

Moorebank Intermodal Freight Terminal - Existing Ecological Values

August 2011

**Department of Finance and
Deregulation**

**PARSONS
BRINCKERHOFF**

*Parsons Brinckerhoff Australia Pty Limited
ABN 80 078 004 798*

*Level 27, Ernst & Young Centre
680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001
Australia*

*Telephone +61 2 9272 5100
Facsimile +61 2 9272 5101
Email sydney@pb.com.au*

*Certified to ISO 9001, ISO 14001, AS/NZS 4801
A+ GRI Rating: Sustainability Report 2009*

Revision	Details	Date	Amended By
00	Original	1 August 2011	Paul Rossington

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Author: Paul Rossington

Signed:

Reviewer: Martin Predavec

Signed:

Approved by: Martin Predavec

Signed:

Date: 02 August 2011

Distribution: Department of Finance and Deregulation, PB file

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1. Introduction

This report describes the flora, fauna and ecological values of the proposed Moorebank Intermodal Freight Terminal site including species, species habitats and vegetation communities. The integrity of the ecological values is described along with any listing under federal or state threatened species legislation. The report presents baseline ecological values for the site as recorded at the time of writing. It is based on desk-based assessment of current vegetation mapping and relevant biodiversity databases, considering the site and surrounds, as well as field surveys aimed at confirming the desk-based results. This assessment is aimed at presenting information useful for planning and design purposes. It presents preliminary assessment of the potential impacts of the project that will be assessed further during the broader environmental assessment.

For the purpose of this assessment, the project is the feasibility study conducted by the Commonwealth Department of Finance and Deregulation into the potential development of an intermodal freight terminal at Moorebank in south-western Sydney.

The study area is defined as the Moorebank and Steele Barracks bordered by the Georges River to the west, Moorebank Avenue to the east, the M5 motorway and ABB site to the north and the Holsworthy Military Area to the south.

2. Scope and methodology

A desktop review of ecological values was undertaken to identify the presence of known threat-listed species and their habitats and threatened ecological communities based on existing information. Subsequently, a detailed field investigation was undertaken to verify the results of the desktop assessment (refer Figure 2-1 for the location of the study area).

Records of threat-listed species known or predicted to occur within the locality of the study area were obtained from a range of standard ecological databases as detailed in Table 2-1. Available literature was reviewed including regional assessments as well as ecological surveys of the site, including:

- topographic maps and aerial photographs of the Moorebank area
- broad scale vegetation mapping projects that cover the study area (Tozer 2003; Tozer *et al.* 2006)
- previous ecology surveys covering the study area (e.g. URS 2004).

Field surveys were undertaken over five days between 8 and 12 November 2010 by two licensed ecologists. This survey sought primarily to identify the terrestrial plant and animal species occupying the study area and to assess the extent and condition of vegetation communities and habitats, especially for threat-listed species. The floristic diversity and terrestrial vertebrate survey effort and design was designed and conducted in accordance with the Department of Sustainability, Environment, Water, Populations and Communities (SEWPAC) nationally threatened species and ecological communities survey guidelines (Department of Sustainability Environment Water Population and Communities 2010) and the NSW *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working Draft)* (Department of Environment and Conservation 2004b) representing best practice methods.

Table 2-1 Database searches

Database	Search date	Area searched ¹	Source
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act) Protected Matters Search Tool	07 October 2010	¹ Locality	SEWPAC (2010b)
Threatened species, populations and communities database	07 October 2010	Hawkesbury Nepean Catchment Management Area, Sydney Cataract subregion	Department of Environment Climate Change and Water (DECCW) (2010e) ²
Atlas of NSW Wildlife	07 October 2010	¹ Locality	DECCW (2010a)
PlantNet Database	07 October 2010	¹ Locality	Royal Botanic Gardens (2010)

Notes: ¹Locality includes a 10 km x 10 km area around the centre of the site (E 307647, N 6241052)

²DECCW is now the Office of Environment and Heritage within the Department of Premier and Cabinet

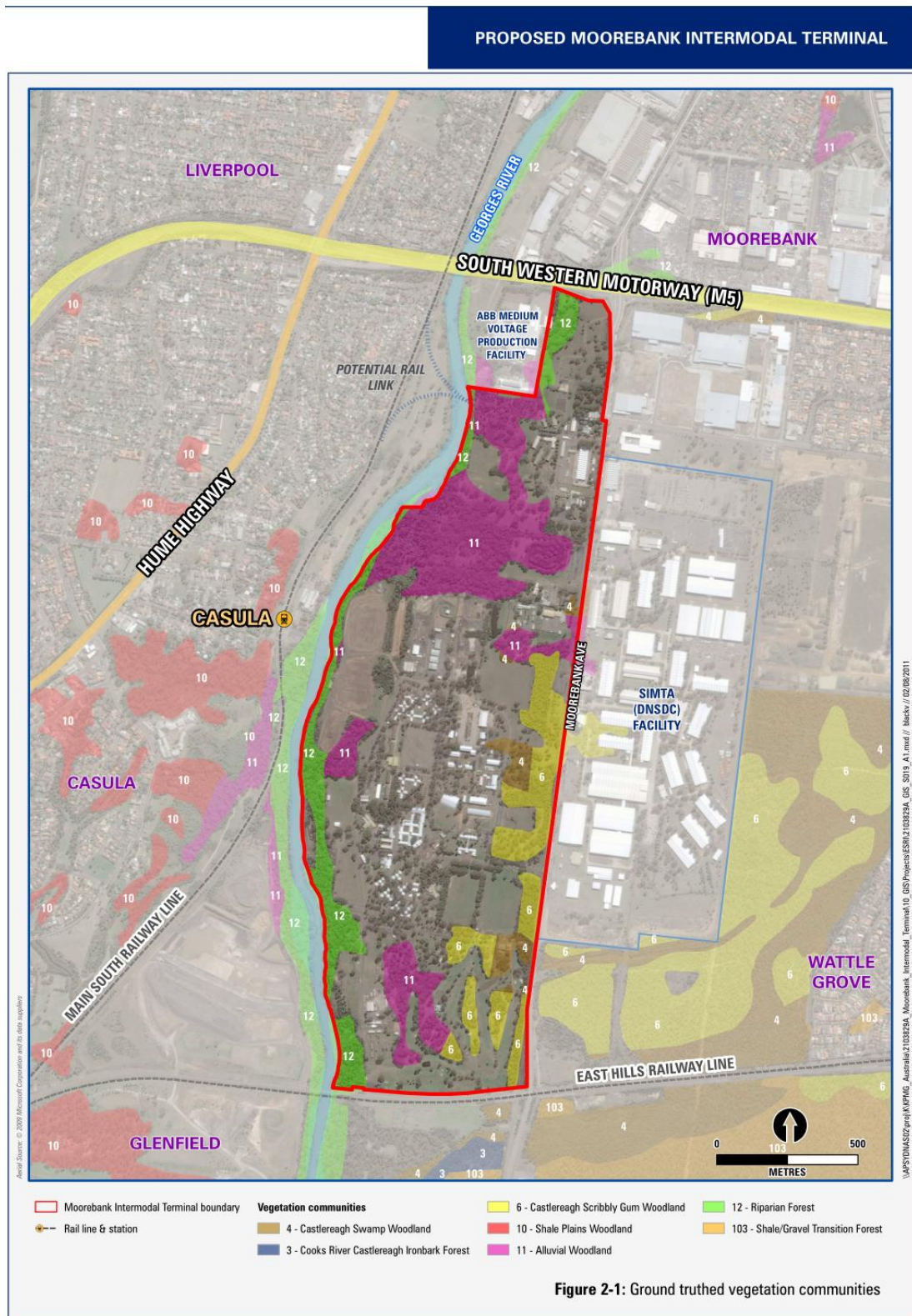


Figure 2-1 Ground-truthed vegetation communities

2.1 Ecological integrity classification

The *Significant Impact Guidelines 1.2: Action on or impacting upon Commonwealth land, and actions by Commonwealth agencies* (Department of the Environment Water Heritage and the Arts 2010a) suggests that in describing the ecological values of a site an assessment should be made of the ecological integrity of vegetation and habitats. As of 18 May 2011, there is no federal statutory method for determining the ecological integrity of vegetation communities and habitats, therefore a general and commonly used ranking criteria was used.

2.1.1 Vegetation ecological Integrity classification

The ecological integrity of vegetation was assessed through general observation and comparison against benchmark data for the described vegetation communities (e.g. NSW National Parks and Wildlife Service 2002l) as well as using parameters such as intactness, diversity, history of disturbance, weed invasion and health. Three categories were used to describe the ecological integrity of vegetation communities:

- **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.
- **Moderate:** Vegetation generally still retains its structural integrity, but has been disturbed and has lost some component of its original species complement. Weed invasion can be significant in such remnants.
- **Poor:** Vegetation that has lost most of its species and is significantly modified structurally. Often such areas have a discontinuous canopy of the original tree cover, with very few shrubs. Exotic species, such as introduced pasture grasses or herbaceous weeds, replace much of the indigenous ground cover. Environmental weeds are often dominant or co-dominant with the original indigenous species.

2.1.2 Fauna habitat ecological integrity classification

Fauna survey sites were chosen to represent the range of different habitat types within the study area and to give a broad spatial spread and coverage to maximise the chance of detecting a variety of species. While targeted surveys can confirm the presence of species, a lack of records does not necessarily indicate the absence of the species from a site when suitable habitat is present. By the very nature of their rarity, threat-listed species are often difficult to detect. Suitable habitat is, therefore, an important factor to consider when determining the potential presence of threat-listed species.

Fauna habitats were assessed generally by examining characteristics such as the structure and floristics of the canopy, understorey and ground vegetation, the structure and composition of the litter layer, and other habitat attributes important for feeding, roosting and breeding. It is recognised that broad fauna habitat classifications can address most species of animal, but that individual species are likely to have individual habitat requirements.

