. This includes considerations such as vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.</p> <p>Site condition</p> <p>The site specific date identified condition scores for the vegetation to be impacted between 56–84/100.</p> <p>Site context</p> <p>The Wattle Grove offset consolidated a large are of remnant vegetation on the urban fringe with adjoining large areas of quality habitat associated with defence land.</p> <p>The Casula Offset Area and Georges River Offset area will consolidate an important riparian a corridor through the urban and industrial land use.</p> <p>Species stocking rate</p> <p>The two threatened flora species, <i>Persoonia nutans</i> and <i>Grevillea parviflora</i> were recorded in relatively significant number (40 and 360 respectively) from the Wattle Grove Offset area immediately to the south east of the development. This area and its habitats are considered important local population of these species.</p>	8
Future quality without offset	<p>The future quality of the proposed offset areas will be predicted based on observed threatening processes (e.g. weed invasion) affecting the offset areas and the likely continuation of these processes in the absence of more intense management for conservation.</p>	7
Future quality with offset	<p>The future quality of the proposed offset areas will be predicted based on proposed management (e.g. weed control, assisted natural regeneration and revegetation of disturbed vegetation) within offset areas.</p> <p>Site condition</p> <p>The site specific date identified condition scores for the vegetation to be impacted between 85–100/100.</p>	9
Confidence in result (%)	<p>The level of certainty about the success of the proposed offset areas will be estimated by taking into consideration the potential change in habitat quality and adverted loss over time. This includes the degree to which the proposed offset actions can be achieved to benefit the protected matters and the strength and effectiveness of risk-mitigation measures.</p> <p>The relatively minor requirements for the substantial area of the Wattle grove offset and relatively small area of rehabilitation required in the Georges River offset area suggest a high confidence result is likely.</p>	75

A summary of the adequacy of the Project offsets generated by the calculations using the Commonwealth Offset Guide is provided below in Table 5.2.

Table 5.2 Commonwealth offset requirement balance

Vegetation community or species	Area to be Impacted (ha)	Area to be impacted (adjusted hectares)	Estimated offset area required (ha) using Offset Guide	Proposed Offset Area (ha)	% of impact offset
<i>Persoonia nutans</i> habitat (Endangered)	17	8.5	40	83	211%
<i>Grevillea parviflora</i> habitat (Vulnerable)	17	8.5	35	83	236%
Grey-headed Flying Fox habitat (Vulnerable)	48.7	24	100	121.5	121%
Potential Habitat for Swift Parrot and Regent Honeyeater (Endangered)	48.7	24	112	121.5	107%
Total*	48.7		142*	121.5	N/A

Note: * indicates that the total equates to the total cumulative requirement of the fauna and flora, however the proposed offsets fauna habitat includes the flora habitat requirement.

To compensate for the impact upon threatened flora, a minimum area of suitable habitat of 40 ha is required. The current offsets would provide 83 ha of suitable habitat with demonstrated occurrence of *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora* and would fulfil this requirement.

In terms of native forest fauna habitat impacts of the project, the calculations have identified that a total offset area of approximately 112 ha needs to be provided. Of this, the current offsets would provide 121.5 ha of similar suitable habitat and would fulfil this requirement.

In summary, the proposed biodiversity offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in moderate condition. The offsets are proportionate to the impact in both size and scale, providing between 107% and 236% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.5:1 has been secured under the currently proposed offsets.

5.2 Principles for the use of biodiversity offsets in NSW

The NSW Secretary's Environmental Assessment Requirements (SEARs) for the Project suggest the offsets strategy must demonstrate how it achieves the overarching principles of current policy. In March 2014, the Draft NSW Biodiversity Offsets Policy for Major Projects (Draft Policy) was released for public exhibition. The Draft Policy has now been finalised (Offset Policy 2014) and commenced implementation from 1 October 2014 when it became mandatory for all SSD and SSI projects.

The Offset Policy 2014 reduced the number of offset principles to six and introduced the use of a new assessment methodology, the Framework for Biodiversity Assessment (FBA).

The principles outlined in this policy are as follows:

Before offsets are considered, impacts must first be avoided and unavoidable impacts minimised through mitigation measures. Only then should offsets be considered for the remaining impacts.

The Project has considered avoiding or minimising direct impacts to biodiversity throughout the lifecycle of the Project in accordance with Section 8.3.2 of the FBA guidelines. The Project is currently seeking concept approvals for a Stage 1 SSD development of a concept design and future avoidance of vegetation will be investigated during detailed design and Stage 2 SSD development approvals.

Given the location and nature of the Project and its context with regard to existing road and rail infrastructure, there is limited scope for using alternative locations to entirely avoid impacts on biodiversity. Reduction of impacts on areas of high ecological value was considered in the analysis and evaluation of design options for the Project, resulting in the retention of substantial areas of vegetation and habitat contiguous with the riparian vegetation of the Georges River (refer section 1.2 above and 6.4.4 EIA in Technical Paper 3, EIS Volume 4).

Offset requirements should be based on a reliable and transparent assessment of losses and gains.

The FBA Methodology provides a transparent and repeatable methodology for assessing impacts on biodiversity through a modified credit calculator, similar to the existing credit calculator used under the BioBanking Assessment methodology (BBAM).

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to **1,409** ecosystem credits or approximately 140 ha and **1,004** species credits (refer to Table 5.3 and Table and Appendix A of this report).

The potential ecosystem and species credits generated from the proposed offsets have been quantified using FBA credit calculator and meet some of the Project ecosystem credit requirements in accordance with the FBA and NSW Offset Policy 2014.

A residual offset requirement of 610 ecosystem credits (approximately 61 ha) of Alluvial woodland and 143 (approximately 14.3 ha) of Castlereagh Scribbly Gum Woodland is required.

MIC is committed to providing an offset that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offsets for Alluvial Woodland and Castlereagh Scribbly Gum Woodland.

Offsets must be targeted to the biodiversity values being lost or to higher conservation priorities.

The proposed offsets have been established based on the presence of Like for Like biodiversity values to those values impacted by the Project under the FBA. MIC is committed to providing an offset that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014.

Offsets must be additional to other legal requirements.

The *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (Department of Sustainability Environment Water Population and Communities 2012) outlines the Commonwealth Government requirements for offsets for matters of national environmental significance. This biodiversity offsets strategy has been designed to conform to the seven principles outlined in this policy.

Offsets must be enduring, enforceable and auditable.

The currently proposed offset areas and additional offset areas identified (as described in section 3.5) will be protected by an agreement that will place legal restrictions on the future use and management of the land that would exist within the title for the land in perpetuity. This will ensure that the offsets are enduring and that they will offset the impact of the development for the period that the impact occurs.

MIC is currently proposing to establish BioBanking agreements over the proposed offsets as the preferred method of providing enduring, enforceable and auditable conservation areas.

Supplementary measures can be used in lieu of offsets.

The offset strategies chosen for the Project include a combination of:

- onsite offsets – securely conserving and improving the condition of existing riparian habitat or providing a buffer to an area of existing habitat within the Project site;
- offsite offsets – securing and improving the condition of existing habitats at other sites in the immediate locality of the Project site; and
- offsite offsets – securing like for like ecosystem credits through the NSW BioBanking Scheme.

The proposed offsets meet some of the Project ecosystem credit requirements in accordance with the FBA and NSW Offset Policy 2014. A residual offset of 610 ecosystem credits (approximately 61 ha) of Alluvial woodland and 143 (approximately 14.3 ha) of Castlereagh Scribbly Gum Woodland is required. MIC is committed to providing an offset that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offsets for Alluvial Woodland and Castlereagh Scribbly Gum Woodland.

5.3 Adequacy assessment of the biodiversity offsets under the FBA (Offset Policy 2014)

The FBA Methodology provides a transparent and repeatable methodology for assessing impacts on biodiversity through a modified credit calculator, similar to the existing credit calculator used under the BBAM.

The key steps in the process under this policy (once impacts have been avoided as far as practicable) are to:

- Identify the residual impacts (once all avoidance and other mitigation measures have been applied) to threatened species, their habitats or threatened ecological communities.
- Determine likely offsets required via use of the FBA calculator.
- Develop an offset strategy and subsequent offset package to formalise appropriate offsets in consultation with OEH.

The maximum offset requirements of the Project under the current *Offset Policy 2014* has been quantified using FBA calculator as up to **1,409** ecosystem credits or approximately 140 ha and **1,004** species credits (refer to Table 5.3 and Appendix A of Technical Paper 3 in Volume 4 of the EIS).

Table 5.3 Summary of vegetation and plants to be impacted and FBA ecosystem credits required to offset the impacts

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Approx. Balance Area
Alluvial Woodland	ME018 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Coastal Valley Grassy Woodlands (95)16.1	28.1	Yes	TSC Act E	844	84.4	70 ³	4.9	-774	-78.0
Riparian Forest	ME044 Sydney Blue GumXBangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin ¹	Wet Sclerophyll Forests (45)	3.6	Yes ²	TSC Act E	91	9.1	255 ³	15.9	164	16.4
EEC RFEF⁴			31.7			935	93.5	325	20.8	-610	-61
Castlereagh Swamp Woodland	ME005 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (45)	0.9	Yes	TSC Act E	30	3	213	23.5	183	18.4

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation (Cleared estimate)	Area or number to be Impacted (ha)	Red Flag	Conservation Status	Estimated credits required	Area (ha)	Estimated credits Provided	Proposed Offset Area (ha)	Balance Credits	Approx. Balance Area
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests (50)	16.1	Yes ²	TSC Act V	444	44.4	301	33.6	-143	-14.3
TOTAL			48.7			1409	140.9	836³	77.6	-753	-75.3

Note: ¹ indicates closest available similar vegetation type in the BBAM calculator

² indicates that a threatened ecological community could not be selected in the calculator despite the observed communities being threatened ecological communities

³ credit estimate excludes potential credits generated from low condition areas identified for rehabilitation of Alluvial Woodland. The contribution of these areas to any final offset package will be assessed in accordance with the proposed methodology identified by OEH in the submissions provided 5/12/14 as part of the Biodiversity Offset package and any formal BioBanking agreement

⁴ = Riparian Forest and Alluvial woodland vegetation communities have been considered the same vegetation formation in accordance with OEH submission comments provided 5/12/14

5.4 Species credits

Species credits were calculated for two threatened flora and recorded during the current and previous targeted surveys (Section of 3.1 of the EIA in Technical Paper 3, EIS Volume 4).

The species credits required for development of the Project site are summarised in Table 5.4.

Table 5.4 Species credits required for development

Scientific name	Common name	No. of individuals recorded to be impacted	No. of credits required	No. of individuals recorded in offsets	No. of credits created in offsets
<i>Persoonia nutans</i>	Nodding Geebung	10	769	120	852
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	16	229	2,000+	14,200
<i>Acacia pubescens</i>		0	0	300+	1,130
Total		26	998	2,420	16,182

5.4.1 Summary of shortfall 'like for like' and residual offset requirements

The proposed offsets areas do not currently meet the entire quantum of ecosystem and species credit requirements for the Project development impacts under the FBA methodology. The short fall in ecosystem credits provided by the proposed offsets is associated with the Alluvial Woodland and Castlereagh Scribbly Gum Woodland vegetation communities. A summary of which is provided below in Table 5.5.

It is proposed that further surveys incorporating the formal assessment of the Moorebank and Casula offset sites under the BioBanking scheme will be undertaken as part of the development of the Biodiversity Offset Package. These surveys and assessment will determine the quantum of ecosystem credits generated from rehabilitation areas in accordance with Chapter 12 of BBAM 2014. Once the quantum of ecosystem credits generated by the rehabilitation of these 'low condition' areas has been determined they will contribute in part to the residual shortfall in biodiversity credit requirements identified in this BOS.

Table 5.5 Summary of shortfall of ecosystem credits and vegetation types to be impacted

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation	Percent cleared in CMA	Conservation Status	Deficit credits required
Alluvial Woodland	ME018 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Coastal Valley Grassy Woodlands	95	TSC Act E	-610

Vegetation community or species	Assigned Biometric vegetation type	Vegetation formation	Percent cleared in CMA	Conservation Status	Deficit credits required
Castlereagh Scribbly Gum Woodland	ME003 Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Dry Sclerophyll Forests	50	TSC Act V	-143

5.4.2 Proposed process for securing residual offsets requirements

The BOS has identified that despite the currently proposed biodiversity offsets, the Project has a residual offset requirement for Alluvial Woodland, Castlereagh Scribbly Gum Woodland vegetation communities in accordance with The FBA and NSW Offset Policy 2014.

MIC is committed to undertaking all reasonable steps to secure the matching ecosystem credit/species credits in accordance with the FBA, including:

- checking the BioBanking public register and placing an expression of interest for credits wanted on it for at least six months;
- liaising with an OEH office (or Fisheries NSW office for aquatic biodiversity) and relevant local councils to obtain a list of potential sites that meet the requirements for offsetting;
- considering properties for sale in the required area; and
- providing evidence of why offset sites are not feasible.

Where MIC can demonstrate that all reasonable steps listed above have been undertaken and specific ecosystem or species credit requirements cannot be found and where the consent authority's opinion 'all reasonable steps to secure a matching ecosystem credit have been taken by the proponent', then alternatives offset arrangements in consultation with the consent authority's will be provided. These may include:

- variation of the offset rules for matching ecosystem credits, by allowing ecosystem credits created for a PCT from the same vegetation formation as the PCT to which the required ecosystem credit relates to be proposed as an offset, or
- a supplementary measure to be proposed as an offset for the PCT where the PCT is associated with an EEC or to any outstanding credit requirements for impacts to threatened species habitats.

6. Conclusion

The proposed biodiversity offset strategy consists of a dual direct offset approach including offsets both within and outside the Project site to achieve an improved conservation outcome combining the long-term protection and/or enhancement of existing habitat in moderate to good condition with the restoration, rehabilitation and re-establishment of habitat in moderate condition.

Three offset sites have been identified which provide 121.7 ha of land suitable for use as offsets for the EPBC Act and TSC Act listed Threatened species and endangered ecological communities.

The offsets are proportionate to the impact in both size and scale, providing between 107% and 236% of the offset requirements for impacted biodiversity under the EPBC Act, through which a ratio (offset: clearing) of approximately 2.5:1 has been secured under the currently proposed offsets.

The proposed offsets meet some of the Projects ecosystem credit requirements in accordance with the FBA and NSW Offset Policy 2014. A residual offset of 610 ecosystem credits (approximately 61 ha) of Alluvial woodland and 143 (approximately 14.3 ha) of Castlereagh Scribbly Gum Woodland is required. MIC is committed to providing an offset that adequately meets quantum of the offset requirements under the FBA and Offset Policy 2014, including any residual offsets for Alluvial Woodland and Castlereagh Scribbly Gum Woodland.

The proposed offsets strategy is underpinned by sound ecological principles to improve or maintain the existing biodiversity values of the local area.

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Appendix C

Biodiversity Offset Strategy



Appendix A

Framework for Biodiversity
Assessment credit report

Moorebank Intermodal Company

Framework for Biodiversity Assessment Moorebank Development Site

19 February 2015






Document information

Client: Moorebank Intermodal Company
Title: Framework for Biodiversity Assessment
Subtitle: Moorebank Development Site
Document No: 2106567A-ECO-REP-0354-RevA
Date: 19 February 2015

Rev	Date	Details
	26/2/2014	Original
A	19/02/2015	Original

Author, Reviewer and Approver details

Prepared by:	Tanya Bangel	Date: 19/02/2015	Signature 
Reviewed by:	Alex Cockerill	Date: 19/02/2015	Signature: 
Approved by:	Alex Cockerill	Date: 19/02/2015	Signature 

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Glossary

Biodiversity	<p>The biological diversity of life is commonly regarded as being made up of the following three components:</p> <p>genetic diversity – the variety of genes (or units of heredity) in any population</p> <p>species diversity – the variety of species</p> <p>ecosystem diversity – the variety of communities or ecosystems.</p>
BOS	Biodiversity Offset Strategy
Critical Habitat	<p>The whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community (Department of Environment and Conservation 2004). Critical habitat is listed under both the <i>Threatened Species Conservation Act 1995</i> and the <i>Environment Protection and Biodiversity Conservation Act 1999</i> and both the State (OEH) and Federal (DoE) environment agencies maintain a register of this habitat. Capitalisation of the term 'Critical Habitat' in this report refers to the habitat listed specifically under the relevant State and Commonwealth legislation.</p>
DOD	The Department of Defence.
Department of the Environment (DoE)	<p>The Department of the Environment changed name in 2013 from the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) to the current name.</p> <p>The department develops and implements national policy, programs and legislation to protect and conserve Australia's natural environment and cultural heritage and administers the <i>Environment Protection and Biodiversity Conservation Act 1999</i>.</p>
Department of Environment, Climate Change and Water (DECCW)	The most recent former name for the NSW Office of Environment and Heritage (OEH).
Department of, Environment (DoE)	Department of Department of the Environment, Water, Heritage and the Arts (DEWHA) changed its name in 2010 to the Commonwealth Department of Sustainability, Environment, Water, Population and Communities. This was replaced in 2013 by the Department of the Environment.
Department of the Environment, Water, Heritage and the Arts (DEWHA)	The most recent former name of the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (SEWPAC).
Ecological community	An assemblage of species occupying a particular area.
Environmental weed	Any plant that is not native to a local area that has invaded native vegetation.
FBA	Framework for Biodiversity Assessment
Habitat	An area or areas occupied, or periodically or occasionally occupied by a species, population or ecological community, including any biotic or abiotic components.
Key Threatening Processes	<p>A process that threatens, or could threaten, the survival, abundance or evolutionary development of native species, populations or ecological communities (Department of Environment and Conservation 2004). Key Threatening Processes are listed under the <i>Threatened Species Conservation Act 1995</i>, the <i>Fisheries Management Act 1994</i> and the <i>Environment Protection and Biodiversity Conservation Act 1999</i>. Capitalisation of the term 'Key Threatening Processes' in this report refers to those processes listed specifically under the relevant state and Commonwealth legislation.</p>
LCC	Liverpool City Council

Likely	Taken to be a real chance or possibility (Department of Environment and Conservation 2004).
Locality	The area within 10 km of the study area.
Local population	The population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary can be demonstrated (Department of Environment and Climate Change 2007).
MIC	The Moorebank Intermodal Company (MIC).
Migratory species	Species protected as Migratory under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> . Listed migratory species are those listed in the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), China-Australia Migratory Bird Agreement (CAMBA), Japan-Australia Migratory Bird Agreement (JAMBA) and Republic of Korea – Australia Migratory Bird Agreement (RoKAMBA). Listed migratory species also include any native species identified in an international agreement approved by the Minister (Department of the Environment Water Heritage and the Arts 2010). Capitalisation of the term 'Migratory' in this report refers to those species listed as Migratory under the <i>Environment Protection and Biodiversity Conservation Act 1999</i> .
Moorebank Intermodal Terminal (IMT)	The Moorebank Intermodal Terminal (IMT) is a project proposed by the Moorebank Intermodal Company that involves the construction and operation of an IMT and associated infrastructure, facilities and warehousing at Moorebank in NSW. The Project also includes a rail link connecting the IMT site to the Southern Sydney Freight Line (SSFL) and a road entry and exit points from Moorebank Avenue at Moorebank in NSW.
Office of Environment and Heritage (OEH)	<p>Following the 2010 NSW elections the NSW Department of Environment Climate Change and Water (DECCW) was abolished, is now known as the Office of Environment and Heritage, and has been incorporated into the Department of Premier and Cabinet.</p> <p>Broadly, the Office of Environment and Heritage works towards a healthy environment cared for and enjoyed by the whole NSW community: manages the state's natural resources, including biodiversity, soils and natural vegetation: manages natural and cultural heritage across the state's land and waters: acts to minimise the impacts of climate change: promotes sustainable consumption, resource use and waste management: regulates activities to protect the environment: and conducts biodiversity, plant, environmental and cultural heritage research to improve decision making.</p>
Protected species	Those species defined as protected under the <i>National Parks and Wildlife Act 1974</i> . Includes all native animals, and all native plants listed on Schedule 13 of the <i>National Parks and Wildlife Act 1974</i> .
Region	A bioregion defined in a national system of bioregionalisation. For this study, this is the Sydney Basin Bioregion as defined in the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995).
Significant	Important, weighty, or more than ordinary (as defined by the Department of Environment and Climate Change 2007).
SSFL	South Sydney Freight Line
Study area	The specific area that has been assessed for flora and fauna present.
Subject site	The extent of direct impacts from the proposal. This includes the footprint of the proposal, associated with the proposed infrastructure and potential construction work sites.
Threatened biodiversity	<p>Threatened species, populations or ecological communities, or their habitats as listed under the <i>Threatened Species Conservation Act 1995 Fisheries Management Act 1994</i> or the <i>Environment Protection and Biodiversity Conservation Act 1999</i>.</p> <p>Capitalisation of the terms 'Threatened' in this report refers to listing under the relevant State and/or Commonwealth legislation.</p>

Threatened species, populations and ecological communities

Species, populations and ecological communities listed as Vulnerable, endangered or critically endangered (collectively referred to as Threatened) under the *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* or the *Environment Protection and Biodiversity Conservation Act 1999*.

