Angas Securities Pty. Ltd.

Lot 1 DP 549247 Subdivision- 15 Lot planning proposal

Ecology Assessment

May 2015

Table of contents

1. Introduction 1
   - 1.1 Overview 1
   - 1.2 Proposal description 1
   - 1.3 Terms and definitions 2
   - 1.4 Scope of Assessment 2
   - 1.5 Relationship to previous rezoning application 3
2. Legislative Context 6
   - 2.1 NSW legislation 6
   - 2.2 NSW policies and guidelines 7
   - 2.3 Commonwealth legislation 8
3. Methods 9
   - 3.1 Desktop assessment 9
   - 3.2 Field survey 10
   - 3.3 Survey Limitations 13
   - 3.4 Staff Qualifications 13
4. Existing Environment 15
   - 4.1 Site Context 15
   - 4.2 Vegetation 17
   - 4.3 Fauna and habitats 25
   - 4.4 Conservation significance 29
5. Preliminary impact assessment 37
   - 5.1 Overview 37
   - 5.2 Direct impacts 37
   - 5.3 Indirect impacts 41
   - 5.4 Key Threatening Processes 43
   - 5.5 Impacts on threatened biota 44
6. Mitigation Measures 48
   - 6.1 Overview 48
   - 6.2 Avoidance of impacts 48
   - 6.3 Mitigation of impacts 48
   - 6.4 Biodiversity Offsets 51
7. Conclusions 53
8. Disclaimer 55
9. References 56

Table index

Table 1 Survey effort....10
Table 2 Staff qualifications....13
Table 3 Vegetation zones within the study area....18
Table 4 Declared noxious weeds recorded during the field survey....25
Table 5 Threatened flora that may occur within the study area....31
Table 6 Threatened fauna that are known or may occur within the study area....32
Table 7 Potential extent of vegetation removal or modification within the Lot 1 Subdivision....39
Table 8 Key threatening processes....43

Figure index

Figure 1 Lot 1 Subdivision Location....4
Figure 2 Site Layout....5
Figure 3 Vegetation Zones....24
Figure 4 Threatened Biota....36

Appendices

Appendix A – Field survey data
Appendix B - Threatened and Migratory Biota

1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) has been engaged by Angas securities to complete an Ecology Assessment to support a rezoning application for the proposed subdivision of Lot 1in the western portion of the Fernhill Estate at Mulgoa, NSW (the proposal). The rezoning application would be submitted to Council for approval under the NSW *Environment Protection and Assessment Act 1979* (EPA Act). This Ecology Assessment is a specialist appendix for inclusion in the rezoning application. It describes the ecological values at the site, with particular emphasis on threatened ecological communities, populations and species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act), and *Matters of National Environmental Significance* (MNES) listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Recommended mitigation measures to ameliorate potential impacts of the proposal are included in Section 6 of this report.

1.2 Proposal description

This report has been prepared to support a rezoning application to amend zoning of areas of land within Lot 1 of the Fernhill Estate under the Penrith Local Environmental Plan 2010 (PLEP). The proposed amendment to the PLEP would change the minimum lot size of “AB1” 10 hectares land parcels to minimum lot size 2 hectares. The proposed land use zoning provisions would allow for the rural residential subdivision of the lots to create 15, 2 hectare minimum allotments on part of the western portionof the Fernhill Estate. The area of land proposed for amendments to the PLEP are currently zoned E3 Environment Management. The amendments to the LEP will allow a modest extension of the Mulgoa environmental / rural living neighbourhood.

The proposal is intended to facilitate a 15 lot Torrens title rural residential subdivision within the western portion of the Fernhill Estate, with access from Fairlight Road. It would incorporate construction of road and infrastructure services associated with the development in accordance with relevant standards to service the allotments. The indicative development footprint comprises two connected parcels of land as shown on Figure 1, including15 residential lots, an entrance road and a network of fire trails as shown on Figure 2. Refer to the planning proposal document for a full description of the proposal.

Native vegetation and habitats not included within the indicative development footprint would be retained under a suitable conservation covenant via a biobanking agreement. The future Development Application is likely to include a BioBanking assessment comprising:

- Preliminary application of the BBAM to help finalise the exact layout and achieve an appropriate balance between development and conservation areas.
- Application for a biobanking statement for the proposed subdivision (i.e. the development).
- Application for a biobanking agreement for the proposed conservation areas (i.e. a biobank).
- Retirement of biodiversity credits in accordance with the biobanking statement for the proposed subdivision.

The exact location, size and nature of the development would be determined using the BBAM at the DA stage. This approach would ensure that the proposed development would improve or

maintain biodiversity values. Benefits to heritage, biodiversity and the community will be secured through a Voluntary Planning Agreement currently being developed in consultation with Penrith City Council to be activated through Development Application processes.

1.3 Terms and definitions

The following terms are used in this report:

The proposal	The proposed residential subdivision of Lot 1 DP 549247, within the western portion of the Fernhill estate at Mulgoa, NSW.
Indicative development footprint	The area to be directly impacted by the proposal (see Figure 1). In this case it comprises the construction footprint of the proposed residential subdivision and ancillary infrastructure. This area includes the two separate parcels of land within the Lot 1 DP 549247 subdivision.
Study area	The area which will be directly and indirectly impacted by the proposal. This includes the indicative development footprint and the indicative South west biobank site.
Lot 1 subdivision	Is the subdivision portion of Lot 1 DP549247 of the Fernhill Estate, as shown on Figure 1.
Locality	The area within a 10 km radius of the study area boundary.
Threatened biota	Threatened species, populations and communities that are listed under the TSC Act, FM Act and/or the EPBC Act.
Biobanking agreement	An agreement entered into between the landowner and the Minister under Part 7A of the TSC Act for establishing a biobank site.
BioBanking Assessment Methodology (BBAM)	The rules of BioBanking established under the TSC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.
BioBanking	The biodiversity banking and offsets scheme established under Part 7A of the TSC Act.
Biobanking statement	Specifies the number and class of credits to be retired for a particular development in accordance with the BBAM. A biobanking statement can only be issued in circumstances that improve or maintain biodiversity values.

1.4 Scope of Assessment

The aim of this ecology assessment report is to:

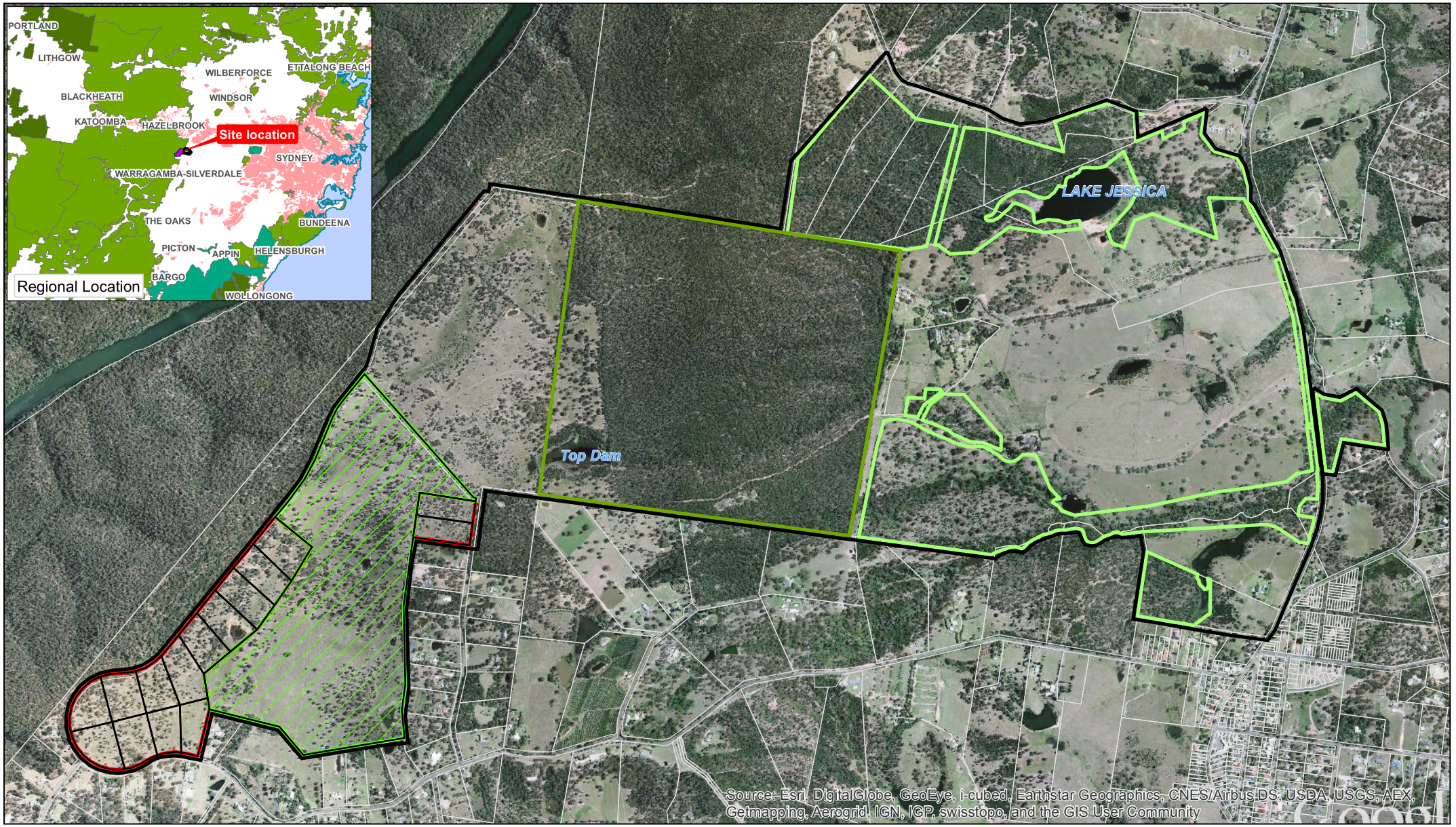
- Describe the existing environment of the study area, including flora species, vegetation communities, fauna habitats and flora and fauna species known or likely to occur.
- Present the ecological assessment of the study area with reference to the BioBanking Assessment Methodology (BBAM) so that the BBAM may be used as appropriate through the rezoning and development application stages of the proposal.

- Assess the value and conservation significance of native vegetation and habitats in the study area and the likelihood of occurrence of threatened biota based on the habitats present.
- Compile a list of threatened biota previously recorded, or predicted to occur in the locality and an assessment of their potential to occur in the study area and/or be affected by the proposal.
- Provide a preliminary assessment of likely impacts of the proposed development.
- Recommend mitigation measures to reduce impacts on biodiversity values.
- Provide concluding statements regarding the likely significance of impact of the proposed development on threatened biota or EPBC Act Matters of National Environmental Significance or the requirement or otherwise for further assessment or approvals at the State or federal level.

1.5 Relationship to previous rezoning application

A rezoning application for the entire Fernhill Estate (previously known as the Owston Estate) was prepared for the previous owner of the estate. The current report draws on information contained in the ecological assessment which was prepared by Eco Logical Australia (hereafter ELA; ELA 2010) to support the former application. There are, however, several important differences between the current report and that prepared by ELA:

- The current application applies to Lot 1 DP 549247 of the of the Fernhill estate only, whereas the previous application also included development in the eastern portion of the Fernhill Estate.
- The indicative development footprint within Lot 1 has been substantially revised, based on considerations including zoning within the *Penrith City Council Local Environment Plan 2010* and minimising the impact of the development on native vegetation and on the threatened Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*).
- The previous application anticipated that adjoining areas of retained vegetation would be managed as part of a community development scheme. The current intent is to proceed under the BioBanking methodology, meaning that retained areas of vegetation would be protected and managed for conservation in perpetuity under a biobanking agreement. This approach provides greater conservation certainty and a secure funding mechanism to manage the site for this purpose.



Paper Size A4

0 100 200 400 600 800

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Fernhill Estate
- Indicative Fernhill South West Biobank site Boundary
- Indicative development footprint
- New Lot Boundaries
- Fernhill Central West biobank site boundary
- Fernhill East biobank site boundary

Angas Securities Pty. Ltd.
Fernhill Lot 1 DP 549247
Subdivision Ecology Assessment

Job Number 22-1670904
Revision A
Date 26 May 2015

Site Location

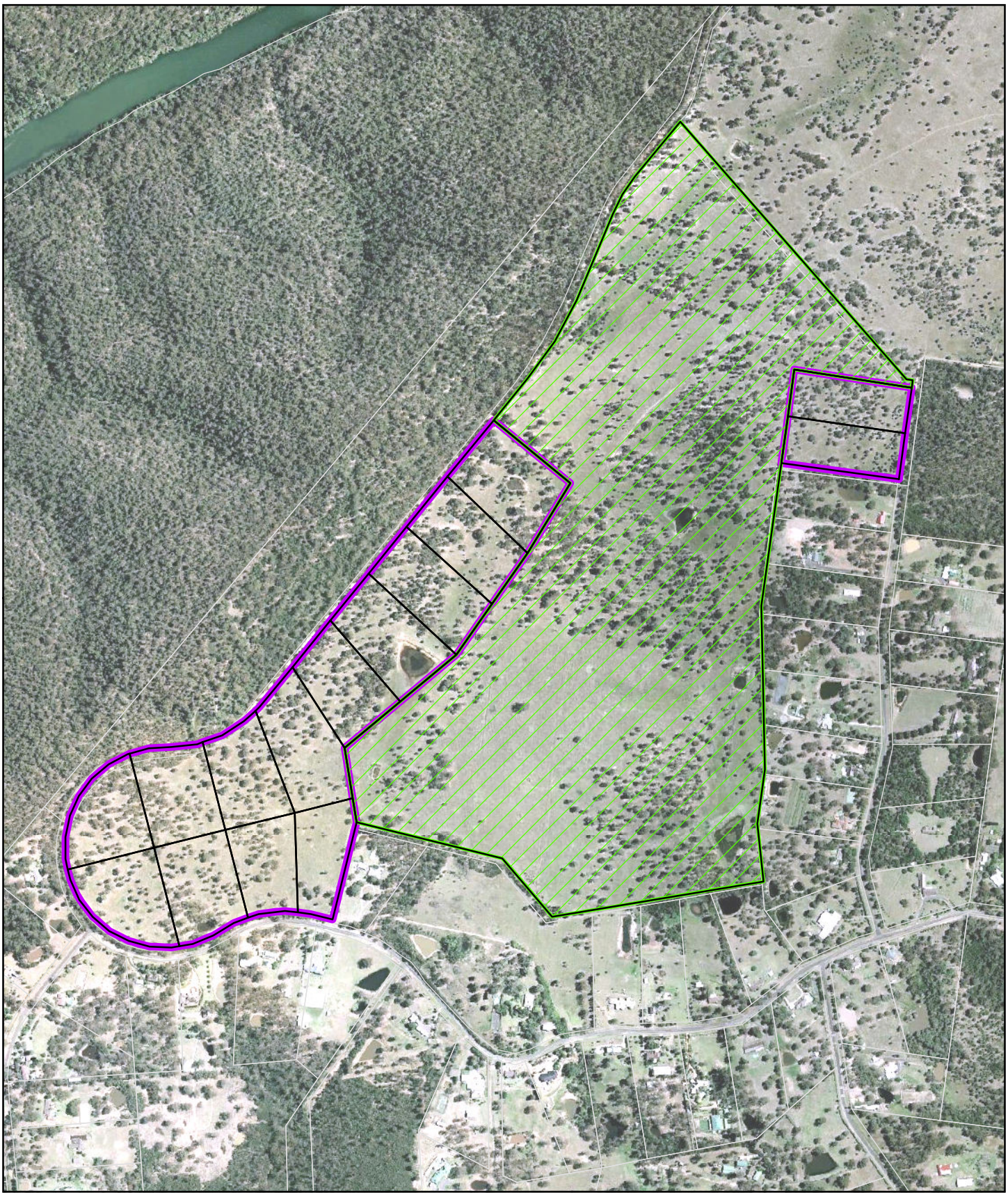
Figure 1

\\ghdnet\ghd\AU\Sydney\Projects\22\16709\GIS\Maps\Fernhill_Northwest_Biobank_site\2216709_Z009_WesternPrecinct_Location_A4.mxd

180 Lonsdale Street Melbourne VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com W www.ghd.com

© 2015. Whilst every care has been taken to prepare this map, GHD (and GeoScience Australia, ESRI, MottMacdonald) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Geoscience Australia: 250k Data - Jan 2011; ESRI World Imagery: Aerial Imagery, Accessed: 2013; Mott Macdonald: Indicative development footprint, digitised from hardcopy. Created by:mweerakoon



LEGEND

- New Lot Boundaries
- Indicative Fernhill South West Biobank site Boundary
- Indicative development footprint
- Watercourse
- Roads
- Cadastre

Paper Size A4

0 100 200 300 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Angas Securities Pty. Ltd.
Fernhill Lot 1 DP 549247
Subdivision Ecology Assessment

Job Number 22-1670902
Revision A
Date 26 May 2015

Site Layout

Figure 2

G:\22\16709\GIS\Maps\Fernhill_Northwest_Biobank_site\221670904_Z002_SiteLayout.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

© 2015. Whilst every care has been taken to prepare this map, GHD (and GeoScience Australia, ELA, Mott Macdonald and Google) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Geoscience Australia: 250k Data - Jan 2011;Google Earth Pro: Aerial Imagery, Accessed: 2013; Mott Macdonald: Indicative development footprint, digitised from hardcopy; GHD: Vegetation 22-10-2013. Created by:mweerakoon

2. Legislative Context

2.1 NSW legislation

2.1.1 Environmental Planning and Assessment Act 1979 (EPA Act)

The EPA Act forms the legal and policy platform for development proposal assessment and approval in NSW and aims to, inter alia, 'encourage the proper management, proposal and conservation of natural and artificial resources'. All development in NSW is assessed in accordance with the provisions of the EPA Act and EPA Regulation 2000. The rezoning applicaiton would be submitted to Council for approval under Part 4 of the NSW Environment Protection and Assessment Act 1979 (EPA Act).

Section 5A of the EPA Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of a proposed activity on threatened species, populations or ecological communities (or their habitats) listed under the TSC Act and the FM Act. The '7-part test' is used to assist in the determination of whether a proposal is 'likely' to impose 'a significant effect' on threatened biota and thus whether a species impact statement (SIS) is required.

The future development application for the proposal would require assessment of impacts on threatened biota under Section 5A or an application for a biobanking statement (see TSC Act below).

2.1.2 Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act provides legal status for biota of conservation significance in NSW. The Act aims to, inter alia, 'conserve biological diversity and promote ecologically sustainable proposal'. It contains schedules that list endangered, critically endangered and vulnerable species, populations, ecological communities, and key threatening processes in NSW. Potential impacts on any of these biota must be subject to an impact significance assessment ("7-part test) through the provisions of Section 5A of the EPA Act or a biobanking statement under Part 7A of the TSC Act.