The following criteria were used to evaluate 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 (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 past clearing.

2.2 Environmental values classification

The following criteria were used to classify the importance of the ecological values in the study area based on interpretation of the existing vegetation mapping, previous studies and recent flora and fauna surveys. These values are shown on Figure 3-1.

2.2.1 High value

The high value classification includes all native vegetation communities of moderate to high ecological integrity as all native communities on site are threat-listed communities under the *Threatened Species Conservation Act 1995* (TSC Act) (although none are listed under the EPBC Act) and have similarly moderate to high value as potential habitat for threat-listed species of animal and plant. Several patches of vegetation with high ecological integrity are inhabited by two plant species listed under the EPBC Act and TSC Act.

The Georges River is a major waterway and the aquatic environment of the river and major tributaries are a high constraint to development. Development within the waterway may affect fish habitat and hence best practice as presented by the requirements of the NSW *Fisheries Management Act 1994* with regard to fish passage need to be considered.

Waterfront land is defined under the *Water Management Act 2000* (WM Act) as the bed of a waterway, together with any land lying between the bed and a line drawn parallel to and within 40 m inland of its highest bank (riparian land). Developments carried out in on or under waterfront land may require a controlled activity approval under WM Act to ensure that minimal harm will be done. Given the present Commonwealth ownership of the land, the requirement or otherwise for controlled activity approval under the WM Act will however be dependent on the land ownership arrangements and approval path for the project.

Riparian land (within 50 m of the river and second order or larger tributaries) is also considered of high value due to the function of vegetation in this area as a wildlife corridor and a buffer for the protection of soil stability, water quality and aquatic habitats. Riparian land as defined by the NSW Office of Water includes a core riparian zone (40 m in the case of a major waterway) and a vegetated buffer zone (a recommended width of 10 m) (NSW Office of Water 2010). The precise location of the top of the bank of the river is assumed to be within 10 m of the mapped edge of the river for the purposes of mapping.

The high value areas are generally likely to remain viable as native vegetation communities and/or fauna habitats in the long term under appropriate management.

2.2.2 Moderate value

The moderate value classification includes all native vegetation communities with substantially reduced canopy cover that have poor to moderate ecological integrity. This vegetation has reduced value as potential habitat for threat-listed species of animals and plants due to its modified vegetation structure and composition. This vegetation, despite its modified state, remains consistent with the threat-listed communities listed under the TSC Act.

Riparian lands within 10 m of minor (first order) streams and artificial water bodies are also of moderate value due to their potential as fauna habitat and their contribution to the protection of soil stability and water quality in downstream aquatic habitats. Due to surrounding land uses (e.g. the golf course) these water bodies generally have relatively poor ecological integrity and less sensitive to the potential impacts of the project.

These moderate value areas are likely to have recovery potential under appropriate management particularly where they are located in riparian lands and/or adjacent to vegetation of higher ecological integrity.

2.2.3 Low value

The low value classification includes all cleared and developed areas of the site (e.g. buildings, roads) and areas dominated by introduced plant species (e.g. lawns, weed-dominated areas). These areas are likely to be of low ecological value however they may contain small areas of habitat for threat-listed biodiversity that are not reflected in the vegetation mapping for the site due to their small spatial scale. These areas are generally considered to have low recovery potential.

2.3 Threat-listed species likelihood-of-occurrence assessment

Species and communities subject to likelihood-of-occurrence assessments were those identified during the desktop and field-based investigations as having been previously recorded or predicted to occur in the project locality. The likelihood of occurrence of each species was assigned to one of the following categories:

- **Low likelihood-of-occurrence** includes species not recorded during the field surveys that fit one or more of the following criteria:
 - ▶ have not been recorded previously in the study area and surrounds and that is 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.

- **Moderate likelihood-of-occurrence** includes species not recorded during the field surveys that fit one or more of the following criteria:
 - ▶ 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 likelihood-of-occurrence** includes species not recorded that fit one or more of the following criteria:
 - ▶ 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:** Where species have been **recorded** within the site this is detailed.

3. Key findings

The following description of the existing environment is based on the landscape, vegetation, fauna habitats, and species identified within the study area during the field survey and existing mapping information.

3.1 Vegetation communities

The study area presents a complex ecology that sees a transition from the Cumberland Plain to the west of the Georges River (and its associated vegetation) to the Castlereagh Plains in the east of the Georges River.

The core of the study area has low vegetation cover consisting chiefly of a mixture of planted and remnant indigenous and introduced trees within areas of cleared and disturbed land arising from past land clearing and use of the study area as an army barracks also exists. These areas of land no longer contain the floristic compliment or vegetation structure to be classified as native vegetation communities. Patches of moderately to highly disturbed remnant native vegetation are found in the south and east of the study area particularly near Anzac Creek and parallel with Moorebank Avenue. Vegetation of moderate to high ecological integrity is largely restricted to the riparian corridor of the Georges River, a large patch in the north-west of the study area and several patches located in parallel with Moorebank Avenue.

3.1.1 Field verified vegetation communities

Four vegetation communities have been verified by field investigations (refer Figure 2-1). While all four communities present on site form part of a threat-listed ecological community listed under the TSC Act, none of these communities correspond with a threat-listed community as listed under the EPBC Act.

The observed vegetation on the site was generally in accordance with the previous mapping of the study area by URS (2004) but showed substantial differences from broad scale vegetation mapping based on remote sensing techniques such as aerial photograph interpretation (NSW National Parks and Wildlife Service 2002; Tozer 2003; Tozer *et al.* 2006). This broad scale mapping indicates the possible presence of a further two vegetation communities in the study area: Cooks River Castlereagh Ironbark Forest and Shale/Gravel Transition Forest. The field survey for the current project and previous surveys that have included the study area by URS (2004) did not find these communities to be present. The patches mapped as these communities in the broad scale mapping have been attributed to Alluvial Woodland and Castlereagh Scribbly Gum Woodland based on the observed species composition as described below

Diagnostic species are those species that are characteristic of a vegetation community and used in its definition and identification. Due to the disturbed condition and transitional form of much of the vegetation on the site, distinctions between closely related communities which naturally intergrade with one-another are not necessarily clear. To aid in the identification of these communities, a comparison of the number of diagnostic species between previously mapped and field verified communities is shown in Table 3-1 for the patches of vegetation that have been attributed to different vegetation communities from those shown in previous broad scale mapping.

This comparison clearly shows that the vegetation previously mapped as Shale/Gravel Transition Forest is much more closely aligned with Alluvial Woodland due to the higher number of diagnostic species. The distinction between Cooks River Castlereagh Ironbark Forest and Castlereagh Scribbly Gum Woodland is not apparent from comparison of the number of diagnostic species. In this case, the vegetation was assigned to Castlereagh Scribbly Gum Woodland based on overall species composition and dominant tree species, most notably the absence of ironbark eucalypts which are a prominent feature of Castlereagh Ironbark Forest.

Table 3-1 Comparison of the number of diagnostic species between previously mapped and field verified vegetation communities where a conflict between the two exists

Vegetation community according to broad scale mapping	Number of diagnostic species (Tozer 2003) observed in a 400 m ² survey plot	Vegetation community according to URS (2004).	Number of diagnostic species (Tozer 2003) observed in a 400 m ² survey plot	Vegetation mapped in Figure 2-1.
Cooks River Castlereagh Ironbark Forest	5	Castlereagh Scribbly Gum Woodland	5	Castlereagh Scribbly Gum Woodland
Shale/Gravel Transition Forest	2	Alluvial Woodland	8	Alluvial Woodland

Riparian Forest and Alluvial Woodland are found in the west of the study area situated on the Quaternary alluvial deposits fringing the Georges River and on the higher floodplain terraces. As two structurally and floristically distinct communities, the Riparian Forest is found in the wettest areas on the lower banks of the Georges River and contains shrub and small tree species including *Backhousia myrtifolia*, *Stenocarpus salignus*, *Westringia longifolia*, and *Santalum obtusifolium*. Alluvial Woodland occurs on the drier high alluvial terraces with an understorey dominated by *Acacia* spp. Both Riparian Forest and Alluvial Woodland are considered to be part of the River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions Endangered ecological community listed under the TSC Act.

Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland are two similar vegetation communities that share structural and floristic composition. Poor localised drainage in low depressions separates these two communities in the study area, with a dense canopy of *Melaleuca decora* formed in ephemeral drainage lines at the eastern edge of the study area. Castlereagh Scribbly Gum Woodland and Castlereagh Swamp Woodland are listed as Vulnerable and Endangered ecological communities respectively under the TSC Act respectively.

A detailed summary of the dominant species recorded in each vegetation community present within the study area is provided below in Table 3-2.