Capitalisation of the terms 'threatened', 'vulnerable', 'endangered' or 'critically endangered' in this report refers to listing under the relevant state and/or Commonwealth legislation.

Viable local population

A population that has the capacity to live, develop, and reproduce under normal conditions, unless the contrary can be conclusively demonstrated through analysis of records and references (Department of Environment and Climate Change 2007).

Weeds of National Significance

In 1998, Australian governments endorsed a framework to identify which weed species could be considered (WONS) within an agricultural, forestry and environmental context. Thirty one WONS were identified through this process (Australian Government 2010).

1. Introduction

This report provides a Framework for Biodiversity Assessment (FBA) of biodiversity conservation values within the Moorebank Intermodal Terminal (IMT) development site (henceforth, referred to as the Moorebank Development Site) as part of the Moorebank IMT Project (henceforth, referred to as the Project) located in the Liverpool City Council (LCC). The proposed Project includes the construction and operation of the IMT and associated infrastructure, facilities and warehousing. The Project also includes a rail link connecting the IMT site to the Southern Sydney Freight Line (SSFL) and a road entry and exit points from Moorebank Avenue at Moorebank in NSW.

Moorebank Intermodal Company (henceforth, referred to as MIC) are investigating whether proposed biodiversity offset sites located within the LCC can be utilised as River-flat Eucalypt Forest (i.e. Riparian Forest and Alluvial Woodland), Castlereagh Swamp Woodland, Cooks River / Castlereagh Ironbark Forest and Castlereagh Scribbly Gum Woodland offsets for the Project. MIC has commissioned Parsons Brinckerhoff Pty Ltd to prepare a FBA of the biodiversity values of the Moorebank Development Site as part of the Biodiversity Offset Strategy (BOS) for the Project.

1.1 Study area

The Moorebank Development Site is situated on land in the Sydney suburb of Moorebank, NSW (Figure 1.1). The Project site is approximately 220 hectares (ha) in area, and is located within a locality that includes the residential suburbs of Casula, Wattle Grove and North Glenfield, as well as industrial, commercial and Department of Defence (DOD) land.

Location information for the study area is outlined in Table 1.1.

Table 1.1 Study area location

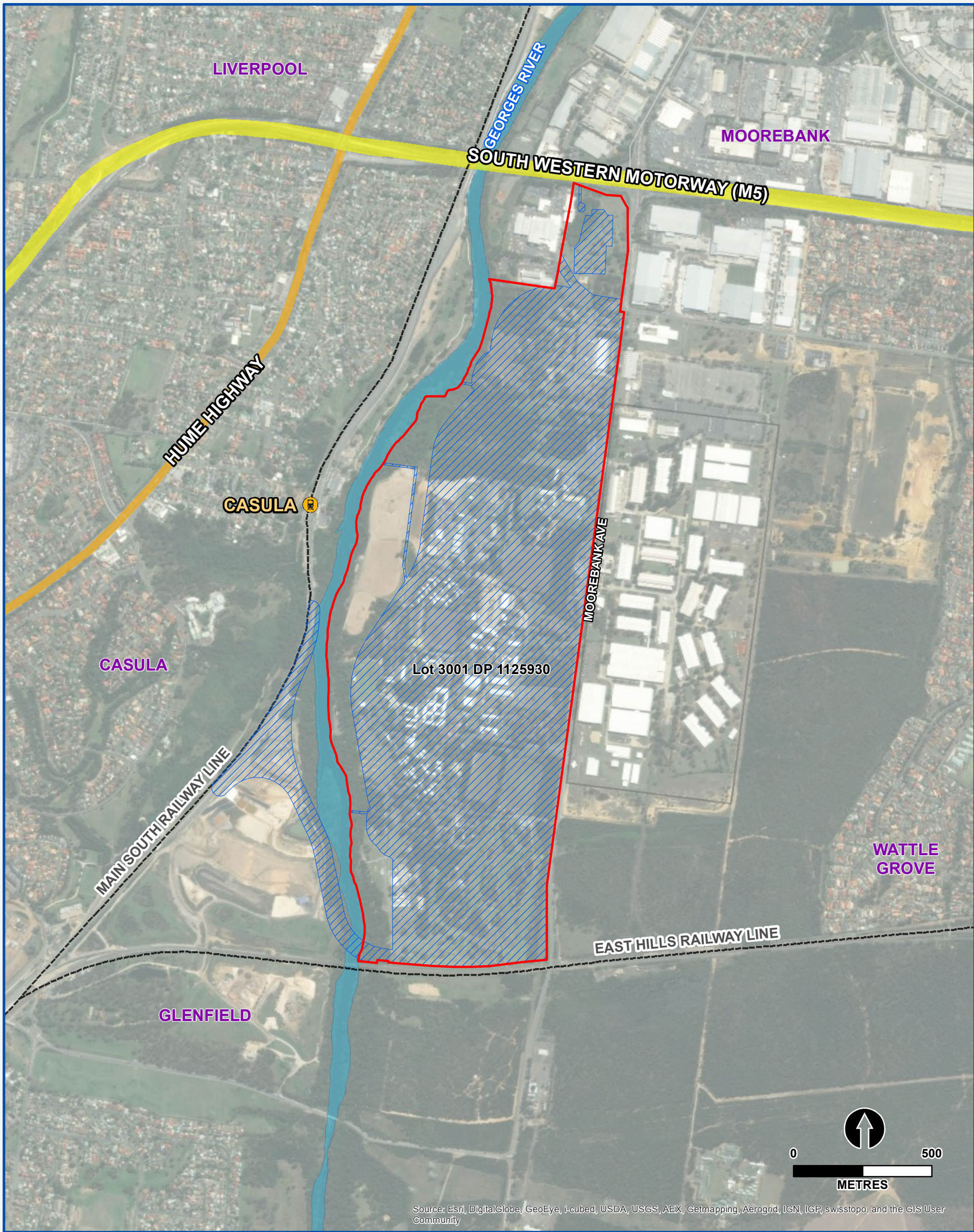
Location information	Study area
Bioregion	Sydney Basin bioregion
Botanical subregion	Central Coast
Local government area	Liverpool
Catchment Management Authority, subregion	Sydney Metropolitan CMA – Georges River sub-region

1.2 Study aims

The overall objective of this study was to provide supporting information required for a FBA. Specifically, this assessment aimed to:

- Determine and describe the characteristics and condition of the vegetation communities and flora and fauna habitats.
- Determine the occurrence, or likelihood of occurrence within the study area, of threatened species, populations and communities (biodiversity) listed under the NSW *Threatened Species Conservation Act 1995*, *Fisheries Management Act 1994* and Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*.
- Complete a FBA report describing the biodiversity credits required to offset biodiversity impacts associated with the Project within the Moorebank Development Site.

PROPOSED MOOREBANK INTERMODAL TERMINAL
FRAMEWORK FOR BIODIVERSITY ASSESSMENT
MOOREBANK DEVELOPMENT SITE



- Moorebank Intermodal Terminal project area
- Rail line & station
- Moorebank Development Site

Figure 1.1 Moorebank Development Site

2. Methodology

The Framework for Biodiversity Assessment (FBA) for the Project included desk-based searches of relevant databases and historical records, as well as field inspections of the study area. The FBA Credit Calculator Version 4.0 (Office of Environment and Heritage 2014a) was also used to identify threatened species predicted to occur within the study area. This section outlines the specific methods used to survey and assess biodiversity within and surrounding the study area.

2.1 Personnel

The contributors to the preparation of this paper, their qualifications and roles are listed in Table 2.1.

Table 2.1 Study team

Name	Qualifications	Position and role
Paul Rossington	BSc, Dip WldMgt	Ecologist – field surveys, report preparation
Tanya Bangel	BSc (Hons)	Ecologist – field surveys, report preparation
Alex Cockerill	BSc (Hons), Accredited biobanking assessor	Technical review

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the *National Parks and Wildlife Regulations 2002*, Section 132C of the NPW Act (License Number: SL100630) as well as an animal research authority issued by the Department of Trade and Investment, Regional Infrastructure and Services (Primary Industries).

2.2 Database searches

The aim of this background research was to identify threatened flora and fauna species, populations and ecological communities; Commonwealth listed Migratory species or critical habitat recorded previously or predicted to occur in the vicinity of the study area.

This allowed the known habitat characteristics to be compared with those of the study area to determinate the likelihood of occurrence of each species or population. This assessment included a review of:

- Research papers, books and other published data
- Aerial photographs
- *Draft Framework for Biodiversity Credit Calculator Version 1.03* (Office of Environment and Heritage 2014a)
- *Native Vegetation Communities of Hornsby Shire Update 2008* (Smith P & Smith J 2008)
- *The Native Vegetation of the Cumberland Plain, Wester Sydney and recent update* (Tozer 2003; Tozer et al. 2006)
- *Moorebank Intermodal Freight Terminal – Ecological Impact Assessment* (Parsons Brinckerhoff 2011)
- *Moorebank Intermodal Terminal – Biodiversity Offset Strategy* (Parsons Brinckerhoff 2014)
- Database searches (refer Table 2.2 and Appendix A and B).

Table 2.2 Database searches

Database	Date of search	Search area	Reference
Bionet Atlas of NSW Wildlife	29 April 2014	10 km x 10 km locality search	Office of Environment and Heritage (2014b)
PlantNet Database	29 April 2014	10 km x 10 km locality search	Limpus (1995)
EPBC Protected Matters Search Tool	29 April 2014	10 km x 10 km locality search	Department of the Environment (2014b)
NSW Threatened Aquatic Fauna Database	29 April 2014	Hawkesbury Nepean CMA	Department of Trade & Investment Region Infrastructure and Services (2014)
Draft Framework for Biodiversity Credit Calculator Version 1.03 ¹	3 September 2014	Hawkesbury – Nepean CMA, Cumberland sub-region	Office of Environment and Heritage (2014a)

Note:

1. While the Moorebank Development Site is located within the Sydney Metropolitan CMA there is a fault in the Draft Framework for Biodiversity Credit Calculator Version 1.03 that prevents the Sydney Metropolitan vegetation types to be entered therefore the Hawkesbury-Nepean CMA has been used as a default (John Seidel 2014).

2.2.1 Nomenclature

Names of vegetation communities used in this report are based on the dominant species and structure of the community. The names used follow names of threatened ecological communities listed under the *Threatened Species Conservation Act 1995* and/or the *Environment Protection and Biodiversity Conservation Act 1999* Act. These names are cross-referenced with those used in the most relevant vegetation mapping for the study area which in this case is '*Native Vegetation of the Cumberland Plain, Wester Sydney*' and recent update (Tozer 2003; Tozer *et al.* 2006). They are also cross-referenced with those of the OEHL vegetation types database (Office of Environment and Heritage 2012) as used in BioMetric 2.0 (Gibbons *et al.* 2008).

Names of plants used in this document follow Harden (Harden 1992, 1993, 2000, 2002) with reference to PlantNet (Royal Botanic Gardens 2014) for recent taxonomic changes. Scientific names are used in this report for species of plant. Scientific and common names (where available) are provided in plant lists in Appendices A and B. The names of introduced species are denoted with an asterisk (*).

For threatened species of plants, the names used in the OEHL Threatened Species Website (Office of Environment and Heritage 2014c) are also provided in the tabulated data in Appendices A and B where these differ from the names used by Harden or the PlantNet database.

Names of vertebrate fauna follow the Australian Faunal Directory maintained by the Department of the Environment (2014a). Common names are used in the report for species of animal. Scientific names are included in species lists found in Appendices C.

For threatened species of animals, the names used in the OEHL Threatened Species Website and NSW Department of Primary Industries (fisheries and Aquaculture) Species Protection website (Office of Environment and Heritage 2014c) (Department of Primary Industries 2014) are also provided in the tabulated data in Appendices C where these differ from the names used by the Australian Faunal Database.

2.3 Field survey

The study area was inspected during daylight hours by a team of two ecologists on 5, 20, 21, 22 and 23 May 2014.

These surveys were designed primarily to assess the extent and condition of vegetation, especially for threatened species and ecological communities.

Numerous flora and fauna field surveys have also been previously conducted as part of the original Environmental Impact Assessment (Parsons Brinckerhoff 2011). These surveys included targeted surveys for threatened flora and fauna species (refer to section 2.6 for more details).

2.3.1 Weather conditions

Weather conditions were generally warm with some light winds (Table 2.3). No rainfall was recorded during the survey period.

Table 2.3 Weather conditions during the site inspection

Date	Qualifications		Rain (mm)	Wind speed (km/h)
	Min (°C)	Max (°C)		
5 May 2014	6.0	19.4	0	11
20 May 2014	7.8	24.1	0	7
21 May 2014	9.2	23.0	0	7
22 May 2014	8.8	25.2	0	9
23 May 2014	6.2	25.0	0	7

Data from Bureau of Meteorology (Bureau of Meteorology 2014) – Holsworthy station

2.4 Flora

The floristic diversity and possible presence of threat-listed species was assessed using a combination of random meander and plot-based (quadrat/transect) surveys in accordance with BioBanking Operation Manual (Seidel & Briggs 2008).

Random meander surveys are a variation of the transect type survey and were completed in accordance with the technique described by Cropper (1993), whereby the recorder walks in a random manner throughout the Study Area recording species observed, boundaries between various vegetation communities and condition of vegetation. The time spent in each vegetation patch was generally proportional to the size of the patch and its species richness.

2.4.1 Field verification of existing vegetation mapping

Vegetation within the study area and locality has been mapped at the regional scale by the '*Native Vegetation of the Cumberland Plain, Western Sydney*' and recent update (Tozer 2003; Tozer *et al.* 2006). Field validation (ground-truthing) of the existing broad scale vegetation classification (Tozer 2003; Tozer *et al.* 2006) was undertaken to determine the vegetation structure, dominant canopy species, native diversity and condition.

2.4.2 Quadrats

Seventeen quantitative (quadrat/transect) site surveys (Table 2.4 and Figure 2.1) were undertaken as outlined in the methodology contained within BioBanking Operation Manual (Seidel & Briggs 2008) and described below. Three BioBanking plots from the Moorebank Conservation Area representative of the Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin vegetation community were used in this assessment. Figure 2.1 illustrates the plot layout that was used at each BioBanking site.

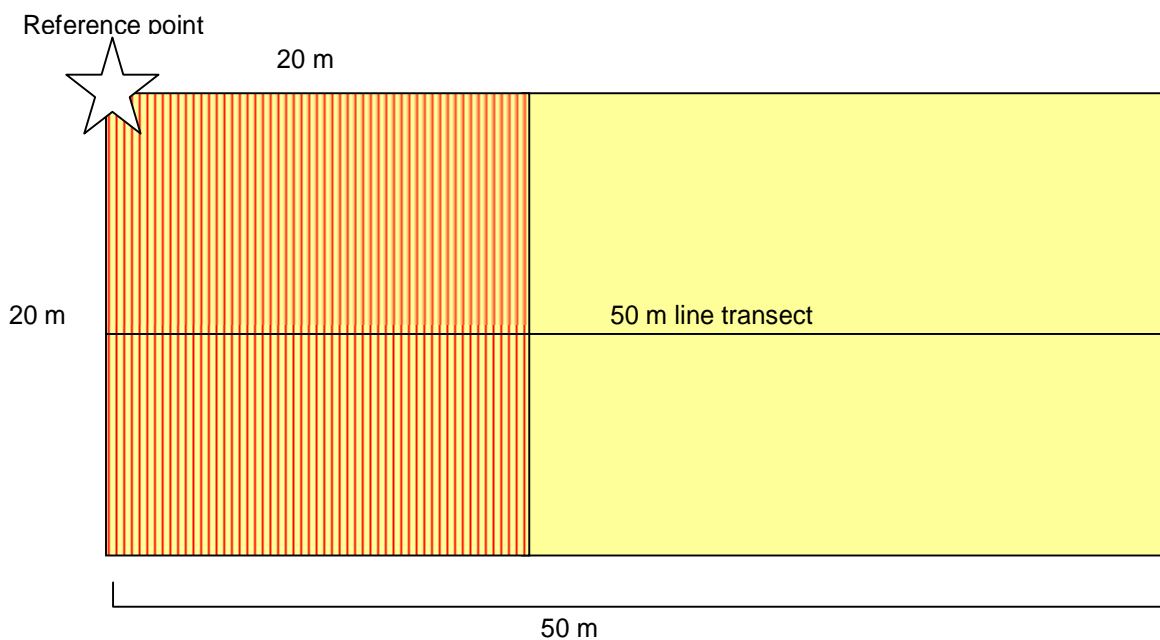
Table 2.4 Location of flora quadrats

Plot	Easting	Northing	Orientation (°)
BB21	307931	6241123	190
BB22	307616	6241569	100
BB23	307468	6241404	10
BB24	307811	6240069	180
BB25	307560	6240000	260
BB26	307467	6240144	190
BB27	307882	6240183	190
BB28	307853	6240640	95
BB29	307962	6240799	270
BB30	307875	6240877	0
BB32	307465	6241530	45
BB33	307995	6241307	10
BB34	307887	6241348	275
BB35	307237	6241923	320
BB3 ¹	307219	6239652	20
BB20 ¹	307186	6240476	345
BB31 ¹	307466	6241638	195

Co-ordinate System = GDA 94 Zone 56

Note:

1. Quadrats from the Moorebank Offset Areas that are representative of the Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin vegetation community.



Key:



-  20 x 20 m quadrat
-  20 x 50 m quadrat

Figure 2.1 Schematic diagram illustrating the layout of the nested 20 x 50m and 20 x 20m quadrats used for the assessment of condition attributes at each site

The following site attributes were recorded at each site:

- **Location** (easting – northing grid type MGA 94, Zone 56).
- **Vegetation structure and dominant species and vegetation condition.** Vegetation structure was recorded through estimates of percentage foliage cover, average height and height range for each vegetation layer. Vegetation condition was recorded in accordance with the BioBanking methodology.
- **Native and exotic species richness** (within a 400 m² quadrat): This consisted of recording all species by systematically walking through each 20 x 20 m quadrat. The cover abundance (percentage of area of quadrat covered) of each species was estimated.
- **Number of trees with hollows** (1,000 m² quadrat): This was the frequency of hollows within living and dead trees within each 50 x 20 m quadrat. A hollow was only recorded if (a) the entrance could be seen: (b) the estimated entrance width was at least 5 cm across: (c) the hollow appeared to have depth: (d) the hollow was at least 1 m above the ground and the (e) the centre of the tree was located within the sampled quadrat.
- **Total length of fallen logs** (1,000 m² quadrat): This was the cumulative total of logs within each 50 x 20 m quadrat with a diameter of at least 10 cm and a length of at least 0.5 m.
- **Native overstorey cover:** This consisted of estimating the percentage foliage projective cover of the tallest woody stratum present (>1 m and including emergents). The woody stratum included species that were native to New South Wales including both indigenous and non-indigenous native species.
- **Native mid-storey cover:** This involved estimating the foliage projective cover of vegetation between the overstorey stratum and a height of 1 m (i.e. tall shrubs, under-storey trees and tree regeneration).
- **Ground cover:** This comprised estimating the foliage projective cover of plants below 1 m in height. The following categories of plants were recorded:
 - ▶ **Native ground cover (grasses):** native grasses (Poaceae family native to NSW).

- ▶ **Native ground cover (shrubs):** all woody vegetation below 1 m in height and native to New South Wales.
- ▶ **Native ground cover (other):** non-woody vegetation (i.e. vascular plants – ferns and herbs) below 1 m in height and native to New South Wales.
- ▶ **Exotic plant cover:** vascular plants not native to Australia.
- **Evaluation of regeneration:** This was estimated as the proportion of overstorey species present at the site that was regenerating (i.e. saplings with a diameter at breast height ≤ 5 cm). The maximum value for this measure was 1.

2.4.3 Condition of vegetation communities

The overall condition of vegetation was assessed through general observation and comparison against the BioBanking condition benchmark data as well as using parameters such as intactness, diversity, history of disturbance, weed invasion and health.