Part 7A of the TSC Act establishes the biodiversity banking and offsets scheme (BioBanking). Under Part 7A a proponent may obtain a 'biobanking statement' for a development which means that Section 5A of the EPA Act does not apply to that development. . A biobanking statement is issued under section 127ZL of the TSC Act and specifies the number and class of biodiversity credits to be retired for a particular development in accordance with the BioBanking assessment methodology (BBAM) in order to achieve an 'improve or maintain' outcome for biodiversity values. The statement may include other conditions to minimise the impact of the development on biodiversity values. If provided to a consent or determining authority under the EPA Act, the statement must be included as a condition of development consent or approval.

2.1.3 National Parks and Wildlife Act 1979

The National Parks and Wildlife Act 1974 (NPW Act) provides the basis for the legal protection of native animals and plants in NSW. A wildlife licence is required under the NPW Act to harm or pick protected fauna and flora. All field surveys were carried out under a Section 132C scientific licence (SL100146).

2.1.4 Fisheries Management Act 1994 (FM Act)

The FM Act contains schedules that list endangered, critically endangered and vulnerable aquatic species, populations, ecological communities, and key threatening processes of relevance to aquatic environments. As for biota listed under the TSC Act, potential impacts on any of these species must be addressed through 7 part tests in accordance with section 5a of the EPA Act. If a significant impact is likely, an SIS must be completed and a licence obtained pursuant to Part 7a of the FM Act. The proposal does not involve any dredgeing or reclamation that would require specific consideration under the Act.

2.1.5 Noxious Weeds Act 1993 (NW Act)

The NW Act provides for the declaration of noxious weeds by the Minister for Primary Industries. Noxious weeds may be considered noxious on a National, State, Regional or Local scale. All private landowners, occupiers, public authorities and Councils are required to control noxious weeds on their land under Part 3 Division 1 of the NW Act. As such, if present, noxious weeds on the site should be assessed and controlled.

There are at least six noxious weed species present in the study area, all of which would require management during construction of the proposal and control once the residential subdivision has been established.

2.2 NSW policies and guidelines

2.2.1 Local Environment Plan

The Lot 1 Subdivision falls within the *Penrith City Council Local Environment Plan 2010* (the LEP). It is currently zoned as E3 Environmental Management under the LEP. The objectives of the E3 zone include: to protect, manage and restore areas with special ecological, scientific, cultural or aesthetic values; and to provide for a limited range of development that does not have an adverse effect on those values.

The proposal is one of three proposed development precincts which are subject to development application under Clause 5.10 Heritage Conservation (10) Conservation incentives of the LEP. This clause allows the consent authority to grant consent to development for any purpose of a building that is a heritage item or of the land on which such a building is erected, or for any purpose on an Aboriginal place of heritage significance, even though development for that purpose would otherwise not be allowed by this Plan, if the consent authority is satisfied that:

(a) the conservation of the heritage item or Aboriginal place of heritage significance is facilitated by the granting of consent, and

(b) the proposed development is in accordance with a heritage management document that has been approved by the consent authority, and

(c) the consent to the proposed development would require that all necessary conservation work identified in the heritage management document is carried out, and

(d) the proposed development would not adversely affect the heritage significance of the heritage item, including its setting, or the heritage significance of the Aboriginal place of heritage significance, and

(e) the proposed development would not have any significant adverse effect on the amenity of the surrounding area.

The proposed heritage conservation is described in the Fernhill Working Heritage Masterplan.

The general intent of the LEP is to conserve and manage the natural environment of the Penrith LGA. The objectives of the E3 zone, Clause 5.10 and the principals of the LEP have been

addressed in this report by the due consideration of the potential for impacts on native biota and the local environment in Section 5, and through impact mitigation and management recommendations provided in Section 6.

2.3 Commonwealth legislation

2.3.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on MNES undergo an assessment and approval process. Under the EPBC Act, an action includes a proposal, undertaking, proposal or activity. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Australian Government Minister for the Environment (the 'Minister').

The EPBC Act identifies MNES as:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- Nuclear actions (including uranium mining).
- A water resource, in relation to coal seam gas development and large coal mining development.

Potential impacts on any MNES must be subject to assessments of significance pursuant to the Department of the Environment (DotE) *Significant Impact Guidelines* (DotE 2009). If a significant impact is considered likely, a referral under the EPBC Act must be submitted to the Commonwealth Environment Minister. The subject contains a number of MNES and/or their habitat and so a referral of the proposal would be prepared and submitted to DotE. The referral will include assessments of significance for MNES considered to have the potential to occur in the study area. Formal assessments of impacts in accordance with the DotE (2009) guidelines will be included in the referral.

3. Methods

3.1 Desktop assessment

3.1.1 Database searches

A desktop assessment was undertaken to identify threatened flora and fauna species, populations and ecological communities listed under the TSC Act and FM Act, and MNES listed under the EPBC Act that may be affected by the proposal. Database records pertaining to the study area and locality (i.e. within a 10 km radius of the study area) were reviewed and included:

- NSW Office of Environment and Heritage (OEH) Wildlife Atlas database for records of threatened species listed under the TSC Act (OEH 2015a; data downloaded on 20 May 2015).
- Department of the Environment (DotE) Protected Matters Online Search Tool for MNES listed under the EPBC Act and predicted to occur in the locality (DotE 2015a; database queried on 20 May 2015).
- Department of Primary Industries (DPI) Threatened Species Records Viewer (DPI 2015; database queried 20 May 2015) for threatened species listed under the FM Act and recorded within the Sydney Metropolitan catchment.
- NPWS (2002) *Native Vegetation of the Cumberland Plain, Western Sydney* to identify threatened ecological communities mapped as occurring within the locality of the site
- OEH (2015b) *NSW Vegetation Types Database* and DECC (2009) BioBanking operation manual to define vegetation types and condition classes within the study area.

The habitat resources present at the site (determined during the site inspection) were compared with the known habitat associations/requirements of the relevant threatened and migratory biota identified by the desktop review. This was used to determine the likelihood of each threatened ecological community, endangered population and threatened or migratory species occurring within the study area. The results of this assessment are presented in Appendix B.

3.1.2 Literature review

A review of the following ecological assessments previously undertaken within the Fernhill estate was also undertaken:

- Eco Logical Australia (2010) *Owston Estate (Fernhill) Ecological Assessment of Proposed Rezoning.*
- Eco Logical Australia (2007a) *Fernhill Ecological Assessment.*
- Eco Logical Australia (2007b) *Fernhill – Maintain or Improve Test.*
- GHD (2014) *Fernhill Western Precinct Subdivision Ecological Assessment*
- GHD (2013a) *Fernhill Eastern Precinct Subdivision Ecological Assessment*.
- GHD (2013b) *Fernhill East Biobank BioBanking Assessment*.
- GHD (2013c) *Fernhill Central West Biobank BioBanking Assessment*.

- GHD (2012) *Preliminary Ecology Assessment and 7-part test to support the Development Application (DA) for the proposed Athletic Endurance course (Tough Mudder) at Fernhill NSW.*

3.2 Field survey

3.2.1 Overview

Field surveys of the Lot 1 Subdivision conducted by ELA primarily consisted of ground-truthing existing vegetation mapping, with opportunistic observations of threatened flora and fauna species (ELA 2007a, b and 2010). ELA also conducted targeted searches for the threatened Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*) and riparian assessments (ELA 2010). GHD have conducted supplementary surveys of the study area with reference to DEC (2004) survey guidelines and appropriate to the habitats present and landscape context (Table 1). The locations of survey sites are shown in Figure 3.

GHD have completed a number of field surveys over the broader Fernhill Estate that have contributed to the understanding of the existing environment for this assessment, including formal flora and fauna surveys in accordance with the BioBanking Assessment Methodology (BBAM). Only survey effort within the Lot 1 Subdivision is described in the following sections.

Table 1 Survey effort

Stage	Date	Survey Technique
Surveys incorporating the Lot 1 Subdivision		
Targeted species credit survey 2 (GHD)	February 2015	Targeted threatened flora searches using walked transects Active searches for Cumberland Plain Land Snail Targeted Rosenberg Goanna surveys using infra-red cameras Nocturnal searches for threatened amphibians
Targeted species credit survey 1 (GHD)	October 2014	Targeted *Grevillea juniperina* subsp. *juniperina and Micromyrtus minutiflora* surveys
Fernhill Lot 1 Subdivision detailed BBAM survey (GHD)	15, 16, 17 July 2014	Nineteen 20 m x 50 m BioBanking plot / transects; targeted threatened flora searches; opportunistic fauna observations; fauna habitat assessment.
Fernhill Lot 1 Subdivision supplementary rezoning survey / preliminary BBAM survey (GHD)	22 October 2013	Ground truthing of vegetation, habitat and threatened biota mapping (ELA 2010). Fine-scale vegetation zone mapping
'Tough Mudder' DA preliminary survey (GHD 2012)	11 December 2012	Broad-scale vegetation survey, vegetation mapping, opportunistic fauna and threatened flora observations.
Rezoning application for Owston Estate (ELA 2010)	March 2010	Targeted *Grevillea juniperina* subsp. *juniperina* surveys
Rezoning application for Owston Estate (ELA 2010)	21 December 2009	Riparian assessments
Fernhill Ecological Assessment (ELA 2007a)	2007	Validation of existing vegetation mapping, opportunistic threatened species observations

3.2.2 Terrestrial flora survey

The flora survey involved the following techniques, which are described in detail below:

- Vegetation mapping
- Flora sampling through BioBanking plot/transects (DECC, 2008) and systematic traverses
- Targeted threatened flora surveys.

The locations of quadrats sampled during the flora survey are displayed in Figure 3.

Vegetation mapping

Vegetation mapping within the Lot 1 Subdivision has gone through multiple iterations. Vegetation was originally mapped by Conacher (2005), but this mapping did not use any standard vegetation classification system and was therefore disregarded by ELA in their assessments. ELA undertook field surveys to map vegetation at the site in accordance with the NPWS (2002) vegetation classification system (ELA 2007a), and then updated this mapping to match subsequent minor changes to the cadastre (ELA 2010).

The methodology used by GHD during the October 2013 survey is described below. This survey was ground-truthed and refined existing mapping from the ELA (2010) report.

Native vegetation within the study area was mapped based on observed species composition and vegetation structure according to the classification of Specht (1970). Intact native vegetation was classified into NSW Vegetation Types (OEH, 2014b). Exotic or planted native vegetation was defined based on structure and species composition.

Preliminary vegetation mapping was ground-truthed in the field via systematic walked/driven transects across the entire study area and by walking the boundary of vegetation communities. Field ecologists checked mapped vegetation polygons with a hand-held Trimble GPS unit loaded with aerial photography and existing vegetation mapping. Necessary adjustments were made by hand on aerial photographs of the site and by capturing waypoints at vegetation community boundaries. The site was divided into relatively homogenous or discrete zones for assessment. Each zone represented a distinct vegetation type according to the OEH (2015a) Vegetation Types Database and broad condition state. Vegetation zones were identified at the site and mapped using aerial photographic interpretation within a geographical information system (GIS) as guided by the field survey results.

Vegetation zone mapping was further refined after the detailed BBAM survey. Plant species lists from plot/transects were compared with Tozer (2010) diagnostic species lists and the distribution of vegetation types adjusted as appropriate. Percentage cover of native and exotic vegetation data from transects was used to adjust the distribution of vegetation condition classes as appropriate (with >50% of the groundcover present exotic the key threshold for discriminating Low from Moderate/good condition according to the BBAM; and >50% of the groundcover present exotic and no native mid storey cover the key threshold for discriminating Cleared land from Low condition vegetation). Vegetation zones are shown on Figure 3.

Vegetation within the study area was assessed against identification criteria for State and Commonwealth listed threatened ecological communities (critically endangered ecological communities (CEECs), endangered ecological communities (EECs) and vulnerable ecological communities (VECs)). Vegetation and habitats were compared with descriptions provided in published threatened species profiles and management plans.

Flora sampling

Nineteen plot and transect surveys were conducted within the study area (of which 8 plots were within the indicative development footprint) in accordance with the BBAM (DECC, 2008), comprising:

- Identification of all plant species within a 20 metre x 20 metre plot
- Collection of native plant cover, vegetation structure data and exotic plant cover data along a 50 metre transect
- Counts of the number of hollow-bearing trees and amounts of woody debris within a 50 metre x 20 metre plot.

The condition of native vegetation was determined by assessing ten site condition attributes against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Cover abundance data was also collected for each species within the 20 metre x 20 metre portion of each plot/transect.

Plots were distributed between vegetation zones (i.e. OEH (2013a) vegetation types and condition classes) according to the minimum number of plots required by the BBAM. The 19 plots sampled within the subject site are shown on Figure 3 and summarised in Section 1.1.

All vascular plants (i.e. not mosses, lichens or fungi) observed were recorded on proforma field data sheets. Each species list was accompanied by a detailed biophysical description, including vegetation structure, soils, geology and geomorphology, habitat and disturbance history. Plant specimens that could not be identified rapidly in the field were collected and subsequently identified using standard botanical texts and/or PlantNet (RBGT, 2013). Plant specimens which were difficult to identify (either insufficient sample collected or buds/fruiting bodies were not available at the time of the survey) were identified to genus level.

Targeted threatened flora surveys

Targeted searches for threatened flora species known or predicted to occur in the locality were carried out using a walked transect during both the October 2014 and February 2015 surveys. Multiple surveys were required at different time of the year to to enhance the detectability of threatened cryptic flora with variable flowering times.

In the October round, targeted surveys focused on the detection of flowering species including Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina), Micromyrtus minutiflora* and *Dillwynia tenuifolia.* The February round consisted of supplementary surveys for flora which were not flowering in October and unlikely to be detected at that time and include Deane's Melaleuca *(Melaleuca deanei),* Hairy Geebung *(Persoonia hirsuta)* and Small Pale Grass-lily *(Caesia parviflora subsp. minor).*

Where threatened flora species were found, random meander searches were used to target any other individuals in the immediate area. Walked transects consisted of two ecologists walking in parallel lines to each other within the subject site.

3.2.3 Terrestrial fauna survey

Opportunistic observations

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. Casual fauna observations were made in suitable areas of habitat throughout the course of the flora survey and while incidentally traversing the subject site. This included visual inspection of trees and woody debris, active searches for small fauna and opportunistic observation of scats, tracks, burrows or other traces.

Targeted threatened fauna surveys

Targeted surveys for the Giant Burrowing Frog (*Heleioporus australiacus*) and Green and Golden Bell Frog (*Litoria aurea*) were conducted over one night in February 2015 by GHD ecologists. Both species are listed as a vulnerable species under the EPBC Act but the Giant Burrowing Frog and Green and Golden Bell Frog are listed as vulnerable and endangered respectively under the TSC Act. Weather conditions for the survey were favourable, with rain within the previous 4 hours (<1mm) and during the survey with hot weather reaching up to 26.8 °C experienced during daylight hours. Less recently, up to 16.8 mm of rain had fallen within the last week (Badgerys Creek AWS). Cloud cover was high during the survey, surface vegetation throughout the survey remained wet and wind levels remained slight. The survey used call playback through a megaphone to illict a vocal response in these species should they occur. Active searches were conducted along small creeks and dams, where debris and leaf litter were overturned. Fringing and aquatic vegetation within dams were scanned for evidence of frogs using binoculars.

Targeted surveys for the Rosenbergs Goanna (*Varanus rosenebergi*) were completed in February 2015 and extended into early March. Infra-red cameras were placed in habitat likely to be used by this species including adjacent heath and open forest. Two chicken-wings placed in perforated PVC piping (to enhance olfactory cues) was used as an attractant. Infra-red cameras were left recording for 21 days.

Targeted surveys for the Cumberland Plain Land Snail (*Meridolum corneovirens*) were completed in the February 2015 survey. This species is listed as an endangered species under the TSC Act. Fallen timber and other potential shelter sites such as corrugated iron sheets were carefully turned and inspected. Snail shells were collected and any live snails were photographed and sent to snail specialists at the Australian Museum to confirm their identity.

3.3 Survey Limitations

The desktop assessment provided a list of the native flora and fauna and especially threatened biota that could potentially occur in the study area or be affected by the proposal (including seasonal, transient or cryptic species). The habitat assessment conducted for the site allows for identification of habitat resources for such species. As such, the survey was not designed to detect all species, rather to provide an overall assessment of the ecological values on site in order to predict potential impacts of the proposal, with particular emphasis on endangered ecological communities, threatened species and their habitats.

Some fauna species are mobile and transient in their use of resources and it is likely that not all species were recorded during the survey period.

Anabat detectors were not implemented due the level of existing information in microchiroperan bat species presence in neighbouring sites such as the Fernhill Eastern precinct.

3.4 Staff Qualifications

This report was prepared by Ben Harrington and Mal Weerakoon based on field surveys conducted by GHD ecologists and review of existing information. The assessment was peer reviewed by Jayne Tipping. Staff qualifications are presented in Table 2.

Table 2 Staff qualifications

Name	Position / Project Role	Qualifications	Relevant Experience
Ben Harrington	Senior Ecologist / site surveys	BSc, MSc (Physical	10+ years

Name	Position / Project Role	Qualifications	Relevant Experience
	and reporting	Geography) BioBanking Assessor Accreditation	
Mal Weerakoon	Graduate Ecologist / site surveys	BSc, MSc (Zoology)	2+ years
Daniel Williams	Principal Environmental Scientist / Peer review of credit calculations, consultation and planning	B. App. Sc. BioBanking Assessor Accreditation[1]	13+ years
Jayne Tipping	Principal Ecologist / Technical review	BSc (Ecology), MEnvLaw	20+ years

4. Existing Environment

4.1 Site Context

4.1.1 Location and Land Uses

The western boundary of the Fernhill Estate is approximately 500 m to the east of the Nepean River and lies on the north-western edge of the town of Mulgoa, approximately 10 km south of Penrith town centre. The estate falls within the Hawkesbury Nepean Catchment Management Authority (CMA), and within the Sydney Basin Bioregion.

The current assessment is focused on the Lot 1 Subdivision of the Fernhill estate, which comprises Lot 1 DP 549247. The Lot 1 Subdivision can be directly accessed via Fairlight Road and contains two parcels of land separated by the proposed South west biobank. Access to the main Fernhill Estate is via Mulgoa Road at two separate entry points.

The Lot 1 Subdivision is bounded to the:

- north and west by the Blue Mountains National Park.
- south and south east by private rural-residential lots.
- east and north east by native vegetation that is conserved within the Fernhill Central West biobank

Areas of the Fernhill Estate to the east of the Central West biobank area include woodland and cleared exotic grassland that has historically been grazed and will be used for grazing, equestrian activities, occasional public events and biodiversity conservation.

Historic land uses within the Lot 1 Subdivision appear to have included grazing, livestock keeping and timber felling and collecting. The Lot 1 Subdivision includes areas of exotic grassland and cleared land, including cleared areas adjacent to fence lines, farm dams and access tracks through native vegetation in the study area. Drainage lines within the Lot 1 Subdivision also show signs of extensive modification, apparently to create permanent dams for livestock.

The Lot 1 Subdivision has also been used for recent events, including the 'Tough Mudder' athletic endurance course. The slashed running tracks and remediated obstacles (such as mud pits) are still visible in sections of the Lot 1 Subdivision.