Table 3-2 Composition of vegetation communities in the study area

Vegetation community	Canopy height	Canopy species	Understorey species	Ground cover species	Conservation significance	Ecological integrity
Riparian Forest	25–30 m	<i>Eucalyptus bosistoana</i> , <i>Eucalyptus baueriana</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 spp.</i> , <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 Poor
Alluvial Woodland	20–25 m	<i>Eucalyptus tereticornis</i> , <i>Eucalyptus botryoides</i> x <i>saligna</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 Poor
Castlereagh Scribbly Gum Woodland	8 – 15 m	<i>Eucalyptus sclerophylla</i> , <i>Eucalyptus parramattensis</i> subsp. <i>parramattensis</i> , <i>Melaleuca decora</i> , <i>Angophora floribunda</i>	<i>Melaleuca nodosa</i> , <i>Kunzea ambigua</i> , <i>Banksia spinulosa</i> , <i>Ozothamnus diosmifolius</i> , <i>Grevillea parviflora</i> var. <i>parviflora</i> , <i>Persoonia nutans</i> , <i>Daviesia ulicifolia</i> , <i>Petrophile sessilis</i> , <i>Hakea dactyloides</i> , <i>Acacia falcata</i> , <i>Persoonia linearis</i> , <i>Hakea sericea</i> , <i>Banksia oblongifolia</i> , <i>Pittosporum undulatum</i> , <i>Glochidion ferdinandi</i>	<i>Pomax umbellata</i> , <i>Lomandra longifolia</i> , <i>Dianella longifolia</i> , <i>Opercularia diphylla</i> , <i>Cheilanthes sieberi</i> , <i>Themeda australis</i> , <i>Austroanthonia spp.</i> , <i>Laxmannia gracilis</i> , <i>Cyathochaeta diandra</i> , <i>Billardiera scandens</i> , <i>Microlaena stipoides</i> , <i>*Rubus fruticosus</i> complex, <i>Poranthera microphylla</i> , <i>Pratia purpurascens</i> , <i>*Asparagus asparagoides</i> , <i>Gahnia aspera</i> , <i>Echinopogon caespitosus</i>	TSC Act listed Vulnerable ecological community <i>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion</i>	Moderate to Good
Castlereagh Swamp Woodland	8 – 10 m	As for Castlereagh Scribbly Gum Woodland but denser canopy of <i>Melaleuca decora</i> ²	As for Castlereagh Scribbly Gum Woodland ¹	As for Castlereagh Scribbly Gum Woodland ¹	TSC Act listed Endangered ecological community <i>Castlereagh Swamp Woodland Community</i>	Moderate to Poor

Note: Castlereagh Swamp Woodland is differentiated from Castlereagh Scribbly Gum Woodland only by location in the landscape, found in wet depressions in ephemeral drainage channels. Castlereagh Swamp Woodland and Castlereagh Scribbly Gum Woodland are not floristically or structurally distinct in the study area.

3.1.1.1 Detailed assessment of the occurrence of threat-listed ecological communities

An assessment of the occurrence of threat-listed ecological communities is provided in Table 3-3. The assessment included all threat-listed communities recorded from the Cumberland sub-region of the Sydney Metropolitan catchment management authority region in which the site is located and is based on the landform, soils and observed vegetation of the site.

Table 3-3 Threat-listed ecological community occurrence assessment

Threatened Ecological Community	Legislative status		Occurrence within the study area
	EPBC Act ¹	TSC Act ²	
Cooks River/ Castlereagh Ironbark Forest in the Sydney Basin Bioregion	-	E	No. Broad scale mapping of the site (Tozer 2003) shows this community on site however field verification by URS (URS 2004) and PB (current study) have not detected this community on site. Vegetation mapped as this community in Tozer (2003) have been attributed by URS and PB to River-flat Eucalypt Forest and Castlereagh Scribbly Gum Woodland communities based on floristic composition.
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	-	E	No This community is found in drainage lines and depressions on sandy alluvium and coastal sand flats (Tozer <i>et al.</i> 2006). While the study site is located within the known range of this community, it does not contain the correct landform and soils and does not have the correct floristic composition.
River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	-	E	Yes. In the Sydney region this community is restricted to the Georges River and Hawkesbury-Nepean systems (Tozer <i>et al.</i> 2006). It is found on stream banks & alluvial flats on soils derived from Wianamatta Shale (Tozer <i>et al.</i> 2006). Mapped previously in the study area and its presence verified during current surveys.
Shale Sandstone Transition Forest in the Sydney Basin Bioregion	E	E	No This community occurs on clay soils derived from Wianamatta Shale on the margins of the Cumberland Plain where the underlying sandstone geology is close to the surface (Tozer <i>et al.</i> 2006). While the study site is on the margin of the Cumberland Plain, it does not have the correct floristic composition. Transitional vegetation in this locality is consistent with the analogous Castlereagh Scribbly Gum Woodland community.
Swamp Oak Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	-	E	No In the locality, this community is found on sandy saline sediments fringing the high tide mark of tidal river estuaries (Tozer <i>et al.</i> 2006). While the study site is located within the known range of this community, it does not contain the correct landform and soils and does not have the correct floristic composition.

Threatened Ecological Community	Legislative status		Occurrence within the study area
	EPBC Act ¹	TSC Act ²	
<p>Cumberland Plain Woodland</p> <p>(Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest)³</p>	CE ³	CE	<p>No</p> <p>Occurs on clay soils derived from Wianamatta Group geology, or more rarely alluvial substrates, on the Cumberland Plain. Transitional stands between Cumberland Plain Woodland and other listed communities occur and should be assigned to the community with which they share greatest resemblance in species composition and other properties (NSW Scientific Committee 1997).</p> <p>Broad scale mapping of the site (Tozer 2003) does not show this community on site and field verification by URS (URS 2004) and PB (current study) have not detected this community. Vegetation on site which shares some characteristics with this community has been attributed by URS and PB to the River-flat Eucalypt Forest (alluvial Woodland) communities based on floristic composition.</p>
<p>Shale Gravel Transition Forest in the Sydney Basin Bioregion</p> <p>(Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest)³</p>	CE	E	<p>No</p> <p>Occurs primarily in areas where shallow deposits of Tertiary alluvium overlie shale soils but may also occur in association with localised concentrations of iron-indurated gravel. Transitional stands between Shale Gravel Transition Forest and other listed communities also occur</p> <p>Broad scale mapping of the site (Tozer 2003) shows this community on site however field verification by URS (URS 2004) and PB (current study) have not detected this community on site. Vegetation patches mapped as this community in Tozer (2003) have been attributed by URS and PB to River-flat Eucalypt Forest (Alluvial Woodland) and Castlereagh Scribbly Gum based on floristic composition.</p>
<p>Moist Shale Woodland in the Sydney Basin Bioregion</p>	-	E	<p>No.</p> <p>Occurs on soils derived from Wianamatta Shale on higher country in the southern half of the Cumberland Plain (NSW Scientific Committee 2002b).</p> <p>The study area does not contain the correct landform or floristic composition.</p>
<p>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion</p>	-	V	<p>Yes.</p> <p>Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion occurs almost exclusively on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium (Tozer 2003).</p> <p>Mapped previously in the study area and its presence verified during current surveys.</p>
<p>Castlereagh Swamp Woodland Community</p>	-	E	<p>Yes.</p> <p>Occurs in western Sydney in the Castlereagh and Holsworthy areas, on deposits from ancient river systems along today's intermittent creeklines, often in poorly drained depressions (Office of Environment and Heritage 2011e).</p> <p>Mapped previously in the study area and its presence verified during current surveys.</p>

Threatened Ecological Community	Legislative status		Occurrence within the study area
	EPBC Act ¹	TSC Act ²	
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	-	E	No Typically associated with gullies and sheltered slopes of hilly, relatively steep sections of the generally elevated Cumberland Plain in the Razorback Range from Cobbitty to Picton, and sporadically elsewhere in Western Sydney (NSW Scientific Committee 2000c). The study area does not contain the correct landform or floristic composition.
Sydney Turpentine-Ironbark Forest (Turpentine-Ironbark Forest in the Sydney Basin bioregion) ⁴	CE	E	No This community occurs on undulating terrain and ridge tops on soils derived from Wianamatta Shale on the edge of the Cumberland Plain and lower Blue Mountains (Tozer <i>et al.</i> 2006). While the study site is on the edge of the Cumberland Plain it does not contain the correct landform or floristic composition.

Notes:

- 1) National conservation status as listed under the EPBC Act. V = Vulnerable, E = Endangered
- 2) Conservation status as listed under the TSC Act. CE = Critically endangered, E = Endangered, V = Vulnerable
- 3) National listing of *Cumberland Plain Shale Woodlands and Shale-Gravel Transition Forest* encompasses both of these communities which are listed separately under TSC Act.
- 4) Listed name under the EPBC Act.

Bold text identifies if the community has been recorded on the site.

Summary of assessment under the EPBC Act

Assessment of vegetation against the vegetation community listings under the EPBC Act was carried out. No EPBC-listed threatened ecological community was identified on the site.

Summary of assessment under the TSC Act

Assessment of the vegetation of the site against vegetation community listings under the NSW TSC Act was undertaken. The following threat-listed communities were found on site.

- Riparian Forest located along the Cooks River forms part of River-flat Eucalypt Forest, listed as Endangered under the TSC Act.
- Alluvial Woodland located chiefly as a large patch in the north-west of the site forms part of River-flat Eucalypt Forest, listed as Endangered under the TSC Act.
- Castlereagh Swamp Woodland is found in small patches in low-lying areas in the east of the site and is listed as Endangered under the TSC Act.
- Castlereagh Scribbly Gum Woodland primarily in the east of the site along Moorebank Avenue is listed as Vulnerable under the TSC Act.

3.2 Threat-listed plant species

Botanical surveys of the site conducted in November 2010 by Parsons Brinckerhoff examined the extent and ecological integrity of the vegetation communities and recorded the presence of two threat-listed species of plant: *Persoonia nutans* (listed as Endangered under the EPBC Act and TSC Act) and *Grevillea parviflora* subsp. *parviflora* (listed as Vulnerable under the EPBC Act and TSC Act). These plants were located in Castlereagh Scribbly Gum Woodland patches parallel with Moorebank Avenue in the east of the site. Preliminary impact significance assessments according to EPBC Act significance criteria have been completed for these two species (refer Appendix A).

Based on preferred habitats and known distribution, together with preliminary analysis of known vegetation and geological associations, eight additional threat-listed plant species have a moderate likelihood of occurrence within the study area (refer Table 3-4).

Targeted searches for these species were undertaken in areas of potential habitat within the study area. These species are non-cryptic and are detectable outside of the flowering period. Although the survey did not detect these species, they have been considered moderately likely to occur due to the presence of suitable habitat and historical records of these species from the locality. It is possible that some of these species may be represented in the study area in the form of soil-stored seed or have gone undetected due to occurrence in very low numbers.

It is unlikely that any of the remaining threat-listed plant species identified in the desk top assessment (refer Table 3-4) would be present for one or more of the following reasons:

- no suitable habitat was recorded in the study area
- the area is outside the normal range of the species and records are likely to be invalid
- the species is considered locally extinct.