Three categories were also used to describe the condition of the vegetation using parameters such as structural intactness, diversity, and disturbance and weed invasion and comparison with BioBanking benchmark data (illustrated in Figure 1.1):

- **Condition category 'Good':** Vegetation still retains the species complement and structural characteristics of the pre-European equivalent. Such vegetation has usually changed very little over time and displays resilience to weed invasion due to intact groundcover, shrub and canopy layers. Native species diversity is relatively high. Weeds may exist in this vegetation type but are not dominant in any vegetation layer (native groundcover is greater than 50%). Corresponds to 'Good' condition category used by the FBA Credit Calculator.
- **Condition category 'Moderate':** Vegetation has retained a native canopy (greater than or equal to 25% of the lower benchmark value) but the understorey and groundcover layers are generally dominated or co-dominated by exotic species (with native groundcover less than 50%). The native shrubs and groundcovers were generally sparse and had low species richness. Corresponds to 'Good' condition category used by the FBA Credit Calculator.
- **Condition category 'Low':** Vegetation that has lost most of native canopy cover and is significantly modified structurally. The understorey and groundcover layer are dominated by weeds and have a very low diversity and abundance of native species. This condition is consistent with the BioBanking definition of low, namely that woody native vegetation communities have a native over-storey percentage foliage cover less than 25% of the lower value of the over-storey percentage foliage cover benchmark for that vegetation type and groundcover is less than 50% indigenous species or greater than 90% of groundcover is exotic. Corresponds to 'Low' condition category used by the FBA Credit Calculator.

2.5 Fauna habitat assessment

Fauna habitat assessments were undertaken to assess the likelihood of threatened species of animal (those species known or predicted to occur within the locality from the literature and database review) occurring within the study area. Fauna habitat characteristics assessed included:

- Structure and floristics of the canopy, understorey and ground vegetation, including the presence of flowering and fruiting trees providing potential foraging resources.
- Presence of hollow-bearing trees providing roosting and breeding habitat for arboreal mammals, birds and reptiles.

- Presence of the ground cover vegetation, leaf litter, rock outcrops and fallen timber and potential to provide protection for ground-dwelling mammals, reptiles and amphibians.
- Presence of waterways (ephemeral or permanent) and water bodies.

The following criteria were used to evaluate the condition of habitat values:

- **Good:** A full range of fauna habitat components are usually present (for example, old-growth trees, fallen timber, feeding and roosting resources) and habitat linkages to other remnant ecosystems in the landscape are intact.
- **Moderate:** Some fauna habitat components are missing or greatly reduced (for example, old-growth trees and fallen timber), although linkages with other remnant habitats in the landscape are usually intact, but sometimes degraded.
- **Poor:** Many fauna habitat elements in low quality remnants have been lost, including old growth trees (for example, due to past timber harvesting or land clearing) and fallen timber, and tree canopies are often highly fragmented. Habitat linkages with other remnant ecosystems in the landscape have usually been severely compromised by extensive clearing in the past.

2.6 Previous ecological field surveys

In November 2010 numerous flora and fauna field surveys were also conducted as part of the original Environmental Impact Assessment (Parsons Brinckerhoff 2011) which involved targeted species surveys for those considered likely to occur. The surveys were conducted in accordance with Commonwealth legislation and included:

- Threatened plant targeted surveys using random meanders, quadrats and BBAM survey techniques as described above
- Night time water bodies searches for Green and Golden Bell Frog
- Targeted diurnal and nocturnal call – playback for threatened bird surveys for species such as the Regent Honeyeater, Swift Parrot and Powerful Owl
- Habitat searches for species such as the Cumberland Plain Land Snail
- Mammal trapping and hair tubes for species such as Spotted-tailed Quoll and Squirrel Glider
- Bat (harp) trapping and ANABAT detection for threatened bat species such as Eastern Bent-wing Bat and Large-footed Myotis
- Opportunistic observations.

2.7 Likelihood-of-occurrence assessment

The likelihood of threatened and migratory and threatened species populations occurring within the study area was assessed against the criteria outlined in Table 2.5.

Species subject to likelihood-of-occurrence assessments were those identified during the desktop and field-based investigations and any additional species considered having the potential to occur in the professional opinion of contributors to this assessment.

Table 2.5 Likelihood of occurrence assessment

Likelihood-of-occurrence	Criteria
Low	<ul style="list-style-type: none"> Have not been recorded previously in the study area and surrounds which are beyond the current known geographic range. Are dependent on specific habitat types or resources that are not present in the study area. Are considered extinct in the locality.
Moderate	<ul style="list-style-type: none"> Have been recorded previously in the study area and surrounds infrequently (i.e. vagrant individuals). Use habitat types or resources that are present in the study area, although generally in a poor or modified condition. Are unlikely to maintain sedentary populations, however may seasonally utilise resources within the study area opportunistically during variable seasons or migration.
High	<ul style="list-style-type: none"> Have been previously recorded in the study area. Are dependent on habitat types or resources that are present in the study area that are abundant and/or in good condition within the study area. Are known or likely to maintain resident populations surrounding the study area. Are known or likely to visit the study area or surrounds during regular seasonal movements or migration.
Recorded	<ul style="list-style-type: none"> Recorded in the study area during current field study.

2.8 Framework for Biodiversity Assessment

The FBA Credit Calculator Version 4.0 (Office of Environment and Heritage 2014a) was used to provide calculations of the number and class of biodiversity credits required by the Project to ensure maintenance or improvement in biodiversity. Quantitative (quadrat) site surveys were undertaken following the methodology contained within BioBanking Operation Manual (Seidel & Briggs 2008) and as outlined in section 2.4.

2.9 Limitations

No sampling technique can totally eliminate the possibility that a species is present on a site. For example, some species of plant may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present on site during surveys. The conclusions in this report are based upon data acquired for the site and the environmental field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of species. Also, it should be recognised that site conditions, including the presence of threatened species, can change with time.

Where surveys were conducted outside the optimal time for detecting a particular species, or field surveys were of limited scope, a precautionary approach was taken and it was assumed that the species was present if suitable habitat was observed.

The data used in the assessment is based on results of the field surveys and are, therefore, merely indicative of the environmental condition of the site at the time of survey, including the presence or otherwise of species. For species where the timing of surveys was not appropriate for detection, a precautionary approach was taken and surveys focussed on detection of areas of potential habitat for these species.

3. Existing environment

3.1 Landscape assessment

3.1.1 Landscape value

A summary of the study area location used in the landscape assessment is provided in Table 3.1.

Table 3.1 Study area location

Location information	Study area
Council	Liverpool
Catchment Management Authority ¹	Hawkesbury – Nepean CMA, Cumberland sub-region
CMA sub region	Cumberland
Mitchell Landscape	Cumberland Plain

Note:

1. While the Moorebank Development Site is located within the Sydney Metropolitan CMA there is a fault in the Framework for Biodiversity Credit Calculator Version 4.03 that prevents the Sydney Metropolitan vegetation types to be entered therefore the Hawkesbury-Nepean CMA has been used as a default (John Seidel 2014).

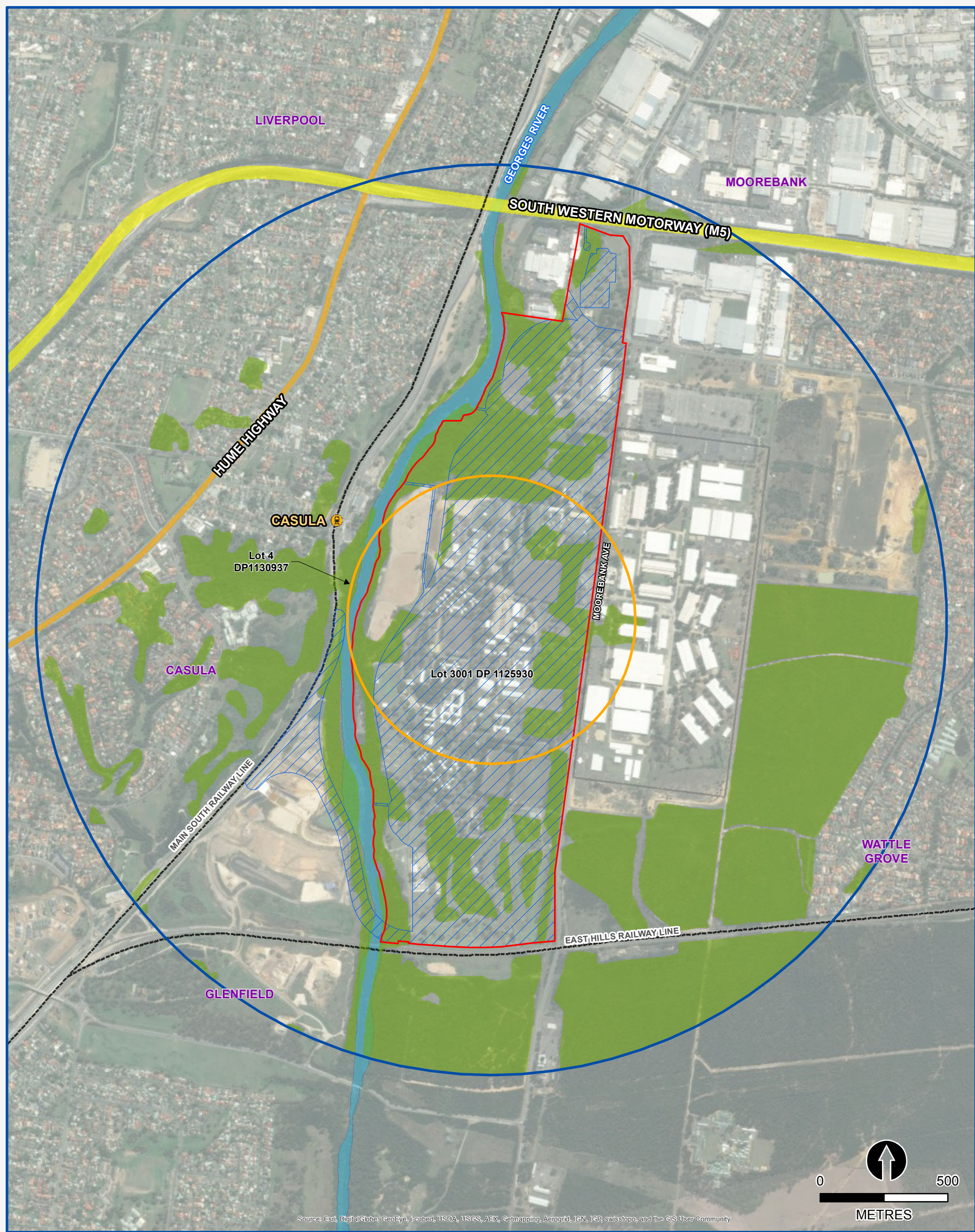
A landscape assessment was undertaken for the Moorebank Development Site using the Draft Framework for Biodiversity Assessment (FBA) Credit Calculator Version 4.0 (Office of Environment and Heritage 2014a). A 100 ha circle and a 1000 ha circle were placed centred on each site (Figure 3.1). The native vegetation cover within these circles was calculated and is summarised in Table 3.2.

Remnant vegetation was determined in accordance with BioBanking Operation Manual as being adjoining areas of native vegetation in moderate to good condition that are less than or equal to 100 m from the next remnant area. The site is connected to riparian vegetation along the George's River and extensive vegetation to the south and south east (including Heathcoat National Park) with an adjacent remnant area greater than 1001 ha.

Table 3.2 Vegetation cover assessment

Assessment circle	Area	Native vegetation cover (%)		Comments / assumptions
		Before Development	After Development	
IMT development site	1,000 ha	16–20	16–20	As the site is relatively cleared of vegetation, the change in the vegetation cover class is minimal.
	100 ha	16–20	11°15	

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FRAMEWORK FOR BIODIVERSITY ASSESSMENT
MOOREBANK DEVELOPMENT SITE



- | | |
|--|---------------------|
| Moorebank Intermodal Terminal project area | Remnant vegetation |
| Rail line & station | 100 hectare buffer |
| Moorebank Development Site | 1000 hectare buffer |

Figure 3.1 Landscape assessment -
Moorebank Development Site

3.1.2 Connectivity

The Moorebank Development Site is located within an urban area and predominantly consists of defence land, urban development, internal road network and a golf course. The site is connected to riparian vegetation along George's River to the west which connects to extensive vegetation in the south and south east.

To determine the existing Linkage Width Class of the site, it was necessary to determine the narrowest (most limiting) link that connects site vegetation to adjoining vegetation. For the site this was within the site itself.

As the site currently occurs as fragmented remnant vegetation within an urban environment the development will not result in a change in the corridor width class. The condition of the site is at benchmark for the overstorey but is below benchmark for the understorey. The overstorey and understorey is not likely to decrease benchmark values.

Connectivity for the landscape assessment is summarised in Table 3.3.

Table 3.3 Connectivity

Site	Corridor values	Before development	After development	Connectivity description
IMT Development Site	Corridor width (m)	>30–100 m	>30–100 m	<p>The Development will have limited impact on the existing connectivity of the Georges River riparian zone as it will not decrease the corridor width or the overstorey and understorey benchmark values.</p> <p>Given the narrow proposal rail crossing of the Georges river will be a bridge over the river and adjoins the existing crossing of the Georges River by the rail corridor, the project is not considered to alter the existing connectivity values further sever native vegetation or form a hard barrier this crossing is not considered in the connectivity assessment</p>
	Overstorey	PFC >50% of lower BM	PFC >50% of lower BM	
	Understorey	PFC mid-storey/ground cover <50% lower BM	PFC mid-storey/ground cover <50% lower BM	

3.1.3 Patch size of remnant vegetation area

Patch size is the area of Moderate/Good vegetation on and adjoining the development site. The site is connected to extensive vegetation in the south encompassing a number of reserves with Patch Size of greater than 1000 ha.

3.2 Vegetation zones

The majority of the vegetation within the Moorebank Development Site consisted of remnant forest and woodland vegetation that has been moderately modified as a result of:

- road infrastructure; e.g. Moorebank Avenue and the internal road network within the Defence land
- Defence infrastructure; e.g. internal road network, training grounds and buildings
- sewerage and stormwater infrastructure
- foot paths and fire trails within the vegetation remnants

- invasion by exotic species of plant such as Lantana (*Lantana camara**), Wandering Jew (*Tradescantia albiflora**) and privets (*Ligustrum* spp.*).

Nevertheless, there remain some areas that contain moderate to good condition remnant vegetation that is connected to larger areas of vegetation. The vegetation within the study area provides habitat for a large variety of flora and fauna species such as those being assessed as part of this FBA report.

3.2.1 Moorebank Development Site

The vegetation within the Moorebank Development Site consisted predominantly on remnant and regrowth vegetation that has been subjected to weed invasion in some areas. The majority of the vegetation within the site was native and representative of endangered ecological communities (Table 3.4) in Schedule 1 and 2 of the TSC Act.

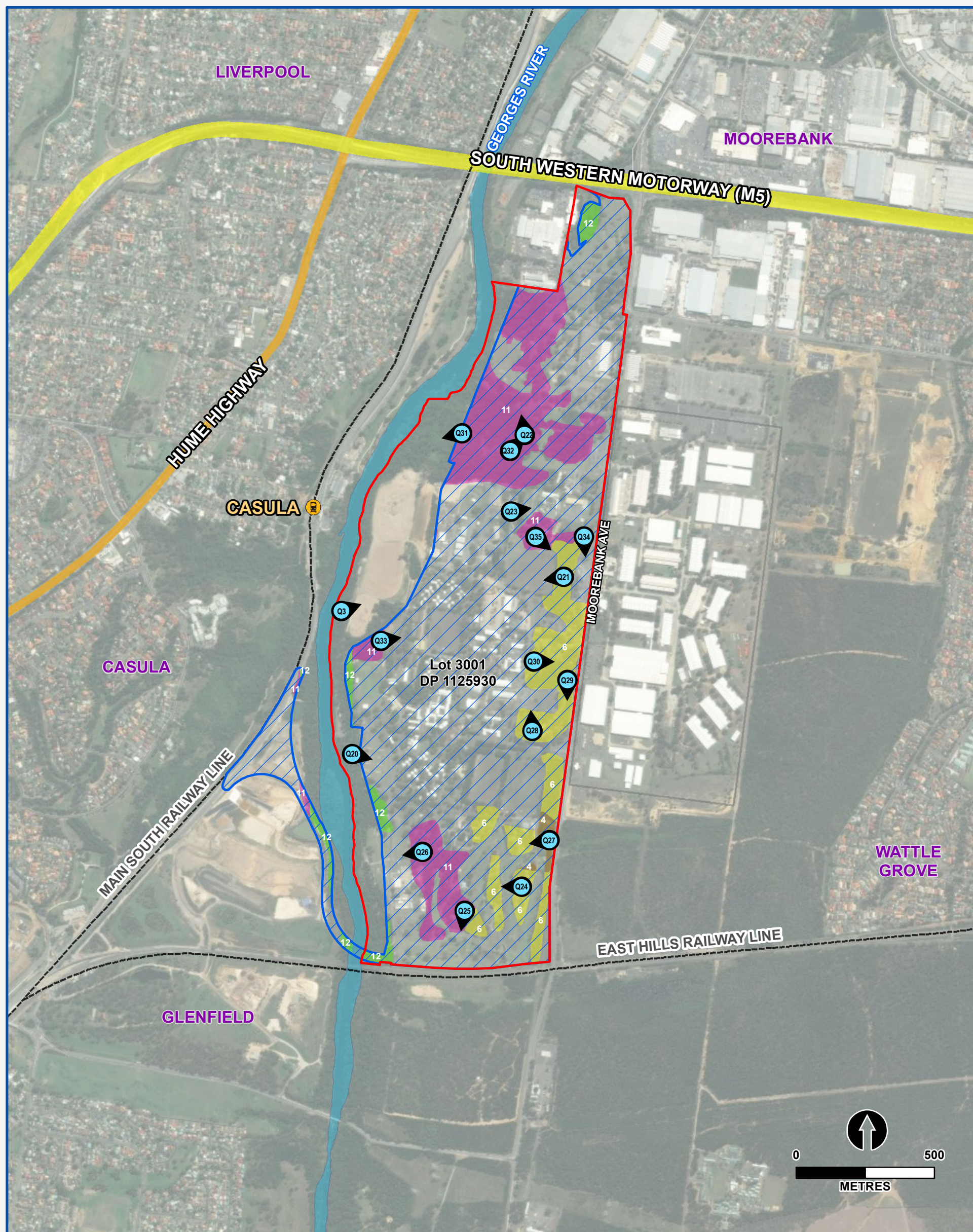
Table 3.4 Vegetation communities within Moorebank Development Site

Field verified vegetation community (Gibbons <i>et al.</i> 2008)	Broadscale mapping (Tozer 2003)	Threatened ecological community	OEI Vegetation formation database (Gibbons <i>et al.</i> 2008)	OEI Vegetation class database (Gibbons <i>et al.</i> 2008)
HN542: Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland	Castlereagh Scribbly Gum Woodland	Vulnerable under the TSC Act ¹	Dry Sclerophyll Forests (Shrubby subformation)	Sydney Sand Flats Dry Sclerophyll Forests
HN562 : Parramatta Red Gum woodland	Castlereagh Swamp Woodland	Endangered under the TSC Act ²	Dry Sclerophyll Forests (Shrub/grass subformation)	Cumberland Dry Sclerophyll Forests
HN526: Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Alluvial Woodland	Vulnerable under the TSC Act ³	Grassy Woodlands	Coastal Valley Grassy Woodlands
HN597: Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin	Riparian Forest	Vulnerable under the TSC Act ³	Wet Sclerophyll Forests (Shrubby subformation)	North Coast Wet Sclerophyll Forests

Note:

1. Consistent with the Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion listed as vulnerable under the TSC Act.
2. Consistent with the Castlereagh Swamp Woodland Community listed as endangered under the TSC Act.
3. Consistent with the River-flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions listed as vulnerable under the TSC Act.

PROPOSED MOOREBANK INTERMODAL TERMINAL
BIOBANKING CREDIT REPORT



- Moorebank Intermodal Terminal project area
- Rail line & station
- Moorebank development site
- BioBanking sites (May 2014)
- Quadrat and orientation

Vegetation communities

- 1. HN542: Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin
- 2. HN562: Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin

- 3. HN526: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin
- 4. HN597: Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin

Figure 3.2 Vegetation zones - Moorebank development site

For the purpose of the FBA the Moorebank Development Site contained four distinct vegetation types in the good condition category (vegetation zones). The vegetation zones are summarised in Table 3.5.