4.1.2 Climate

The locality has a relatively mild climate, typical of western Sydney. Based on data from the Orchard Hills Treatment Works weather station (number 067084), the site has a mean annual rainfall of 834 mm, mean daily maximum temperature of 23.3°C and a mean daily minimum temperature of 11.6°C. The locality does experience regular extremes in temperature, with average ranges of a mean daily maximum temperature of 5.3°C to mean daily maximum temperature of 17.2°C in July, through to a mean daily maximum temperature of 15.5°C to mean daily maximum temperature of 28.5°C in December (BOM, 2015).

4.1.3 Hydrology

The Lot 1 Subdivision contains two drainage systems (see Figure 1 for approximate locations). In the north, the main drainage line runs approximately parallel to the western boundary of the Lot 1 Subdivision, and is joined just before the northern boundary of the site by a small drainage line running south east – north west from the adjoining Central West biobank area. This

drainage system flows into the Nepean River approximately 850 m downstream of the Lot 1 Subdivision boundary.

Drainage in the south of the Lot 1 Subdivision is part of the Mulgoa Creek Northern Tributary catchment as identified in ELA (2010). This tributary flows into Mulgoa Creek and then into the Nepean Creek near Jamisontown, approximately 8 km from the site (ELA 2010). Surface water in the south of the Lot 1 Subdivision flows approximately south west to north east towards Top Dam, which falls mainly within the adjoining Central West biobank area. In the south west, surface water flows roughly parallel to the western boundary of the Lot 1 Subdivision until it reaches a large, modified dam in the centre of the Lot 1 Subdivision where it is directed east. In the south east, surface water flows east from areas of higher elevation in the central south of the Lot 1 Subdivision to meet a drainage line running roughly parallel with the eastern boundary of the Lot 1 Subdivision.

Drainage lines across the Lot 1 Subdivision have been dammed at multiple locations along the flow channels, presumably to create permanent water points for livestock. This has caused flows along these channels to become less frequent (ELA 2010). The various dams present within the Lot 1 Subdivision all contain native aquatic and emergent vegetation, with plant diversity generally increasing with dam size. The drainage lines typically do not contain aquatic vegetation but support moisture-loving shrubby species such as *Leptospermum polygalifolium* and *Melaleuca thymifolia.*

4.1.4 Landscape Context

The site is contained within the Kurrajong Fault Scarp Mitchell Landscape (DECC, 2008a). This landscape consists of dissected and broken slopes on Triassic Quartz sandstone and shale across the Lapstone monocline and Kurrajong fault scarp. The general elevation is 100 to 250m, with local relief of up to 100m and abundant rock outcrop with pockets of yellow-brown sand and occasional yellow texture-contrast soils (DECC 2008b). Vegetation comprises an open forest with a shrubby understorey of; Blue-leaved stringybark (*Eucalyptus agglomerata*), Turpentine (*Syncarpia glomulifera*), Red Bloodwood (*Corymbia gummifera*). Smooth-barked apple (*Angophora costata*), Sydney peppermint (*Eucalyptus piperita*), Narrow-leaved Peppermint (*Eucalyptus radiata*), Grey Gum (*Eucalyptus punctata*), Blackbutt (*Eucalyptus pilularis*) and She-oaks (*Allocasuarina sp*.) along with several streams which have formed extensive reed swamps behind the fault.

The site shares some characteristics of the adjoining Cumberland Plain Mitchell landscape, which is noted to be approximately 30 – 120 m ASL, and comprises 'low rolling hills and valleys in a rain shadow area between the Blue Mountains and the coast' (DECC 2008b), with vegetation characterised by 'woodlands and open forest of Grey box (*Eucalyptus moluccana*), Forest red gum (*Eucalyptus tereticornis*), Narrow-leaved ironbark (*Eucalyptus crebra*), Thin-leaved Stringybark (*Eucalyptus eugenioides*), Cabbage Gum (*Eucalyptus amplifolia*) and Broad-leaved Apple (*Angophora subvelutina*). The grassy to shrubby understorey is often dominated by Australian Boxthorn (*Bursaria spinosa*), poorly drained valley floors, often salt affected with Swamp Oak (*Casuarina glauca*) and Paperbark (*Melaleuca* sp.)' (DECC 2008b).

According to the Soil Landscapes of the Penrith 1:100,000 Map Sheet the majority of the Lot 1 Subdivision is located on residual soil landscapes, with erosional soil landscapes occurring around the edges of the Lot 1 Subdivision (Bannerman and Hazelton 1990). Residual soils in the centre of the site primarily derive from the Blacktown subgroup of Triassic Wianamatta Shales, which is characterised by low to moderate fertility, shallow to moderately deep podzolic soils. The edges of the site are mapped as the Gymea erosional landscape with small patches of the Faulconbridge residual landscape, both of which derive from Hawkesbury Sandstone. These landscapes are typically characterised by low fertility, shallow to moderately deep yellow earths and earthy sands.

There are number of small drainage lines through the Lot 1 Subdivision which appear to be incised through Quaternary alluvial deposits of gravel, sand, silt and clay.

Based on the soil landscapes mapping, the observed geomorphology and the vegetation at the site (see Section 1.1) it is clear that the site is transitional between the Cumberland Plain and the Kurrajong Fault Scarp Mitchell Landscapes. The Kurrajong Fault Scarp Mitchell landscapes probably best reflects conditions at the site and so this landscape was entered in the BioBanking credit calculations.

4.2 Vegetation

4.2.1 Flora species

One-hundred and seventy three species of flora from 46 families were recorded within the study area, comprising 142 indigenous native and 32 exotic or non-indigenous native species. The Poaceae (grasses, 29 species, 20 native), Myrtaceae (flowering trees and shrubs, 27 species, all native) and Fabaceae (flowering herbs and shrubs, 25 species, 24 native) were the most diverse families recorded. One threatened flora species Juniper-leaved Grevillea (*Grevillea Juniperina subsp. juniperina*) was recorded during the survey. A list of dominant species recorded is presented in Appendix A. Species recorded are discussed below in relation to the vegetation zones occurring within the study area.

4.2.2 Vegetation zones

Overview

Vegetation has been mapped and described at the site in accordance with the BBAM. Field surveys confirmed the presence and distribution of five NSW vegetation types within the study area. Stands of these vegetation types include near-intact vegetation in 'moderate/good – high' condition, partially cleared vegetation in 'moderate/good – poor' condition and extensively modified regrowth in 'low' condition (according to the BBAM, DECC, 2008c). There is also highly modified habitat that supports predominantly exotic vegetation and which meets the definition of 'cleared' according to the BBAM. Vegetation zones are shown on Figure 3, summarised in Appendix A and described below.

Five of the vegetation zones within the study area comprise local occurrences of threatened ecological communities (TECs) listed under the EPBC Act and/or TSC Act (see Appendix B and Section 4.4).

The distribution of vegetation zones in the study area is closely tied to soil type, underlying geology and geomorphic position. The study area has an overall slope from south west to north east, dropping from approximately 190 masl in the south west corner to approximately 160 masl in the north and north east. The majority of the study area is characterised by shale-influenced soils above lithic sandstone substrate on gently rolling hills, which supports Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (HN556). This vegetation type is an occurrence of Shale/Sandstone Transition Forest, which is listed as an endangered ecological community (EEC) under the TSC Act and EPBC Act. This vegetation type has been extensively affected by previous grazing and clearing activities within the study area. Vegetation within the study area occurs in a range of condition classes from moderate/good – high to low (see 4.2.2and Appendix A). Patches of varying condition were defined based on the level of canopy and midstorey cover and the degree of infestation by exotic grasses and other weeds in the understorey.

Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (HN542) occurs on Tertiary alluvium-derived soils along drainage lines in the north portion of the study area. This vegetation type is an occurrence of Castlereagh Scribbly Gum Woodland, which is listed as a vulnerable

ecological community (VEC) under the TSC Act and EEC under the EPBC Act. It has been modified to varying extents through clearing for grazing and alterations to the drainage line, and occurs as a matrix of moderate/good-high and moderate/good-poor condition patches.

There is a transition to sandstone-derived soils and vegetation communities in areas of slightly higher elevation in the north-west of the study area along the western boundary. Geology in this area is Hawkesbury sandstone. These areas support patches of Red Bloodwood – Grey Gum Woodland (HN564). These patches are continuous with vegetation within the Blue Mountains National Park and are in moderate/good condition, with isolated weed patches and evidence of minor impacts associated with clearing and grazing.

Drainage lines throughout the study area have been dammed at several locations and the inundated area now supports Coastal freshwater wetlands (HN630). These Coastal freshwater wetlands do not comprise an occurrence of an EEC because they are clearly artificial features.

There has been extensive clearing, canopy thinning and modification of vegetation throughout the study area, presumably associated with grazing activities. There are some areas with no canopy or only isolated paddock trees remaining, particularly in the southern portions of the site. These areas are dominated by Whiskey Grass (*Andropogon virginicus*) and pasture grass species, with patches of noxious weeds such as Lantana (*Lantana camara*) and Blackberry (*Rubus fruticosus* spp. agg.). These areas fit the definition of 'cleared' vegetation according to the BBAM and have been excluded from adjoining vegetation zones. There are also a number of small clearings, such as informal, dirt tracks that have been included in surrounding vegetation zones because they do not comprise a gap in over storey vegetation and contain partial cover of native understorey vegetation.

There are also isolated occurrences of exotic grasses and noxious weeds throughout more intact vegetation across the study area . Despite this evidence of historic modification, vegetation across the majority of study area exhibits a high potential for recovery. Large areas of the Lot 1 Subdivision previously mapped as 'cleared' by ELA (2007a) now support dense stands of native shrubs 1-2 metres tall and juvenile eucalypts and meets the standard of 'moderate/good' according to the BBAM. Vegetation with the canopy layer still present exhibits moderate to good habitat values for native fauna, including a number of hollow-bearing trees and scattered mature and over-mature trees observed occurring throughout the study area.

Table 3 Vegetation zones within the study area

Vegetation Type (OEH, 2014a)	Veg Type ID	Condition	Area (ha)	Conservation Significance
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest	HN556	Moderate/good - high	52.72	EEC listed on TSC Act and EPBC Act (Shale Sandstone Transition Forest)
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest	HN556	Moderate/good - poor	7.69	EEC listed on TSC Act and EPBC Act (Shale Sandstone Transition Forest)
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest	HN556	Low	9.75	EEC listed on TSC Act and EPBC Act (Shale Sandstone Transition Forest)
Red Bloodwood - Grey Gum woodland	HN564	Moderate/	18.24	

Vegetation Type (OEH, 2014a)	Veg Type ID	Condition	Area (ha)	Conservation Significance
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland	HN542	Moderate/good - medium	17.17	VEC listed on TSC Act (Castlereagh Scribbly Gum Woodland)
Coastal freshwater wetland	HN630	Moderate/good	1.05	
Total area			**106.62**	

The structure, species composition and condition of each of the vegetation zones within the study area are described below. Dominant plant species within each vegetation zone are listed in Appendix A.

Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (high condition)

This vegetation zone is a moderate/good - high condition form of the NSW vegetation type 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest' (HN556, OEH, 2014a), which is consistent with 'Shale Sandstone Transition Forest (low sandstone influence) and Shale Sandstone Transition Forest (high sandstone influence)' in the NPWS (2002) vegetation mapping and classification of the Cumberland Plain. It comprises an occurrence of a EEC listed on TSC Act and EPBC Act (Shale/Sandstone Transition Forest).

Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest occurs on gently rolling hills and flats in throughout the Lot 1 Subdivision. It has an open forest structure with a canopy ranging up to approximately 25 m in height, dominated by Narrow-leaved Ironbark (*Eucalyptus crebra*), Broad-leaved Ironbark (*E. fibrosa*), Grey Gum (*E. punctata*), Narrow-leaved Stringybark (*E. eugenioides*) and Yellow Bloodwood (*Corymbia eximia*). The canopy is dominated by Forest Red Gum (*Eucalyptus tereticornis*) in the south east of the site reflecting higher shale influence and probably also historical selective clearing and subsequent regrowth of seedlings derived from a few remnant trees.

The midstorey is typically sparse, with occasional patches of Parramatta Wattle (*Acacia parramattensis*), Black Wattle (A. *decurrens*), Box-leaved Wattle (*A. buxifolia*), Thin-leaved Geebung (*Persoonia linearis*), Dwarf Cherry (*Exocarpos strictus*) and scattered patches of Lantana.

The groundcover is generally dominated by grasses, including Kangaroo Grass (*Themeda australis*) Purple Wiregrass (*Aristida ramosa*), Bushy Hedgehog-grass (*Echinopogon caespitosus*), Two-colour Panic (*Panicum simile*) and Wiry Panic (*Entolasia stricta*). Characteristic herb and forbs include Burr-daisy (*Calotis dentex*), Many Flowered Mat Rush (*Lomandra multiflora*), *Glycine clandestina*, and *Phylanthus hirtellus*. There are occasional shrubs including Prickly Shaggy Pea (*Podolobium ilicifolium*), Large-leaf Hop-bush (*Dodonaea triquetra*) and Gorse Bitter Pea (*Daviesia ulicifolia*) and localised extensive patches of Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*). Juniper-leaved Grevillea is listed as a vulnerable species under the TSC Act. Exotic species are occasionally present within the community and include noxious and environmental weeds such as Lantana, Cobbler's Pegs (*Bidens pilosa*) and Whiskey Grass (*Andropogon virginicus*).

Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (poor condition)

This vegetation zone is a moderate/good – poor condition form of the NSW vegetation type 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest' (HN556, OEH, 2014a). It comprises an occurrence of the Shale/Sandstone Transition Forest EEC.

Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest in poor condition occurs in partially cleared and disturbed areas, mainly within the eastern boundary of the indicative dwelling foorprint of the proposal. These areas have previously been slashed or cleared for asset protection zones or grazing. Preliminary inspection indicates that this vegetation would qualify as moderate/good – poor condition under the BBAM, rather than as 'low' condition, because the average native overstorey cover is greater than 25% of benchmark and/or greater than 50% of the groundcover vegetation cover is native species.

This vegetation zone has an open woodland, derived grassland or derived shrubland structure with occasional remnant Forest Red Gum, Narrow-leaved Ironbark, Narrow-leaved Stringybark and Grey Gum. Much of this vegetation zone contains dense regrowth of tall shrubs, especially Tantoon (*Leptospermum polygalifolium*) forming the aforementioned derived shrubland.

The groundcover is patchy, diverse and highly variable. Some areas are completely dominated by Tantoon, which appears to have excluded most other native understorey species. Other native shrub species present include Rough Guinea Flower (*Hibbertia aspera*) and Juniper-leaved Grevillea. More open areas contain native grasses such as Kangaroo Grass, Purple Wiregrass and Bushy Hedgehog-grass and occasional herbs and forbs such as Rock Fern (*Cheilanthes sieberi* subsp. *sieberi*), *Juncus usitasis, Glycine tabacina* and Rough Saw-sedge (*Gahnia aspera*). Up to 50% of the groundcover consists of exotic grasses, especially African Love Grass (*Eragrostis curvula*), Whiskey Grass (*Andropogon virginicus*) and *Briza subaristata*.

Exotic species are widespread and abundant within this vegetation zone including extensive cover of Whiskey Grass, *Briza subaristata* and exotic pasture species and localised infestation with Lantana and African Lovegrass (*Eragrostis curvula*). Other weed species include Fireweed (*Senecio madagascariensis*) and Purpletop (*Verbena bonariensis*).

Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (low condition)

This vegetation zone is a low condition form of the NSW vegetation type 'Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest' (HN556, OEH, 2014b). It comprises degraded habitat for the EEC Shale/Sandstone Transition Forest. Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest in low condition occurs in cleared and modified flats witin the indicative South West Biobank site boundary. It does not occur within the indiciative dwelling footprint of the proposal. This vegetation zone was discriminated from adjoining moderate/good condition vegetation based on the very low native over storey cover and the extent of exotic plant cover (greater than 50%) in the understorey. It was discriminated from adjoining cleared land by the presence of native mid storey vegetation and at least some native understorey vegetation.

It has a derived grassland or shrubland structure with occasional remnant trees such as Forest Red Gum, Grey Gum or Narrow-leaved Stringybark. There is a patchy, locally dense mid-storey containing Black Wattle, Tantoon and Lantana. The groundcover is dominated by exotic grasses and herbs with occasional patches of exotic shrubs or scramblers, small areas of of bare earth and rubbish. There are only occasional native understorey species including Kangaroo Grass, Purple Wiregrass, Rough-leaved Guinea Flower and *Hypericum gramineum*.

Exotic species dominate this vegetation zone, including localised very severe infestation of African Lovegrass and Blackberry and extensive areas dominated by Whiskey Grass and *Briza subaristata.*

Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (medium condition)

This vegetation zone is a moderate/good – high condition form of the NSW vegetation type 'Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland' (HN542; OEH, 2014b). HN542 is consistent with 'Castlereagh Scribbly Gum Woodland' in the NPWS (2002) vegetation

mapping and classification of the Cumberland Plain and comprises a local occurrence of the VEC of the same name. Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland occurs on lower slopes and flats adjoining drainage lines in the north and north-west of the Lot 1 Subdivision and also in the adjacent and proposed North west Fernhill Biobank.

It has an open woodland structure with a shrub – grass understorey. There is an open canopy ranging up to approximately 10 m in height, dominated by Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *parramattensis*), Hard-leaved Scribbly Gum (*E. sclerophylla*), Narrow-leaved Apple (*Angophora bakeri*) and Yellow Bloodwood.

There is a dense mid storey of tall shrubs such as Finger Hakea (*Hakea dactyloides*), Tantoon (*Leptospermum polygalifolium*), Slender Tea-tree (*L. trinervium*) and Lance-leaved Geebung (*Persoonia lanceolata*). The ground cover is dense, diverse and structurally complex. Ground cover vegetation includes: shrubs such as Hairpin Banksia (*Banksia spinulosa*), Fern-leaved Banksia (*Banksia oblongifolia*), Heathy Mirbelia (*Mirbelia rubiifolia*) and Pinnate Wedge Pea (*Gompholobium pinnatum*); sedges such as *Lepyrodia scariosa, L. anarthria* and Curly Wig (*Caustis flexuosa*); herbs such as Poverty Raspwort (*Gonocarpus tetragynus*), Grass Triggerplant (*Stylidium graminifolium*) and Silky Purple-Flag (*Patersonia sericea*); and scramblers such as *Glycine microphylla* and *Cassytha glabella*.

Exotic species are only occasionally present within the community and are limited to Whiskey Grass along the edge of vegetated patches and wind borne environmental weeds such as Dandelion and Fireweed.

Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (poor condition)

This vegetation zone is a moderate/good – poor condition form of the NSW vegetation type 'Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland' (HN542; OEH, 2014b). HN542 is consistent with 'Castlereagh Scribbly Gum Woodland' in the NPWS (2002) vegetation mapping and classification of the Cumberland Plain and comprises a local occurrence of the VEC of the same name. Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland occurs on lower slopes and flats in the north of the Lot 1 Subdivision .