Table 3-4 Threat-listed flora likelihood of occurrence assessment

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	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 study area. Unlikely to occur elsewhere in study area.
Fabaceae (Mimosoideae)	<i>Acacia prominens</i> Endangered population	<i>Acacia prominens</i> 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 2011e).	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 2003a).	Moderate Historic records of this species exist in the locality. Marginal habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
Casuarinaceae	<i>Allocasuarina glareicola</i>		E	E1	Yes 1 record occurs nearby at Holsworthy form 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).	Moderate One record of this species in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
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 sclerorophyll 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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 (Robinson 1994; Fairley, A. & Moore 2002; Harden 2002). 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.
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 2011e).	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 1999h).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 2011e).	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 ²	TSC Act ¹	Recorded in locality ⁴	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 study area.
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 2002c).	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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 2011d). 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 2011c).	Low This New England Tableland species is not native to the Sydney area and is planted near Warwick Farm.
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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 (NSW Scientific Committee 1998a; Harden 2002).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.
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 2011e).

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
Dilleniaceae	<i>Hibbertia</i> sp. Bankstown		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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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.
Hygrophoraceae	<i>Hygrocybe lanecovensisi</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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
Hygrophoraceae	<i>Hygrocybe reesiaae</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 study area along the Georges River corridor. Three local records. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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.
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 2000b).	Low Species not associated with the vegetation communities of the site.
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.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 (James 1997b; Harden 2002).	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 2011e).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere 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 (James 1997b; NSW National Parks and Wildlife Service 2001c; Harden 2002).	Recorded Recorded in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 (James 1997b; NSW Scientific Committee 1998e; James <i>et al.</i> 1999; Harden 2000).	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> (James 1997b; Harden 2000; 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

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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.
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 2011e)	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 2002m).	Moderate Historic records of this species exist in the locality. Suitable habitat present in Castlereagh Scribbly Gum Woodland along eastern boundary of the study area. Unlikely to occur elsewhere in study area.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
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 (NSW Scientific Committee 1999c; Harden 2000; NSW National Parks and Wildlife Service 2002n).	Moderate Historic records of this species exist in the locality. Potential habitat present in Alluvial Woodland along Georges River in the west of the study area. Unlikely to occur elsewhere in study area.
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 2011e).	Low No suitable habitat or historic records of this species exist in the locality.
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 2011e).	Low No suitable habitat or historic records of this species exist in the locality.

Family	Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat	Likelihood of occurrence in study area
Orchidaceae	<i>Thelymitra</i> sp. Kangaloon	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 2009b).	Low No suitable habitat or historic records of this species exist in the locality. <i>Thelymitra</i> sp. Kangaloon is only found in upland swamps near the town of Kangaloon.
Campanulaceae	<i>Wahlenbergia multicaulis</i> Endangered population	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 2003c).	Low N/A - Only considered Endangered in the Auburn, Bankstown, Baulkham Hills, Canterbury, Hornsby, Parramatta and Strathfield LGAs
Convolvulaceae	<i>Wilsonia backhousei</i>	Narrow-leafed Wilsonia		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 2000d).	Low No suitable habitat for this species exists in the study area.

Notes:

1: TSC Act - *Threatened Species and Conservation Act 1995*. E4A = Extinct, CE = Critically Endangered, E1 = Endangered V = Vulnerable E2= Endangered Population, P = Protected (NPWS Act)

2. EPBC Act - *Environmental Protection and Biodiversity Conservation Act 1999*. X = Extinct, CE = Critically Endangered, E = Endangered V = Vulnerable

4. Based on database searches and field surveys

Bold text identifies if the likelihood of occurrence in the study area is moderate, high or if the species has been recorded on the site.

3.3 Fauna habitats and threat-listed animal species

Most patches of vegetation in the study area are small and consequently can be considered poor to moderate habitat for a range of species. However, in the context of the highly cleared landscape of the Cumberland subregion, these small patches are likely to play an important role in maintaining the biodiversity that remain in the locality.

Vegetation within the region of the study area is generally highly fragmented, with large expanses of urbanised land surrounding small vegetation remnants. The remnant vegetation of the study area is well connected to the surrounding vegetation of the Holsworthy Army base through the Georges River riparian corridor. The main terrestrial fauna habitats of the study area based on field verification include:

- riparian vegetation along Georges River
- fragmented patches of regrowth woodland
- disturbed areas containing large remnant trees
- artificial wetlands.

These habitats are described in Table 3-5 below in terms of their potential use by threat-listed species of animal which are considered to have potential to occur on the site based on the characteristics of the habitat present and previously records of the species in the broader locality.

Table 3-5 Fauna habitats within the study area

Habitat	Description	Threat-listed animal species that may use habitat	Ecological integrity ¹
Riparian vegetation along Georges River	Riparian forest/Alluvial Woodland corridor with tall eucalypt canopy; sparse subcanopy of <i>Acacia</i> spp and mesic shrubs and small trees; Understorey ranging from moderately dense native shrub layer to weed (e.g. <i>Lantana camara</i>) thickets; groundcover ranging from native herbs and grasses to areas of exotic vines (e.g. <i>Cardiospermum grandiflorum</i>), scramblers and grasses. Moderate connectivity to other habitat in the locality. Hollow-bearing trees moderately abundant.	Barking Owl Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Eastern Pygmy-possum Flame Robin Gang-gang Cockatoo Greater Broad-nosed Bat Grey-headed Flying-fox* Koala Little Eagle Little Lorikeet Powerful Owl Regent Honeyeater* Scarlet Robin Spotted Harrier Spotted-tailed Quoll* Square-tailed Kite Squirrel Glider Swift Parrot* Varied Sittella Yellow-bellied Sheathtail Bat	Moderate to Good Provides foraging, roosting and/or breeding opportunities for a wide variety of threat-listed fauna and has high value as a fauna movement corridor due to its connectivity north and south of the site.

Habitat	Description	Threat-listed animal species that may use habitat	Ecological integrity ¹
Fragmented patches of regrowth woodland	Shrubby woodland with a eucalypt canopy of moderate height; Understorey ranging from moderately dense, high diversity native shrub layer to thickets of disturbance tolerant native shrubs (e.g. <i>Kunzea ambigua</i>) and weed patches (e.g. <i>Rubus</i> sp.) thickets; groundcover ranging from native herbs and grasses to mats of exotic scramblers and grasses. Low connectivity to other habitat in the locality. Very few hollow-bearing trees present. Ephemeral wetlands present after heavy rain.	Grey-headed Flying-fox* Scarlet Robin Little Lorikeet Swift Parrot* Flame Robin Yellow-bellied Sheathtail Bat	Moderate Provides foraging, roosting and/or breeding opportunities for a limited suite of Threat-listed fauna; little opportunity for hollow-dependent species. Has moderate value as a fauna movement corridor due to its fragmentation.
Disturbed areas containing large remnant trees	Remnant canopy; Understorey generally absent or depauperate; groundcover ranging from a mixture of native herbs and grasses with exotic species (co-dominant) to areas dominated by exotic species. Low connectivity to other habitat in the locality. Hollow-bearing trees moderately abundant.	Powerful Owl Barking Owl Grey-headed Flying-fox* Eastern Free-tail bat Yellow-bellied Sheathtail Bat Regent Honeyeater* Gang-gang Cockatoo Spotted Harrier Little Eagle Square-tailed Kite	Poor to Moderate Incomplete vegetation structure and lack of canopy connectivity limits its value as habitat for many species. Tree hollows provide potential roost/breeding sites for species capable of using isolated trees.
Artificial ponds/wetlands	Artificial ponds with varying cover of open water and aquatic macrophytes. Canopy absent or sparse consisting chiefly of relatively small trees; Understorey generally absent or depauperate; groundcover ranging from a mixture of native emergent aquatic herbs, grasses and sedges with exotic species (co-dominant) to areas dominated by native species. Low to moderate connectivity to other aquatic habitat in the locality. Hollow-bearing trees scarce. Exotic fish present in some ponds absent from others. Access to fresh water for birds and bats.	Gang Gang Cockatoo Eastern Bent-wing Bat Eastern False Pipistrelle Eastern Free-tail bat Greater Broad-nosed Bat Yellow-bellied Sheathtail Bat	Poor to Moderate Modified vegetation structure and limited connectivity makes this habitat unsuitable for many species.

Notes: Definitions of habitat ecological integrity are provided in Section 2 above.

* indicates species listed under the EPBC Act.

The recent fauna survey conducted in November 2010 detected the Grey-headed Flying-fox (listed as Vulnerable under the EPBC Act and TSC Act) flying over the site. The Lesryk (2003) fauna study recorded the presence of two threat-listed microbat species in the study area: Large-footed Myotis and Eastern Bent-wing Bat. Analysis of ultrasonic bat calls collected on the site for the current study is not yet complete and the presence of additional threat-listed species of bats is considered possible.

The site is also likely to provide habitat for 23 additional threat-listed species of animals not detected during surveys and play an important role in the local and regional corridor network given its location adjacent to the Georges River and extensive areas of vegetation to the south (refer Table 3-5).

Many of these species are only likely to utilise the intact riparian habitats along the Georges River and would only occasionally, if ever, utilise the more fragmented patches of vegetation in the central and eastern areas of the site. Most of these species have large home ranges which may extend well beyond the study area and/or are migratory or nomadic and likely to use the study area on a sporadic or seasonal basis.

It is unlikely that any of the remaining threat-listed species of animal identified in the desk top assessment (refer Table 3-6) would be present for one or more of the following reasons:

- no suitable habitat was recorded in the study area
- the area is outside the normal range of the species and records are likely to be invalid
- the species is considered locally extinct.