Table 3.5 Summary of vegetation zones in Moorebank Development Site

Vegetation zone	1	2	3	4
Vegetation formation	Dry Sclerophyll forests (Shrub/grass)	Dry Sclerophyll forests (Shrub/grass)	Grassy Woodlands	Wet Sclerophyll Forests (Shrubby subformation)
Vegetation code	HN542	HN562	HN526	HN597
Vegetation name	Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin	Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin	Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin
Condition class	Good	Good	Good	Good
Area (ha)	16.1	0.9	28.1	3.6
Plots	<ul style="list-style-type: none"> ■ Q21 ■ Q24 ■ Q28 ■ Q29 ■ Q30 ■ Q33 	<ul style="list-style-type: none"> ■ Q27 	<ul style="list-style-type: none"> ■ Q22 ■ Q23 ■ Q25 ■ Q26 ■ Q32 ■ Q34 ■ Q35 	<ul style="list-style-type: none"> ■ Q3 ■ Q20 ■ Q31

3.2.2 Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin

Vegetation mapping of the study area identified the presence of Hard-leaved Scribbly Gum – Parramatta Red Gum heathy Woodland of the Cumberland Plain, Sydney Basin corresponding to the Castlereagh Scribbly Gum Woodland community described in 'Native Vegetation of the Cumberland Plain, Western Sydney' (Tozer 2003). This was confirmed during the site surveys. It covers approximately 16.1 ha within the Moorebank Development Site. The vegetation characteristics of this community are summarised in Table 3.6.

Table 3.6 Characteristics of good condition Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland

Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland			
Description			
Conservation significance	Listed as a vulnerable ecological community, <i>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion</i> under the TSC Act.		
Condition	<p>Moderate. The majority of this community is remnant of Castlereagh Scribbly Gum Woodland which is subject to high disturbance from edge effects, existing roads, foot paths, golf course and weed invasion.</p> <p>The canopy and shrublayer are dominated by native species including <i>Leucopogon juniperina</i>, <i>Pittosporum undulatum</i>, <i>Acacia</i> spp., <i>Exocarpos cupressiformis</i>, <i>Grevillea parviflora</i> subsp. <i>parviflora</i> and <i>Persoonia nutans</i>. The groundcover is dominated by native species including <i>Microlaena stipoides</i>, <i>Lomandra longifolia</i>, <i>Dianella revolute</i>, <i>Poa affinis</i>, <i>Dichondra repens</i> and <i>Echinopogon ovatus</i> with scattered exotic species such as <i>Ehrharta erecta</i>*, <i>Lantana camara</i>*, <i>Asparagus asparagoides</i>*, <i>Senecio madagascariensis</i>*, <i>Eragrostis curvula</i>*, <i>Chloris gayana</i>*, <i>Ligustrum sinense</i>* and <i>Olea europaea</i> subsp. <i>cuspidata</i>*.</p>		
Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	8–26	10–30	<i>Eucalyptus sclerophylla</i> , <i>Eucalyptus globoidea</i> , <i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> and <i>Melaleuca decora</i> .
Sub-canopy	3–8	0–30	<i>Pittosporum undulatum</i> , <i>Acacia parramattensis</i> , <i>Acacia binervia</i> and <i>Acacia floribunda</i> and the occasional <i>Grevillea robusta</i> .
Shrub cover	0.4–2	<5–40	<i>Ozothamnus diosmifolius</i> , <i>Kunzea ambigua</i> , <i>Melaleuca nodosa</i> , <i>Leucopogon juniperinus</i> , <i>Pultenaea villosa</i> , <i>Jacksonia scoparia</i> , <i>Grevillea parviflora</i> subsp. <i>parviflora</i> , <i>Persoonia nutans</i> , <i>Persoonia linearis</i> , <i>Pimelea linifolia</i> , <i>Daviesia ulicifolia</i> , <i>Bursaria spinosa</i> , <i>Dillwynia parviflora</i> and <i>Pavonia hastata</i> .
Ground cover	0–1	50–80	<i>Microlaena stipoides</i> , <i>Imperata cylindrica</i> , <i>Gahnia aspera</i> , <i>Hardenbergia violacea</i> , <i>Dianella revolute</i> , <i>Pratia purpurascens</i> , <i>Themeda australis</i> , <i>Aristida vagans</i> , <i>Billardiera scandens</i> , <i>Poa affinis</i> , <i>Juncus ustisaris</i> , <i>Glycine clandestine</i> , <i>Cynodon dactylon</i> , <i>Aristida ramosa</i> , <i>Echinopogon ovatus</i> , <i>Eragrostis brownii</i> , <i>Dichondra repens</i> , <i>Lomandra multiflora</i> and <i>Aristida vagans</i> .



3.2.3 Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin

Vegetation mapping of the study area identified the presence of Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin corresponding to the Castlereagh Swamp Woodland community described in 'Native Vegetation of the Cumberland Plain, Western Sydney' (Tozer 2003). This was confirmed during the site surveys. It covers approximately 0.90 ha within the Moorebank Development Site. The vegetation characteristics of this community are summarised in Table 3.7.

Table 3.7 Characteristics of good condition Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin

Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin			
Description			
Conservation significance	Listed as an endangered ecological community, Castlereagh Swamp woodland under the TSC Act.		
Condition	<p>Moderate. This community is remnant of Castlereagh Swamp Woodland which is subject to high disturbance from edge effects, existing roads, foot paths, DOD activities and weed invasion.</p> <p>The canopy and shrublayer are dominated by native species including <i>Melaleuca linariifolia</i>, <i>Casuarina glauca</i> and <i>Leptospermum trinervium</i>. The groundcover is dominated by native species including <i>Pteridium esculentum</i>, <i>Persicaria decipiens</i>, <i>Imperata cylindrica</i>, <i>Gratiola pedunculata</i>, <i>Typha orientalis</i>, <i>Baumea articulata</i>, <i>Hydrocotyle verticillata</i> and <i>Euchiton sphaericus</i> with scattered exotic species such as <i>Rubus fruticosus</i>*, <i>Ludwigia peruviana</i>*, <i>Araujia sericifera</i>*, <i>Gomphocarpus fruticosus</i>* and <i>Paspalum urvillei</i>*.</p>		
Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	4–6	40–60	<i>Melaleuca linariifolia</i> and the occasional <i>Casuarina glauca</i> .
Shrublayer	0.5–2	5–10	The occasional <i>Leptospermum trinervium</i> .
Ground cover	0–1	40–80	<i>Lomandra longifolia</i> , <i>Hydrocotyle verticillata</i> , <i>Euchiton sphaericus</i> , <i>Gratiola pedunculata</i> , <i>Typha orientalis</i> , <i>Baumea articulata</i> , <i>Imperata cylindrica</i> , <i>Persicaria decipiens</i> and <i>Pteridium esculentum</i> .



3.2.4 Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin

Vegetation mapping of the study area identified the presence of Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin corresponding to the Alluvial Woodland community described in 'Native Vegetation of the Cumberland Plain, Western Sydney' (Tozer 2003). This was confirmed during the site surveys. It covers approximately 28.3 ha within the Moorebank Development Site. The vegetation characteristics of this community are summarised in Table 3.8.

Table 3.8 Characteristics of good condition Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin

Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin			
Description			
Conservation significance	Listed as an endangered ecological community, <i>River-flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions</i> under the TSC Act.		
Condition	<p>Good. This community is remnant of River-flat Eucalypt Forest which is subject to high disturbance from edge effects, existing roads, foot paths, DOD activities and weed invasion.</p> <p>The canopy and shrublayer are dominated by native species including <i>Eucalyptus tereticornis</i>, <i>Eucalyptus amplifolia</i>, <i>Angophora floribunda</i>, <i>Bursaria spinosa</i>, <i>Breynia oblongifolia</i>, <i>Leucopogon juniperinus</i>, <i>Jacksonia scoparia</i>, <i>Acacia</i> spp., and <i>Exocarpos cupressiformis</i>. The groundcover is dominated by native species including <i>Microlaena stipoides</i>, <i>Lomandra longifolia</i>, <i>Entolasia stricta</i>, <i>Austrostipa ramosissima</i>, <i>Dianella revoluta</i>, <i>Themeda australis</i>, <i>Cynodon dactylon</i>, <i>Aristida ramosa</i>, <i>Carex appressa</i>, <i>Dichondra repens</i> and <i>Oplismenus imbecillis</i>. Some areas within this community were dominated by an exotic shrub layer such as <i>Ehrharta erecta</i>*, <i>Ligustrum</i> spp.*, <i>Olea europaea</i> subsp. <i>cuspidata</i>* and <i>Lantana camara</i>*.</p>		
Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	8-24	20–40	<i>Eucalyptus tereticornis</i> , <i>Eucalyptus amplifolia</i> , <i>Angophora subvelutina</i> , <i>Angophora floribunda</i> and <i>Eucalyptus baueriana</i> .
Sub-canopy	3-6	5-20	<i>Acacia decurrens</i> , <i>Acacia binervia</i> , <i>Pittosporum undulatum</i> , <i>Acacia parramattensis</i> and <i>Melaleuca decora</i> .
Shrub layer	0.5-3	0-20	<i>Breynia oblongifolia</i> , <i>Bursaria spinosa</i> , <i>Kunzea ambigua</i> , <i>Ozothamnus diosmifolius</i> , <i>Leucopogon juniperinus</i> and <i>Jacksonia scoparia</i> .
Ground cover	0–1.5	60-100	<i>Microlaena stipoides</i> , <i>Commelina cyanea</i> , <i>Oplismenus imbecillis</i> , <i>Cassytha pubescens</i> , <i>Juncus usitatus</i> , <i>Cynodon dactylon</i> , <i>Entolasia stricta</i> , <i>Opercularia aspera</i> , <i>Sigesbeckia orientalis</i> , <i>Carex appressa</i> , <i>Trachymene incisa</i> , <i>Aristida ramosa</i> , <i>Pratia purpurascens</i> , <i>Einadia hastata</i> , <i>Dichondra repens</i> , <i>Centella asiatica</i> , <i>Glycine tabacina</i> , <i>Rumex brownii</i> , <i>Lomandra longifolia</i> , <i>Dianella revoluta</i> , <i>Themeda australis</i> and <i>Hardenbergia violaceae</i> .

Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin



3.2.5 Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin

Vegetation mapping of the study area identified the presence of Sydney Blue gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney basin corresponding to the Riparian Forest community described in ‘*Native Vegetation of the Cumberland Plain, Western Sydney*’ (Tozer 2003). This was confirmed during the site surveys. It covers approximately 4.7 ha within the Moorebank Development Site. The vegetation characteristics of this community are summarised in Table 3.9.

Table 3.9 Characteristics of good condition Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin

Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin	
Description	
Conservation significance	Listed as an endangered ecological community, <i>River-flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions</i> under the TSC Act.
Condition	<p>Good. This community is remnant of River-flat Eucalypt Forest which is subject to high disturbance from edge effects, existing roads, foot paths, DoD activities and weed invasion.</p> <p>The canopy and shrublayer are dominated by native species including <i>Leucopogon juniperina</i>, <i>Zieria smithii</i>, <i>Pittosporum</i> spp., <i>Acacia</i> spp., <i>Exocarpos cupressiformis</i> and <i>Breynia oblongifolia</i>. The groundcover is co-dominated by native species including <i>Microlaena stipoides</i>, <i>Lomandra longifolia</i>, <i>Pteridium esculentum</i>, <i>Entolasia marginata</i>, <i>Pratia purpurascens</i>, <i>Glycine clandestina</i>, <i>Dianella</i> spp., <i>Adiantum aethiopicum</i>, <i>Billardiera scandens</i>, <i>Einadia hastata</i> and <i>Oplismenus aemulus</i>. Some area within this community showed a moderate diversity of exotic species such as <i>Ehrharta erecta</i>*, <i>Cardiospermum grandiflorum</i>*, <i>Senna pendula</i>*, <i>Ligustrum</i> spp.*, <i>Olea europaea</i> subsp. <i>cuspidata</i>* and <i>Lantana camara</i>*.</p>

Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin			
Strata	Height range (m)	Foliage cover (%)	Dominant species
Canopy	20–28	20–40	<i>Eucalyptus saligna</i> X <i>botryoides</i> with the occasional <i>Angophora subvelutina</i> , <i>Angophora floribunda</i> and <i>Eucalyptus tereticornis</i>
Sub-canopy	2–8	10–30	<i>Acacia binervia</i> , <i>Acacia decurrens</i> and the occasional <i>Grevillea robusta</i> .
Shrub layer	0.5–4	5–20	<i>Breynia oblongifolia</i> , <i>Bursaria spinosa</i> , <i>Banksia integrifolia</i> , <i>Backhousia myrtifolia</i> and the occasional <i>Leucopogon juniperinus</i> .
Ground cover	0–1.5	80–100	<i>Lomandra longifolia</i> , <i>Dianella revoluta</i> , <i>Cheilanthes sieberi</i> , <i>Billardiera scandens</i> , <i>Pratia purpurascens</i> , <i>Microlaena stipoides</i> , <i>Pteridium esculentum</i> , <i>Cassytha glabella</i> , <i>Glycine tabacina</i> , <i>Cheilanthes sieberi</i> , <i>Austrostipa ramosissima</i> , <i>Entolasia marginata</i> , <i>Einadia hastata</i> , <i>Centella asiatica</i> , <i>Eustrephus latifolius</i> , <i>Cayratia clematidea</i> , <i>Senecio hispidus</i> , <i>Cassytha glabella</i> , <i>Plectranthus parviflorus</i> and <i>Oplismenus aemulus</i> .



A comparison of the quadrat data against biometric benchmark data (Department of Environment and Climate Change 2008b) suggests that within the Study Area is provided below in Table 3.10.

Table 3.10 Comparison of quadrat data against vegetation benchmark data

Plot	Plant species richness	Native overstorey (% cover)	Native mid-storey cover (% cover)	Native groundcover (% cover)			Number of trees with hollows	Exotic plant cover	Length of fallen timber (m)	Condition ⁷
				Grasses	Shrubs	Other				
HN542: Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland (Castlereagh Scribbly Gum Woodland)										
Benchmark ¹	40	10-20	23-33	12-24	0-10	12-24	1		30	
Q21	33	22	18	44	2	22	0*	0	2*	Good
Q24	8*	24	1.5*	72	0	0*	1	2	0*	Moderate
Q28	21	15.5	26	40	18	24	0*	4	1*	Moderate
Q29	7*	13	3.5*	16	0	2*	0*	62	4*	Moderate
Q30	12	14	1*	28	0	0*	0*	6	0*	Moderate
Q33	26	26	5.5	52	2	18	0*	44	0*	Good
HN562 : Parramatta Red Gum woodland (Castlereagh Swamp woodland)										
Benchmark ²	36	6.5-41.5	5-25	12.2-38.2	0-10	12.2-38.2	0		0	
Q27	12	35	0*	0*	0	52	0	0	4	Moderate
HN526: Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin (Alluvial Woodland)										
Benchmark ³	24	27.5-32.5	21-31	24.45-30.45	0-10	24.45-32.45	1		50	
Q22	9	17.5	0.5*	20	0	50	0*	6	0*	Moderate
Q23	10	24	6	4*	6	0*	0*	72	0*	Moderate
Q25	10	30	0*	50	0	2*	0*	20	0*	Moderate
Q26	21	20	15	62	8	12	0*	0	4*	Good
Q32	2*	31	0*	0*	2	0*	0*	70	0*	Moderate
Q34	4*	15	0*	32	0	0*	0*	8	0*	Moderate
Q35	14	24	0.5*	32	0	8	0*	12	0*	Moderate

HN597: Sydney Blue Gum X Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin (Riparian Forest)⁴										
Benchmark⁵	30	61-71	70-81	0-15	0-5	23.1-29.1	0		0	
Q3 ⁶	20	27	17.5	60	0	0*	0	14	21	Good
Q20 ⁶	13	19.5	0.5*	28	0	16	10	26	11	Moderate
Q31 ⁶	2*	22	0*	20	0	0*	1	80	0	Moderate

1. benchmark data for equivalent community in Hawkesbury Nepean CMA (Vegetation Type: Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin: Keith Formation: Dry sclerophyll forests (shrubby sub-formation): Keith Class: Sydney Sand Flats Dry Sclerophyll Forests: source (Keith 2004): Red font indicates results below benchmark value: * indicates, less than 25% of lower benchmark value.
2. benchmark data for equivalent community in Hawkesbury Nepean CMA (Vegetation Type: Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin: Keith Formation: Dry sclerophyll forests (shrub/grass sub-formation): Keith Class: Cumberland Dry Sclerophyll Forests: source (Keith 2004): Red font indicates results below benchmark value: * indicates, less than 25% of lower benchmark value.
3. benchmark data for equivalent community in Hawkesbury Nepean CMA (Vegetation Type: Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin: Keith Formation: Grassy Woodlands: Keith Class: Coastal Valley Grassy Woodlands: source (Keith 2004): Red font indicates results below benchmark value: * indicates, less than 25% of lower benchmark value.
4. Quadrats from the Moorebank Offset Area that are representative of the Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin vegetation community.
5. benchmark data for equivalent community in Hawkesbury Nepean CMA (Vegetation Type: Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin: Keith Formation: Wet sclerophyll forests (shrubby sub-formation): Keith Class: North Coast Wet Sclerophyll Forests: source (Keith 2004): Red font indicates results below benchmark value: * indicates, less than 25% of lower benchmark value.
6. Quadrats from the Moorebank Offset Areas that are representative of the Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin vegetation community.
7. Description of vegetation conditions described in Section 2.4.3.

3.2.6 Species of plant recorded

One hundred and twenty eight plant species were recorded within the study area. Of these, 90 were native and 38 were introduced species (refer Appendix A).

Of these 38 exotic species that were recorded in the study area, twelve species of plant are listed under the *Noxious Weeds Act 1993* for the Liverpool City Council noxious weed control area (refer Table 3.11). Of these species seven (Alligator Weed, Ground Asparagus, Bridal Creeper, Asparagus, Lantana, Blackberry and Fireweed) are listed as a Weeds of National Significance (Department of Trade and Investment Regional Infrastructure and Services 2014).

Table 3.11 Noxious weeds identified on the site

Scientific name	Common name	Noxious Weeds Act 1993 control class ⁽¹⁾	Weed of National Significance
<i>Alternanthera philoxeroides</i> *	Alligator Weed	3	Yes
<i>Arundo donax</i> *	Giant Reed	4	
<i>Asparagus aethiopicus</i> *	Ground Asparagus	4	Yes
<i>Asparagus asparagoides</i> *	Bridal Creeper	4	Yes
<i>Asparagus officinalis</i> *	Asparagus	4	Yes
<i>Lantana camara</i> *	Lantana	4	Yes
<i>Ligustrum sinense</i> *	Small-leaved Privet	4	
<i>Ludwigia peruviana</i> *	Ludwigia	3	
<i>Olea europaea subsp. cuspidata</i> *	African olive	4	
<i>Ricinus communis</i> *	Castor Oil Plant	4	
<i>Rubus fruticosus</i> *	Blackberry	4	Yes
<i>Senecio madagascariensis</i> *	Fireweed	4	Yes

Control Categories under the Noxious Weeds Act 1993: Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority, Class 3: The plant must be fully and continuously suppressed and destroyed (Department of Trade and Investment Regional Infrastructure and Services 2014).

3.2.7 Plot data

The plot data is provided in Table 3.12. A list of flora species found in each quadrat is provided in Appendix A.

Table 3.12 Plot data

Plot name	Veg type ²	Condition	Native plant species	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic plant cover	Number of trees with hollows	Overstorey regeneration	Total length of fallen logs	Zone ³	Easting	Northing
Q21	HN542	Good	33	22	18	44	2	22	0	0	1	2	56	307931	6241123
Q22	HN526	Moderate	9	17.5	0.5	20	0	50	0	6	1	0	56	307616	6241569
Q23	HN526	Moderate	10	24	6	4	6	0	0	72	1	0	56	307468	6241404
Q24	HN542	Moderate	8	24	1.5	72	0	0	2	1	0	0	56	307811	6240069
Q25	HN526	Moderate	10	30	0	50	0	2	0	20	1	0	56	307560	6240000
Q26	HN526	Good	21	20	15	62	8	12	0	0	1	4	56	307467	6240144
Q27	HN562	Moderate	12	35	0	0	0	52	0	0	1	4	56	307882	6240183
Q28	HN542	Moderate	21	15.5	26	40	18	24	4	0	1	1	56	307853	6240640
Q29	HN542	Moderate	7	13	3.5	16	0	2	62	0	1	4	56	307962	6240799
Q30	HN542	Moderate	12	14	1	28	0	0	6	0	1	0	56	307875	6240877
Q32	HN526	Moderate	2	31	0	0	2	0	0	70	1	0	56	307465	6241530
Q33	HN526	Good	26	26	5.5	52	2	18	0	44	1	0	56	307995	6241307
Q34	HN526	Moderate	4	15	0	32	0	0	0	8	1	0	56	307887	6241348
Q35	HN526	Moderate	14	24	0.5	32	0	8	0	12	1	0	56	307237	6241923
Q3 ¹	HN597	Good	20	27	17.5	60	0	0	0	14	1	21	56	307219	6239652
Q20 ¹	HN597	Moderate	13	19.5	0.5	28	0	16	10	26	1	11	56	307186	6240476
Q31 ¹	HN597	Moderate	2	22	0	20	0	0	1	80	1	0	56	307466	6241638

Note:

1. Quadrats from the Moorebank Offset Areas that are representative of the Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin vegetation community.
2. Description of vegetation conditions described in section 2.4.3.
3. MGA 94: Zone 56

3.3 Fauna habitat

The quality of vertebrate fauna habitats is typically correlated with the patch size, configuration, structure, species composition and connectivity of the vegetation communities present at a given site and the presence of non-biological features such as rock outcrops and water bodies. Therefore, the fauna habitats present in the study area vary from low in highly modified areas through moderate in partially cleared areas to high in less disturbed vegetation.