It has a very open woodland or derived shrubland structure with a shrub – grass understorey. This modified structure presumably reflects historical clearing and ongoing grazing. The canopy is sparse to absent and consists of occasional isolated Parramatta Red Gum, Hard-leaved Scribbly Gum, Narrow-leaved Apple and Yellow Bloodwood. The mid-storey and groundcover is structurally simple and has relatively low diversity. There are patches with very dense, near monospecific mid storey cover of Tantoon. Other areas feature an open grassy understorey dominated by Kangaroo Grass with occasional shrubs such as Fern-leaved Banksia or Needle Hakea (*Hakea sericea*) and forbs such as *Xanthorrea minor* and *Macrozamia spiralis*. The understorey features light to moderate cover of exotic grasses including Whiskey Grass and African Lovegrass and other environmental weeds. Based on the presence of at least some over and mid storey cover and greater than 50% native understorey cover this vegetation zone qualifies as moderate/good-poor rather than low condition.

Red Bloodwood - Grey Gum woodland

This vegetation zone is a moderate/good condition form of the NSW vegetation type 'Red Bloodwood - Grey Gum woodland' (HN564; OEH, 2014b). HN564 is transitional between 'Western Sandstone Gully Forest' and 'Sandstone Ridgetop Woodland' in the NPWS (2002) vegetation mapping and classification of the Cumberland Plain. Red Bloodwood - Grey Gum woodland occurs at higher elevations along the north western border of the Lot 1 Subdivision, and is continuous with similar vegetation within the Blue Mountains National Park to the west.

It has an open forest structure with a shrub – grass understorey. There is an open canopy ranging up to approximately 20 m in height, with a diverse range of tree species including Red

Bloodwood (*Corymbia gummifera*), Grey Gum, Turpentine (*Syncarpia glomulifera*), Brown Stringybark (*Eucalyptus oblonga*) and Sydney Red Gum (*Angophora costata).* There is a relatively sparse mid-storey of species such as Woody Pear (*Xylomelum pyriforme*), Thin-leaved Geebung, Slender Tea-tree (*Leptospermum trinervium*) and Flax-leaved Wattle (*Acacia linifolia*). The groundcover is diverse and includes: shrubs such as Spiny Bossiaea (*Bossiaea obcordata*), and Prickly Moses (*Acacia ulicifolia*); grasses such as Kangaroo Grass, Bottle Washers (*Enneapogon avenaceus*) and Brown's Lovegrass (*Eragrostis brownii*); *Xanthorrhoea media*; and sedges such as Variable Sword-sedge (*Lepidosperma laterale);* and herbs such as *Dianella caerulea* var. *producta* and *Lomandra* species.

This community exhibits some signs of previous canopy thinning and disturbance from grazing. The mid storey is relatively open and the groundcover structure is relatively simple and grassy. This structure is not typical of the vegetation type and probably a product of the ongoing grazing of the site suppressing shrub regeneration.

There are localised outbreaks of exotic species such as Lantana, open patches dominated by Bracken (*Pteridium esculentum*) and occurrences of wind borne environmental weeds such as Dandelion (*Taraxacum officianale*), Fireweed and Lamb's Tongues (*Plantago lanceolata*). None of these patches are extensive enough to warrant a separate vegetation zone.

Coastal freshwater wetland

This vegetation zone is a moderate/good condition form of the NSW vegetation type '*Phragmites australis* and *Typha orientalis* coastal freshwater wetlands of the Sydney Basin', abbreviated in this report to 'Coastal freshwater wetland' (HN630; OEH, 2014b). Coastal freshwater wetlands are associated with dammed portions of drainage lines throughout the Lot 1 Subdivision. This vegetation zone does not comprise an occurrence of an EEC because it is clearly an artificial feature. Nonetheless it has considerable habitat value in its current form and so there would be no justification for treating it as cleared land in a future development or attempting to restore it to a forest vegetation zone in a future biobank. Therefore for the purposes of the application of the BBAM to the Lot 1 Subdivision it has been treated as the vegetation type closest to its current state rather than the vegetation type that is likely to have occurred prior to disturbance. This approach is supported by OEH (Seidel, J., OEH, pers. comm.).

It has a closed wetland structure sometimes with a narrow fringe of Flax-leaved Paperbark (*Melaleuca linariifolia*) or Tantoon around its margins. The wetland is dominated by Tall Spike Rush (*Eleocharis sphacelata*). Other species include: the sedges *Chorizandra cymbaria* and *Lepyrodia anarthria*; aquatic herbs such as *Triglochin microtuberosa*; emergent herbs such as Frogsmouth (*Philydrum lanuginosum*); and herbs of wetland margins such as *Goodenia paniculata*, *Drosera spatulata* and Indian Pennywort.

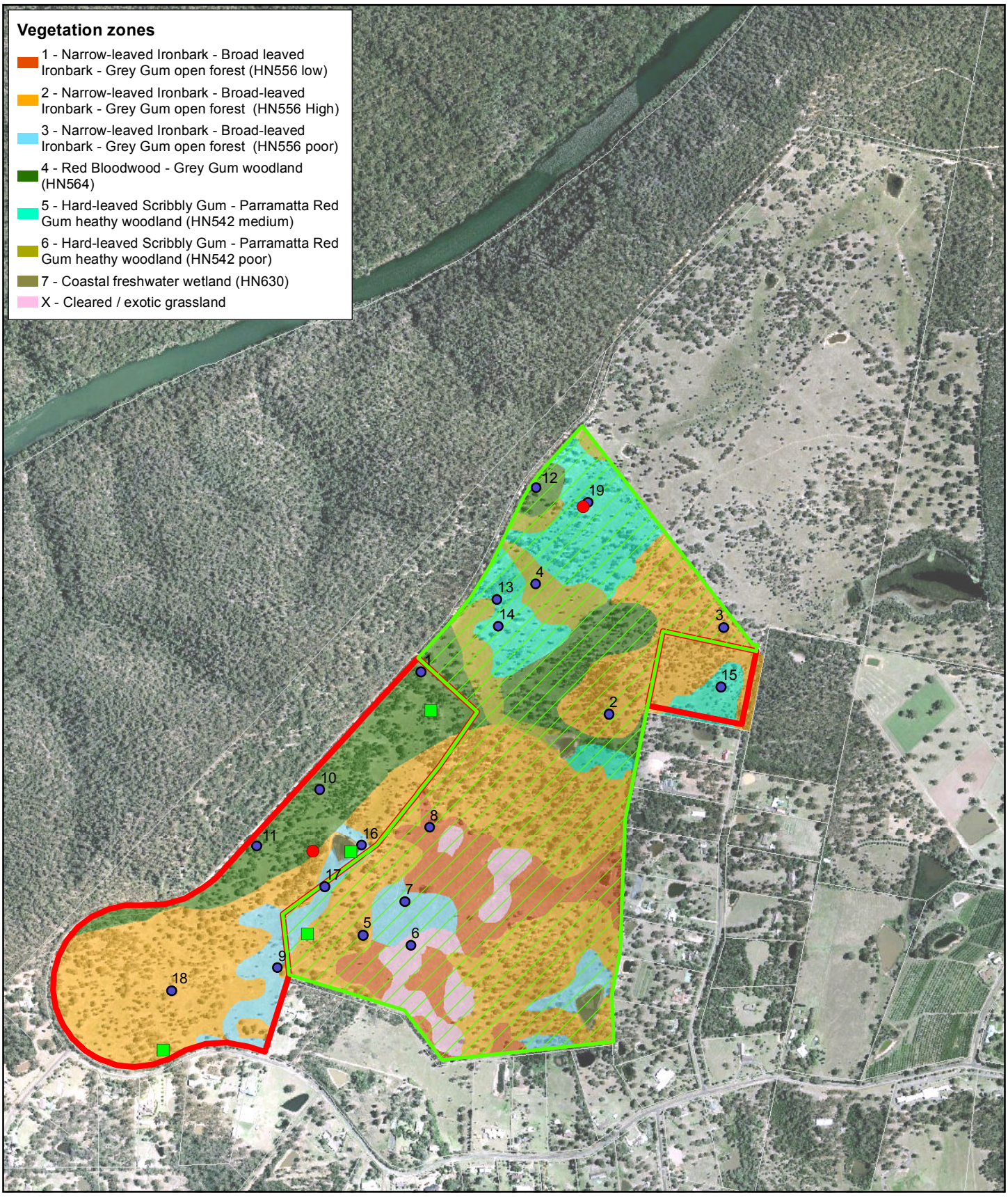
Exotic plant cover is relatively low and no aquatic noxious weed species such as Alligator Weed (*Alternanthera philoxeroides*) or Water Hyacinth (*Eichornia crassipes*) were observed.

Cleared land

There are areas of cleared land that have been excluded from the vegetation zones described above. These areas have been cleared and probably subject to more severe grazing and/or exotic plant infestation that has precluded the native regrowth present in the moderate/good – poor and low condition vegetation zones described above. These areas feature greater than 50% exotic groundcover vegetation but also contain no native over storey or mid storey vegetation and so do not qualify as 'low' condition vegetation according to the BBAM (DECC, 2008c).

Groundcover vegetation is predominantly exotic pasture species such as *Briza subaristata* or Kikuyu (*Pennisetum clandestinum*) or dense patches of noxious and environmental weeds such

as Blackberry, Lantana or African Love Grass. There are occasional native understorey species such as Kangaroo Grass, Rough-leaved Guinea Flower or Rough Saw Sedge.



LEGEND

Indicative Fernhill South West Biobank site Boundary

Indicative development footprint

Camera trap

Targeted frog survey

Plot transect

Watercourse

Roads

Cadastre

Paper Size A4

0 240 480

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

GHD

Angas Securities Pty. Ltd.
Fernhill Lot 1 DP 549247
Subdivision Ecology Assessment

Job Number 22-1670902
Revision A
Date 26 May 2015

Vegetation Zones and Survey Effort Figure 3

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com **W** www.ghd.com

G:\22\16709\GIS\Maps\Fernhill_Northwest_Biobank_site\2216709_Z010_WesternPrecinct_VegetationZones_portrait.mxd

© 2015. Whilst every care has been taken to prepare this map, GHD (and GeoScience Australia, ELA, Mott Macdonald and ESRI) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Geoscience Australia: 250k Data - Jan 2011; ;ESRI World Imagery: Aerial Imagery, Accessed: 2013; Mott Macdonald: Indicative development footprint, digitised from hardcopy; GHD: Vegetation 22-10-2013. Created by:mweerakoon

4.2.3 Noxious and environmental weeds

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds in local government areas. Landowners and occupiers must control noxious weeds according to the control category specified in the Act. Public authorities must control noxious weeds according to the control category to the extent necessary to prevent their spread to adjoining land.

The Lot 1 Subdivision contains at least five species declared as noxious weeds in the Penrith LGA, as shown in Table 4. These noxious species occur in low densities in forest throughout the study area and as moderate infestations within cleared areas. Other noxious weeds such as African Olive (*Olea europaea* subsp. *cuspidata*) and Broad-leaf Privet (*Ligustrum lucidum*) would be likely to occur given the habitats present and observed occurrences elsewhere on the Fernhill Estate.

Wetlands and water bodies in the study area appear to be free of noxious aquatic weeds such as Alligator weed (*Alternanthera philoxeroides*) and Water Hyacinth (*Eichhornia crassipes*).

Table 4 Declared noxious weeds recorded during the field survey

Scientific Name	Common Name	Control category	Legal Requirements
*Lantana camara**	Lantana	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction
Rubus fruticosus aggregate species	Blackberry	4	The growth of the plant must be managed in a manner that reduces its numbers spread and incidence and continuously inhibits its reproduction and the plant must not be sold propagated or knowingly distributed
Ligustrum sinense	Small leaved Privet	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction
Hypericum perforatum	St John's Wort	4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continuously inhibits its reproduction
Asparagus asparagoides	Bridal Creeper	4	The plant must not be sold, propagated or knowingly distributed

4.3 Fauna and habitats

4.3.1 Fauna species

112 species were recorded within the study area or surrounds and include 84 species of bird, 11 species of mammals, 10 species of amphibian, six reptiles and two gastropods. Exotic species that were recorded were predominantly mammals (5) but also included birds (1). One threatened species was recorded within the Lot 1 Subdivision:

- Cumberland Plain Land Snail (*Meridolum corneovirens*)

The fauna species that were recorded, habitat associations and additional species of fauna that may occur based on the habitats present are described below.

4.3.2 Fauna habitats

Three broad fauna habitat types were recorded within the study area:

- Exotic grassland and cleared areas.
- Native woodland and forest.
- Drainage line and wetland habitats.

The suitability of these habitats for native fauna is discussed below, with particular emphasis on habitat resources of relevance to threatened fauna. Native fauna species which have been sighted opportunistically are also mentioned: a list of opportunistic fauna sightings from the Fernhill Estate is included in Appendix A.

Exotic grassland and cleared areas

Large areas of exotic grassland and cleared areas occur throughout the centre of the southern portion of the study area, and are present as small patches in other areas. As discussed in Section 4.1, these areas would have historically supported native woodland vegetation but have been extensively modified by previous clearing and agriculture.

Exotic grassland and cleared land contain few habitat resources of relevance to most native species. Exotic grasses and herbs provide foraging resources for relatively mobile and opportunistic native fauna, including birds such as the Australian Magpie (*Cracticus tibicen*) and Galah (*Eolophus roseicapillus*) and mammals such as the Eastern Grey Kangaroo (*Macropus giganteus*) which were observed in the study area.

Regrowth trees and shrubs provide foraging resources for native woodland birds such as Thornbills (*Acanthiza* spp.) and Red-browed Finches (*Neochmia temporalis*) which were observed in these areas during the survey. Some native reptile and frog species would also forage, shelter or bask in areas of exotic grassland particularly where they adjoin woodland or water bodies. Most of these species would use these areas as an adjunct to the higher quality, more extensive areas of suitable habitat available to the west in the Fernhill Estate and other rural residential blocks with limited clearing and it is unlikely that any local populations of native fauna would be reliant on the exotic grassland on the subject site for their survival.

These areas contain few habitat features of relevance to threatened fauna. The edges of forest and woodland habitats may be used for foraging by raptors and less agile microbats, potentially including threatened species such as the Square-tailed Kite (*Lophoictinia isura*), Eastern Freetail-bat (*Mormopterus norfolkensis*) or Greater Broad-nosed Bat (*Scoteanax rueppellii*). Given the lack of foraging or shelter habitat (such as woody debris), the Cumberland Plain Land Snail (*Meridolum corneovirens*) or threatened birds would be considered unlikely to occur within areas of exotic grassland or cleared areas.

Native woodland and forest

Native woodland and forest communities within the study area are more structurally and floristically diverse and provide good quality habitats for a wide range of native fauna. Habitat resources include:

- mature canopy trees that provide nectar, fruits, leaves and foraging, roosting or nesting substrates;
- habitat trees with hollows and/or decorticating bark;
- abundant woody debris and leaf litter;

- patches of dense understorey shrubs;
- a range of fruiting and flowering small trees and shrubs;
- connectivity with wetland and aquatic habitats.

As discussed in Section 4.2.2, this vegetation also has good connectivity with extensive protected areas of native vegetation protected within the Blue Mountains National Park, as well as large patches of vegetation in adjacent rural residential land and the rest of the Fernhill Estate (see Figure 4). There is minimal noise and light disturbance from Fairlight Road and rural residences to the south and south-east of the precinct. Based on these attributes this vegetation would be expected to support a diverse suite of native fauna, including a number of threatened species.

Pre-European age trees and habitat trees containing hollows of varying size, fissures or decorticating bark were observed scattered throughout forest and woodland within the Lot 1 Subdivision. These resources may be used by a range of native fauna, including threatened birds, microbats and arboreal mammals, particularly given the continuity of vegetation with similar habitats within the Blue Mountains National Park. Examples of threatened species which may use such nesting or roosting sites include threatened birds such as Little Lorikeets (*Glossopsitta pusilla*), Turquoise Parrot (*Neophema pulchella*), Gang-gang Cockatoos (*Callocephalon fimbriatus*) and Glossy Black-cockatoos (*Calyptorhynchus lathami*) and microbats such as the Eastern Freetail-bat (*Mormopterus norfolkensis*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*). There are also four threatened forest owls which may occur within the Lot 1 Subdivision. These species are reliant on tree hollows for roosting and nesting and may use hollows within the precinct, but their preferred nesting habitat associations may not be present (see Appendix B for details). These owls would therefore be more likely to roost in hollows in adjacent areas and use habitats within the precinct for foraging only.

Eucalypts in the study area represent known or preferred feed trees for a number of fauna species, including threatened birds, the Koala and the Grey-headed Flying-fox. The canopy species Coastal Grey Box and Forest Red Gum are nectar and seed-bearing and would provide a food resource for native fauna, including the Grey-headed Flying Fox and arboreal mammals. Eucalypt species within the study area are summer and autumn-flowering (Brooker and Koenig, 2006) and so would not provide winter foraging resources for the Swift Parrot (*Lathamus discolor*) or Grey-headed Flying-fox. Winter-flowering acacias at the site would help provide year-round foraging resources for a range of native birds, bats and mammals. Arboreal mammal species are also likely to feed on the sap of these Acacias. The subject site is continuous with an extensive patch of vegetation which contains large, mature trees in an intact corridor and so would provide good concentrations of these foraging resources in a context that is suitable for migratory use. Forest Red Gum is a Koala food tree listed under Schedule 2 of SEPP 44 and is a regional primary food tree identified in the Koala Recovery Plan (DECC 2008d).

Woodland and forest at the site contains good quantities of woody debris and thick leaf litter which would provide shelter and foraging substrate for native reptiles, frogs and invertebrates including the Cumberland Plain Land Snail. Woody debris and flaking bark on mature-age trees within the precinct would also provide potential foraging habitat for a number of threatened insectivorous birds, such as the Hooded, Flame and Scarlet Robins (*Melanodryas cucullata cucullata, Petroica phoenica and P. boodang),* Speckled Warbler (*Chthonicola sagittata*), Varied Sittella (*Daphoenositta chrysoptera*) and Diamond Firetail (*Stagonopleura guttata*).

Areas of dense shrubs within the Castlereagh Scribbly Gum community and regenerating areas would also provide good foraging and shelter habitats for small woodland birds such as the Eastern Spinebill (*Acanthorhynchus tenuirostris*) and Rufous Whistler (*Pachycephala rufiventris*), which were observed throughout the Lot 1 Subdivision. These areas may also

provide potential shelter habitat for the threatened insectivorous bird species listed above, and could provide shelter or foraging habitat for the threatened Eastern Pygmy-possum (*Cercartetus nanus*).

Other habitat resources

The study area is situated on shale-derived colluvium and alluvial sediments on lower slopes and flats. There are no caves, cliffs, rock outcrops or substantial surface rock fragments within the precinct, which would therefore not support fauna that rely on rocky substrate for shelter. There are a number of threatened reptile and frog species known or predicted to occur in the locality (OEH 2015a; DotE 2013a), including the Broad-headed Snake (*Hoplocephalus bungaroides*), Giant Burrowing Frog (*Heleioporus australiacus),* and Littlejohns Treefrog (*Litoria littlejohni*). Records of these species within the locality are from Hawkesbury Sandstone substrates at higher elevations. These species depend on specific habitat resources from these environments (OEH 2012; Ehman, 1997) and would not occur in the subject site.