Table 3-6 Threat-listed and Migratory fauna likelihood of occurrence assessment

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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 2004a, 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.
<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 2000a).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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 2011e)	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 2003b).	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		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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<i>Prototroctes maraena</i>	Australian Grayling	V		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.
Invertebrates						
<i>Meridolum corneovirens</i>	Cumberland Land Snail		E1	Yes 208 records exist within the locality including records near 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 1999c).	Low Alluvial Woodland habitat marginal and species not detected despite targeted surveys. Unlikely in other vegetation types.
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 leucoxyton</i> (Garnett & Crowley 2000).	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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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.
<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 1999b, 2003c).	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. Unlikely elsewhere in the study area.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<i>Callocephalon fimbriatum</i> Endangered population	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>Calyptorhynchus lathamii</i>	Glossy Black-Cockatoo		V	No	Occurs in eucalypt woodland and forest with <i>Casuarina/Allocasuarina</i> spp. Characteristically inhabits forests on sites with low soil nutrient status, reflecting the distribution of key <i>Allocasuarina</i> species. The drier forest types with intact and less rugged landscapes are preferred by the species. Nests in tree hollows (NSW National Parks and Wildlife Service 1999d; Garnett & Crowley 2000).	Low No suitable habitat or historic records of this species exist in the locality.
<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 2010d).	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).

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 2010f).	Moderate The Varied Sittella is relatively common within the Greater Southern Sydney Region (Department of Environment and Climate Change 2007). May occur in the Alluvial Woodland of the Georges River area. 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 2000).	Low No suitable habitat for this species exists in the study area.
<i>Ephianura 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 (Higgins <i>et al.</i> 2001; Pizzey & Knight 2007; Department of Environment Climate Change and Water 2009).	Low No suitable habitat for this species exists in the study area.
<i>Ephianura albifrons</i> Endangered population	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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 2000).	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 Alluvial Woodland in the west. Unlikely to breed in the locality.
<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 2000).	Low No suitable habitat or historic records of this species exist in the locality.
<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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<i>Hieraetus 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 Duarina. 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 2000; 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 ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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	This species 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. Seems to prefer structurally diverse landscapes (Garnett & Crowley 2000).	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 2000).	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	Found in dry eucalypt woodland particularly those containing ironbark and box. Occurs within areas of annual rainfall between 400-700 mm. Feeds on insects, nectar and lerps (Garnett & Crowley 2000).	Moderate Marginal quality in Alluvial Woodland habitat. 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 along the Georges River, unlikely elsewhere in the study area.
<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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 (Garnett & Crowley 2000).	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 ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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 2000).	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. Unlikely elsewhere in 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 (Higgins & Peter 2002; Department of Environment Climate Change and Water 2010c).	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 2010b).	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 ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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 2000).	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 2000).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 2000).	Low Poor quality habitat and no historic records of this species exist in the locality.
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 1999f, 1999h).	Moderate Marginal habitat and local records present. Moderately likely only along the Georges River. Other vegetation unlikely to be occupied due to fragmentation.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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).
<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 ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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.
<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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 Leichardt 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 Leichardt 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
<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 1999i, 2003e).	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 1999g).	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.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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 2003b).	Low Inappropriate habitat and one local record only. Likely to be locally extinct.
<i>Phascolarctos cinereus</i>	Koala		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 1999e, 2003d).	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). If present, likely to be restricted to the Georges River Corridor as other areas too disturbed and fragmented.
<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 1999h).	Low No suitable habitat or historic records of this species exist in the locality.

Scientific Name	Common Name	EPBC Act ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	Likelihood of occurrence
<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.
<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 (NSW National Parks and Wildlife Service 2001b; Churchill 2008)	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 ²	TSC Act ¹	Recorded in locality ⁴	Preferred Habitat ⁴	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, E1 = Endangered, E2 = Endangered Population (*Threatened Species Conservation Act 1995*)

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

3. 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).

4. Based on database searches and field surveys

Bold text identifies if the likelihood of occurrence in the study area is moderate, high or if the species has been recorded on the site.

3.4 Mapping of ecological values

Ecological value categories are based on interpretation of the existing vegetation mapping, previous studies and recent flora and fauna surveys as described above. These values are mapped in Figure 3-1.

3.5 Preliminary impact assessment for EPBC Act listed biodiversity

As the design of the project is not yet finalised, only a preliminary assessment of the significance of impact on biodiversity has been undertaken.

Preliminary impact assessments have been undertaken in accordance with the EPBC Act significant impact guidelines (Department of the Environment Water Heritage and the Arts 2009a) for the two threat-listed species of plant recorded on the site (*Grevillea parviflora* ssp. *parviflora* and *Persoonia nutans*) (refer Appendix A).

The EPBC Act listed threatened species of animal considered to have potential to occur on the site all have large home ranges that would extend well beyond the study area and/or are migratory or nomadic and likely to use the study area on a sporadic or seasonal basis. The preliminary design retains the riparian corridor and its vegetation which contains the most important fauna habitat on the site. These species are hence unlikely to be significantly affected by the small proportion of locally occurring habitat likely to be affected by the project.

Based on the preliminary designs for the project and the ecological assessment conducted to date, no EPBC Act listed threatened species, population or ecological community is likely to be significantly affected by the project.

This assessment will be updated based on additional ecological assessment once the design for the project is finalised.

3.6 Proposed further studies

Upon confirmation of a preferred concept, an assessment of ecological impacts would be undertaken to satisfy the requirements of SEWPAC and the NSW Department of Planning and Infrastructure



Figure 3-1 Ecology study area and ecological value

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Appendix A

Preliminary Commonwealth impact
significance assessments for two
species of plant found on site

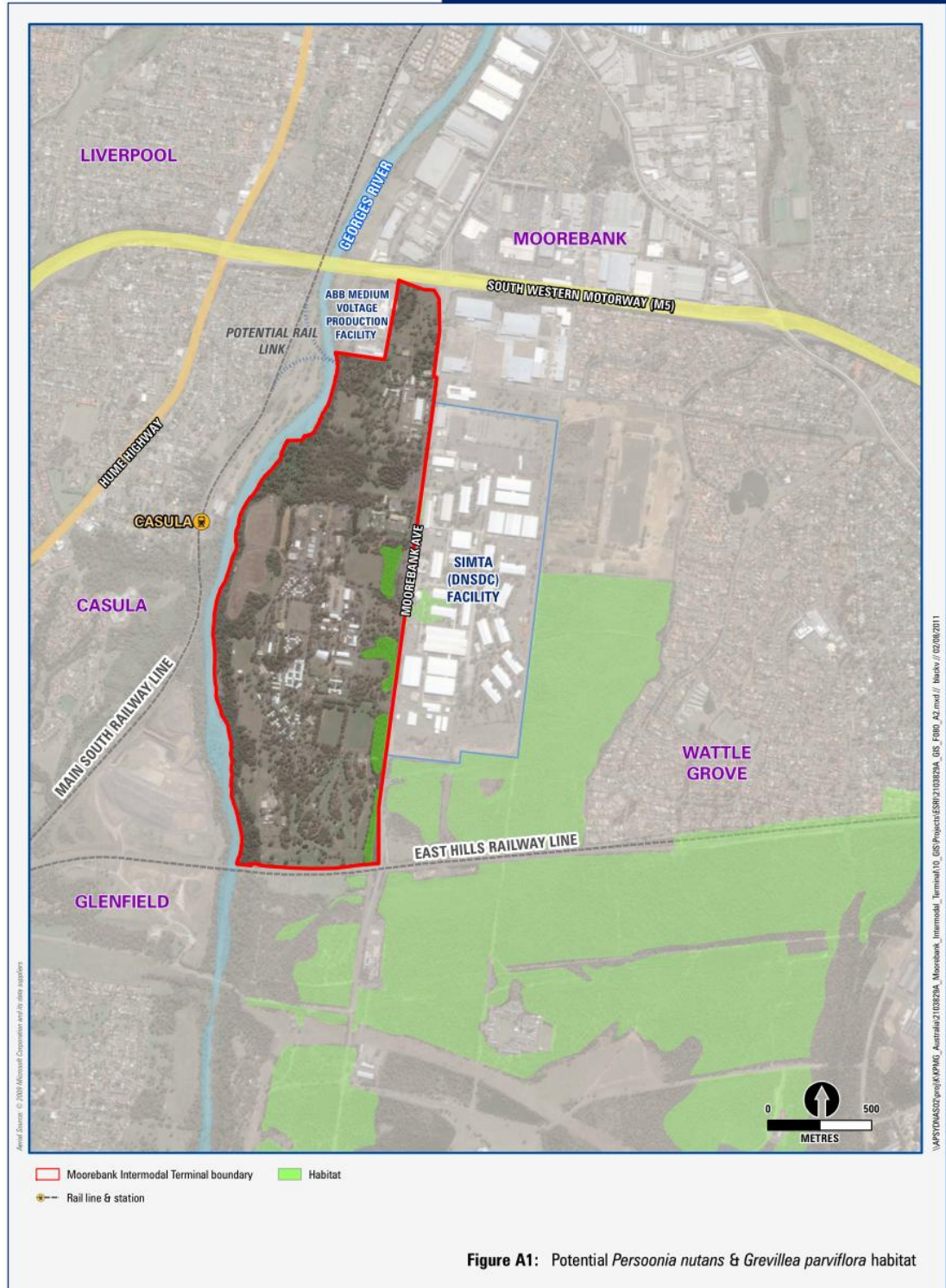
1. EPBC Act significance assessment

For species and communities listed under the EPBC Act, the significance of impacts is assessed in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment Water Heritage and the Arts 2009b) where a 'significant impact' is defined as an impact which is important, notable, or of consequence, having regard to its context or intensity.

Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of the Environment Water Heritage and the Arts 2009b). Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50% chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of the Environment Water Heritage and the Arts 2009b).

Preliminary impact assessments are provided below for *Grevillea parviflora* subsp. *parviflora* and *Persoonia nutans*, both of which have been recorded on site. A map of the habitat for these species on the site and within locally occurring stands of vegetation is provided in Figure A-1.