3.3.1.1 Terrestrial fauna habitats

Four broad types of terrestrial fauna habitat were found within the study area referred to here as:

- riparian vegetation along George's River
- structurally intact woodland
- highly disturbed areas with scattered trees
- aquatic habitats.

These habitats are described below.

3.3.1.2 Riparian vegetation along the George's River

This habitat type includes all moderate to good condition Riparian Forest and Alluvial Woodland that runs adjacently along the George's River within the Moorebank development site.

These areas contain relatively intact native understorey and/or groundcover vegetation (some areas contain a high diversity of exotic shrub and groundcover species such as *Lantana camara** thickets and *Cardiospermum grandiflorum**). They contain a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna. Patches of dense understorey and diverse groundcover in this habitat type provide potential foraging and nesting habitat for a variety of terrestrial birds, reptiles and mammals.

The canopy of this habitat type consists of a moderate to dense cover of immature, semi-mature and mature trees. The canopy provides foraging habitat for nectar-feeding and seed-eating animals and is likely to contain hollows suitable for birds such as small to large parrots, owls, tree roosting microchiropteran bat and small to large arboreal mammals. Foraging opportunities exist in the canopy for predatory species including Powerful Owl and Spotted-tailed Quoll.

Overall, this fauna habitat type is in moderate to good condition providing potential habitat for species of animal that require diverse native understorey vegetation, canopy connectivity to other habitat in the locality and tree hollows.

3.3.1.3 Structurally intact woodland

This habitat type includes all moderate to good condition native woodland vegetation that occurs scattered throughout the Moorebank development site.

These areas contain relatively intact native understorey and/or groundcover vegetation. They contain a complete vegetation structure, fallen timber, and dense leaf litter layers that are essential to the life cycles of many fauna. Patches of dense understorey and diverse groundcover in this habitat type provide potential foraging and nesting habitat for a variety of terrestrial reptiles, bird and mammals.

The canopy of this habitat type consists of a moderate to dense cover of immature, semi-mature and mature trees. The canopy provides foraging habitat for nectar-feeding and seed-eating animals and is likely to contain hollows suitable for birds such as small to large parrots, owls, tree roosting microchiropteran bat and small to large arboreal mammals. Foraging opportunities exist in the canopy for predatory species including Powerful Owl and Spotted-tailed Quoll.

Overall, this fauna habitat type is in moderate to good condition providing potential habitat for species of animal that require diverse native understorey vegetation, canopy connectivity and tree hollows.

3.3.1.4 Highly disturbed areas with scattered trees

This habitat type occurs in areas that have been subject to substantial human disturbance such as clearing for urban development, DOD land, golf course and transport and power infrastructure. This habitat type does not correspond to any native vegetation community.

Native vegetation in this habitat type is restricted to occasional trees, shrubs and groundcover plants within otherwise exotic vegetation.

This habitat is only likely to provide habitat for native and introduced fauna species that are adapted to open environments and tolerant of human disturbance. Many such native species (e.g. Willie Wagtail and Noisy Miners) have increased in abundance in response to human disturbance.

This habitat type is in poor condition and generally of very limited value to threatened fauna species.

3.3.1.5 Aquatic habitats

Field observations identified a small ephemeral water body within the native Castlereagh Swamp Woodland community recorded within the development site along Moorebank Avenue. The water body ranged from approximately 0.1–0.4 m in depth. The ephemeral swamp is subjected to changes in water depth and turbulence dependent upon rainfall patterns. The substrate consisted of clay soils.

Field observation of the water body revealed that it was in moderate ecological condition. Moderate condition aquatic fauna habitat occurs where some habitat components are missing or have been reduced, but linkages with other remnant habitats in the landscape are generally intact, but sometimes degraded. The aquatic habitat within the study area has been subjected to low levels of weed invasion and vegetation fragmentation as a result of weed invasion and urban developments (such as the access paths, DOD land and golf course). Although, the habitat has been moderately degraded, it still retains most aquatic fauna habitat features such as rocks, organic detritus, aquatic vegetation and occasional snags. These habitat features provide potential habitat for a number of aquatic and terrestrial species of fish, reptiles, birds invertebrates and amphibians.

The aquatic habitat was unlikely to provide habitat for any threatened species listed under the *Fisheries Management Act 1994* due to the condition of habitat and as no records have been identified in the Hawkesbury/Nepean Catchment Management Authority (Department of Trade & Investment Region Infrastructure and Services 2014).

3.4 Habitat and geographic features

The site has been surveyed in November 2010 as part of the impact assessment for the original Environmental Impact Assessment (Parsons Brinckerhoff 2011) and has since been surveyed in February 2013 and May 2014 to conduct additional surveys (specifically flora based). These previous surveys have included numerous targeted surveys for flora and fauna species considered likely to occur on site. To date, three threatened species have been recorded within the study area as a result of these surveys (Grey-headed Flying-fox, *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans*).

The following geographic and habitat features were identified within both sites:

- alluvial soils
- land containing bark or leaf litter accumulation
- land within 100 m of emergent aquatic or riparian vegetation
- Land within 40 m of fresh/brackish/saline waters of larger rivers or creeks, estuaries, coastal lagoons, lakes and/or inshore marine waters
- wet and damp areas only
- land within 250 m of termite mounds or rock outcrops.

3.5 Threatened communities, populations and species

This section details the threatened biodiversity and other species of conservation concern recorded or likely to occur in the study area, based on those found within the locality and the nature of the habitats observed within the existing environment.

The sites were surveyed in May 2014, but did not include any targeted surveys for threatened species or populations. However, three threatened species (Grey-headed Flying-fox, *Persoonia nutans* and *Grevillea parviflora* subsp. *parviflora*) were/or have been previously recorded within the Moorebank Development Site (Parsons Brinckerhoff 2011).

3.5.1 Threatened ecological communities

Threatened ecological communities (critically endangered, endangered and vulnerable) are listed under the *Threatened Species Conservation Act 1995*, *Fisheries Management Plan Act 1994* and *Environmental Protection and Biodiversity Conservation Act 1999*.

No Commonwealth listed threatened ecological communities were recorded as present during the field survey.

Three State listed threatened ecological communities were recorded as present during the recent field survey:

- Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion listed as vulnerable under the *Threatened Species Conservation Act 1995*.
- Castlereagh Swamp Woodland Community listed as endangered under the *Threatened Species Conservation Act 1995*.
- River-flat Eucalypt Forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions listed as vulnerable under the *Threatened Species Conservation Act 1995*.

The occurrence of this community in the study area is described in section 3.2.

3.5.2 Endangered populations

Endangered populations are listed under Schedule 1, Part 2 of the *Threatened Species Conservation Act 1995*. Results of the desk-top assessment indicate that two endangered populations have the potential to occur in the study locality (Appendices B and C):

- Gang-gang cockatoo (*Callocephalon fimbriatum*) endangered population in the Hornsby and Ku-ring-gai Local Government Area. This population is not considered endangered in the Liverpool LGA.
- Long-nosed Bandicoot population, Inner Western Sydney. While Long-nosed Bandicoots are likely to occur in the study area they would not be considered part of the Endangered Inner Western Sydney Population.
- White-fronted Chat in the Sydney Metropolitan Catchment Management Authority Area. This species was not recorded within the study area and no suitable habitat was recorded.
- *Acacia prominens* population in the Hurstville and Kogarah LGAs. This population is not considered endangered in the Liverpool LGA.
- *Dillwynia tenuifolia* - endangered population Kemps Creek. This population is not considered endangered in the Liverpool LGA.
- *Marsdenia viridiflora* subsp. *viridiflora* in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs. This species was not recorded within the study area and no suitable however potential habitat was recorded. This species is considered to have moderately likely to occur within the study area.
- *Pomaderris prunifolia* population in the Parramatta, Auburn, Strathfield and Bankstown LGAs. This population is not considered endangered in the Liverpool LGA.
- *Wahlenbergia multicaulis* (Tadgell's Bluebell) population, Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs. This population is not considered endangered in the Liverpool LGA.

3.5.3 Threatened species of plant

Eight species of threatened plant listed under the *Threatened Species Conservation Act 1995* and/or the *Environmental Protection and Biodiversity Conservation Act 1999 Act* are known to occur or predicted to occur within and surrounding the study area. Details of these species and their habitat requirements are provided in Appendix B.

Two threatened species of plant have been previously recorded within the Moorebank Development Site (*Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans*) (Parsons Brinckerhoff 2011) (Table 3.13). The remaining species are considered to have a low likelihood of occurrence based on absence during targeted surveys and/or the availability of habitat. Full details of species requirements are provided in Appendix B.

Table 3.13 Threatened species of plant with potential to occur in habitat of the study area

Species	Common name	TSC Act	EPBC Act	Likelihood of occurrence
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	Recorded
<i>Persoonia nutans</i>	Nodding Geebung	E1	E	Recorded
<i>Acacia pubescens</i>	Downy Wattle	V	V	Low
<i>Acacia bynoeana</i>	Bynoe's Wattle	E1	V	Low

Species	Common name	TSC Act	EPBC Act	Likelihood of occurrence
<i>Dillwynia tenuifolia</i>		V	V	Low
<i>Leucopogon exolasius</i>	Woronora Beard-heath	V	V	Low
<i>Persoonia hirsuta</i>	Hairy Geebung	E1	E	Low
<i>Pultenaea parviflora</i>	Sydney Bush-pea	E1	V	Low

E1 = Endangered species, E = Endangered, V = Vulnerable

Thirteen threatened species of plant were predicted to occur in the Moorebank Development Site (Table 3.14) by the FBA credit calculator Version 4.0 (Office of Environment and Heritage 2014a) based on the data entered. Two of these species (*Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans*) have been recorded within the study area during previous surveys.

Table 3.14 Threatened species predicted to occur by the FBA credit calculator within the Moorebank Development Site

Scientific name	Common name	TSC Act ⁽¹⁾	EPBC Act ⁽²⁾	Targeted survey completed	On site?
<i>Acacia bynoeana</i>	Bynoe's Wattle	E1	V	Yes (all surveys)	Unlikely
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	E1	V		Unlikely
<i>Callistemon linearifolius</i>	Netted Bottle Brush	V	-	Yes (all surveys)	Unlikely
<i>Cynanchum elegans</i>	White-Flowered Wax Plant	E1	E	Yes (Nov 2010)	Unlikely
<i>Dillwynia tenuifolia</i>		V	V	Yes (Nov 2010)	Unlikely
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	Yes (all surveys)	Recorded
<i>Hibbertia puberula</i>		E1	-	Yes (Nov 2010)	Unlikely
<i>Hibbertia</i> sp. <i>Bankstown</i>		CE	E4	Yes (Nov 2010)	Unlikely
<i>Hypsela sessiliflora</i>		E1	E4	Yes (Nov 2010)	Unlikely
<i>Leucopogon exolasius</i>	Woronora Beard-heath	V	V	Yes (all surveys)	Unlikely
<i>Persoonia nutans</i>	Nodding Geebung	E1	E	Yes (all surveys)	Recorded
<i>Pimelea curviflora</i> subsp. <i>curviflora</i>		V	V	Yes (all surveys)	Unlikely
<i>Pultenaea parviflora</i>		E1	V	Yes (Aug 2012)	Unlikely

E1 = Endangered species, E = Endangered, E4 = Presumed extinct, V = Vulnerable

3.5.4 Threatened species of animal

One threatened species has been previously recorded (Grey-headed Flying-fox) within the Moorebank Development Site (Parsons Brinckerhoff 2011), based on the presence of suitable habitat, and additional 20 species are considered to have a moderate or greater likelihood of occurrence (Table 3.15). The remaining species are considered to have a low likelihood of occurrence based on the availability of habitat. Full details of species requirements are provided in Appendix C.

Table 3.15 Threatened species of animal with potential to occur in habitat within the study area

Scientific name	Common name	TSC Act ⁽¹⁾	EPBC Act ⁽²⁾	Likelihood of occurrence
Birds				
<i>Glossopsitta pusilla</i>	Little Lorikeet	V		High
<i>Ninox connivens</i>	Barking Owl	V		Moderate
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater	V		Moderate
<i>Petroica phoenicea</i>	Flame Robin	V		Moderate
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V		Moderate
<i>Hieraaetus morphnoides</i>	Little Eagle	V		Moderate
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	EM	Moderate
<i>Ninox strenua</i>	Powerful Owl	V		Moderate
<i>Petroica boodang</i>	Scarlet Robin	V		Moderate
<i>Circus assimilis</i>	Spotted Harrier	V		Moderate
<i>Lophoictinia isura</i>	Square-tailed Kite	V		Moderate
<i>Lathamus discolor</i>	Swift Parrot	E1	E	Moderate
<i>Calyptorhynchus lathamii</i>	Varied Sittella	V		Moderate
Bats				
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bent-wing Bat	V		High
<i>Mormopterus norfolkensis</i>	Eastern Free-tail Bat	V		High
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V		Moderate
<i>Myotis adversus</i>	Large-footed Myotis	V		High
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V		Moderate
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail Bat	V		Moderate
Mammals				
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V	Recorded
<i>Dasyurus maculatus maculatus</i>	Spotted-Tailed Quoll (Southern Subspecies)	V	E	Unlikely
<i>Cercartetus nanus</i>	Eastern Pygmy-possum	V		Unlikely
<i>Petaurus norfolkensis</i>	Squirrel Glider	V		Unlikely
<i>Phascolarctos cinereus</i>	Koala	V	V	Unlikely
Invertebrates				
<i>Meridolum corneovirens</i>	Cumberland Land Snail	E1		Moderate

TSC Act = Threatened Species Conservation Act 1995, V = Vulnerable, E1 = Endangered, E2 = Endangered population in the Liverpool LGA.
 EPBC Act = Environment Protection and Biodiversity Conservation Act 1999, E = Endangered.

Twenty-nine threatened species were predicted to occur in the Moorebank Development Site (Table 3.16) by the FBA credit calculator Version 4.0 (Office of Environment and Heritage 2014a) based on the data entered. This search did not predict any additional threatened species likely to occur within the Moorebank Development Site that were not predicted or known (i.e. with a moderate or higher likelihood of occurrence) to occur based on the database searches (see above). Although none of these species have been recorded within the study area 14 of these species are considered to have a moderate to high likelihood of occurring.

Table 3.16 Threatened species predicted to occur by the FBA credit calculator within the Moorebank Development Site

Scientific name	Common name	TSC Act ⁽¹⁾	EPBC Act ⁽²⁾	Survey required/ completed	Tg value	On site?
Birds						
<i>Ninox connivens</i>	Barking Owl	V	-	Yes	1.5	Moderate likelihood
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V	-	Yes	1.3	Moderate likelihood
<i>Climacteris picumnus subsp. victoriae</i>	Brown Treecreeper (eastern subspecies)	V	-	Yes	2.0	Unlikely
<i>Pandion cristatus</i>	Eastern Osprey	V	-	Yes	1.3	Unlikely
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1	-	Yes	2.5	Unlikely
<i>Stagonopleura guttata</i>	Diamond Firetail	V	-	Yes	1.3	Unlikely
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	E1	-	Yes	1.5	Moderate Likelihood
<i>Petroica phoenicea</i>	Flame Robin	V	-	Yes	1.7	Moderate likelihood
<i>Melanodryas cucullata</i>	Hooded Robin (South-eastern subspecies)	V	-	Yes	1.7	Unlikely
<i>Hieraaetus morphnoides</i>	Little Eagle	V	-	Yes	1.4	Moderate likelihood
<i>Glossopsitta pusilla</i>	Little Lorikeet	V	-	Yes	1.7	High likelihood
<i>Grantiella picta</i>	Painted Honeyeater	V	-	Yes	1.3	Unlikely
<i>Ninox strenua</i>	Powerful Owl	V		Yes	1.5	Moderate likelihood
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	EM	Yes (Nov 2010)	7.7	Moderate likelihood
<i>Petroica boodang</i>	Scarlet Robin	V		Yes	1.7	Moderate likelihood
<i>Chthonicola sagittata</i>	Speckled Warbler	V	-	Yes	2.6	Unlikely

Scientific name	Common name	TSC Act ⁽¹⁾	EPBC Act ⁽²⁾	Survey required/ completed	Tg value	On site?
<i>Lathamus discolor</i>	Swift Parrot	E1	E	Yes	1.3	Moderate likelihood
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V	-	Yes	1.3	Moderate Likelihood
Mammals						
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Yes (Nov 2010)	2.9	Unlikely
<i>Mormopterus norfolkensis</i>	Eastern Free-tail Bat	V	-	Yes (Nov 2010)	2.2	High likelihood
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V	-	Yes (Nov 2010)	2.2	Moderate likelihood
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V	-	Yes (Nov 2010)	2.2	Moderate likelihood
<i>Phascolarctos cinereus</i>	Koala	V	V	Yes (all surveys)	2.6	Unlikely
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	V	V	Yes (Nov 2010)	2.4	Unlikely
<i>Cercartetus nanus</i>	Eastern Pygmy Possum	V	-	Yes (Nov 2010)	2.0	Unlikely
<i>Petaurus norfolcensis</i>	Squirrel Glider	V	-	Yes (Nov 2010)	2.2	Unlikely
Invertebrates						
<i>Meridolum corneovirens</i>	Cumberland Plain Land Snail	E1	-	Yes (Nov 2010)	1.3	Unlikely
Amphibians						
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1	V	Yes (Nov 2010)	2.5	Unlikely
Reptiles						
<i>Varanus rosenbergi</i>	Rosenberg's Goanna	V	-	Yes (Nov 2010)	3.3	Unlikely

1. TSC Act = Threatened Species Conservation Act 1995, V = Vulnerable, E1 = Endangered, E2 = Endangered population in the Liverpool LGA.

2. EPBC Act = Environment Protection and Biodiversity Conservation Act 1999, E = Endangered.

3.5.5 Migratory species

Migratory species are protected under international agreements to which Australia are a signatory, including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), the Republic of Korea Australia Migratory Bird Agreement (RoKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered to comprise 'Matters of National Environmental Significance' and are protected under the EPBC Act.

Based on the findings of the desk-top assessment, a total of 13 Migratory species have been recorded or have the potential to occur in the study area locality (Appendix C). No Migratory species were recorded during field surveys the site does contain potential habitat however for the Regent Honeyeater, Fork-tailed Swift, Cattle Egret, Eastern Great Egret, Latham's Snipe, White-bellied Sea-Eagle, White-throated Needletail, Black-faced Monarch, Satin Flycatcher and Rufous Fantail.

4. Framework of Biodiversity Assessment

The Framework of Biodiversity Assessment (FBA) Credit Calculator Version 1.03 (Office of Environment and Heritage 2014a) was used to provide a calculation of the number and class of biodiversity credits required to offset the biodiversity impacts associated with the Project to ensure maintenance or improvement in biodiversity. The FBA is summarised below.

4.1 Ecosystem credits

The ecosystem credits required to offset biodiversity impacts associated with the Project based on the vegetation zones identified for the Moorebank Development Site are summarised in Table 4.1.

Table 4.1 Ecosystem credits required to offset biodiversity impacts associated the Project based on the vegetation zones for the Moorebank Development site

Veg code	Vegetation name	Vegetation zone	Vegetation zone area (ha)	Development site vale loss	Number of credits
HN542	Hard-leaved Scribbly Gum – Parramatta Red Gum heathy woodland – Good Condition	1	16.1	44.3	444
HN562	Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin – Good Condition	2	0.9	39.6	30
HN526	Forest Red Gum – Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin – Good Condition	3	28.1	35.8	844
HN597	Sydney Blue Gum X Bangalay – Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin – Good Condition	4	3.6	40.1	91
TOTAL					1,409

4.2 Species credits

Species credits were calculated for two threatened flora and recorded during the current and previous targeted surveys (Parsons Brinckerhoff 2011).

The species credits required for development of the Moorebank Development Site are summarised in Table 4.2.