There are significant cave and cliff formations in the Blue Mountains National Park to the west of the site. Cave-roosting microbats such as the Little Bentwing-bat (*Miniopterus australis*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensisi)* and Large-eared Pied Bat (*Chalinolobus dwyeri*) may roost and breed in these areas but would only use aerial foraging habitat in the study area.

Patch size and connectivity

Although there has been extensive modification and thinning of vegetation within the study area, forest and woodland areas at the site are relatively continuous with only the south-eastern portion heavily cleared and fragmented. There are currently light grazing levels from cattle pastured within the study area, but other disturbances are limited to periodic slashing for asset protection zones near residences in the south and minimal light and noise spill from these residences.

Habitat value of vegetation within the study area is further increased by its connectivity with extensive areas of high quality habiat in adjacent areas. Vegetation within study area is continuous with forest and woodland contained within the Blue Mountains National Park, and within the proposed North West and South West biobank areas of Fernhill Estate (refer Figure 1). It also provides links to patches of native vegetation retained within rural residential properties to the south and south east. As such, the study area forms part of a vegetated corridor between higher elevation forest and habitats in the Blue Mountains and lowland grassy woodlands of the Cumberland Plain. Habitats within the study area are therefore likely to represent high value habitat for a variety of native fauna, including mobile threatened fauna with large home ranges such as the Spotted-tailed Quoll (*Dasyurus maculatus*). *Eucalyptus* species within the precinct may also provide migratory habitat and seasonal nectar resources for migratory bird species, including the threatened Regent Honeyeater (*Anthochaera phrygia*) and Swift Parrot (*Lathamus discolor*), although the precinct does not support the productive forests or winter flowering eucalypts preferred by these species in coastal areas.

4.3.3 Aquatic and riparian habitats

Drainage line and wetland habitats

Drainage lines within the study area consist of unnamed, ephemeral first and second order drainage lines. As discussed in Section 4.1.3, these waterways have been highly modified through the creation of relatively large dams at intervals along their length. Sections of the drainage lines linking the dams are poorly defined and typically devoid of aquatic vegetation and habitats. Based on this lack of aquatic habitat and through consultation with the Office of

Hawkesbury Nepean, drainage lines within the Lot 1 Subdivision were classified by ELA as 3rd and 2nd order watercourses using the Riparian Corridor Management Study (RCMS) methodology (DIPNR 2004; ELA 2010). According to the DPI classification of fish habitat in NSW waterways (Fairfull and Witheridge 2003), these drainage lines would represent Class 3 (Minimal fish habitat) or Class 4 (Unlikely fish habitat).

There are at least two moderate to large dams mapped within the study area, which contain healthy populations of native wetland plant and aquatic plants, including emergent Tall Spikerush and Frogsmouth. There are also a number of smaller dams and depressions with varying levels of habitat complexity, of which the Lot Subdivision contains three of these dams. These wetlands would provide habitat for native fish and aquatic invertebrates and potential breeding habitat for a number of pool breeding frogs, potentially including the Green and Golden Bell Frog (*Litoria aurea*). The potential for the Green and Golden Bell Frog and other native frog species to occur and breed at the site may be limited by other factors such as the presence of predatory fish and/or Chytrid fungus. These wetlands contained common, generalist frogs and reptiles during the field survey such as the Common Eastern Froglet (*Crinia signifera*), Dwarf Eastern Tree Frog (*Litoria fallax*) and Eastern Snake-necked Turtle (*Chelodonia longicollis*) and would also be likely to provide habitat for additional reptile species such as the Red-bellied Black-snake (*Pseudechis porphyriacus*), Brown-striped Frog (*Limnodynastes peronii*) and Eastern Water Skink (*Eulamprus quoyii*).

The wetlands are likely to support a moderately high diversity and abundance of native waterfowl, waders and other wetland birds, including the Purple Swamphen (*Porphyrio porphyria*), Australasian Grebe (*Tachybaptus novaehollandiae*), White-necked Heron (*Ardea pacifica*) and Pacific Black Duck (*Anas superciliosa*), all of which were observed within the Lot 1 Subdivision or adjacent areas of the Fernhill Estate (Appendix A). These wetlands may provide foraging habitat for threatened wetland birds such as the Australasian Bittern (*Botaurus poiciloptilus*), Black Bittern (*Ixobrychus flavicollis*) or Australian Painted Snipe (*Rostratula australis*) on occasion. The threatened Southern Myotis (*Myotis macropus*) may also forage for small fish and insects over the surface of these waterbodies.

4.4 Conservation significance

4.4.1 Overview

Based on the desktop assessment the following threatened biota and MNES are known or predicted to occur in the locality:

- 28 threatened ecological communities (TECs).
- 25 threatened flora species.
- 51 threatened fauna species, comprising six frogs, 25 birds, two fish, three invertebrates, 14 mammals and one reptile
- One endangered population.
- 13 migratory species.
- One National and World Heritage Place.

This list does not include marine threatened and migratory species or shorebirds which were highlighted by the database searches because the locality does not contain any marine or estuarine habitats.

The occurrence and potential occurrence of these threatened biota within the Lot 1 Subdivision is discussed in the following sections.

4.4.2 Threatened biota (TSC Act and FM Act)

The database searches identified 26 threatened flora species, 51 threatened fauna species and 24 TECs listed under the TSC Act as having been previously recorded or predicted to occur in the locality (see Appendix B).

Three fish and two invertebrates listed under the FM Act have been previously recorded or are predicted to occur in the locality of the study area (see Appendix B).

The potential for these threatened biota to occur within the study area is discussed in the following sections.

Threatened ecological communities

Two native vegetation types within the study area are consistent with TECs listed under the TSC Act:

- Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest, which is consistent with the Shale/Sandstone Transition Forest community listed as endangered under both the TSC and EPBC Acts.
- Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland, which is consistent with the Castlereagh Scribbly Gum Woodland ecological community listed as vulnerable under the TSC Act.

Both TECs occur as mosaics of different condition classes across the Lot 1 Subdivision, as shown on Figure 4. The distribution of these TECs in the study area is shown in Figure 4. No other threatened ecological communities are present in the study area.

Threatened flora species

No flora species has previously been recorded within the Lot 1 Subdivision (Figure 4). However two species have been recorded in the study area and include:

- Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*), which is listed as vulnerable under the TSC Act. The estimated population of this species within the study area numbers 4 308 individuals within four main patches (ELA 2010) and occurs between the two parcels of land of the Lot 1 Subdivision (Figure 4). The locations of these populations were verified during the GHD 2013 survey.
- *Micromyrtus minutiflora,* which is listed as endangered under the TSC Act and vulnerable under the EPBC Act. This species has been observed in disturbed areas to the north of the Lot 1 Subdivision, in association with Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (Figure 4) of the proposed North west biobank. This species is relatively cryptic and individuals or populations may occur elsewhere in this community within the wider Western Precinct.

Micromyrtus minutiflora has not been detected in the Lot 1 Subdivision since the original ELA (2010) observation despite multiple rounds of targeted threatened flora surveys as part of: this assessment (see Section 3.2.2); the BioBanking assessment for the proposed Fernhill North West biobank site in the northern portion of the Lot 1 Subdivision (GHD in prep.); the BioBanking assessment of the adjoining Fernhill Central West biobank (GHD, 2013c); and site walkovers and checking of known locations of *Micromyrtus* spp. with OEH staff. OEH threatened plant specialists have been satisfied that each of the *Micromyrtus* they have observed on site were the very similar species 'Fringed Heath-myrtle (*M. ciliata*)' (Steenbeeke, G. OEH, pers. comm.). The original ELA (2010) observation may have been a mis-identification of *M. ciliata* as the two species are very similar and are indistinguishable when not flowering. Irrespective of the identity of the individual plants recorded by ELA they are located several

hundred metres from the subject site within the proposed biobank. GHD have confirmed through targeted survey of the Lot 1 Subdivision during the flowering period for *M. minutiflora* that the species is not present.

Based on the assessment of habitats, soil types and vegetation occurring within the Lot 1 Subdivision, there is potential habitat for a further seven threatened flora species and one endangered flora population. These species are listed in Table 5.

Table 5 Threatened flora that may occur within the study area

Common Name	Scientific name	TSC Act status	EPBC Act status
Bynoe's Wattle	*Acacia bynoeana*	E	V
	Allocasuarina glareicola	E	E
	Dillwynia tenuifolia	V	V
Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	*Marsdenia viridiflora subsp. viridiflora*	EP	
Hairy Geebung	*Persoonia hirsuta*	E	E
Rufous Pomaderris	*Pomaderris brunnea*	V	V
	Pultenaea parviflora	E	V
Eastern Underground Orchid	*Rhizanthella slateri*	V	E

With the exception of the Eastern Underground Orchid these species can be reliably discounted as occurring based on the field survey effort undertaken. These species comprise six shrubs and a climber respectively. They are not cryptic. GHD have conducted multiple rounds of targeted threatened flora surveys as part of this assessment (see Section 3.2.2). It is unlikely that they would not have been detected if they were present.

The Eastern Underground Orchid is highly cryptic given that it grows almost completely below the soil surface, with flowers being the only part of the plant that can occur above ground. A precautionary approach has been undertaken and the subject site is assumed to comprise habitat for a local population of the Eastern Underground Orchid.

Threatened fauna species

One threatened fauna species, the Cumberland Land Snail (*Meridolum corneovirens*), has been recorded within Shale/Sandstone Transition Forest in the south-west of the Lot 1 Subdivision (ELA 2007a, b and 2010), as well as elsewhere within the Fernhill Estate and adjacent areas (GHD 2013a,b and c, OEH 2015a). This species is listed as endangered under the TSC Act.

Nine additional threatened fauna species have previously been recorded elsewhere within or directly adjacent (within 500 m) to the Fernhill Estate, comprising:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*) which is listed as vulnerable under the TSC Act.
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) which is listed as vulnerable under the TSC Act.
- Varied Sittella (*Daphoenositta chrysoptera*) which is listed as vulnerable under the TSC Act.

- Swift Parrot (*Lathamus discolor*) which is listed as endangered under both the TSC and EPBC Acts, and is also listed as a migratory species under the EPBC Act.
- Hooded Robin (*Melanodryas cucullata cucullata*) which is listed as vulnerable under the TSC Act
- Scarlet Robin (*Petroica boodang*) which is listed as vulnerable under the TSC Act.
- Grey-headed Flying-fox (*Pteropus poliocephalus*) which is listed as vulnerable under both the TSC and EPBC Acts.
- Eastern Freetail-bat (*Mormopterus norfolkensis*) which is listed as vulnerable under the TSC Act.
- Large-eared Pied Bat (*Chalinolobus dwyeri)* which is listed as vulnerable under both the TSC and EPBC Acts.

See Appendix B for details of the records of each of these threatened species.

The diversity of threatened fauna previously recorded within the study area and wider Fernhill Estate reflects the diverse range of habitats present within the estate, and excellent connectivity with adjacent conservation areas. For mobile species in particular, the intrinsic value of habitats within the study area is substantially increased by their connectivity with adjacent extensive areas of native vegetation. Notwithstanding the lack of preferred habitats for highly mobile threatened species such as the Swift Parrot (*Lathamus discolor*), these species may be expected to use habitats within the study area for movement and as an adjunct to higher quality habitats in adjacent areas, and may therefore occur on an occasional or opportunistic basis.

There are a number of records of threatened fauna from Mulgoa Nature Reserve to the north east of the subject site and the Blue Mountains National Park to the west, including large forest owls, microchiropteran bats and woodland birds (OEH, 2015b). Mulgoa Nature Reserve contains similar vegetation types and habitat resources to the study area.

A total of 33 threatened fauna species (including those listed above) have been assessed as having the potential to occur within the study area based on the habitats present. These species are listed in Appendix B and comprise 21 threatened birds, seven threatened bats, three threatened arboreal and terrestrial mammals, one threatened frog and one threatened invertebrate. The value of habitats within the study area for these species is discussed in Sections 4.3.2 and 4.3.3. As discussed in Section 4.3.2, several of these species have been assessed as having the potential to occur within the study area based on the high connectivity of vegetation with large areas of high quality habitats in adjacent areas, rather than solely on the basis of the presence of specific habitat features.

Table 6 Threatened fauna that are known or may occur within the study area

Common Name	Scientific name	TSC Act status	EPBC Act status
Birds			
Regent Honeyeater	*Anthochaera phrygia*	CE	E
Australasian Bittern	*Botaurus poiciloptilus*	E	E
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V	
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	V	
Speckled Warbler	*Chthonicola sagittata*	V	

Common Name	Scientific name	TSC Act status	EPBC Act status
Varied Sittella	*Daphoenositta chrysoptera*	V	
Little Lorikeet	*Glossopsitta pusilla*	V	
Black Bittern	*Ixobrychus flavicollis*	V	
Swift Parrot	*Lathamus discolor*	E	E
Black-tailed Godwit	*Limosa limosa*	V	M; C,J,K
Square-tailed Kite	*Lophoictinia isura*	V	
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	V	
Turquoise Parrot	*Neophema pulchella*	V	
Barking Owl	*Ninox connivens*	V	
Powerful Owl	*Ninox strenua*	V	
Scarlet Robin	*Petroica boodang*	V	
Flame Robin	*Petroica phoenicea*	V	
Australian Painted Snipe	*Rostratula australis*	E	V,M
Diamond Firetail	*Stagonopleura guttata*	V	
Masked Owl	*Tyto novaehollandiae*	V	
Sooty Owl	*Tyto tenebricosa*	V	
Mammals			
Eastern Pygmy-possum	*Cercartetus nanus*	V	
Large-eared Pied Bat	*Chalinolobus dwyeri*	V	V
Spotted-tailed Quoll	*Dasyurus maculatus*	V	E
Little Bentwing-bat	*Miniopterus australis*	V	-
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	V	
Eastern Freetail-bat	*Mormopterus norfolkensis*	V	
Southern Myotis	*Myotis macropus*	V	
Koala	*Phascolarctos cinereus*	V	V
Grey-headed Flying-fox	*Pteropus poliocephalus*	V	V
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	
Frogs			
Green and Golden Bell Frog	*Litoria aurea*	E	V

Common Name	Scientific name	TSC Act status	EPBC Act status
Invertebrates			
Cumberland Plain Land Snail	*Meridolum corneovirens*	E	

The remainder of the threatened fauna species that are known or predicted to occur in the locality have a close association with specific habitat resources that are not present in the study area. Notably there are a number of fauna species that are associated with shrubby, sclerophyll vegetation types on sandstone substrates or rocky escarpments that would not occur in the grassy woodlands on flat, shale landscapes that characterise the study area (refer Appendix B).

The desktop review revealed two threatened fish species (Macquarie Perch *Macquaria australasica* and Australian Grayling *Prototroctes mairaena*) and two aquatic invertebrates Adam's Emerald Dragonfly (*Archaeophya adamsi* and Sydney Hawk Dragonfly *Austrocordulia leonardi)* which are predicted to occur in the locality of the site. Each of these species is associated with clear, deep streams with rocky or gravel substrates whereas the aquatic habitats in the study area are shallow and turbid with clay substrate. A review of the specific habitat requirements of these species and the habitat present led to the conclusion that these aquatic species are unlikely to occur in the study area or to be affected by the proposal (Appendix B).

4.4.3 EPBC Act MNES

The database searches identified 16 threatened ecological communities, 23 threatened flora species, 21 threatened fauna species and 13 migratory species listed under the EPBC Act as potentially occurring in the study area (see Appendix B). One additional MNES, The Greater Blue Mountains World Heritage Area, was identified as occurring within the locality.

Threatened ecological communities

As discussed in Section 4.4.1, the Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest community is consistent with the Shale/Sandstone Transition Forest community listed as endangered under both the TSC and EPBC Acts.

The distribution of vegetation that is consistent with the EPBC Act-listed form of this community within the Lot 1 Subdivision is shown in Figure 4. No other threatened ecological communities listed under the EPBC Act are present in the study area.

Threatened flora

As stated in Section 4.4.1, *Micromyrtus minutifolia,* which is listed under the TSC Act and was recorded outside the study area to the north of the Lot 1 subdivision, is also listed as vulnerable under the EPBC Act. A further eight threatened flora species listed as threatened under the EPBC Act were also assessed as having the potential to occur (see Table 5). These species are all also listed under the TSC Act and are addressed in Section 4.4.1 and Appendix B.

Threatened fauna

No threatened fauna species listed under the EPBC Act have been recorded within the study area. As discussed in Section 4.4.1, three fauna species listed as threatened under the EPBC Act (the Grey-headed Flying-fox, Swift Parrot and Large-eared Pied Bat) have been recorded within or immediately adjacent to the wider Fernhill Estate. Based on the habitats present, a total of nine threatened fauna species listed under the EPBC Act may occur in the study area and/or be affected by the proposal. These fauna species are also listed under the TSC Act and are listed in Table 6. Relevant habitats for these species are discussed in Section 4.3.2.