PROPOSED MOOREBANK INTERMODAL TERMINAL



Aerial Source: © 2008 Microsoft Corporation and its data suppliers

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2. *Grevillea parviflora* subsp. *parviflora*

2.1 Description

Grevillea parviflora subsp. *parviflora*, family Proteaceae, is a low open to erect shrub usually 0.3–1 m high with narrow leaves and white flowers with rusty brown hairs (Benson & McDougall 2000; Royal Botanic Gardens 2011). The flowers are spider like, and are white or pinkish with rusty brown hairs. The fruiting capsule is 8-10 mm long with 1-2 seeds per capsule (NSW National Parks and Wildlife Service 2002b).

2.2 Conservation status

Grevillea parviflora subsp. *parviflora* is listed as Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and the NSW *Threatened Species Conservation Act 1995* (TSC Act).

2.3 Life history

Little is known of the life history of *Grevillea parviflora* subsp. *parviflora* and most knowledge on this species has arisen from general observation rather than direct scientific study (NSW National Parks and Wildlife Service 2002b). However, it is known that this species is relatively long lived with generation times between 25-60 years (Benson & McDougall 2000).

Flowers are produced between April and May and between July and December and are insect pollinated (Makinson 2000). One to two seeds are released at maturity, with short range (probably <2 m) seed dispersal most likely to be via gravity and ant dispersal (Benson & McDougall 2000; NSW National Parks and Wildlife Service 2002a). Little is known about the production and viability of seed, seed predation or germination rates and requirements (NSW National Parks and Wildlife Service 2002b).

Plants are capable of suckering or regenerating from a rootstock after disturbance (NSW National Parks and Wildlife Service 2002b). After fire or other disturbance, regeneration can occur from both the rhizomes and seed in the soil seed bank; however, after fire, adult plants are killed and seedling recruitment is uncommon (Benson & McDougall 2000). Most populations of *Grevillea parviflora* subsp. *parviflora* appear relatively large as a result of suckering.

2.4 Habitat requirements

Grevillea parviflora subsp. *parviflora* inhabits ridge crests, upper slopes, or flat plains in low-lying areas between 30–65 m above sea level (in the Lower Hunter Valley and Lake Macquarie) and on higher topography between 200–300 m above sea level south of Sydney (NSW National Parks and Wildlife Service 2002b).

Grevillea parviflora subsp. *parviflora* prefers areas of shale/sandstone transition geology with sandy or light clay soils derived from Tertiary sands or alluvium that are deposited over thin shales, often with lateritic ironstone gravels that are infertile and poorly drained. Soils from the Mittagong Formation with alternating shale and fine-grained sandstones are also suitable (NSW National Parks and Wildlife Service 2002b).

This species has been recorded in a range of habitats, from heath and shrubby woodland to open forest and can often occur in exposed and disturbed sites such as beside tracks and roadways (NSW National Parks and Wildlife Service 2002b). Specifically, in the Sydney region, *Grevillea parviflora* subsp. *parviflora* is known to occur in the Shale Sandstone Transition Forest, Sydney Sandstone Ridgetop Woodland and Castlereagh Ironbark Forest (NSW National Parks and Wildlife Service 2002b) and in Castlereagh Scribbly Gum Woodland (NSW Scientific Committee 2010).

2.4.1 Critical habitat

Critical habitat cannot be declared for *Grevillea parviflora* subsp. *parviflora* under the EPBC Act or TSC Act as it is a Vulnerable species. However, this does not mean that habitat critical for the survival of this species does not exist.

Habitat critical to the survival of a species may include areas that are necessary:

- for activities such as foraging, breeding, roosting, or dispersal
- for the long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- to maintain genetic diversity and long term evolutionary development, or
- for the reintroduction of populations or recovery of the species or ecological community (Department of the Environment Water Heritage and the Arts 2009a).

According to the NSW National Parks and Wildlife service (2002a), until there is adequate protection of *Grevillea parviflora* subsp. *parviflora*, all sites where this species occurs are considered important and the habitat is considered significant. Sites of particular significance would include the following:

- sites with a population of >50 plants
- sites with a population that has a varied age structure including active recruitment of seedlings
- sites in an area of intact habitat away from high disturbance areas (NSW National Parks and Wildlife Service 2002a).

2.5 Distribution

2.5.1 Limits of known distribution

Grevillea parviflora subsp. *parviflora* is restricted to the Sydney Basin bioregion and occurs in scattered coastal locations in three disjunct populations, one in south-western Sydney (the focus of this assessment), one on the Central Coast and Lower Hunter Valley, and a northern population at Karuah and Tea Gardens (Makinson 2000; NSW National Parks and Wildlife Service 2002b)

Presently, the northern limit of *Grevillea parviflora* subsp. *parviflora* is at Heddon Greta in the Lower Hunter Valley. The southern and western limit is Bargo and the eastern limit is Awaba, near Newcastle (NSW National Parks and Wildlife Service 2002a).

2.5.2 Large and important populations

Grevillea parviflora subsp. *parviflora* occurs in substantial numbers in Werakata National Park to the south-west of Kurri Kurri (NSW National Parks and Wildlife Service 2002b). There are at least 21 known populations of *Grevillea parviflora* subsp. *parviflora* with several other older records requiring confirmation (NSW National Parks and Wildlife Service 2002b) (refer Table 2.1).

Table 2.1 Locality and number of plants in each known population

Locality	Number of plants (stems)
Appin, Wollondilly LGA	Unknown
Picton, Wollondilly LGA	Unknown
Bargo, Bargo Rd, Wollondilly LGA	Approximately 2,000
Wirrimbirra, Bargo, Wollondilly LGA	50
Kemps Creek, Liverpool LGA	1
Voyager Point, Liverpool LGA	Small
Tahmoor, Wollondilly LGA	Extinct
Thirlmere, Wollondilly LGA	Extinct
Prospect LGA	Extinct
Upper Georges River, Liverpool LGA	Large
Wedderburn, Campbelltown LGA	Unknown
Maldon, Wollondilly LGA	Unknown
Sydney Water	at least 2
Moss Vale, Wingecarribee LGA	To be confirmed
Kurri Kurri, Cessnock LGA	Unknown
Heddon Greta, Cessnock LGA	Unknown
Dooralong, Wyong LGA	Unknown
Cooranbong, Freemans Drive Macquarie LGA	Unknown
Awaba, Lake Macquarie LGA	Unknown
Karuah	Unknown
Wyong to Putty, Wyong LGA	Unknown
Werakata National Park (Kitchener area)	Substantial numbers

Locality	Number of plants (stems)
Cessnock LGA	At least 94
West Wallsend, Lake Macquarie LGA	Unknown

Due to the suckering nature of *Grevillea parviflora* subsp. *parviflora* it is often difficult to determine the number of plants at a site. All population estimates for this species are therefore a reflection of the number of suckers rather than individual plants and populations may be smaller than previously thought (Department of Sustainability Environment Water Population and Communities 2011a). The *Grevillea parviflora* subsp. *parviflora* subject to this assessment belong to the Upper Georges River population as highlighted in bold in the table.

Population sizes of *Grevillea parviflora* subsp. *parviflora* are variable but are mostly small (less than 20 plants) to medium size (50–100 plants) with few large populations (greater than 200 plants) (NSW National Parks and Wildlife Service 2002b; Department of Sustainability Environment Water Population and Communities 2011a). The largest known population occurs north of Bargo (refer Table 2.1) with an estimated 2,000 or more plants. The viable population size for *Grevillea parviflora* subsp. *parviflora* is unknown and until such information is available all populations should be assumed to be viable (NSW National Parks and Wildlife Service 2002a).

2.6 Diseases and invasive species harmful to *Grevillea parviflora* subsp. *parviflora*

Soil-borne fungal diseases and oomycetes (water moulds) are perhaps the greatest threat to the family Proteaceae in Australia. The genus *Grevillea*, common with other members of the family Proteaceae, is generally considered susceptible to infection from *Phytophthora cinnamomi* which causes dieback. *Grevillea parviflora* subsp. *parviflora* is identified as a species that may be adversely affected by *P. cinnamomi* either because populations are threatened by direct infestation or by degradation of habitat (NSW Scientific Committee 2002).

Weed invasion is recognised as a threat to *Grevillea parviflora* subsp. *parviflora* (NSW National Parks and Wildlife Service 2002b). Aggressive native species such as *Imperata cylindrica* and *Kunzea ambigua* can reduce available habitat and create barriers for *Grevillea parviflora* subsp. *parviflora* (NSW National Parks and Wildlife Service 2002b; Department of Sustainability Environment Water Population and Communities 2011a).

Grevillea parviflora subsp. *parviflora* may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

2.7 Susceptibility of *Grevillea parviflora* subsp. *parviflora* to fragmentation

While direct habitat loss is the most important threat to *Grevillea parviflora* subsp. *parviflora*, fragmentation of populations and habitat are also an issue. The creation of barriers as a result of vegetation clearing and degradation of habitat due to weed invasion, frequent fires, dumping of fill or rubbish, and grazing by domestic animals may isolate populations of *Grevillea parviflora* subsp. *parviflora* resulting in a reduction in gene flow, lowering the genetic diversity of populations (NSW National Parks and Wildlife Service 2002a).

The naturally limited seed dispersal range of *Grevillea parviflora* subsp. *parviflora* means that even minimal clearing may act as an effective barrier for this species (NSW National Parks and Wildlife Service 2002a).

Connectivity between populations of *Grevillea parviflora* subsp. *parviflora* is likely to be good in southern parts of its distribution (i.e. around Bargo) and in some areas in the Lower Hunter Valley (NSW National Parks and Wildlife Service 2002a). However, in more urbanised areas closer to Sydney (such as the study area), isolation of populations is likely to be increasing and presents more of an issue (NSW National Parks and Wildlife Service 2002a).