Table 4.2 Species credits required for development

Scientific name	Common name	No. of individuals recorded to be impacted	No. of credits required
<i>Persoonia nutans</i>	Nodding Geebung	10	770
<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	16	235
Total		26	1,005

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Appendix A

Species of plant recorded



A1. Species of plant recorded

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Adiantaceae	<i>Cheilanthes sieberi</i>	Mulga Fern			Y	X					X									X	X	
Amaranthaceae	<i>Alternanthera philoxeroides</i>	Alligator Weed			N																	X
Apiaceae	<i>Centella asiatica</i>	Pennywort			Y						X		X	X					X		X	
Apiaceae	<i>Hydrocotyle verticillata</i>	Shield Pennywort			Y							X										
Apiaceae	<i>Trachymene incisa</i>				Y						X											
Asclepiadaceae	<i>Araujia sericifera</i>	Moth Vine			N		X					X										
Asclepiadaceae	<i>Gomphocarpus fruticosus</i>	Narrow-leaved Cotton Bush			N							X										
Asparagaceae	<i>Asparagus aethiopicus</i>	Asparagus Fern			N						X			X								
Asparagaceae	<i>Asparagus asparagoides</i>	Bridal Creeper			N	X	X				X		X				X		X	X	X	
Asparagaceae	<i>Asparagus officinalis</i>	Asparagus			N		X															
Asteraceae	<i>Bidens pilosa</i>	Cobblers Pegs			N							X				X			X		X	X
Asteraceae	<i>Cirsium vulgare</i>	Spear Thistle			N											X						
Asteraceae	<i>Conyza albida</i>	Tall Fleabane			N											X						
Asteraceae	<i>Conyza sp.</i>				N					X		X							X			
Asteraceae	<i>Euchiton sphaericus</i>	Annual Cudweed			Y							X										
Asteraceae	<i>Hypochaeris radicata</i>	Catsear			N				X													
Asteraceae	<i>Ozothamnus diosmifolius</i>	White Dogwood			Y						X						X					
Asteraceae	<i>Senecio madagascariensis</i>	Fireweed			N					X			X	X								
Brassicaceae	<i>Brassica sp.</i>				N											X						

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Caprifoliaceae	<i>Lonicera japonica</i>	Japanese Honeysuckle			N																	X
Casuarinaceae	<i>Allocasuarina torulosa</i>	Forest Oak			Y												X					
Casuarinaceae	<i>Casuarina glauca</i>	Swamp Oak			Y			X				X										
Chenopodiaceae	<i>Einadia hastata</i>	Berry Saltbush			Y					X									X			
Commelinaceae	<i>Tradescantia fluminensis</i>	Wandering Jew			N																X	X
Convolvulaceae	<i>Dichondra repens</i>	Kidney Weed			Y								X	X			X		X			
Cyperaceae	<i>Baumea articulata</i>	Jointed Twig-rush			Y							X										
Cyperaceae	<i>Carex appressa</i>	Tussock Sedge			Y		X															
Cyperaceae	<i>Gahnia aspera</i>				Y	X											X					
Cyperaceae	<i>Lepidosperma laterale</i>	Variable Sword-sedge			Y	X											X					
Dennstaedtiaceae	<i>Pteridium esculentum</i>	Bracken			Y							X								X		X
Elaeocarpaceae	<i>Elaeocarpus reticulatus</i>	Blueberry Ash			Y	X					X						X				X	
Epacridaceae	<i>Leucopogon juniperinus</i>	Long-flower Beard-heath			Y	X					X										X	
Euphorbiaceae	<i>Breynia oblongifolia</i>	Coffee Bush			Y														X	X	X	
Euphorbiaceae	<i>Ricinus communis</i>	Castor Oil Plant			N			X								X						
Fabaceae (Faboideae)	<i>Daviesia ulicifolia</i>	Gorse Bitter Pea			Y	X																
Fabaceae (Faboideae)	<i>Dillwynia parvifolia</i>				Y								X	X								
Fabaceae (Faboideae)	<i>Glycine clandestina</i>	Twining Glycine			Y	X							X	X			X				X	
Fabaceae (Faboideae)	<i>Glycine microphylla</i>	Small-leaf Glycine			Y												X					
Fabaceae (Faboideae)	<i>Glycine tabacina</i>				Y			X			X						X		X			
Fabaceae (Faboideae)	<i>Hardenbergia violacea</i>	False Sarsaparilla			Y	X							X	X			X	X	X			
Fabaceae (Faboideae)	<i>Jacksonia scoparia</i>	Dogwood			Y						X											

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Fabaceae (Faboideae)	<i>Pultenaea villosa</i>				Y	X											X					
Fabaceae (Mimosoideae)	<i>Acacia binervia</i>	Coast Myall			Y			X			X		X	X	X				X	X	X	
Fabaceae (Mimosoideae)	<i>Acacia decurrens</i>	Black Wattle			Y		X	X									X		X	X		
Fabaceae (Mimosoideae)	<i>Acacia falcata</i>				Y												X					
Fabaceae (Mimosoideae)	<i>Acacia floribunda</i>	White Sally			Y										X				X			
Fabaceae (Mimosoideae)	<i>Acacia parramattensis</i>	Parramatta Wattle			Y			X			X				X	X						
Juncaceae	<i>Juncus usitatus</i>	Billabong Rush			Y	X	X					X										
Lamiaceae	<i>Plectranthus parviflorus</i>	Cockspur Flower			Y																X	
Lauraceae	<i>Cassytha glabella</i>	Slender Dodder-laurel			Y	X								X						X	X	
Lauraceae	<i>Cassytha pubescens</i>				Y												X					
Lobeliaceae	<i>Pratia purpurascens</i>	Whiteroot			Y	X				X			X	X					X			
Lomandraceae	<i>Lomandra longifolia</i>	Spiny-headed Mat-rush			Y					X	X	X								X	X	
Lomandraceae	<i>Lomandra multiflora</i>				Y								X	X			X					
Malvaceae	<i>Pavonia hastata</i>				N										X					X		
Malvaceae	<i>Sida rhombifolia</i>	Paddys Lucerne			N			X					X	X		X	X		X		X	
Myrtaceae	<i>Angophora floribunda</i>	Rough-barked Apple			Y				X	X										X		
Myrtaceae	<i>Angophora subvelutina</i>	Broad-leaved Apple			Y																X	
Myrtaceae	<i>Backhousia myrtifolia</i>	Grey Myrtle			Y															X		
Myrtaceae	<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush			Y	X																
Myrtaceae	<i>Callistemon salignus</i>	Willow Bottlebrush			Y	X																
Myrtaceae	<i>Eucalyptus fibrosa</i>	Red Ironbark			Y				X								X					

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Myrtaceae	<i>Eucalyptus globoidea</i>	White Stringybark			Y					X												
Myrtaceae	<i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i>	Parramatta Red Gum			Y	X																
Myrtaceae	<i>Eucalyptus saligna</i> x <i>botryoides</i>				Y															X	X	X
Myrtaceae	<i>Eucalyptus sclerophylla</i>	Hard-leaved Scribbly Gum			Y	X			X				X	X	X							
Myrtaceae	<i>Eucalyptus tereticornis</i>	Forest Red Gum			Y		X	X		X	X					X		X	X			
Myrtaceae	<i>Kunzea ambigua</i>	Tick Bush			Y	X		X			X		X	X			X					
Myrtaceae	<i>Leptospermum trinervium</i>	Paperbark Tea-tree			Y							X										
Myrtaceae	<i>Melaleuca decora</i>	White Feather Honeymyrtle			Y	X			X				X				X	X	X			
Myrtaceae	<i>Melaleuca linariifolia</i>				Y							X										
Myrtaceae	<i>Melaleuca nodosa</i>	Pricklyleaf Paperbark			Y	X			X		X		X	X			X					
Oleaceae	<i>Ligustrum sinense</i>	Small-leaved Privet			N	X	X	X			X					X	X			X	X	X
Oleaceae	<i>Olea europaea</i> subsp. <i>cuspidata</i>				N	X		X			X				X		X			X	X	
Onagraceae	<i>Ludwigia peruviana</i>				N							X										
Oxalidaceae	<i>Oxalis</i> sp.				Y															X		
Phormiaceae	<i>Dianella revoluta</i>				Y	X			X		X		X	X			X					
Pittosporaceae	<i>Billardiera scandens</i>	Appleberry			Y	X							X	X								
Pittosporaceae	<i>Bursaria spinosa</i>	Native Blackthorn			Y		X		X				X	X			X		X	X	X	
Pittosporaceae	<i>Pittosporum undulatum</i>	Sweet Pittosporum			Y	X	X				X				X		X			X		
Plantaginaceae	<i>Plantago lanceolata</i>	Lambs Tongues			N		X	X	X				X					X	X			
Poaceae	<i>Aristida ramosa</i>	Cane Wire-grass			Y				X	X	X		X				X		X			

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Poaceae	<i>Aristida vagans</i>	Threeawn Speargrass			Y								X	X								
Poaceae	<i>Arundo donax</i>	Giant Reed			N																	X
Poaceae	<i>Austrostipa ramosissima</i>	Stout Bamboo Grass			Y																X	
Poaceae	<i>Austrostipa verticillata</i>				Y															X		
Poaceae	<i>Axonopus fissifolius</i>	Narrow-leaved Carpet Grass			N				X				X	X								
Poaceae	<i>Chloris gayana</i>	Rhodes Grass			N								X		X				X			
Poaceae	<i>Cynodon dactylon</i>	Common Couch			Y		X		X	X	X		X	X				X	X			
Poaceae	<i>Digitaria ramularis</i>				Y						X											
Poaceae	<i>Echinopogon caespitosus</i>				Y					X												
Poaceae	<i>Echinopogon ovatus</i>	Forest Hedgehog Grass			Y				X				X									
Poaceae	<i>Ehrharta erecta</i>	Panic Veldtgrass			N						X				X				X		X	
Poaceae	<i>Entolasia marginata</i>	Bordered Panic			Y	X		X		X	X						X				X	
Poaceae	<i>Entolasia stricta</i>	Wiry Panic			Y										X					X		
Poaceae	<i>Eragrostis brownii</i>	Browns Lovegrass			Y				X				X	X								
Poaceae	<i>Eragrostis curvula</i>	African Lovegrass			N			X			X		X	X	X		X		X		X	
Poaceae	<i>Eragrostis sp.</i>				Y	X																
Poaceae	<i>Imperata cylindrica</i>	Bladey Grass			Y	X						X	X	X			X					
Poaceae	<i>Microlaena stipoides</i>				Y	X	X		X	X	X						X		X	X	X	
Poaceae	<i>Oplismenus imbecillis</i>	Creeping Beard Grass			Y		X													X		
Poaceae	<i>Paspalidium distans</i>	Spreading Panic-grass			Y		X															
Poaceae	<i>Paspalum dilatatum</i>	Paspalum			N				X													

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Poaceae	<i>Paspalum urvillei</i>	Vasey Grass			N							X										
Poaceae	<i>Pennisetum clandestinum</i>	Kikuyu Grass			N				X													
Poaceae	<i>Poa affinis</i>				Y	X																
Poaceae	<i>Setaria gracilis</i>	Slender Pigeon Grass			N	X	X	X					X	X			X			X		
Poaceae	<i>Themeda australis</i>	Kangaroo Grass			Y						X		X	X			X					
Polygonaceae	<i>Persicaria decipiens</i>	Slender Knotweed			Y							X										
Polygonaceae	<i>Rumex brownii</i>	Swamp Dock			Y											X						
Primulaceae	<i>Anagallis arvensis</i>	Scarlet/Blue Pimpernel			N					X									X			
Proteaceae	<i>Grevillea parviflora subsp. parviflora</i>	Small-flower Grevillea	V	V	Y	X																
Proteaceae	<i>Grevillea robusta</i>	Silky Oak			Y	X					X										X	
Proteaceae	<i>Hakea sericea</i>				Y								X	X								
Proteaceae	<i>Persoonia linearis</i>	Narrow-leaved Geebung			Y	X					X											
Proteaceae	<i>Persoonia nutans</i>	Nodding Geebung	E	E1	Y								X									
Ranunculaceae	<i>Clematis aristata</i>	Mountain Clematis			Y															X		
Rosaceae	<i>Rubus fruticosus</i>	Blackberry complex			N							X					X					
Rubiaceae	<i>Richardia stellaris</i>				N			X	X	X			X		X			X				
Rutaceae	<i>Phebalium squameum</i>				Y															X	X	
Santalaceae	<i>Exocarpos cupressiformis</i>	Native Cherry			Y	X					X											
Sapindaceae	<i>Cardiospermum grandiflorum</i>	Balloon Vine			N																	X
Scrophulariaceae	<i>Gratiola pedunculata</i>	Stalked Brooklime			Y							X										
Solanaceae	<i>Solanum mauritianum</i>	Wild Tobacco Bush			N											X						X

Family name	Scientific name	Common name	EPBC Act	TSC Act	Native	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q32	Q33	Q34	Q35	Q3	Q20	Q31
Thymelaeaceae	<i>Pimelea linifolia</i>	Slender Rice-flower			Y	X																
Typhaceae	<i>Typha orientalis</i>	Broad-leaved Cumbungi			Y							X										
Verbenaceae	<i>Lantana camara</i>	Lantana			N	X	X	X			X	X				X			X	X	X	X
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop			N		X									X					X	X

Note:

3. E1 = Endangered, V = Vulnerable under the State *Threatened Species Conservation Act 1995*.

4. E = Endangered, V = Vulnerable under the Commonwealth *Environment Conservation and Biodiversity Conservation Act 1999*.