Migratory and marine fauna

Three migratory marine bird species, four wetland birds (two of which are also listed as marine species) and seven 'terrestrial' bird species were identified by the database searches as known or having the potential to occur within the locality, comprising:

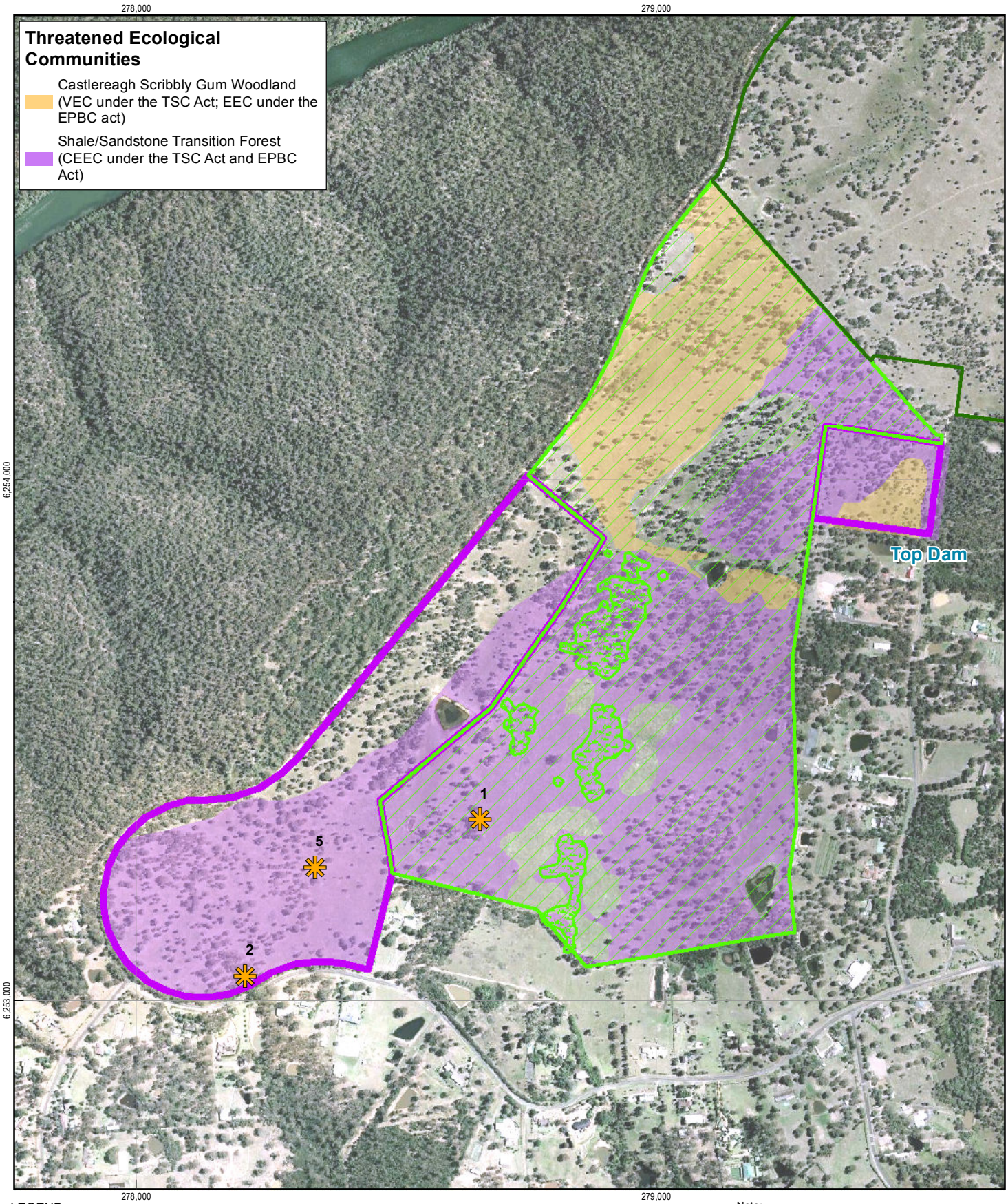
- Migratory wetland species:
  - Black-tailed Godwit (*Limosa limosa*)
  - Great Egret (*Ardea alba*; also listed as marine)
  - Cattle Egret (*Ardea ibis*; also listed as marine)
  - Latham's Snipe (*Gallinago hardwickii*)
  - Painted Snipe (*Rostratula benghalensis*), also listed as an endangered species under the EPBC Act.
- Migratory 'terrestrial' species
  - White-bellied Sea-eagle (*Haliaeetus leucogaster*)
  - White-throated Needletail (*Hirundapus caudacutus*)
  - Rainbow Bee-eater (*Merops ornatus*)
  - Black-faced Monarch (*Monarcha melanopsis*)
  - Spectacled Monarch (*Monarcha trivirgatus*)
  - Satin Flycatcher (*Myiagra cyanoleuca*)
  - Rufous Fantail (*Rhipidura rufifrons*)
  - Regent Honeyeater (*Xanthomyza phrygia*), also listed as an endangered species under the EPBC Act.
- Migratory 'marine' species
  - Fork-tailed Swift (*Apus pacificus*).

One of these migratory bird species was recorded during field surveys in the Eastern Precinct of the Fernhill estate: the Cattle Egret (*Ardea ibis*) which was observed foraging in moist grassland adjacent to a large dam. Given the habitats present and connectivity of the precinct to large areas of high quality habitats on three sides, each of the predicted species listed above may occur in habitats within the Lot 1 Subdivision on occasion.

The EPBC Act lists migratory species listed under international agreements, as well as families of birds (such as ducks, waders, eagles and hawks) that are also known to be migratory but are not listed under international agreements. A range of waterfowl and waders have been recorded within the Fernhill Estate (see Appendix A). Other seasonally migratory or nomadic species would also be likely to utilise habitats within the study area on occasion.

Additional MNES

The protected matters search (DotE 2013a) identified 'The Greater Blue Mountains Area' which is listed as a declared World Heritage Property and a National Heritage Place under the EPBC Act. The Greater Blue Mountains Area includes the Blue Mountains National Park which is located directly adjacent to the west and north of the Lot 1 Subdivision. Vegetation and habitats are continuous between the park and vegetation within the Lot 1 Subdivision.



LEGEND

- Indicative Fernhill South West Biobank site Boundary
- Indicative development footprint
- Northwest Biobank Site Boundary
- *Meridolum corneovirens* (endangered species under the TSC Act)
- *Grevillea juniperina* subsp *juniperina* (approximate location(endangered under the TSC Act))

Note:
1. Point labels the indicate number of shells at each location.
2. Approximate Grevillea juniperina subsp. juniperina locations that are shown as polygons are based on ELA (2010) survey and mapping. GHD have ground-truthed this mapping within the indicative development footprint and have not recorded G. juniperina subsp. juniperina in this area

Paper Size A4

0 80 160 240 320 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

Angas Securities Pty. Ltd.
Fernhill Lot 1 DP 549247
Subdivision Ecology Assessment

Job Number 22-1670904
Revision A
Date 26 May 2015

Threatened Biota

Figure 4

G:\22\16709\GIS\Maps\Fernhill_Northwest_Biobank_site\2216709_Z004_WesternPrecinct_Threatened_Biota_RevB.mxd

Level 15, 133 Castlereagh Street Sydney NSW 2000 Australia T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com W www.ghd.com

© 2015. Whilst every care has been taken to prepare this map, GHD and NSW DEPARTMENT OF LANDS, GEOSCIENCE AUSTRALIA, NSW DEPARTMENT OF PRIMARY INDUSTRY, GOOGLE EARTH PRO make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data Source: NSW Department of Lands: Cadastre - Jan 2014; Geoscience Australia: 250k Data - Jan 2014; NSW Department of Primary Industry - Jan 2014; Google image Jan 2015. Created by: mweerakoon

5. Preliminary impact assessment

5.1 Overview

A preliminary assessment of impacts of the proposal is included below. This assessment is based on the proposal and indicative development footprint as described in Section 1.2 and is intended to provide an overview of the potential impacts associated with the proposal. It should be noted, however, that a more comprehensive impact assessment, based on the final development footprint and informed by more extensive survey effort and assessment, would be undertaken at the Development Application stage should this rezoning application be successful.

The exact location, size and nature of the development would be determined using the BBAM at the Development Application stage. The BioBanking assessment would comprise:

- Preliminary application of the BBAM to help finalise the precinct layout and achieve an appropriate balance between development and conservation areas.
- Application for a biobanking statement for the proposed subdivision (i.e. the development).
- Application for a biobanking agreement for the proposed conservation areas (i.e. a biobank).
- Purchase and retirement of biodiversity credits in accordance with the biobanking statement for the proposed subdivision.

This approach would ensure that the proposed development of the Lot 1 Subdivision would improve or maintain biodiversity values, as discussed in Section 6.4.

The intended amendments to E3 – Environmental Management zoning would not result in direct impacts within the entire indicative development footprint shown on Figure 1. Impacts are likely to be reduced through retention of vegetation and habitat resources within large lots and potentially also a reduction or reconfiguration of lots. This preliminary impact assessment should therefore be considered as an indication of the maximum impacts that could be associated with the proposal.

5.2 Direct impacts

The direct impacts of the proposal would be limited to the areas within the subject site shown on Figure 1. The indicative development footprint is contained within Lot 1 DP 549247 but would not affect the entirety of this lot.

Areas outside of the indicative development footprint shown on Figure 1 but within the abovementioned Lot would be subject to a biobanking agreement, and would be managed in perpetuity to maintain or improve biodiversity values. Impacts within proposed biobank areas would therefore be positive in terms of biodiversity outcomes.

5.2.1 Removal of vegetation and habitat

The proposal would result in the removal or modification of approximately 36.39 ha of native vegetation within the indicative development footprint of 40.86 ha, as shown on Table 7. Impacts would include clearing for the permanent infrastructure components of the proposal such as residential lots, access roads, fire trails, surface water management ponds and pumps and all associated earthworks. It is assumed that construction site compounds, temporary sediment management structures and any other ancillary structures would be entirely contained within the indicative development footprint.

There is likely to be some scope to retain native trees and some understorey vegetation within within asset protection zones. However this is expected to be limited given the size of the rezoned lots.

The extent of vegetation and habitats within the indicative development footprint is summarised in Table 7. Vegetation removal would include up to 23.80 ha of Shale/Sandstone Transition Forest and 1.41 ha of Castlereagh Scribbly Gum Woodland. Impacts on these threatened biota and others that may occur within the indicative development footprint are discussed in detail in Section 5.5.

The proposal would remove 36.39 ha of native vegetation in predominantly moderate/good condition (in accordance with the BBAM) within the indicative development footprint. Construction within the indicative development footprint would have moderate impacts on local biodiversity due to its vicinity to remnant bushland in the adjacent Blue Mountains National Park.

The total area of native vegetation within the indicative development footprint (36.39 hectares) is around 0.37 % of the estimated area of native vegetation in the locality (around 9,803 hectares, based on Tozer (2010) vegetation mapping[1]). Approximately 70.24 ha of native vegetation, including equivalent vegetation zones and habitats, would be retained and managed for biodiversity values within the proposed South west biobank area as shown in Table 7.

[1] Note: NPWS (2002) mapping does not include vegetation within the Blue Mountains Area. This mapping was used to provide estimates of the extent of Cumberland Plain vegetation types within the locality as it provides more detailed information on condition classes, and these communities do not extend west into the Blue Mountains area. Tozer (2010) mapping was used to estimate the total area of vegetation within the locality as the NPWS (2002) mapping would severely underestimate this extent.

Table 7 Potential extent of vegetation removal or modification within the Lot 1 Subdivision

Vegetation community	TSC Act Status	EPBC Act Status	Area within indicative development footprint (hectares)	Area within proposed biobank areas (hectares)	Area within locality [a] (hectares)	Percentage of extent in locality within the indicative development footprint
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest Moderate/good - high	EEC	EEC	20.57	32.15	522.89[a]	3.93
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest Moderate/good - poor	EEC	EEC	3.22	4.46		
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest Low condition	EEC	EEC	0.00	9.75	612.56[a]	0.0
Total Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest			*23.80*	*46.36*	*1135.45[a]*	*2.10*
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland Moderate/good - medium	VEC		1.41	10.80	*0[a, c]*	
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland Moderate/good - poor	VEC		0.00	4.96	*0[a, c]*	
Total Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland			*1.41*	*15.76*	*0[a, c]*	
Red Bloodwood - Grey Gum woodland			10.90	7.34	8667.59b	0.13

Vegetation community	TSC Act Status	EPBC Act Status	Area within indicative development footprint (hectares)	Area within proposed biobank areas (hectares)	Area within locality [a] (hectares)	Percentage of extent in locality within the indicative development footprint
Coastal freshwater wetland			0.28	0.78	No estimate[d]	
Cleared			0.00	4.47		
Total Native Vegetation			**36.39**	**70.24**	**9803.04**	**0.37**

Notes

a = based on NPWS (2002) vegetation mapping (for Cumberland Plain Communities, includes condition information).

b = based on Tozer (2010) vegetation mapping (includes sandstone vegetation types in the Blue Mountains area)

c = regional vegetation mapping such as NPWS (2000) may omit small areas of a given vegetation map unit, in this instance including the extent of this map unit within the precinct. This value should be taken to represent small, infrequent patches of this vegetation map unit in the locality rather than literally '0' hectares.

d = NPWS (2002) mapping does not include freshwater wetlands because this vegetation map unit occurs as small polygons that cannot be readily mapped at the regional scale. This ommission should be taken to represent small, infrequent patches of this vegetation map unit in the locality.

5.2.2 Impacts on aquatic habitats

Two mapped areas of wetland (dam) habitat fall within the development footprint as shown on Figure 3, comprising an area of approximately 0.75 hectares (see Table 7). There may be scope to retain the dam within the south-east of the indicative development footprint within public spaces or the proposed large residential blocks. The habitat value for aquatic and wetland fauna may be reduced by the removal of surrounding vegetation and impacts to water quality through increased runoff from hardstand areas and potential for contamination from surrounding residences. This would mainly affect the dam in the southeastern corner of the precinct, but may also affect retained dams between the two development parcels.

5.2.3 Habitat fragmentation and isolation

As discussed in Sections 4.1.4 and 4.3.2, the study area forms part of an important vegetated corridor between higher habitats within the Blue Mountains area and lowland forests and woodlands of the Cumberland Plain. At a local scale, vegetation within the study area is continuous with that of Blue Mountains National Park.

The indicative development footprint would increase habitat fragmentation within the eastern portion of the precinct through the removal of native vegetation and construction of fences, buildings and roads. It would also partially alter habitat connectivity between the Cumberland Plain and the Blue Mountains. However, the proposed South west biobank may reduce impacts of the proposal on habitat connectivity between biogeographical regions.

Habitat within the indicative development footprint comprise small patches of retained vegetation and remnant trees, which would be utilised mainly by mobile or disturbance-tolerant fauna such as birds and microbats. These species would be likely to continue to traverse the gaps in habitat created by the proposal.

No areas of habitat would be isolated as a result of the proposal.

5.2.4 Fauna injury and mortality

As described above, the study area provides habitat resources for native fauna species, including threatened fauna. More mobile native fauna such as adult birds, microbats, terrestrial and arboreal mammals are highly unlikely to be affected by construction activities. Construction may result in the injury or mortality of small terrestrial fauna that may be sheltering in vegetation within the subject site, such as the Cumberland Land Snail, frogs and reptiles described as above. The frog and reptile species that are known or likely to occur within the study area are widespread and abundant and so the potential injury or mortality of individuals within a maximum of 40.86 hectares of habitat (comprising all vegetation, including native and exotic, within the indicative development footprint) is highly unlikely to affect an ecologically significant proportion of any local populations. Impacts on threatened fauna are discussed in detail in Section 5.5.3.

Nesting birds and roosting microbats may be vulnerable to injury or mortality if present during clearing of trees. Notably, these less mobile fauna may be resident in habitat trees occurring across the western portion of the Fernhill Estate including the proposed South west and North west Biobank areas. Pre-clearing fauna surveys would be recommended as part of the Construction Environmental Management Plan (CEMP) to reduce the risk of injury or mortality to native fauna and especially tree-dwelling fauna. These surveys would involve the inspection of trees for resident fauna as a precautionary measure prior to felling. The CEMP would also contain protocols for the felling of habitat trees and measures for the safe management of native fauna if detected within construction areas during construction (see Section 6).

The proposal would increase the extent of developed land in the study area and locality and may result in a minor increase in the volume of traffic. Given the value of vegetation within the study area as a fauna movement corridor (see Section 4.3.2), this may increase the risk of vehicle collisions with native fauna. Recommended mitigation measures to address this issue would include signposting and enforcing safe speed limits (see Section 6.3). Given the relatively low volumes of traffic anticipated within the proposed low-density rural residential area, impacts associated with vehicle strike are anticipated to be minor. Safe passage for native fauna between the Blue Mountains National Park and the Fernhill Central West biobank area would be retained through the proposed biobank areas to the north of the Lot 1 Subdivision within the wider Fernhill Estate.

5.3 Indirect impacts

5.3.1 Erosion, sedimentation and contamination

There are potential sensitive receptors for indirect impacts on aquatic habitats in the study area, including the large dams and wetlands downstream including Top Dam, a relatively extensive wetland area in the Fernhill Central West biobank area to the east. Potential impacts that could result in a decline in aquatic habitat value include:

- Alterations to riparian and floodplain geomorphology
- Alterations to catchment hydrology
- Reduced water quality through hydrocarbon contamination or through increased nutrient or sediment inputs.

The hydrology and water quality of the study area is already substantially modified by clearing, damming and livestock access. The proposal would result in an increase in the proportion of hardstand surfaces within the Lot 1 Subdivision and may also modify drainage through drains and other engineered structures. Given the current modified nature of aquatic habitats and the proposed low density residential properties proposed, it is anticipated that potential impacts

such as those listed above could be controlled through appropriate mitigation measures as outlined in Section 6.

It is also anticipated that erosion, sedimentation and contamination effects on retained native vegetation in areas directly adjacent to the indicative development footprint would be minimised or avoided through mitigation measures as described in Section 6, and through the placement of asset protection zones (intended to reduce bushfire risk to properties and infrastructure) adjacent to all such areas. These zones would comprise retained canopy trees over a slashed grassy understorey.

5.3.2 Weed invasion and edge effects

'Edge effects' refers to changed environmental conditions at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from clearing of vegetation within the indicative development footprint and then continue to affect vegetation and habitats adjoining development areas for the life of the proposal. This is of particular concern for this proposal given the high habitat value of surrounding habitats, including relatively intact areas within conservation areas.

Construction may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via wind and water and via worker's shoes, clothing and through construction vehicles. The risk of introduction of weeds would continue during operation of the propsal through wind or water transmission of propagules from gardens, or through recreational use of retained vegetation by property owners or their pets.

A Vegetation Management Plan is recommended for the proposal, which would contain measures to avoid direct and indirect impacts on native vegetation adjoining the subject site (refer Section 6). These measures would include, but not be limited to, the maintenance of buffer zones (including asset protection zones, retained native vegetation within public spaces and on residential lots and weed management activities) between areas to be developed and adjacent retained areas of vegetation.

It should also be noted that adjoining vegetation within the proposed biobank adjacent to the Lot 1 Subdivision and in the adjacent Fernhill Central West biobank would be managed for conservation in perpetuity, which would include weed management and revegetation activities. This would therefore limit the impacts of edge effects within these areas.

5.3.3 Pests and pathogens

Construction activities within the subject site have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) in the Lot 1 Subdivision through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can eliminate entire populations once introduced into an area.

As a precautionary measure a 'clean on entry, clean on exit' policy should be implemented during construction activities as outlined under a CEMP (detailed further in Section 6.3.1) to prevent the introduction or spread of these pathogens.

5.3.4 Light, noise and vibration

The proposal would increase the level of light, noise and vibration disturbance in retained habitats within areas adjacent to the indicative development footprint. Given the large lot size and low density of the proposed development and the provision of buffer zones (including asset protection zones) between the indicative development area and retained areas of native vegeation, it is anticipated that these imapcts would be relatively minor.

5.4 Key Threatening Processes

A key threatening process (KTP) is defined in the TSC Act as an action, activity or proposal that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

KTPs are listed under the TSC Act, the FM Act and also under the EPBC Act. A number of KTPs are listed under more than one Act. Those potentially relevant to this proposal are discussed in Table 8 below. Mitigation measures to limit the impacts of these KTPs are discussed in Section 6.