2.8 Key threatening processes relevant to *Grevillea parviflora* subsp. *parviflora*

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect *Grevillea parviflora* subsp. *parviflora*:

- Land clearance/Clearing of native vegetation.
- Competition and land degradation by rabbits/Competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Competition from feral honey bees (*Apis mellifera*).
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of native plant communities by exotic perennial grasses.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/Infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

2.9 Recovery strategies for *Grevillea parviflora* subsp. *parviflora*

A recovery plan has not been developed for *Grevillea parviflora* subsp. *parviflora* under the EPBC Act or TSC Act. However, there are recovery strategies and actions recognised by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) for implementation at a regional and local scale. Regional priority actions include:

- Habitat Loss, Disturbance and Modification:
 - ▶ Identify populations of high conservation priority.
 - ▶ Manage threats to areas of vegetation that contain populations/occurrences/remnants of *Grevillea parviflora* subsp. *parviflora*.
 - ▶ Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the species occurs do not adversely impact on known populations.

- ▶ Ensure chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on *Grevillea parviflora* subsp. *parviflora*.
- ▶ Investigate formal conservation arrangements, such as the use of covenants, conservation agreements or inclusion in reserve tenure.
- Conservation Information:
 - ▶ Raise awareness of *Grevillea parviflora* subsp. *parviflora* within the local community.
 - ▶ Liaise with land managers to encourage the preparation of site management plans and the implementation of appropriate threat abatement measures, particularly in fire management, bush regeneration, roadside management, weed control, fencing and signage.
 - ▶ Ensure this species is considered in all planning matters on land that contains or may contain populations of the species.
- Enable Recovery of Additional Sites and/or Populations:
 - ▶ Investigate options for linking, enhancing or establishing additional populations.
 - ▶ Implement appropriate national translocation protocols if establishing additional populations is considered necessary and feasible.
 - ▶ Undertake seed collection and storage.

Local Priority Actions include:

- Habitat Loss, Disturbance and Modification:
 - ▶ Monitor known populations to identify key threats.
 - ▶ Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them if necessary.
 - ▶ Control access routes to suitably constrain public access to known sites on public land.
 - ▶ Undertake survey work in suitable habitat and potential habitat to locate any additional populations.
 - ▶ Minimise adverse impacts from land use at known sites.
 - ▶ Mark and fence off sites during development/road maintenance activities.
 - ▶ Ensure that personnel responsible for planning and undertaking maintenance activities are able to identify the species and are aware of its habitat.
 - ▶ Avoid use of heavy machinery in areas of known populations.

- Invasive Weeds:
 - ▶ Identify and remove weeds in the local area, which could become a threat to Small-flower *Grevillea*, using appropriate methods.
 - ▶ Manage sites to prevent introduction of invasive weeds, which could become a threat to *Grevillea parviflora* subsp. *parviflora*, using appropriate methods.
- Fire:
 - ▶ Reinststate an appropriate fire regime for *Grevillea parviflora* subsp. *parviflora*; either restrict fire or undertake ecological burns as required.

2.10 Project specific impacts

The proposed action may result in the removal of 6.5 ha of habitat known to be occupied by *Grevillea parviflora* subsp. *parviflora* within the proposed project site. This will result in the loss of at least 16 individuals of the species with many suckers; however, additional individuals may be represented in a soil seed bank.

It is estimated that at least 420 ha of potential habitat exists within the Holsworthy area to the south of the site. The areas to be cleared for the project therefore equates to no more than 2% of the local habitat for the species.

Whilst the precise Upper Georges River local population of the species is unknown, it is considered to be large; i.e. in excess of 200 plants (Department of Sustainability Environment Water Population and Communities 2011a). The plants within the subject site are therefore likely to make up a small proportion of the local population.

2.11 Significance assessment

2.11.1 Defining the population subject to this assessment

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area and includes:

- geographically distinct regional populations or collections of local populations or,
- populations, or collections of local populations, that occur within a particular bioregion. (Department of the Environment Water Heritage and the Arts 2009b).

Accordingly, the population of *Grevillea parviflora* subsp. *parviflora* that is subject to this assessment is the Upper Georges River population in the Liverpool LGA.

Whether or not an action is likely to have a significant impact on a Vulnerable species, such as *Grevillea parviflora* subsp. *parviflora*, is influenced by the importance of the population under assessment. An important population, as defined under the EPBC Act, is a population that is necessary for a species' long-term survival and recovery (Department of the Environment Water Heritage and the Arts 2009b).

This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity
- populations that are near the limit of the species range.

Is the population within the subject site an important population?

A recovery plan for *Grevillea parviflora* subsp. *parviflora* has not been prepared and as such, no important populations have been identified in this manner. A discussion of the likely importance of the population of *Grevillea parviflora* subsp. *parviflora* subject to this assessment under the definition of the EPBC Act is provided below.

The Upper Georges River population of *Grevillea parviflora* subsp. *parviflora* is recognised as being large (see Department of Sustainability Environment Water Population and Communities 2011a).

Although no studies on the genetics of the population have been conducted it is considered possible that the Upper Georges River population is genetically distinct from other populations in the bioregion.

The Upper Georges River *Grevillea parviflora* subsp. *parviflora* population lies in the central portion of this species distributional range. However, as this species is distributed in a narrow north - south band from Bargo to the Lower Hunter Valley this population is near the easternmost extent of this species' distribution.

The Upper Georges River population may therefore be an important population.

2.11.2 Significant impact criteria

In accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of the Environment Water Heritage and the Arts 2009b), an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will result in one or more of the following.

Lead to a long-term decrease in the size of an important population of a species

The project will lead to a reduction in the size of the *Grevillea parviflora* subsp. *parviflora* population. As only a small proportion of the population of the species would be affected however, this impact is unlikely to result in a significant long-term decrease in the size of the population.

Reduce the area of occupancy of an important population

The project will lead to a small (less than 2%) reduction in the area of habitat of the *Grevillea parviflora* subsp. *parviflora* population. As only a small proportion of habitat of the population would be affected, this impact is unlikely to result in a significant reduction in the area of occupancy of the population.

Fragment an existing important population into two or more populations

In the context of this species limited dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur due to the Project as only functionally isolated areas of habitat and habitat at or very near the edge of a patch will be removed.

The project will not fragment the population into two or more populations.

Adversely affect habitat critical to the survival of a species

The habitat for *Grevillea parviflora* subsp. *parviflora* that would be removed to the west of Moorebank Ave, while in good to moderately degraded condition, is functionally isolated (for this species due to its limited seed dispersal) from other areas of *Grevillea parviflora* subsp. *parviflora* habitat in the locality. This habitat is in an area of high disturbance and based on the data collected during the field survey, the population is composed of approximately 16 mature plants with many suckers. Due to the suckering nature of *Grevillea parviflora* subsp. *parviflora* it is impossible to determine if active recruitment of seedlings is occurring as the smaller plants may have been suckers or seedlings.

The larger areas of potential habitat to the east of Moorebank Ave and further to the south that retain functional connectivity for this species are more likely to represent an area of habitat critical to the survival of *Grevillea parviflora* subsp. *parviflora*.

Given the small proportion of this potential habitat (<0.5%) that would be affected, a significant adverse impact on critical habitat for the species is unlikely.

Disrupt the breeding cycle of an important population

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the population and is hence unlikely to significantly affect the breeding cycle of the population.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Project would result in the direct removal of approximately 6.5 ha of habitat for *Grevillea parviflora* subsp. *parviflora* in the subject site that contains approximately 16 genetic individuals.

The habitat for *Grevillea parviflora* subsp. *parviflora* within the subject site will be completely removed by the Project. Hence no isolation of individuals would occur due to the project as the habitat to be removed is already isolated from the larger patch of habitat to the east by Moorebank Avenue.

With the presence of large areas of suitable habitat for *Grevillea parviflora* subsp. *parviflora* in the locality (approximately 420 ha - refer Figure A-1), particularly to the east of Moorebank Avenue, only a very small proportion of the available habitat for this species in the locality will be removed by the Project. The Project would result in the loss of approximately 1.5% of the currently available habitat for *Grevillea parviflora* subsp. *parviflora* in the locality. Therefore, it is unlikely that the Project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that *Grevillea parviflora* subsp. *parviflora* is likely to decline.

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The habitat for *Grevillea parviflora* subsp. *parviflora* within the subject site will be completely removed by the Project. Consequently, no invasive species harmful to *Grevillea parviflora* subsp. *parviflora* would become established in habitat for the species in this area.

Introduce disease that may cause the species to decline

The field survey did not detect the presence of any dieback that may indicate the presence of *Phytophthora cinnamomi* in the project site or the surrounding area. However, construction works may provide a source of introduction for this pathogen into the habitat of *Grevillea parviflora* subsp. *parviflora*. Mitigation measures would be provided to minimise the chance of *P. cinnamomi* introduction and therefore the Project would be unlikely to introduce a disease that may cause *Grevillea parviflora* subsp. *parviflora* to decline.

Interfere substantially with the recovery of the species

A recovery plan has not been prepared for *Grevillea parviflora* subsp. *parviflora* however, several regional and local scale recovery actions have been identified (see Section 2.9). Most of the identified recovery actions will not be interfered with however, as the Project involves removal of *Grevillea parviflora* subsp. *parviflora* plants and habitat, the project will interfere with two recovery actions:

- Ensure road widening and maintenance activities (or other infrastructure or development activities) in areas where the species occurs do not adversely impact on known populations.
- Avoid use of heavy machinery in areas of known populations.

As the proportion of the population affected is small and the habitat which affected constitute a small proportion of habitat for the population, the project is unlikely to interfere substantially with the recovery of the species.

Conclusion

Taking into consideration the significant impact criteria, and based on the fact that the *Grevillea parviflora* subsp. *parviflora* in the project site is likely to make up a small proportion of the population under the definition of the EPBC Act, the project is unlikely to result in a significant impact to *Grevillea parviflora* subsp. *parviflora*. Overall, the potential impact from the project on *Grevillea parviflora* subsp. *parviflora* is not considered significant with regard to its context and intensity.