Appendix B

Threatened species of plant



Attachment B 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.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Fabaceae (Mimosoideae)	<i>Acacia bynoeana</i>	Bynoe's Wattle	V	E1	No	Grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically occurs in association with <i>Corymbia gummifera</i> , <i>Eucalyptus haemastoma</i> , <i>Eucalyptus gummifera</i> , <i>Eucalyptus parramattensis</i> , <i>Eucalyptus sclerophylla</i> , <i>Banksia serrata</i> and <i>Angophora bakeri</i> (NSW National Parks and Wildlife Service 1999a).	Moderate No historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in Project Site.
Fabaceae (Mimosoideae)	<i>Acacia prominens</i> <i>Endangered population</i>	Acacia prominens population in the Hurstville and Kogarah LGAs		E2	Yes 1 record of this species exists at Bankstown Airport	Occurs on clay, loam or sand soils, often requiring a moist, protected habitat in wet sclerophyll forest (Royal Botanic Gardens 2011). The Endangered population is known as isolated trees from a few sites at Penshurst and Oatley (Office of Environment and Heritage 2011c).	Low Only considered Endangered in the Hurstville and Kogarah LGAs.
Fabaceae (Mimosoideae)	<i>Acacia pubescens</i>	Downy Wattle	V	V	Yes 161 records exist in the locality including one near the study area from 1998	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 gravelly soils often with ironstone (Harden 2002; NSW National Parks and Wildlife Service 2003).	Moderate Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in Project Site.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Casuarinaceae	<i>Allocasuarina glauca</i>		E	E1	Yes 1 record occurs nearby at Holsworthy from 1996	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).	Low One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland within Wattle Grove Offset Area, however, this species was not recorded on the site and is unlikely to exist in a soil-stored seed bank as <i>Allocasuarina</i> species have canopy-stored seed and do not form persistent soil seed banks (Lunt 1997).
Anthericaceae	<i>Caesia parviflora</i> var. <i>minor</i>	Small Pale Grass-lily		E1	Yes 1 record near Panania	Occurs south from Corindi area where it grows in heath woodland and dry sclerophyll forest on sandstone derived soils (Harden 1993).	Low No suitable habitat for this species exists in the study area.
Orchidaceae	<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	V	E1	No	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a heathy or sometimes grassy understorey (Bishop 2000). 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 2002a).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	<i>Callistemon linearifolius</i>	Netted Bottle Brush		V	Yes 4 records exist including the Holsworthy restricted area	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 (Fairley, A. & Moore 2002; Harden 2002; Robinson 1994). Within the Sydney region, recent records are limited to the Hornsby Plateau area near the Hawkesbury River (NSW Scientific Committee 1999a).	Low No suitable habitat for this species in the study area.
Hygrophoraceae	<i>Camarophyllopsis kearneyi</i>			E1	No	Small, pale, gilled fungus and is known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002a).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Euphorbiaceae	<i>Chamaesyce psammogeton</i>	Sand Spurge		E1	No	Occurs in coastal regions of NSW where it grows on sand dunes near the sea (Harden 2000). Grows on fore-dunes and exposed headlands, often with Spinifex (<i>Spinifex sericeus</i>) (Office of Environment and Heritage 2011c).	Low No suitable habitat or historic records of this species exist in the locality.
Orchidaceae	<i>Cryptostylis hunteriana</i>	Leafless Tongue Orchid	V	V	No	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; NSW National Parks and Wildlife Service 1999b).	Low No suitable habitat or historic records of this species exist in the locality.
Asclepiadaceae	<i>Cynanchum elegans</i>	White-flowered Wax Plant	E	E1	Yes 2 records in Western Sydney Regional Parklands	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). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997b; NSW National Parks and Wildlife Service 2002b).	Low No suitable habitat for this species exists in the study area.
Myrtaceae	<i>Darwinia biflora</i>		V	V	No	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). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> and/or <i>Eucalyptus squamosa</i> . The vegetation structure is usually woodland, open forest or scrub-heath (Office of Environment and Heritage 2011c).	Low No suitable habitat or historic records of this species exist in the locality.
Poaceae	<i>Deyeuxia appressa</i>		E	E1	Yes 1 record exists near Revesby from 1930	Occurs in the Hornsby area on wet ground (Harden 1993; Sharp & Simon 2002).	Low No suitable habitat for this species exists in the study area. Thought to be restricted to the Hornsby area.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Fabaceae (Faboideae)	<i>Dillwynia tenuifolia</i>		V	V	Yes 1 record exists near Kemps Creek	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). Specifically, occurs within Castlereagh woodlands, particularly in shale gravel transition forest. Associated species include <i>Eucalyptus fibrosa</i> , <i>Eucalyptus sclerophylla</i> , <i>Melaleuca decora</i> , <i>Daviesia ulicifolia</i> , <i>Dillwynia juniperina</i> and <i>Allocasuarina littoralis</i> (James 1997b).	Moderate One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site.
Orchidaceae	<i>Diuris aequalis</i>	Buttercup Doubletail	V	E1	Yes 1 record exists from 1905 near Hoxton Park	Occurs chiefly in the ranges and tablelands from Braidwood to Kanangra and Liverpool where it grows among grass in sclerophyll forest (Harden 1993). It typically occurs on gentle slopes, in gravely clay-loam soil within montane eucalypt forest with a grass or heath understorey (Bishop 2000). Three small populations are known to occur within Kanangra Boyd National Park, other populations are restricted to remnant vegetation within roadsides and agricultural lands (NSW Scientific Committee 2002b).	Low No suitable habitat for this species exists in the study area and this species hasn't been found nearby since 1905.
Ericaceae	<i>Epacris purpurascens</i> var. <i>purpurascens</i>			V	Yes 4 records exist nearby at Bankstown	Occurs in the Gosford and Sydney districts where it grows in sclerophyll forest, scrub and swamps (Harden 1992). Usually found in sites with a strong shale influence (NSW National Parks and Wildlife Service 2002c).	Low Species not associated with the vegetation communities of the site.
Myrtaceae	<i>Eucalyptus camfieldii</i>	Heart-leaved Stringybark	V	V	Yes 1 record exists in the Georges River NP in Sutherland	Restricted distribution in a narrow band with the most northerly records in the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park (Office of Environment and Heritage 2011b). Occurs within poor coastal country in shallow sandy soils overlying Hawkesbury sandstone. Coastal heath mostly on exposed sandy ridges.	Low No suitable habitat for this species exists in the study area.
Myrtaceae	<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	V	V	Yes 1 record exists near Warwick Farm	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. Endemic on the NSW Northern Tablelands, of limited occurrence, particularly in the area from Walcha to Glen Innes; often on porphyry or granite (Brooker & Kleinig 1999; Office of Environment and Heritage 2011a).	Low This New England Tableland species is not native to the Sydney area and is planted near Warwick Farm.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Myrtaceae	<i>Eucalyptus scoparia</i>		V	E1	Yes 1 record exists near Hoxton Park	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 2011).	Low This New England Tableland species is not native to the Sydney area and is planted near Hoxton Park.
Orchidaceae	<i>Genoplesium baueri</i>	Bauer's Midge Orchid		V	No	Grows in sparse sclerophyll forest and moss gardens over sandstone; from the Hunter Valley to Nowra district (Royal Botanic Gardens 2011).	Low No suitable habitat or historic records of this species exist in the locality.
Grammitaceae	<i>Grammitis stenophylla</i>	Narrow-leaf Finger Fern		E1	No	Fern which occurs in coastal regions from Queensland to the NSW south coast where it grows in moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest (Harden 2000).	Low No suitable habitat or historic records of this species exist in the locality.
Proteaceae	<i>Grevillea parviflora</i> subsp. <i>parviflora</i>	Small-flower Grevillea	V	V	Yes 2 records exist near the study area with a recent record from 2002	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 (Harden 2002; NSW Scientific Committee 1998a).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in the Project Site.
Gyrostemonaceae	<i>Gyrostemon thesioides</i>			E1	Yes 31 records exist with the closest to the study area from Ingleburn	Confined to the Colo, Georges and Nepean Rivers where it occurred on river banks. It is a fire-opportunist (James 1997b; NSW Scientific Committee 1998b; Royal Botanic Gardens 2011).	Low Not recorded on the Georges River for 30 years despite searches (Office of Environment and Heritage 2011c).
Haloragaceae	<i>Haloragodendron lucasii</i>		E	E1	No	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone (Harden 2002). 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 (Office of Environment and Heritage 2011c).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Dilleniaceae	<i>Hibbertia sp. Bankstown</i>		CE	E4A	Yes 1 record exists nearby at Bankstown Airport	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 LGA. The species is not known from any conservation reserves. The population comprises fewer than 50 individuals.	Low The only population is known from Bankstown Airport.
Dilleniaceae	<i>Hibbertia superans</i>			E1	No	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 <i>Pimelea curviflora</i> var. <i>curviflora</i> , <i>Darwinia biflora</i> , <i>Epacris purpurascens</i> var. <i>purpurascens</i> , <i>Leucopogon fletcheri</i> subsp. <i>fletcheri</i> , <i>Acacia bynoeana</i> , <i>Eucalyptus</i> sp. <i>Cattai</i> and <i>Persoonia hirsuta</i> (NSW Scientific Committee 2001).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe anomala</i> var. <i>ianthinomarginata</i>			V	No	Small, brightly-coloured gilled fungus and has been found in Lane Cove Bushland Park in the Lane Cove LGA in Sydney, and from Royal and Blue Mountains National Parks (NSW National Parks and Wildlife Service 2002d).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe aurantipes</i>			V	No	Small, brightly-coloured gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney and from the Blue Mountains National Park and Hazelbrook (NSW National Parks and Wildlife Service 2002e).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe austropratensis</i>			E1	No	Small, brightly-coloured gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002f).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe collucera</i>			E1	No	Small, brightly-coloured red gilled fungus known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002g).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe griseoramosa</i>			E1	No	Small, buff to brown gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002h).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Hygrophoraceae	<i>Hygrocybe lanecovens</i>			E1	No	Small, brightly-coloured gilled fungus known only from its type locality in Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002i).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe reesia</i>			V	No	Small, lilac coloured gilled fungus known in New South Wales only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney, and from the Blue Mountains National Park. It is also found in Tasmania (NSW National Parks and Wildlife Service 2002j).	Low No suitable habitat or historic records of this species exist in the locality.
Hygrophoraceae	<i>Hygrocybe rubronivea</i>			V	No	Small, brightly-coloured gilled fungus and is known only from its type locality in the Lane Cove Bushland Park in the Lane Cove LGA in Sydney (NSW National Parks and Wildlife Service 2002k).	Low No suitable habitat or historic records of this species exist in the locality.
Lobeliaceae	<i>Hypsela sessiliflora</i>		X	E1	No	Previously thought to be extinct, recently rediscovered in Erskine Park on the Cumberland Plain in western Sydney. Past records include Homebush and South Creek in Blacktown LGA (James 1997b). It has been reported from damp places (NSW Scientific Committee 2003a) such as river banks (James 1997b). Specifically it is known to occur within Sydney Coastal River-flat Forest (Upper Parramatta River Catchment Trust 1999).	Low Marginal habitat present, however no historic records of this species exist in the locality.
Ericaceae	<i>Leucopogon exolasius</i>	Woronora Beard-heath	V	V	Yes 3 records exist nearby with a record near the study area from the year 2000	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 2011).	Moderate Marginal habitat for this species exists in the Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in the Project Site.
Ericaceae	<i>Leucopogon fletcheri</i> subsp. <i>fletcheri</i>			E1	Yes 1 record exists on the Holsworthy prohibited area	Grows in dry eucalypt woodland or in shrubland on clay, lateritic soils or Hawkesbury sandstone (Fairley, Alan 2004). Found on sandstone ridges and upper slopes in heath or woodland, sometimes in or below sandstone-shale ecotone; often associated with lateritic soils with some clay influence (James 1997a; James <i>et al.</i> 1999).	Low Species not associated with the vegetation communities of the site.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Asclepiadaceae	<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> Endangered population	<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith LGAs		E2	Yes 10 records from Hoxton Park, Prestons and Potts Hill	<i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> has a wide distribution in subcoastal and southern Queensland but has been recorded rarely in NSW and from a disjunct occurrence near Sydney. The Endangered <i>Marsdenia viridiflora</i> subsp. <i>viridiflora</i> population occurs as very scattered plants in areas of remnant vegetation (NSW Scientific Committee 2000a).	Low No suitable habitat recorded within the study area.
Juncaginaceae	<i>Maundia triglochinosides</i>	-		V	No	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 <i>Triglochin procerum</i> (Harden 1993).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	<i>Melaleuca biconvexa</i>	Biconvex Paperbark	V	V	No	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 1998c). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Harden 2002).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	<i>Melaleuca deanei</i>	Deane's Paperbark	V	V	Yes 14 records exist in the locality with 6 occurring at Sandy Point	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 (Harden 2002; James 1997b).	Low No suitable habitat for this species exists in the study area.
Proteaceae	<i>Persoonia hirsuta</i>	Hairy Geebung	E	E1	Yes 3 records exist near Holsworthy	Occurs in central coast and central tableland districts where it grows in woodland to dry sclerophyll forest on sandstone (Harden 2002) and rarely shale (NSW Scientific Committee 1998d). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997b; Office of Environment and Heritage 2011c).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in the Project Site.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Proteaceae	<i>Persoonia nutans</i>	Nodding Geebung	E	E1	Yes 31 records exist near the study area including a recent record from 2002	Confined to the western Sydney where it grows in Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (Harden 2002; James 1997b; NSW National Parks and Wildlife Service 2001).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in Project Site.
Thymelaeaceae	<i>Pimelea curviflora</i> var. <i>curviflora</i>		V	V	No	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. Usually occurs in woodland in the transition between shale and sandstone (Harden 2000; James 1997b; James <i>et al.</i> 1999; NSW Scientific Committee 1998e).	Low No suitable habitat or historic records of this species exist in the locality.
Thymelaeaceae	<i>Pimelea spicata</i>	Spiked Rice-flower	E	E1	Yes 39 records exist in the locality with records from Glenfield in 2004.	In western Sydney, <i>Pimelea spicata</i> grows on Wianamatta Shales in Greybox - Ironbark Woodland with <i>Bursaria spinosa</i> and <i>Themeda australis</i> (Harden 2000; James 1997b; NSW National Parks and Wildlife Service 2000).	Low Species not associated with the vegetation communities of the site.
Rhamnaceae	<i>Pomaderris brunnea</i>		V	V	No	Confined to the Colo and Upper Nepean Rivers where it grows in open forest (Harden 2000); in western Sydney (Camden to Picton area) known from sandy alluvium on levee and creek banks (James 1997b).	Low No suitable habitat or historic records of this species exist in the locality.
Rhamnaceae	<i>Pomaderris prunifolia</i> Endangered population	<i>Pomaderris prunifolia</i> population in the Parramatta, Auburn, Strathfield and Bankstown LGAs		E2	Yes 3 records exist near Bankstown Airport and in Sutherland	Occurs on rocky slopes, often along creeks (Harden 2000). Within Parramatta, Auburn, Strathfield and Bankstown LGAs, the only recent record of this species is from Rydalmere, where only 3 plants occur (NSW Scientific Committee 1999b).	Low N/A - The Endangered population is restricted to the Parramatta, Auburn, Strathfield and Bankstown LGAs
Orchidaceae	<i>Pterostylis gibbosa</i>		E	E1	Yes 1 record exists near Menai found in 1949	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest (Harden 2002).	Low No suitable habitat for this species exists in the study area.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Orchidaceae	<i>Pterostylis nigricans</i>	Dark Greenhood		V	Yes 1 record exists near Prestons from 1967	Grows in coastal heathland with <i>Banksia ericifolia</i> , and lower-growing heath with lichen-encrusted and relatively undisturbed soil surfaces, on sandy soils (Bishop 2000; Royal Botanic Gardens 2011).	Low No suitable habitat for this species exists in the study area.
Orchidaceae	<i>Pterostylis saxicola</i>	Sydney Plains Greenhood	E	E1	Yes 5 records exist near the Holsworthy restricted area including a record from 2007	Grows in Sydney Sandstone Gully Forest in shallow or skeletal soils over sandstone shelves, often near streams (Harden 1993; James 1997b; Office of Environment and Heritage 2011c)	Low No suitable habitat for this species exists in the study area.
Fabaceae (Faboideae)	<i>Pultenaea parviflora</i>	Sydney Bush-pea	V	E1	Yes 1 record exists at Potts Hill	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale/Gravel Transition Forest on tertiary alluvium or laterised clays (James 1997b; NSW National Parks and Wildlife Service 2002l).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the Project Site. Unlikely to occur elsewhere in Project Site.
Fabaceae (Faboideae)	<i>Pultenaea pedunculata</i>	Matted Bush-pea		E1	Yes 23 records exist near Hoxton Park, Prestons and Potts Hill	Restricted to Wianamatta Shales of the Cumberland Plain from Bankstown to Liverpool and on the South Coast in the Southeast Corner Bioregion at Bournda. It grows on a variety of soils in dry sclerophyll forest and disturbed sites (Harden 2000; NSW National Parks and Wildlife Service 2002m; NSW Scientific Committee 1999c).	Low No suitable habitat or historic records of this species exist in the locality.
Myrtaceae	<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V	E1	No	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). On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Office of Environment and Heritage 2011c).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	Recorded in locality ³	Preferred Habitat	Likelihood of occurrence in study area
Elaeocarpaceae	<i>Tetratheca glandulosa</i>		V	V	No	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest (Office of Environment and Heritage 2011c).	Low No suitable habitat or historic records of this species exist in the locality.
Orchidaceae	<i>Thelymitra sp. Kangaloon</i>	Kangaloon Sun Orchid	CE		No	The Kangaloon Sun-orchid is known from three locations near Robertson in the Southern Highlands. The Kangaloon Sun-orchid has an estimated area of occupancy of 10 km ² . The three localities are Butler's Swamp, Stockyard Swamp (once known as Molly Morgan Swamp) and Wildes Meadow Swamp. All swamps are located above what is known as the Kangaloon Aquifer (Department of the Environment Water Heritage and the Arts 2009).	Low No suitable habitat or historic records of this species exist in the locality. <i>Thelymitra sp. Kangaloon</i> is only found in upland swamps near the town of Kangaloon.
Campanulaceae	<i>Wahlenbergia multicaulis</i> <i>Endangered population</i>	Tadgell's Bluebell population in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs		E2	No	Occurs in coastal and tableland districts south from Sydney and the Blue Mountains west along the Murray River to Mathoura where it grows in a variety of habitats including forest, woodland, grassland (Harden 1992), forest, scrub and the edges of watercourses and wetlands. It is a coloniser and typically occurs in damp, disturbed sites (NSW Scientific Committee 2003b).	Low N/A - Only considered Endangered in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs
Convolvulaceae	<i>Wilsonia backhousei</i>	Narrow-leaved <i>Wilsonia</i>		V	Yes 2 records exist near Bankstown Airport and Revesby	Occurs chiefly in the Sydney district but also common at Jervis Bay (Harden 2000). A salt tolerant species, it is found in intertidal saltmarshes and sometimes on seacliffs (NSW Scientific Committee 2000b).	Low No suitable habitat for this species exists in the study area.

Notes:

1. EPBC Act - *Environment Protection and Biodiversity Conservation Act 1999*. X = Extinct, CE = Critically Endangered, E = Endangered V = Vulnerable
2. TSC Act - *Threatened Species and Conservation Act 1995*. E4A = Extinct, CE = Critically Endangered, E1 = Endangered V = Vulnerable E2= Endangered Population,
3. Based on database searches and field surveys