Table 8 Key threatening processes

KTP	Status	Comment
Clearing of native vegetation	TSC Act; EPBC Act	The proposal would result in the increase of this KTP within an indicative development footprint containing 36.39 hectares of native vegetation, including approximately 45.74 hectares of vegetation consistent with threatened ecological communities. Conversely, the proposal would also prevent further operation of this KTP within the proposed South west biobank area in the study area by ensuring that the 70.24 hectares of native vegetation within these areas would be conserved in perpetuity.
Clearing of hollow-bearing trees	TSC Act	The proposal would remove hollow-bearing trees within the 36.39 hectares of native vegetation within the indicative development foortprint. Some hollow-bearing trees may be retained within public spaces or on private land but their habitat value would be reduced by the removal of surrounding vegetation and increase in noise, light and fragmentation disturbances. Conversely, the proposal would also prevent the removal of hollow-bearing trees within 70.24 hectares of vegetation within the proposed South west biobank area.
Removal of dead wood and dead trees	TSC Act	The proposal would remove habitat resources for native fauna through clearing dead wood and trees in the 36.39 hectares of native vegetation to be cleared. This could be partially mitigated by the salvage and reinstatement of some of this woody debris into adjoining areas as part of the CEMP. Retained vegetation within the proposed biobank areas would be managed for biodiversity in perpetuity, which would include the maintenance of such habitat features.
Invasion of plant communities by perennial exotic grasses	TSC Act	Disturbed areas in the south of the Lot 1 Subdivision features moderate to severe infestation with perennial exotic grasses. Adjoining areas of native

KTP	Status	Comment
		vegetation also feature localised moderate infestation. There is the potential for perennial exotic grasses to further invade native vegetation through disturbance during construction of the proposal and an increased in disturbed edge habitats around the indicative development footprint. A Vegetation Management Plan is recommended, which would include measures to limit the spread of weeds. Retained areas of vegetation would also be managed to reduce the incidence and spread of weeds under the proposed biobank agreement. These mitigation measures would be likely to effectively limit the operation of this KTP.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act; FM Act	The hydrology of the study area is already substantially modified by damming of the drainage lines, clearing for agriculture and surrounding suburban development. Up to two dams would be directly impacted by the proposal. Such habitat is not limited in the locality. Impacts on downstream areas could be effectively limited through the implementation of appropriate mitigation measures. The proposal would therefore eresult in a minor increase of the operation of this KTP.
Infection of native plants by *Phytophthora cinnamomi*	TSC Act; EPBC Act	Construction activities have the potential to introduce the root-rot fungus *Phytophthora cinnamomi* into the Lot 1 Subdivision, which could lead to dieback of vegetation. The implementation of a Vegetation Management Plan is recommended to limit the potential for adverse impacts on retained native vegetation as discussed in Section 6. The proposal is unlikely to increase the operation of this KTP.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Construction activities have the potential to introduce Myrtle Rust to the Lot 1 Subdivision. The implementation of a Vegetation Management Plan is recommended to limit the potential for adverse impacts on retained native vegetation as discussed in Section 6. The proposal is unlikely to increase the operation of this KTP.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Construction activities have the potential to introduce amphibian chytrid to the Lot 1 Subdivision, which could lead to death of local frogs. The implementation of a Fauna Management Plan is recommended to limit the potential for adverse impacts on fauna and their habitats as discussed in Section 6. The proposal is unlikely to increase the operation of this KTP.

5.5 Impacts on threatened biota

The proposal would result in impacts to known occurrences of threatened biota, comprising:

- Impacts on up to 23.80 hectares of vegetation consistent with Shale/Sandstone Transition Forest, listed as an endangered ecological community under both the TSC and EPBC Acts within the indicative development footprint.
- Impacts on up to 1.41 hectares of vegetation consistent with Castlereagh Scribbly Gum Woodland, listed as a vulnerable ecological community under the TSC Act within the indicative development footprint.

The proposal also has the potential to impact on a further 11 threatened flora, 33 threatened fauna and 14 migratory species through the removal of known or potentially suitable habitat. Larger areas of habitats similar to those to be removed would be retained within proposed conservation areas adjacent to the Lot 1 Subdivision and within the western portion of the Fernhill Estate, as discussed in Section 6.4.

As previously discussed, this impact assessment is based on preliminary surveys for the Lot 1 Subdivision. It is anticipated that more extensive survey effort would be undertaken at the development application stage for the proposal, allowing a more detailed assessment of the final proposed footprint and associated impacts on threatened biota. It should also be noted that current levels of impact on both the Shale/Sandstone Transition Forest community would constitute 'red flags' under the BBAM. Approval of a red flag variation or substantial modification of the current proposal would therefore be required in order to gain a biobanking statement at the Development Application stage.

5.5.1 Threatened ecological communities

Within the indicative development footprint, the proposal would remove a total of 25.21 hectares of vegetation comprising local occurrences of threatened ecological communities, as described below. Based on a preliminary consideration of the BBAM, the proposal would require red flag variations for Shale/Sandstone Transition Forest. There is some scope to reduce these impacts through retention of overstorey vegetation within residential lots, asset protection zones and public spaces within the indicative development footprint.

Shale/Sandstone Transition Forest

The indicative development footprint contains a total of 23.80 hectares of Shale/Sandstone Transition Forest, which is listed as an EEC under both the TSC and EPBC Acts. Vegetation to be removed would include up to 20.57 hectares in moderate/good- high condition, as well as up to 3.23 hectares in moderate/good- poor or low condition. This represents approximately 2.1% of the occurrence of this community within the locality, as mapped by NPWS (2002).

At least 46.36 hectares of this community, including 36.62 hectares in moderate/good – high and poor condition, would be retained and actively managed for biodiversity values within the proposed South west biobank which may occur between the two parcels of land of the Lot 1 Subdivision.

Castlereagh Scribbly Gum Woodland

The indicative development footprint contains 1.41 hectares of Castlereagh Scribbly Gum Woodland, which is listed as a VEC under the TSC Act and is in medium condition. There are no additional areas of this vegetation community mapped in the locality (NPWS, 2002). Regional vegetation mapping such as NPWS (2000) may omit small areas of a given vegetation map unit, in this instance including the extent of this map unit within the precinct. This value should be taken to represent small, infrequent patches of this vegetation map unit in the locality rather than literally '0' hectares. Nonetheless this suggests that the area within the precinct is locally and regionally significant.

At least 15.76 hectares of this community would be retained and actively managed for biodiversity values within the proposed South west biobank area.

5.5.2 Threatened flora

No threatened flora was recorded within the Lot 1 Subdivision and is unlikely to be impacted by the proposal. The total surveyed population of 4, 308 *Grevillea juniperina* subsp. *juniperina*)

plants (ELA 2010) would be retained in the proposed South west biobank area between the two parcels of land within the Lot 1 Subdivision.

The proposal would also remove potential habitat for up to 10 additional threatened flora species identified as having the potential to occur within the study area (see Section 4.4.2). Greater areas of similar habitats would be retained within proposed conservation areas as discussed in Section 6. It is anticipated that targeted surveys for threatened flora, would be undertaken to inform a more detailed impact assessment at the development application stage.

5.5.3 Threatened fauna

The proposal would remove known and potential habitat for the Cumberland Land Snail, which is listed as endangered under the TSC Act, and has previously been recorded in the south west of the site, within the indicative development footprint (ELA 2007b, 2010). This species has been recorded in high numbers elsewhere within the Fernhill Estate and in the locality, and is more commonly observed in association with Cumberland Plain Woodland communities. It is considered unlikely that the removal of Shale/Sandstone Transition Forest within Lot 1 would lead to the extinction of local populations of this species, given the proposed conservation of other areas of higher value Cumberland Plain Woodland habitat with known populations elsewhere on the Fernhill Estate (GHD 2013a, b and c). Targeted pre-clearing surveys and relocation of individuals and habitat resources from the indicative development footprint are likely to reduce the risk of harm to acceptable levels (see Section 6.3).

5.5.4 Migratory species

Up to 14 species of migratory birds listed under the EPBC Act were identified as having the potential to occur within the western portion of the Fernhill Estate, based on the habitat types present and connectivity with large tracts of vegetation along the Nepean River and in the Blue Mountains National Park. The indicative development footprint would therefore involve removal of up to 36.39 hectares of potential habitat for these species. Over 70.24 hectares of similar habitats would be retained within the proposed South west biobank areas. Connectivity between high quality habitats in the Blue Mountains National Park and the Fernhill Central West biobank area would be retained or improved through the protection and management of vegetation in the biobank area in the north of the Lot 1 subdivision, as discussed in Section 5.2.3. The 14 migratory species identified in Section 4.4.3 are all highly mobile species which would readily traverse gaps in habitat such as those caused by the proposal. The proposal would therefore represent a reduction in potential habitat for these species in the locality, but would be unlikely to threaten the persistence of local populations or impede migratory movements between areas of high quality habitat in the locality

5.5.5 Greater Blue Mountains World Heritage Area

Vegetation immediately to the east of both sections of the indicative development precinct is contained within the Blue Mountains National Park, which is part of the Greater Blue Mountains Area, which is listed as a declared World Heritage Property and a National Heritage Place under the EPBC Act.As discussed in Section 5.3, the proposal would have the potential to impose indirect impacts on adjacent areas of vegetation through: erosion, sedimentation and contamination; weed and pest invasion; and increased light, noise and vibration.

The Lot 1 Subdivision is separated from vegetation within the Blue Mountains National Park by Fairlight Road. It is anticipated that sections of the indicative development footprint directly adjacent to this road would contain bushfire asset protection zones, which would act as a partially vegetated buffer to minimise indirect impacts such as those listed above from affecting vegetation within the Blue Mountains National Park. Minor edge effects (including altered vegetation structure and higher weed incidence) are already present along the road edges

through these areas. It is therefore considered that these impacts would be minor and readily controlled through mitigation measures as described in Section 6.

The proposal would also reduce connectivity between vegetation in the Blue Mountains National Park and adjacent lowland areas of vegetation to the east. These impacts are discussed in detail in Section 5.2.3. The main loss of connectivity would be between the National Park and fragmented habitats to the south and south-east of the Lot 1 Subdivision. Connectivity between the National Park and the relatively intact vegetation within Fernhill Central West biobank area would be retained through the proposed biobank area within Lot 31, north of the proposed subdivision.

6. Mitigation Measures

6.1 Overview

The proposal would result in direct impacts on native biota and their habitats within the indicative development footprint. There is also the potential for indirect impacts on retained areas of native vegetation adjacent to the indicative development footprint, both during construction and from the resulting residential area. The following sections provide an overview of recommended mitigation measures likely to be required to avoid or minimise such impacts. These measures are presented according to the hierarchy of avoidance and mitigation of impacts, and the provision of offsets to counter residual impacts of the proposal. It is anticipated that these measures would be revised based on a more detailed and accurate assessment of potential impacts which would be undertaken during the Development Application stage. The Development Application is likely to include a BioBanking assessment that would ensure that the proposal would improve or maintain biodiversity values. The BioBanking assessment would provide the framework for avoidance, mitigation and offsetting of impacts as follows:

- Preliminary application of the BBAM to help finalise the precinct layout and achieve an appropriate balance between development and conservation areas.
- Conservation of land outside of the development footprint under a biobanking agreement.
- Purchase and retirement of biodiversity credits in accordance with the biobanking statement for the proposed subdivision.

Supplementary assessment and approval under the EPBC Act would also be required. The EPBC Act approval is also likely to require the provision of specific biodiversity offsets for MNES. EPBC Act offsets would be aligned with the BioBanking assessment as far as is practicable.

6.2 Avoidance of impacts

The indicative development footprint has been substantially revised compared to that referred to in the previous rezoning application (ELA 2010). These revisions have aimed to reduce impacts on native (and particularly threatened) biota, by reducing impacts on the threatened *Grevillea juniperina* subsp *juniperina* and by improving habitat connectivity through the centre of the site relative to the previous development footprint. As mentioned above, the indicative development footprint may require further revision during the Development Application phase in order to further reduce the impacts on native biota and comply with the BBAM.

6.3 Mitigation of impacts

6.3.1 Pre-construction phase

Detailed Design Phase

The indicative development footprint shows the maximum area to be impacted by the development.There is some potential to reduce the impacts of the proposal through retention of native biota and habtiats within this footprint. The proposed development comprises a low density residential area with a minimum lot size of 2 hectares. Native vegetation and habitat features (such as habitat trees or aquatic areas) may therefore be retained in some areas of the indicative development, for example through tree preservation orders on residential lots, in public spaces or retention of canopy trees within bushfire asset protection zones.

During the detailed design process, the impact of the proposal on areas with high biodiversity values should be minimised wherever possible by:

- Minimising the area of native vegetation and especially intact threatened ecological communities to be cleared.
- Retention of native vegetation within residential lots, open public spaces and bushfire asset protection zones wherever possible.
- Avoidance of identified habitat trees wherever possible.

Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) would be required for the construction phase of the project, and should be prepared prior to the commencement of construction.The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures including the procedures outlined below. The CEMP should be prepared and implemented by the contractor. The proposed measures would include environmental safeguards for protection of downstream properties and waterways in accordance with relevant policy documentation and Government guidelines.

The CEMP would be required to address the following as a minimum:

- An erosion and sediment control plan, which would require:
  - Installation of erosion and sediment control measures prior to construction.
  - Regular inspection of erosion and sediment control measures, particularly following rainfall events, to ensure their ongoing functionality.
  - Restriction of stockpiles to identified construction compounds, in areas of cleared land and exotic grassland and management of these stockpiles to ensure no offsite impacts through dust generation or sedimentation
  - Separate erosion controls for individual house sites would be established to support the building stage of the development.
  - The indicative development footprint would include landscaped open space as part of the detailed landscaping plans prepared for the proposed development. Open space would be landscaped as soon as practicable after construction of dwellings to minimise the time that bare earth is exposed to erosion.
- A vegetation management plan (VMP), which should include (but not be limited to) the following:
  - Delineation and protection of exclusion zones around native vegetation to be retained, in particular around threatened flora and TECs.
  - Communication with construction personnel of the conservation value of surrounding habitats and their responsibilities with regards to protecting these habitats during construction.
  - Hygiene procedures to prevent the introduction and spread of pathogens such as Phytophthora and Myrtle Rust in areas of native vegetation. These would include exclusion zones around retained areas of native vegetation and/or provision of machine and footwear washdown stations for all equipment and personnel working in areas of native vegetation
- A weed management sub-plan to the VMP, including a description of:
  - Type and location of weeds of concern (including noxious weeds) within the subject site.

  - Sensitive receivers (such as native vegetation and waterways) within or adjacent to the subject site.
  - Measures to prevent the spread of weeds, including hygiene procedures for equipment, footwear and clothing.
  - Proposed weed control methods and targeted areas.
  - Weed disposal protocols.
- A landscaping plan for areas outside of building envelopes. This should include:
  - Progressive landscaping of disturbed areas during construction to minimise soil erosion and weed establishment.
  - Retention of large trees wherever possible within design constraints.
  - Use of native flora species of local provenance where possible.
  - No exotic or invasive native flora species to be used.
- A fauna management plan, including (but not limited to) the following:
  - Minimising the clearing of mature trees where possible
  - A Cumberland Plain Land Snail management protocol, including pre-clearing surveys for snails and salvage and relocation of any snails and/or suitable shelter sites that are detected in the subject site into areas of adjoining suitable habitat.
  - A fauna management protocol, including pre-clearing surveys for nests or sheltering terrestrial fauna and rescue and salvage (where possible) of fauna entering the construction site.
  - A habitat feature protocol, including pre-clearing surveys for habitat features such as hollow logs and hollow-bearing trees that can be retained or salvaged and placed in adjoining retained vegetation, and protocols for the safe clearing of hollow-bearing trees to ensure no resident fauna are injured.
  - Protocols to prevent introduction or spread of chytrid fungus should be implemented following OEH Hygiene protocol for the control of disease in frogs (DECCW, 2008c).

Pre-clearance surveys

Prior to clearing of areas of native vegetation, pre-clearance surveys by a qualified ecologist would be required. The required methodology and targeted species would be developed as part of the CEMP. Surveys should include:

- Clear marking/erection of exclusion fencing around protected vegetation areas and delineation of ‘no-go’ areas
- Targeted pre-clearing surveys in accordance with the Cumberland Plain Land Snail protocol. Pre-clearing surveys would include targeted searches of the subject site for snails and salvage and relocation of any snails and/or suitable shelter sites that are detected. Snails and/or suitable shelter sites would be relocated to appropriate Cumberland Plain Land Snail habitat in the proposed biobank areas or other nearby, suitable habitats. Snail collection and relocation would need to be conducted by appropriately experienced ecologists under a Licence obtained under Section 91 of the TSC Act.
- Inspections of native vegetation for other resident fauna and/or nests or other signs of fauna occupancy.
- Capture and relocation or captive rearing of less mobile fauna (such as roosting microbats, nestling birds or any injured fauna) by a trained fauna handler and with assistance from Wildlife Information Rescue and Education Service (WIRES) as required.

- Inspection and identification/marking of hollow-bearing trees adjacent to construction footprints to help ensure against accidental impacts.

6.3.2 Construction phase

The following principles should be followed throughout the construction phase:

- All works should be undertaken in accordance with the CEMP
- Clearing surveys should be undertaken by a suitably qualified ecologist during any construction stages that involve removal of native vegetation. Clearing methods and presence/fate of any resident fauna should be documented.
- Wildlife should not be handled wherever possible. Construction staff should only handle wildlife in an emergency situation. Uninjured wildlife should be gently encouraged to leave the site by the ecologist/ wildlife specialist. Injured wildlife would be taken to a local WIRES carer or veterinarian for treatment and care if necessary.
- All equipment must be refuelled at least 20 metres away from drainage lines or wetlands and all fuel and chemical storages should be bunded.

6.3.3 Operational Phase

The following recommended mitigation measures are of relevance to the operational phase of the proposed development (i.e. the use of the indicative development footprint as a residential area):

- Signposting and enforcement of appropriate speed limits along internal roads to reduce the likelihood of vehicle strikes for native fauna.
- Appropriate management of bushfire asset protection zones to prevent the spread of weeds or soil into adjacent areas of retained vegetation.
- Restriction of access into retained areas of vegetation within proposed biobank areas (particularly for livestock or domestic pets).
- Enforcement of legal obligations to control noxious weeds within residential areas to prevent the spread of propagules into retained areas of native vegetation.
- Lighting should be designed to minimise light spill into adjacent areas of native vegetation within the proposed South West and North West biobank sites or the Blue Mountains National Park.

6.4 Biodiversity Offsets

As previously discussed, the Development Application would likely include an application for a biobanking statement. This would require the purchase and retirement of the biodiversity credits specified in the statement and in accordance with the BBAM to ensure that the development would ‘improve or maintain’ biodiversity values. Biodiversity credits would be sourced from biobank sites within the Fernhill Estate including the portion of Lot 1 outside of the development footprint. These biobanks would be protected, funded and managed for biodiversity conservation in perpetuity in accordance with the biobanking agreement and site management actions plan (MAP). The MAP would include measures to improve the condition of native vegetation and fauna habitats within the biobank, such as:

- Management of grazing for conservation.
- Weed control.
- Management of fire for conservation.

- Management of human disturbance.
- Retention of regrowth and remnant native vegetation.
- Replanting or supplementary planting where natural regeneration will not be sufficient.
- Retention of dead timber.
- Erosion control.
- Retention of rocks.

The management of the biobank would be considered in the environmental planning of the Lot 1 subdivision including through:

- Retention of water bodies, *Grevillea juniperina* subsp. *juniperina*, large trees and other habitat resources as far as possible within large lots.
- Consideration of fauna movement requirements in the design of fencing and access tracks.
- Measures to address potential water quality impacts from adjacent development areas.