3. *Persoonia nutans*

3.1 Description

Persoonia nutans is an erect to spreading shrub in the family Proteaceae with yellow flowers and reddish stems and branches (NSW Department of Environment and Conservation 2005).

3.2 Conservation status

Persoonia nutans is listed as EPBC Act) and the TSC Act (NSW Department of Environment and Conservation 2005).

3.3 Distribution

3.3.1 Limits of known distribution

The species is a NSW endemic, restricted to western Sydney, between Richmond in the north and Macquarie Fields in the south (NSW Department of Environment and Conservation 2005).

3.3.2 Large and important populations

Persoonia nutans does not typically appear in discrete populations, but rather, occurs as scattered individuals throughout suitable habitat. It is therefore difficult to place precise limits on the boundaries of known populations. The majority of populations (and 99% of individuals) occur in the north of the species range in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species (NSW Department of Environment and Conservation 2005).

3.3.3 Local population

It is estimated that approximately 420 ha of potential habitat for this species exists within the Holsworthy area to the south and lands to the west of the site. Whilst the population of the species in this area is unknown, nine individuals of the species were recorded previously in four distinct locations in vegetation to the east of the site (URS 2004). It is hence considered likely that this habitat, and other habitat to the south, contains a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of this population.

3.4 Habitat

3.4.1 Habitat requirements

The species is confined to western Sydney where it grows on to aeolian and alluvial sediments primarily on the Agnes Banks and Berkshire Park soil landscapes. The species is associated with the following vegetation communities; Agnes Banks Woodlands, Castlereagh Scribbly Gum Woodlands, Cooks River Castlereagh Ironbark Forest, Shale/Gravel Transition Forest, Shale Sandstone Transition Forest and Castlereagh Swamp Woodland (James 1997; NSW National Parks and Wildlife Service 2001; Harden 2002; NSW Department of Environment and Conservation 2005).

3.4.2 Critical habitat

To date, critical habitat has not been declared for *P. nutans* under the EPBC Act or TSC Act . However, the large populations located in the Agnes Banks, Londonderry, Castlereagh, Berkshire Park and Windsor Downs areas would contain habitat that is critical to the survival of the species. The smaller disjunct populations located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species are unlikely to be critical to the survival of the species (NSW Department of Environment and Conservation 2005).

3.4.3 Life-history

Persoonia nutans is an obligate seed regenerator (Benson & McDougall 2000; NSW Department of Environment and Conservation 2005). In the event of a fire all existing plants of *P. nutans* are killed and regeneration is dependent upon recruitment from a soil stored seed bank. Consequently, *P. nutans* populations are likely to be dynamic throughout the landscape and fluctuations in space and time of above ground individuals will be a natural occurrence.

Bees and wasps appear to be the major foragers on the flowers of *Persoonia* in eastern Australia (Bernhardt & Weston 1996).

Plants appear to set abundant fruit which is likely to be dispersed by large birds such as Currawongs and mammals such as rats, macropods and possums (Benson & McDougall 2000).

Nothing is known of the longevity of the soil-stored seed bank of *P. nutans*. It appears germination is promoted, not only by fire, but also by physical disturbance (NSW Department of Environment and Conservation 2005).

3.5 Diseases and invasive species

Typically, a major consequence of habitat degradation and fragmentation is weed invasion however survey of *P. nutans* sites in 1996 revealed that weed invasion did not then pose a major threat to any populations (NSW Department of Environment and Conservation 2005).

The Castlereagh Scribbly Gum Woodlands and Agnes Banks Woodlands (the predominant habitat for *P. nutans*) grow on acidic, nutrient poor soil which is not highly susceptible to extensive weed invasion (Benson 1992).

It is possible however that some populations of the species are threatened by weed invasion, particularly by exotic perennial grasses. The species may also be affected by introduced animals including grazing by the feral European rabbit and disruption of reproduction due to competition between feral honey bees and the species' native pollinators.

P. nutans may be adversely affected by the soil borne pathogen *Phytophthora cinnamomi* either because of direct infection or degradation of habitat.

3.6 Susceptibility to fragmentation

Habitat fragmentation can potentially reduce the long-term viability of remnant populations of *P. nutans* because the species is dependent upon recolonisation via seed dispersal in the event of local extinction (NSW Department of Environment and Conservation 2005). Given the relatively large distance seed dispersal capabilities of the bird and mammal species that fed on the fruit of the species however it is unlikely to be sensitive to small scale fragmentation of habitat.

3.7 Threatening processes

The following key threatening processes listed under the EPBC Act and/or TSC Act are known or considered likely to affect the species:

- Land clearance/clearing of native vegetation.
- Competition and land degradation by rabbits/competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*).
- Competition from feral honey bees (*Apis mellifera*).
- High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of native plant communities by exotic perennial grasses.
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)/infection of native plants by *Phytophthora cinnamomi* (Department of Sustainability Environment Water Population and Communities 2011b; Office of Environment and Heritage 2011).

3.8 Recovery strategies

The following strategies for the recovery of the species have been identified in the combined National and NSW State Recovery Plan recovery plan for the species:

- minimise the loss and fragmentation of *P. nutans* habitat

- identify and minimise the operation of threats at sites where *P. nutans* occurs
- implement a survey and monitoring program that will provide information on the extent and viability of *P. nutans*
- provide public authorities with information that assists in conserving the species
- raise awareness of the species and involve the community in the recovery program
- promote research questions that will assist future management decisions (NSW Department of Environment and Conservation 2005).

3.9 Project specific impacts

The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* within the proposed project site. This will result in the loss of at least 10 individuals of the species however additional individuals may be represented in a soil seed bank.

It is estimated that approximately 420 ha of potential habitat exists within the Holsworthy area to the south and lands to the west of the site. The areas to be cleared for the project therefore equates to approximately 1.5% of the local habitat for the species. Whilst the population of the species in this area is unknown, nine individuals of the species were recorded in four distinct locations in vegetation to the east of the site (URS 2004). It is hence considered likely that this habitat and other habitat to the south contain a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants within the subject site are therefore likely to make up a small proportion of the local population.

3.10 Significance assessment

An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will result in one or more of the following.

Lead to a long-term decrease in the size of a population of a species

The project will lead to a reduction in the size of the *Persoonia nutans* population. As only a small proportion of the population of the species would be affected however, this impact is unlikely to result in a significant long-term decrease in the size of the population.

Reduce the area of occupancy of the species

The project will lead to a small (less than 2%) reduction in the area of habitat of the *Persoonia nutans* population. As only a small proportion of habitat of the population would be affected however, this impact is unlikely to result in a significant reduction in the area of occupancy of the population.

Fragment an existing population into two or more populations

In the context of this species high dispersal ability, minimal habitat fragmentation (i.e. the breaking apart of habitat into smaller pieces) will occur as:

- only spatially isolated areas of habitat and habitat at or very near the edge of a patch will be removed, and
- the species is capable of dispersal between patches of habitat separated by small breaks due to its bird and mammal vectored seed dispersal mechanism.

The project will not fragment the population into two or more populations.

Adversely affect habitat critical to the survival of a species

The smaller disjunct populations (including that of the subject site) located in the southern portion of the species' distribution are estimated to constitute less than 1% of the population of the entire species are unlikely to be critical to the survival of the species (NSW Department of Environment and Conservation 2005).

The larger areas of potential habitat to the east of Moorebank Ave and further to the south are more likely to represent an area of importance to the survival of *Persoonia nutans* but are unlikely to be critical habitat.

Given the small proportion of this potential habitat (<0.5%) that would be affected, a significant adverse impact on critical habitat for the species is unlikely.

Disrupt the breeding cycle of a population

The project is unlikely to create any barriers to cross-pollination or seed dispersal between patches of habitat within the population and is hence unlikely to significantly affect the breeding cycle of the population.

Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposed action will result in the removal of 6.5 ha of habitat known to be occupied by *Persoonia nutans* and the loss of at least 10 individuals. The areas to be cleared for the project therefore equates to approximately 1.5% of the local habitat for the species. Whilst the population of the species in this area is unknown, nine individuals of the species were recorded in four distinct locations in vegetation to the east of the site (URS 2004). It is hence considered likely that this habitat and other habitat to the south contain a moderately large population of the species as mature plants and/or as a soil-stored seed bank. The plants affected by the project are therefore likely to make up a small proportion of the local population.

The large areas of suitable habitat for *Persoonia nutans* in the locality particularly to the east of Moorebank Ave mean that only a very small proportion of the available habitat for this species in the locality will be removed by the Project. Therefore, it is unlikely that the project would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that *Persoonia nutans* is likely to decline.

Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat

The habitat for *Persoonia nutans* within the subject site will be completely removed by the Project. Consequently, no invasive species harmful to *Persoonia nutans* would become established in habitat for the species in this area.

It is unlikely that the works would introduce European rabbits or feral honey bees into the habitat of *Persoonia nutans* and it is likely that these species are already present.

Introduce disease that may cause the species to decline

The field survey did not detect the presence of any dieback that may indicate the presence of *Phytophthora cinnamomi* in the project site or the surrounding area. However, construction works may provide a source of introduction for this pathogen into the habitat of *Persoonia nutans*. Mitigation measures would be provided to minimise the chance of *P. cinnamomi* introduction and therefore the Project would be unlikely to introduce a disease that may cause *Persoonia nutans* to decline.

Interfere substantially with the recovery of the species.

Conclusion

Taking into consideration the significant impact criteria, and based on the fact that the *Persoonia nutans* population in the project site is likely to make up a small proportion of the population under the definition of the EPBC Act, the project is unlikely to result in a significant impact to *Persoonia nutans*. Overall, the potential impact from the project on *Persoonia nutans* is not considered significant with regard to its context and intensity.

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