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Appendix C

Threatened species of animal



Attachment C Threatened species of animal

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

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
Amphibians							
<i>Heleioporus australiacus</i>	Giant Burrowing Frog	V	V		Yes 2 records exist in the locality in the Holsworthy restricted area	The Giant Burrowing Frog has a marked preference for sandstone ridgetop habitat and broader upland valleys. In these locations, the frog is associated with small headwater creeklines and along slow flowing to intermittent creeklines. They have also been observed occupying artificial ponded structures including dams, detention basins and box drains that are still surrounded by undisturbed habitat. Does not appear to inhabit areas that have been cleared for agriculture or for urban development. (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	Low Habitat unsuitable
<i>Litoria aurea</i>	Green and Golden Bell Frog	V	E1		Yes 30 records exist in the locality including 2 near the study area	For breeding the Green and Golden Bell Frog uses waterbodies including natural and man-made structures (marshes, dams and stream sides, and ephemeral pools). Also, found in small pockets of habitat in developed areas. Habitat attributes associated with preferred waterbodies 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 (Department of Environment and Conservation 2004, 2005).	Low Marginal habitat and local records in Holsworthy area however local population considered likely to be extinct (White & Pyke 2010). Not detected despite targeted surveys conducted in ideal conditions (Parsons Brinckerhoff 2011).
<i>Litoria littlejohni</i>	Heath Frog	V	V		No	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest south to Buchan in north-eastern Victoria. It is restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Litoria raniformis</i>	Southern Bell Frog	V	E1		No	Usually found in or around permanent or ephemeral Black Box/Lignum/Nitre Goosefoot swamps, Lignum/Typha swamps and River Red Gum swamps or billabongs along floodplains and river valleys. They are also found in irrigated rice crops, particularly where there is no available natural habitat (Office of Environment and Heritage 2011c)	Low No suitable habitat or historic records of this species exist in the locality.
<i>Mixophyes balbus</i>	Stuttering Frog	V	E1		No	A Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	Low No suitable habitat or historic records of this species exist in the locality.
<i>Pseudophryne australis</i>	Red-crowned Toadlet		V		Yes 7 records exist in the locality in the Holsworthy restricted area	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).	Low Habitat unsuitable
Fish							
<i>Macquaria australasica</i>	Macquarie Perch	E		E	No	The natural range of Macquarie Perch included the upper and middle reaches of the Murray-Darling basin as well as the Shoalhaven and Hawkesbury Rivers. However, this species has recently been sighted in only a few localities within these river systems. Preferred habitat is deep holes covered with rocks, and spawning occurs above shallow running water. Macquarie Perch is a schooling species (Department of the Environment and Heritage 2004).	Low No suitable habitat or historic records of this species exist in the locality.
<i>Prototroctes maraena</i>	Australian Grayling	V		P	No	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).	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the Georges River.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
Invertebrates							
<i>Meridolum corneovirens</i>	Cumberland Land Snail		E1		Yes 208 records exist within the locality including records within the study area	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 1999b).	Moderate Species was apparently recorded on site in 2006 (Office of Environment and Heritage 2012a) however it was not detected in targeted surveys in 2010. May be present on site in low numbers or have gone extinct on site. Mistaken identity is also a possibility as this species is sometimes confused with some colour variants of the exotic Asian Tramp Snail <i>Bradybaena similis</i> which was recorded on the site in 2010 surveys.
<i>Archaeophya adamsi</i>	Adam's Emerald Dragonfly			E	No	Only five adults have ever been collected, and the species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation (Department of Primary Industries 2014).	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the degraded sections of the Georges River or Anzac Creek within or adjacent to the Project site.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Austrocordulia leonardi</i>	Sydney Hawk Dragonfly			E	No	The Sydney Hawk dragonfly has specific habitat requirements, and has only ever been collected from deep and shady river pools with cooler water. Larvae are found under rocks where they coexist with the Eastern Hawk dragonfly. It has a very restricted distribution including three locations in a small area south of Sydney, from Audley to Picton. The species is known from the Hawkesbury-Nepean, Georges River, Port Hacking and Karuah drainages (Department of Trade and Investment Regional Infrastructure and Services 2011).	Low No suitable habitat or historic records of this species exist in the locality. Unlikely to occur in the degraded sections of the Georges River or Anzac Creek within or adjacent to the Project site.
Birds							
<i>Anthochaera phrygia</i>	Regent Honeyeater	EM	CE		Yes 6 records exist in the locality including near Warwick farm and Revesby	Occurs mostly in box-ironbark forests and woodland and prefers the wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Important food trees include <i>Eucalyptus sideroxylon</i> , <i>Eucalyptus albens</i> , <i>Eucalyptus melliodora</i> and <i>Eucalyptus leucoxylon</i> (Garnett & Crowley 2000a).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records are present. May forage sporadically on the site in winter but unlikely to breed locally. Unlikely elsewhere in the study area.
<i>Apus pacificus</i>	Fork-tailed Swift	M			No	Breeds from central Siberia eastwards through Asia, and is migratory, wintering south to Australia. Individuals never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks (Higgins 1999).	Moderate Marginal habitat present.
<i>Ardea ibis</i>	Cattle Egret	M			Yes 2 records exist near the study area	The Cattle Egret is found across the Indian subcontinent and Asia as far north as Korea and Japan, and in South-east Asia, Papua New Guinea and Australia (McKilligan 2005).	Moderate Marginal habitat and local records present.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Ardea modesta</i>	Eastern Great Egret	M			Yes 11 records exist in the locality near the Georges River	Great Egrets are common throughout Australia, with the exception of the most arid areas. Great Egrets prefer shallow water, particularly when flowing, but may be seen on any watered area, including damp grasslands. Great Egrets can be seen alone or in small flocks, often with other egret species (Australian Museum 2003).	Moderate Marginal habitat and local records present.
<i>Burhinus grallarius</i>	Bush Stone-curlew		E1		Yes 4 records exist in the locality near Bankstown Airport in 1996 and Hoxton Park in 1950	Require sparsely grassed, lightly timbered, open forest of woodland. In southern Australia they often occur where there is a well-structured litter layer and fallen timber debris. Feed on a range of invertebrates and small vertebrates, as well as seeds and shoots (NSW National Parks and Wildlife Service 1999a, 2003b).	Low Poor quality habitat and few recent records of this species exist in the locality.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo		V		Yes 3 records exist in the locality with a record near the Georges River from 2006.	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 & Knight 2007).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site, particularly in winter but unlikely to breed locally.
<i>Callocephalon fimbriatum</i> <i>Endangered population</i>	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai LGAs		E2		No	A population of Gang-gang Cockatoos found in the Hornsby and Ku-ring-gai LGAs.	N/A Endangered population is only listed in the Hornsby and Ku-ring-gai LGAs but birds are likely to disperse to other areas including the study area.
<i>Calyptrorhynchus lathamii</i>	Glossy Black-Cockatoo		V		No	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 & Crowley 2000a; NSW National Parks and Wildlife Service 1999c).	Low No suitable habitat for this species exists in the study area.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Circus assimilis</i>	Spotted Harrier		V		Yes 1 record exists at Hoxton Park	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 & Higgins 1993). It is found mostly commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands (Department of Environment Climate Change and Water 2010c).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
<i>Climacteris picumnus victoriae</i>	Brown Treecreeper (eastern subsp)		V		Yes 1 record exists near Menai	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 (Office of Environment and Heritage 2011b).	Low One local record only. Species likely to be extinct in the locality as it is considered to be virtually extinct on the Cumberland Plain (Department of Environment and Climate Change 2007).
<i>Daphoenositta chrysoptera</i>	Varied Sittella		V		Yes 28 records exist in the locality with recent records near the study area	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 (Department of Environment Climate Change and Water 2010d).	Moderate The Varied Sittella is relatively common within the Greater Southern Sydney Region (Department of Environment and Climate Change 2007). May occur in the woodland vegetation throughout the offset areas. Unlikely elsewhere in the study area.
<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork		E1		Yes 1 record exists near Revesby from 1978	Feed in shallow water up to 0.5 m deep on fish, reptiles and frogs. Build nests in trees close to feeding sites (Garnett & Crowley 2000a).	Low No suitable habitat for this species exists in the study area.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Epthianura albifrons</i>	White-fronted Chat		V		Yes 2 records exist from the Holsworthy restricted area and the Georges River NP at Sutherland	The White-fronted Chat occupies foothills and lowlands below 1000 m above sea level. 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. 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 (Department of Environment Climate Change and Water 2009; Higgins <i>et al.</i> 2001; Pizzey & Knight 2007).	Low No suitable habitat for this species exists in the study area.
<i>Epthianura albifrons</i> <i>Endangered population</i>	White-fronted Chat in the Sydney Metropolitan Catchment Management Authority Area		E2		Yes 2 records exist from the Holsworthy restricted area and the Georges River NP at Sutherland	As above for the White-fronted Chat	Low No suitable habitat for this species exists in the study area.
<i>Gallinago hardwickii</i>	Latham's Snipe	M			Yes 51 records exist in the locality around the Bankstown Airport	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 & Crowley 2000a).	Moderate Marginal habitat and local records present.
<i>Glossopsitta pusilla</i>	Little Lorikeet		V		Yes 13 records exist in the locality with 5 records near the study area from 2006.	The Little Lorikeet is found in forests, woodland, and in 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).	High Potential habitat and local records present. A nomadic species which may forage in the study area, particularly in the areas that contains flowering Eucalypts.
<i>Grantiella picta</i>	Painted Honeyeater		V		No	Lives in dry forests and woodlands. Primary food is the mistletoes in the genus <i>Amyema</i> , though it will take some nectar and insects. Its breeding distribution is dictated by presence of mistletoes which are largely restricted to older trees (Garnett & Crowley 2000a).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	M			Yes 3 records exist in the locality along the Georges River	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a large nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 2007).	Moderate Marginal habitat and local records present.
<i>Hieraaetus morphnoides</i>	Little Eagle		V		Yes 19 records exist in the locality with a record near the study area from 2006	The Little Eagle is distributed throughout the Australian mainland occupying habitats rich in prey within open eucalypt forest, woodland or open woodland. She-oak 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 (Marchant & Higgins 1993).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
<i>Hirundapus caudacutus</i>	White-throated Needletail	M			Yes 4 records exist in the locality near the Georges River and near the study area	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 & Knight 2007).	High Potential habitat and local records present.
<i>Lathamus discolor</i>	Swift Parrot	E	E1		Yes 11 records exist in the locality with a record near the study area from 1998	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 Daringa. On mainland Australia, the Swift Parrot 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 <i>Acacia pycnantha</i> , is indicated. Sites used vary from year to year. (Garnett & Crowley 2000a; Swift Parrot Recovery Team 2001).	Moderate Marginal habitat present in the Alluvial Woodland of the Georges River riparian corridor and local records present. May forage sporadically on the site in winter but extremely unlikely to breed locally.
<i>Limosa limosa</i>	Black-tailed Godwit	M	V		No	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 & Knight 2007).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Lophoictinia isura</i>	Square-tailed Kite		V		Yes 2 records exist in the locality from near Revesby and the Holsworthy restricted area as recently as 2006	The Square-tailed Kite hunts primarily over open forest, woodland and mallee communities as well as over adjacent heaths and other low scrubby habitats in wooded towns. It feeds on small birds, their eggs and nestlings as well as insects and seems to prefer structurally diverse landscapes (Garnett & Crowley 2000a). The species shows a particular preference for timbered watercourses and appears to occupy large hunting ranges of more than 100km ² . Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (Office of Environment and Heritage 2012b).	Moderate Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.
<i>Melanodryas cucullata</i>	Hooded Robin		V		No	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 (Garnett & Crowley 2000a).	Low Marginal quality habitat and no historic records of this species exist in the locality. Considered near extinct on the Cumberland Plain (Department of Environment and Climate Change 2007).
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater		V		Yes 7 records exist in the locality near Warwick Farm	Occurs within areas of annual rainfall between 400-700 mm. Feed on insects, nectar and lerps (Garnett & Crowley 2000b). 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).	Moderate Marginal quality habitat in Alluvial Woodland. Considered rare in the region and is nomadic (Department of Environment and Climate Change 2007). May forage in the study area when dominant eucalypts are in flower and possibly breed along the Georges River, unlikely elsewhere in the study area.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Merops ornatus</i>	Rainbow Bee-eater	M			No	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	Low Marginal habitat and no historic records of this species exist in the locality.
<i>Monarcha melanopsis</i>	Black-faced Monarch	M			Yes 8 records exist in the locality along the Georges River	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp gullies in rainforest, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.
<i>Myiagra cyanoleuca</i>	Satin Flycatcher	M			Yes 2 records exist in the locality at Hoxton Park and Warwick Farm	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 1997).	Moderate Marginal habitat and local records present.
<i>Ninox connivens</i>	Barking Owl		V		Yes 1 record exists in the locality near Warwick Farm	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 (Garrett & Crowley 2000a).	Moderate Very rare in the region but considered to be widespread (Department of Environment and Climate Change 2007). Marginal potential breeding habitat present in the Alluvial Woodland of the Georges River riparian corridor and foraging habitat along forest edges. May forage occasionally on the site as part of a much larger territory extending well beyond the study area.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Ninox strenua</i>	Powerful Owl		V		Yes 7 records exist in the locality with a record near the study area (Leacock Regional Park) from 2006	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 dense vegetation including rainforest and 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 & Crowley 2000a).	Moderate Relatively common in the region (Department of Environment and Climate Change 2007). Potential breeding and foraging habitat present in the Alluvial Woodland of the Georges River riparian corridor as part of a much larger territory extending well beyond the study area.
<i>Petroica boodang</i>	Scarlet Robin		V		Yes 2 records exist in the locality in the Holsworthy restricted area near the study area from 2006	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 open habitats such as grassy open woodland or paddocks with scattered trees (Department of Environment Climate Change and Water 2010b; Higgins & Peter 2002).	Moderate Marginal habitat and local records present. Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the study area only.
<i>Petroica phoenicea</i>	Flame Robin		V		Yes 3 records exist in the locality near Revesby in 1992 and the Holsworthy restricted area from 1996	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 & Peter 2002). 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 2010a).	Moderate Marginal habitat and local records present (Department of Environment and Climate Change 2007). Likely only as a non-breeding migrant. Likely in the Alluvial Woodland of the study area only.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Petroica rodinogaster</i>	Pink Robin		V		Yes 1 record exists in the locality the Georges River NP from 1972	Found in open forest and woodland including native tea-tree scrubs. Rarely found in open cleared areas. Breeds in dense gullies in temperate rainforests (Pizzey & Knight 1997).	Low One local record only. Species likely to occur in the locality as very rare visitor only (Department of Environment and Climate Change 2007).
<i>Pyrrholaemus sagittatus</i>	Speckled Warbler		V		Yes 1 record exists in the locality near Hoxton Park	The Speckled Warbler 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 & Crowley 2000a).	Low One local record only. Species very rare in the locality (Department of Environment and Climate Change 2007). Likely to be locally extinct.
<i>Rhipidura rufifrons</i>	Rufous Fantail	M			Yes 54 records exist in the locality near the Georges River and in Sutherland	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 1997).	High Potential habitat and local records present.
<i>Rostratula australis</i>	Australian Painted Snipe	VM	E1		No	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as <i>Eucalyptus camaldulensis</i> , <i>Eucalyptus populnea</i> or shrubs such as <i>Muehlenbeckia florulenta</i> or <i>Sarcocornia quinqueflora</i> . Feeds at the water's edge and on mud flats, on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000a).	Low No suitable habitat or historic records of this species exist in the locality.
<i>Stagonopleura guttata</i>	Diamond Firetail		V		No	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. Feed on seeds, mostly of grasses (Garnett & Crowley 2000a).	Low Poor quality habitat and no historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
Mammals							
<i>Cercartetus nanus</i>	Eastern Pygmy-possum		V		Yes 2 records exists in the locality near the Georges River, recorded in 1993	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 hollows, between the wood and bark of a tree, abandoned birds' nests and/or shredded bark in the fork of trees (Turner & Ward 1995).	Moderate Marginal habitat and local records present. Likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V		No	Occurs in moderately wooded habitats and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins. Thought to forage below the forest canopy for small flying insects (Churchill 2008).	Low No suitable habitat or historic records of this species exist in the locality.
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	E	V		Yes 4 records occur in the Holsworthy restricted area and in the Georges Rover National Park	In NSW, the Spotted-tailed Quoll occurs on both sides of the Great Dividing Range. 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 heath. Nests in rock caves and hollow logs or trees (NSW National Parks and Wildlife Service 1999e, 1999g).	Moderate Marginal habitat and local records present. Moderately likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle		V		Yes 9 records exist in the locality near Sandy Point and to the east of the study area	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).	Moderate Species recorded locally from ultrasonic calls only which may be misidentifications and predictive habitat quality mapping shows the locality with a low probability of occurrence (Department of Environment and Climate Change 2007).

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Miniopterus schreibersii</i>	Eastern Bent-wing Bat	C	V		Yes 11 records exist in the locality near Glenfield, Warwick Farm and Sutherland	Usually found in well-timbered valleys where it forages on small insects above the canopy. Roosts in caves, old mines, stormwater channels and sometimes buildings and often return to a particular nursery cave each year (Churchill 2008).	High The Eastern Bentwing-bat is common and widespread within the greater southern Sydney Region and is a lower conservation priority overall, with the exception of roosting and nursery sites (Department of Environment and Climate Change 2007). Potential foraging habitat present. Marginal roosting habitat may be present in artificial structures. Nursery sites very unlikely.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Mormopterus norfolkensis</i>	Eastern Free-tail bat		V		Yes 26 records exist in the locality near the study area and at Glenfield	The Eastern Freetail-bat is found along the east coast from south Queensland to southern NSW. Occur in dry sclerophyll forest and woodland east of the Great Dividing Range. Roost mainly in tree hollows but will also roost under bark or in man-made structures (Churchill 2008). It will travel and forage in open country or along creek lines and may utilise remnants too isolated or disturbed for many other species. (Department of Environment and Climate Change 2007).	High Local records exist in the locality and potential habitat present, chiefly in Alluvial Woodland along the Georges River Corridor however may also occur elsewhere in the site including in mature isolated trees and patches of disturbed woodland. The Eastern Free-tail bat is rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence (Department of Environment and Climate Change 2007). Potential foraging and roost/breeding habitat present mainly in Alluvial woodland along the Georges River.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Myotis adversus</i>	Large-footed Myotis		V		Yes 10 records exist in the locality including at Glenfield	Colonies occur in caves, mines, tunnels, under bridges and buildings. Colonies always occur close to bodies of water where this species feeds on aquatic insects (Churchill 2008).	High Within the Greater Southern Sydney Region, the Large-footed Myotis is strongly associated with the Cumberland Plain where it utilises waterways in relatively disturbed environments including the Georges River catchment around Liverpool and Campbelltown (Department of Environment and Climate Change 2007). Potential foraging and roost/breeding habitat present mainly in Alluvial woodland along the Georges River.
<i>Perameles nasuta</i> Endangered Inner Western Sydney population	Long-nosed Bandicoot population, Inner Western Sydney		E2		Yes Restricted to the Marrickville and Canada Bay LGAs. May also be found in Canterbury, Ashfield and Leichhardt LGAs	Occurs in a range of habitats from rainforest through wet and dry woodland areas with little ground cover. Nests in a shallow hollow on the surface of the ground (Strahan 1995). The Endangered Inner Western Sydney population is restricted to the LGAs of Marrickville and Canada Bay, with the likelihood that it also includes Canterbury, Ashfield and Leichhardt LGAs.	N/A While Long-nosed Bandicoots are likely to occur in the study area they would not be considered part of the Endangered Inner Western Sydney Population

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Petaurus australis</i>	Yellow-bellied Glider		V		Yes 1 record exists in the locality on the Georges River National Park near Menai	Restricted to tall, mature eucalypt forest in high rainfall areas of temperate to sub-tropical eastern Australia. Feeds on nectar, pollen, the sap of eucalypts and sometimes insects. Preferred habitats are productive, tall open sclerophyll forests where mature trees provide shelter and nesting hollows and year round food resources are available from a mixture of eucalypt species (NSW National Parks and Wildlife Service 1999h, 2003d).	Low One local record only. Species likely to be extinct in the study area or record a misidentification. Predictive habitat modelling shows to area with a low probability of occurrence (Department of Environment and Climate Change 2007).
<i>Petaurus norfolcensis</i>	Squirrel Glider		V		Yes 1 record exists in the locality near the study area along the Georges River.	Found in dry sclerophyll forest and woodland but not found in dense coastal ranges. Nests in hollows and feeds on gum of acacias, eucalypt sap and invertebrates (NSW National Parks and Wildlife Service 1999f).	Moderate Marginal habitat and one local record only. Comprehensive surveys of the Cumberland Plain detected this species at only two locations one of which was at Holsworthy Army Reserve (Department of Environment and Climate Change 2007). If present, likely to be restricted to the Georges River Corridor as other areas too disturbed and fragmented.
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	V	E1		Yes 1 record exists in the locality in the Holsworthy restricted area	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 each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003a).	Low Inappropriate habitat and one local record only. Likely to be locally extinct.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Phascolarctos cinereus</i>	Koala	V	V		Yes 97 records exist in the locality including a record near the study area from 2005	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. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include <i>Eucalyptus tereticornis</i> , <i>Eucalyptus punctata</i> , <i>Eucalyptus cypellocarpa</i> and <i>Eucalyptus viminalis</i> (NSW National Parks and Wildlife Service 1999d, 2003c).	Moderate The species is frequently recorded in the locality along the transition of the Cumberland Plain and coastal sandstone areas in an area known as the Cumberland Koala Linkage which includes areas immediately adjacent to the southern end of the site (Department of Environment and Climate Change 2007).
<i>Potorous tridactylus</i>	Long-nosed Potoroo	V	V		No	In NSW, the Long-nosed Potoroo 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 (Johnston 1995; NSW National Parks and Wildlife Service 1999g).	Low No suitable habitat or historic records of this species exist in the locality.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse	E			No	The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (<i>Mus musculus</i>), 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).	Low Marginal habitat and no local records present.

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V	V		Yes 88 records exist in the locality including many near the study area	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 lilly pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b)	Recorded Within the Greater Southern Sydney Region there is one large and regularly used Flying-fox camp site on Cabramatta Creek (Department of Environment and Climate Change 2007). Recorded flying overhead and likely to forage throughout the study area. Vegetation along the Georges River is most suitable as foraging habitat and may have potential for roosting.
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat		V		Yes 4 records exist in the locality including at Sandy Point and to the south east of the study area	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 in tree hollows. Thought to be migratory (Churchill 2008).	Moderate A rarely detected species however, Anabat ultrasonic call records have been made around the Holsworthy Military Area. The habitat and distribution of this species is very poorly known and it may occur regularly within the locality or only occur as a summer visitor (Department of Environment and Climate Change 2007).

Scientific Name	Common Name	EPBC Act ¹	TSC Act ²	FM Act ³	Recorded in locality ⁴	Preferred Habitat ⁵	Likelihood of occurrence
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat		V		Yes 12 records exist in the locality with 5 records near the study area along the Georges River and at Glenfield	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).	High Local records exist in the locality and potential habitat present along the Georges River Corridor. Rarely recorded within the greater southern Sydney Region and predictive habitat quality mapping shows the locality with a medium to high probability of occurrence. (Department of Environment and Climate Change 2007).
Reptiles							
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	V	E1		No However, records exist in the Holsworthy restricted area	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 & Shine 1998).	Low Marginal habitat local records restricted to sandstone soils of the Holsworthy range. Study site within an area mapped with low probability of occurrence (Department of Environment and Climate Change 2007).
<i>Varanus rosenbergi</i>	Heath Monitor		V		Yes 2 records exist in the locality near Menai and Lucas Heights	Found in coastal heaths, humid woodlands, and wet and dry sclerophyll forests. Mostly a terrestrial species it shelters in burrows, hollow logs and rock crevices (Cogger 2000).	Low Marginal habitat and few local records present. Site mapped as having medium probability of occurrence in predictive habitat modelling (Department of Environment and Climate Change 2007).

Notes: 1. V = Vulnerable, E = Endangered, M = Migratory, C = Conservation Dependent (*Environment Protection and Biodiversity Conservation Act 1999*)

2. V= Vulnerable, E1 = Endangered, E2 = Endangered Population (*Threatened Species Conservation Act 1995*)

3. E = Endangered, P = protected (*Fisheries Management Act 1994*)

4. 'Previously recorded' refers to records of Threatened species that were identified within the locality from the Atlas of NSW Wildlife (*Office of Environment and Heritage 2011a*).

5. Based on database searches and field surveys

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Appendix D

BioBanking Credit Report



Biodiversity credit report



This report identifies the number and type of biodiversity credits required for a major project.

Date of report: 15/04/2015

Time: 9:34:42AM

Calculator version: v4.0

Major Project details

Proposal ID: 0034/2014/1071D

Proposal name: Moorebank Southern Option

Proposal address: Moorebank Avenue Moorebank NSW

Proponent name: Department of Finance and Deregulation

Proponent address: John Gorton Building King Edward Terrace PARKES ACT 2600

Proponent phone: 8265 5604

Assessor name: Alexander Cockerill

Assessor address: PO Box 1162 Newcastle NSW 2300

Assessor phone: 4929 8333

Assessor accreditation: 0058

Summary of ecosystem credits required

Plant Community type	Area (ha)	Credits created
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion	28.10	843.56
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion	16.10	444.00
Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin Bioregion	0.90	29.60
Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion	3.60	91.00
Total	48.70	1,408

Credit profiles

1. Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion, (ME044)

Number of ecosystem credits created

91

IBRA sub-region

Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
<p>Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion, (ME044)</p> <p>Sydney Blue Gum - Blackbutt - Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin Bioregion, (HN596)</p> <p>Blackbutt - Turpentine - Bangalay moist open forest on sheltered slopes and gullies, southern Sydney Basin Bioregion, (ME030)</p> <p>Blackbutt - Narrow-leaved White Mahogany shrubby tall open forest of coastal ranges, northern Sydney Basin Bioregion, (HN505)</p> <p>Sydney Blue Gum x Bangalay - Lilly Pilly moist forest in gullies and on sheltered slopes, southern Sydney Basin Bioregion, (HN597)</p> <p>Sydney Blue Gum - Blackbutt - Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin Bioregion, (ME001)</p> <p>Sydney Blue Gum - Deane's Gum - River Peppermint shrubby riparian tall forest of the lower Colo River, Sydney Basin Bioregion, (HN647)</p> <p>Deane's Gum - Mountain Grey Gum - Turpentine tall moist forest on shale, Sydney Basin Bioregion, (HN636)</p>	<p>Cumberland - Sydney Metro</p> <p>and any IBRA subregion that adjoins the IBRA subregion in which the development occurs</p>

2. Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018)

Number of ecosystem credits created	844
IBRA sub-region	Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (ME018) Forest Red Gum - Rough-barked Apple grassy woodland on alluvial flats of the Cumberland Plain, Sydney Basin Bioregion, (HN526) Grey Box - Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion, (HN529) Grey Box - Forest Red Gum grassy woodland on flats of the Cumberland Plain, Sydney Basin Bioregion, (HN528)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

3. Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin Bioregion, (ME005)

Number of ecosystem credits created

30

IBRA sub-region

Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
<p>Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin Bioregion, (ME005)</p> <p>Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion, (HN556)</p> <p>Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, (ME041)</p> <p>Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (HN512)</p> <p>Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (HN513)</p> <p>Parramatta Red Gum woodland on moist alluvium of the Cumberland Plain, Sydney Basin Bioregion, (HN562)</p> <p>Broad-leaved Ironbark - Grey Box - Melaleuca decora grassy open forest on clay/gravel soils of the Cumberland Plain, Sydney Basin Bioregion, (ME004)</p> <p>Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest of the edges of the Cumberland Plain, Sydney Basin Bioregion, (ME021)</p> <p>Turpentine - Grey Ironbark open forest on shale in the lower Blue Mountains, Sydney Basin Bioregion, (HN604)</p> <p>Broad-leaved Ironbark - Melaleuca decora shrubby open forest on clay soils of the Cumberland Plain, Sydney Basin Bioregion, (ME002)</p>	<p>Cumberland - Sydney Metro</p> <p>and any IBRA subregion that adjoins the IBRA subregion in which the development occurs</p>

4. Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, (ME003)

Number of ecosystem credits created	444
IBRA sub-region	Cumberland - Sydney Metro

Offset options - Plant Community types	Offset options - IBRA sub-regions
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, (ME003) Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland of the Cumberland Plain, Sydney Basin Bioregion, (HN542)	Cumberland - Sydney Metro and any IBRA subregion that adjoins the IBRA subregion in which the development occurs

Summary of species credits required

Common name	Scientific name	Extent of impact Ha or individuals	Number of species credits created
Small-flower Grevillea	Grevillea parviflora subsp. parviflora	16.00	235
Nodding Geebung	Persoonia nutans	10.00	770