The final areas to be provided as offets for the proposed development and details of the management actions required to improve biodiversity values within these areas would be determined at the Development Application stage, in accordance with the BBAM.

The EPBC Act approval is also likely to require the provision of specific biodiversity offsets for MNES. EPBC Act offsets would be aligned with the BioBanking assessment as far as is practicable.

A Voluntary Planning Agreement (VPA) is proposed for the Fernhill Estate to coordinate heritage, biodiversity and community outcomes. This VPA is to set out the coordinated delivery framework which, amongst other things:

- recognises the potential for biobanking across a range of areas in the Fernhill Estate;
- provides for greater heritage and biodiversity conservation through consolidation of land in the in the western portion of the Fernhill Estate not proposed for rezoning and subdivision

7. Conclusions

This report has been prepared to support a rezoning application for the Lot 1 Subdivision of the Fernhill Estate under the Penrith Local Environmental Plan 2010. The proposed amendment would change the associated lot size of the area subject of the current E3 (Environmental Management) zoning to allow subdivision into 15 lots with a minimum lot size of 2 hectares.

If approved, the rezoning of land within the western portion of the Fernhill Estate would allow for the consideration of a Development Application for a low density (minimum allotment size 2 hectare) rural residential development. The indicative development footprint has been revised from a previous design in order to reduce impacts on threatened biodiversity (particularly individuals of *Grevillea juniperina* subsp. *juniperina*).

Based on this preliminary assessment of the indicative development footprint, the proposed development would result in the following impacts on native biodiversity:

- Removal of up to 36.39 ha of native vegetation, including the following occurrences of threatened biota:
  - Up to 23.80 hectares of vegetation consistent with Shale/Sandstone Transition Forest, which is listed as an endangered ecological community under both the EPBC and TSC Acts.
  - Up to 1.41 hectares of vegetation consistent with Castlereagh Scribbly Gum Woodland, which is listed as a vulnerable ecological community under the TSC Act.
- Removal or modification of habitats for native flora and fauna within the indicative development footprint, including potentially suitable habitat for 12 threatened flora, 33 threatened fauna and 14 migratory species.
- Reducing connectivity of habitats within an important vegetated corridor between high elevation habitats within the Blue Mountains and lowland areas of the Cumberland Plain. A vegetated corridor would be retained via the proposed south west and north west biobank areas.

The intended amendments to the current E3 - Environmental Management zoning would not result in direct impacts within the entire indicative development footprint. Impacts would be avoided where possible through retention of native vegetation, and fauna habitat resources. Impact avoidance may also include reconfiguration of development areas. Recommended mitigation measures to further minimise impacts and prevent secondary impacts on adjoining areas of native vegetation have been included in this report and would be included within management plans for the construction of the proposed development.

The Development Application would include an application for a biobanking statement, which would ensure that the proposal would improve or maintain biodiversity values. The biobanking statement would require the purchase and retirement of biodiversity credits which would in turn fund the conservation and management of a biobank (i.e. offset site) in perpetuity. Biodiversity offsets for the proposal would include two biobank sites within the western portion of the Fernhill Estate, ensuring the conservation of vegetation and habitats of similar or greater value than those to be removed and in the immediate vicinity of the development footprint.

Based on a preliminary consideration of the BBAM, the proposal would require red flag variations for Shale/Sandstone Transition Forest. Tree preservation measures throughout the subdivision area may provide scope to further reduce impacts on these threatened biota. The

exact location, size and nature of the development would be determined using the BBAM at the Development Application stage.

The proposed development would also require approval from the Commonwealth Department of the Environment as it would include impacts on MNES listed under the EPBC Act. A referral of the proposed development would therefore be undertaken during the Development Application phase. Biodiversity offsets are also likely to be required as part of the EPBC Act approval.

In summary, the current rezoning application would facilitate the development of a low-density residential subdivision within the western portion of the Fernhill Estate. This development would have residual impacts on native biodiversity, including threatened biota listed under both the TSC and EPBC Acts; however these impacts would be balanced by the provision of biodiversity offsets in accordance with the BBAM. This approach would ensure that conservation land was securely titled, funded and managed for biodiversity conservation in perpetuity. The assessment of the proposal using BioBanking would ensure that the planned Lot 1 subdivision would lead to no net loss of biodiversity values within the locality.

8. Disclaimer

This report: has been prepared by GHD for Angas Securities Pty. Ltd. and *may only be used and relied on by Angas Securities Pty. Ltd. for the purpose agreed between GHD and the Angas Securities Pty. Ltd. as set out in Section 1.4 of this report.*

GHD otherwise disclaims responsibility to any person other than Angas Securities Pty. Ltd. arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Angas Securities Pty. Ltd. and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

9. References

ATRP (2010). *Streblus pendulinus*. [Online]. Available from: http://keys.trin.org.au:8080/key-server/data/0e0f0504-0103-430d-8004-060d07080d04/media/Html/taxon/Streblus_pendulinus.htm. Australian Tropical Rainforest Plants.

Backhouse, G., Jackson, J. and O'Connor, J. (2008). National Recovery Plan for the Australian Grayling Prototroctes maraena. Department of Sustainability and Environment, Melbourne.

Bannerman, S.M. and Hazelton, P. A. (1990). *Soil Landscapes of the Penrith 1:100 000 Sheet.* Soil Conservation Service of NSW, Sydney

BOM (2013) Climate Data Online. http://www.bom.gov.au/climate/averages/tables/cw_067084.shtml

Brooker, M.I.H. and Kleinig, D.A. (1983). *Eucalypts.* 2nd ed. Bloomings Books Pty Ltd, Melbourne Australia.

Campbell, S. (2011). Ecological specialisation and conservation of Australia's large-footed myotis: a review of trawling bat behaviour. In 'The Biology and Conservation of Australasian Bats' (eds B. Law, P. Eby, D. Lunney and L. Lumsden). Royal Zoological Society of NSW, pp. 72-85

Churchill, S. (2008).Australian Bats. Second Edition. Allen & Unwin, Australia.

DEC (2005) Pimelea spicata *R. Br. Recovery Plan*. Department of Environment and Conservation (NSW), Department of Environment and Conservation , Hurstville NSW.

DECC (2008a) NSW (Mitchell) Landscapes Version 3. Department of Environment and Climate Change, Hurstville NSW

DECC (2008b) Descriptions for NSW (Mitchell) Landscapes. Department of Environment and Climate Change, Hurstville NSW

DECC (2008c). *BioBanking Assessment Methodology.* Department of Environment and Climate Change, Hurstville NSW.

DECC (2008d). Recovery Plan for the Koala (*Phascolarctos cinereus*). Department of Environment and Climate Change, Hurstville NSW.

DECC (2009). *BioBanking Assessment Methodology and Credit Calculator Operational Manual.* Department of Environment and Climate Change, Hurstville NSW.

DEWHA (2009) *Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia.

DIPNR 2004. Wollongong Riparian Corridor Management Study : Covering all of the Wollongong Local Government Area and Calderwood Valley in the Shellharbour Local Government Area. Prepared for Wollongong City Council by Department of Infrastructure Planning and Natural Resources, March 2004.

DotE (2015a). *EPBC Online Protected Matters Database* (queried May 2015), Department of the Environment.

DotE (2015b). *Species Profiles and Threats Database*. Online resource <http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl> (viewed May 2015). Department of the Environment.

DPI (2015a). Online Records Viewer. Online resource < http://www.dpi.nsw.gov.au/fisheries/species-protection/records>, accessed May 2015. Department of Primary Industries NSW.

Eby, P. and Law, B. (2008). Ranking the feeding habitats of Grey-headed flying foxes for conservation management: a report for The Department of Environment and Climate Change (NSW) & The Department of Environment, Water, Heritage and the Arts. Available from http://www.environment.nsw.gov.au/resources/threatenedspecies/GHFFmainreport.pdf (accessed 07 July 2010).

ELA (2007a) *Fernhill Ecological Assessment.* Report prepared for Warren Anderson. Project number 163-01, Eco Logical Australia, October 2007.

ELA (2007b) *Fernhill – Maintain or Improve Test.* Report prepared for Warren Anderson. Project number 136-001, Eco Logical Australia, December 2007.

ELA (2010) *Owston Estate (Fernhill) Ecological Assessment of Proposed Rezoning.* Report prepared for Owston Nominees No. 2 Pty Ltd. Project number 09SYDPLA – 0038, Eco Logical Australia.

Fairfull, S. and Witheridge, G. (2003). Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW DPI, Cronulla, 16 pp.

GHD (2012) *Preliminary Ecology Assessment and 7-part test to support the Development Application (DA) for the proposed Athletic Endurance course (Tough Mudder) at Fernhill NSW*.

GHD (2013a) *Fernhill Eastern Precinct Subdivision Ecological Assessment*. Report prepared for Angas Securities Limited.

GHD (2013b) *Fernhill East Biobank BioBanking Assessment*. Report prepared for Angas Securities Limited.

GHD (2013c) *Fernhill Central West Biobank BioBanking Assessment*. Report prepared for Angas Securities Limited.

Harden, G. (Ed) (1990-1993) Flora of New South Wales – Vols 1 – 4. University of New South Wales Press, Sydney.

Higgins, P.J. (Ed) (1999), Handbook of Australian, New Zealand and Antarctic Birds, vol. 4, Oxford University Press, Melbourne.

Hoye, G.A. and Hall, L.S. (2008). Little Bent-winged Bat *Miniopterus australis*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

Hoye, G.A. and Richards, G.C. (2008). Greater Broad-nosed Bat *Scoteanax rueppellii*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

Hoye, G.A. and Schulz, M. (2008). Large-eared Pied Bat *Chalinolobus dwyeri*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

Jessup, L.W. (2003). *Flora of South-eastern Queensland: Volume 1: Changes to names or status of taxa.* [Online]. Queensland Herbarium. Toowong, Queensland: Queensland Herbarium, Environmental Protection Agency. Available from: http://www.derm.qld.gov.au/register/p00721aa.pdf.

Johnston, P.G. (2008) Long-nosed Potoroo *Potorous tridactylus*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

Lock, M.L. and Wilson, B.A. (1999). The distribution of the New Holland mouse (*Pseudomys novaehollandiae*) with respect to vegetation near Anglesea, Victoria. Wildlife Research 26 (4) 565-577

Mahony, M., Knowles, R. and Pattinson, L. (1997). Stuttering Barred Frog. In H. Ehmann (ed) 'Threatened Frogs of New South Wales: Habitats, Status and Conservation' pp.65-71. Frog and Tadpole Study Group of NSW.

NPWS (2002) *Native Vegetation of the Cumberland Plain, Western Sydney* and *Interpretation Guidelines for the Native Vegetation Maps of the Cumberland Plain, Western Sydney*. *Final Edition* NSW NPWS Hurstville. http://www.environment.nsw.gov.au/surveys/GetHoldOfMapsDataAndReports.htm

Office of Environment and Heritage (2012) *NSW Threatened Species* http://www.environment.nsw.gov.au/threatenedspecies/

Office of Environment and Heritage (OEH) (2013a) NSW BioNet. The Website for the Atlas of NSW Wildlife. http://www.bionet.nsw.gov.au/

Office of Environment and Heritage (OEH) (2013b) *Vegetation Types Database.* http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm

Office of Environment and Heritage (OEH) (2013c) Vegetation Benchmarks Database. http://www.environment.nsw.gov.au/BioBanking/VegTypeDatabase.htm

The Royal Botanic Gardens and Domain Trust (2011). PlantNET. [Online]. The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney, Australia (version 2). Available from: http://plantnet.rbgsyd.nsw.gov.au.

Specht R.L. (1970). *Vegetation*. In: The Australian environment. (Ed. G.W. Leeper). pp. 44-67. CSIRO and Melbourne University Press, Melbourne.

Sutter, G. (2011). National Recovery Plan for the Rufous Pomaderris (*Pomaderris brunnea*). Department of Sustainability and Environment, East Melbourne.

Tozer, M.G., Turner, K., Keith, D.A., Tindall, D., Pennay, C., Simpson, C., MacKenzie, B., Beukers, P. and Cox, S. (2010) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia* **11**(3): 359-406.

Tulloch, A.I. and Dickman, C.R. (2006). Floristic and structural components of habitat use by the eastern pygmy-possum (*Cercartetus nanus*) in burnt and unburnt habitats. Wildlife Research 33: 627-637

Ward, S.J. and Turner,V. (2008). Eastern Pygmy Possum *Cercartetus nanus*. In S. Van Dyke and R. Strahan (eds), 'The Mammals of Australia' 3rd edition. Reed New Holland, Chatswood.

White, A.W. (2008a). *The Distribution and Conservation Status of Barred Frogs in the Sydney Basin. Part 1. Giant Barred Frog* Mixophyes iteratus. Herpetofauna **38**(1) 24-34.

White, A.W. (2008b). The Distribution and Conservation Status of Barred Frogs in the Sydney Basin. Part 2. Stuttering Frog *Mixophyes balbus*. *Herpetofauna* **38(2)** 84-95.

Wilson, B.A. and Bradtke, E. (1999). The diet of the New Holland mouse, *Pseudomys novaehollandiae* (Waterhouse) in Victoria. *Wildlife Research* **26(4)** 439-451

Appendices

Appendix A – Field survey data

Appendix Table 1 Dominant plant species in vegetation zones in the study area

Vegetation Zone	Condition	Canopy species	Mid storey species	Groundcover species
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (HN556 high)	Moderate/good - high	Narrow-leaved Ironbark (*Eucalyptus crebra*), Forest red Gum (*E. tereticornis*), Broad-leaved Ironbark (*E. fibrosa*), Grey Gum (*E. punctata*), Thin-leaved Stringybark (*E. eugenioides*), Yellow Bloodwood (*Corymbia eximia*).	Box-leaved Wattle (*Acacia buxifolia*), Thin-leaved Geebung (*Persoonia linearis*), Black Wattle (*A. decurrens*).	Kangaroo Grass (*Themeda australis*), Large-leaf Hop-bush (*Dodonaea triquetra*), Purple Wiregrass (*Aristida ramosa*), Bushy Hedgehog-grass (*Echinopogon caespitosus*), Weeping Meadow Grass, Burr-daisy (*Calotis dentex*), *Lomandra multiflora, Glycine clandestina*, and Indian Pennywort (*Centella asiatica*).
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (HN556 poor)	Moderate/good - poor	Occasional remnant Narrow-leaved Ironbark, Broad-leaved Ironbark Grey Gum, Thin-leaved Stringybark.	Locally dense Tantoon (*Leptospermum polygalifolium*) or Juniper-leaved Grevillea (*Grevillea juniperina juniperina*). Occasional Box-leaved Wattle, Black Wattle.	Kangaroo Grass, Purple Wiregrass, Bushy Hedgehog-grass, Weeping Meadow Grass, Burr-daisy, *Lomandra multiflora.*
Narrow-leaved Ironbark - Broad-leaved Ironbark - Grey Gum open forest (HN556 low)	Low	Very occasional remnant Narrow-leaved Ironbark, Forest Red Gum.	Locally dense Tantoon. Occasional Box-leaved Wattle, Black Wattle.	African Love Grass (*Eragrostis curvula*), Whiskey Grass (*Andropogon virginicus*) and *Briza subaristata* Occasional Kangaroo Grass, Purple Wiregrass.
Red Bloodwood – Grey Gum woodland (HN564)	Moderate/good	Red Bloodwood (*Corymbia gummifera*), Grey Gum, Turpentine (*Syncarpia glomulifera*), Brown	Woody Pear (*Xylomelum pyriforme*), Thin-leaved Geebung, Slender Tea-tree (*Leptospermum trinervium*) and Flax-leaved Wattle (*Acacia*	Prickly Shaggy Pea, Mountain Devil (*Lambertia formosa*), Spiny Bossiaea (*Bossiaea obcordata*), Prickly Moses (*Acacia ulicifolia*); Bottle Washers (*Enneapogon avenaceus*), Brown's Lovegrass (*Eragrostis brownii*); *Xanthorrhoea media*; *Dianella caerulea var. producta, Lomandra* species.

Vegetation Zone	Condition	Canopy species	Mid storey species	Groundcover species
		Stringybark (*Eucalyptus oblonga*), Sydney Red Gum (*Angophora costata*).	*linifolia*).	
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (HN542 medium)	Moderate/good - medium	Hard-leaved Scribbly Gum, Narrow-leaved Apple and Yellow Bloodwood.	Finger Hakea (*Hakea dactyloides*), Tantoon (*Leptospermum polygalifolium*), Slender Tea-tree and Lance-leaved Geebung.	Hairpin Banksia (*Banksia spinulosa*), Fern-leaved Banksia (*Banksia oblongifolia*), Heathy Mirbelia (*Mirbelia rubiifolia*) Pinnate Wedge Pea (*Gompholobium pinnatum*); *Lepyrodia scariosa*, *L. anarthria,* Curly Wig (*Caustis flexuosa*), Poverty Raspwort (*Gonocarpus tetragynus*), Grass Triggerplant (*Stylidium graminifolium*) and Silky Purple-Flag (*Patersonia sericea*), *Cassytha glabella*.
Hard-leaved Scribbly Gum - Parramatta Red Gum heathy woodland (HN542 poor)	Moderate/good - poor	Occasional remnant Hard-leaved Scribbly Gum, Narrow-leaved Apple and Yellow Bloodwood.	Occasional remnant Finger Hakea, Fern-leaved Banksia or Needle Hakea (*Hakea sericea*).	Abundant Kangaroo Grass. Occasional *Xanthorrea minor* and *Macrozamia spiralis.* Occasional moderate infestation with Whiskey Grass and African Lovegrass.
Coastal freshwater wetland (HN630)	Moderate/good	Absent.	A narrow fringe of Flax-leaved Paperbark (*Melaleuca linariifolia*) or Tantoon around margins of some waterbodies.	Tall Spike Rush (*Eleocharis sphacelata*), *Chorizandra* cymbaria, Lepyrodia *anarthria*; *Triglochin microtuberosa*; Frogsmouth (*Philydrum lanuginosum*); *Goodenia paniculata*, *Drosera* species and Indian Pennywort.
Cleared land	Cleared	Absent.	Absent.	Blackberry (*Rubus fruticosus* species aggregate), Lantana (*Lantana camara*), African Love Grass (*Eragrostis curvula*), Whiskey Grass (*Andropogon*

Vegetation Zone	Condition	Canopy species	Mid storey species	Groundcover species
				virginicus) and *Briza subaristata* Very occasional Kangaroo Grass, Purple Wiregrass.

Appendix Table 2 Fauna species recorded in the Fernhill Estate

Class	Family	Exotic	Scientific Name	Common Name	TSC Status	EPBC Status	Observation Type
Aves	Podicipedidae		*Tachybaptus novaehollandiae*	Australasian Grebe			O
Aves	Psittacidae		*Alisterus scapularis*	Australian King-Parrot			O
Aves	Artamidae		*Cracticus tibicen*	Australian Magpie			W
Aves	Corvidae		*Corvus coronoides*	Australian Raven			W
Aves	Alcedinidae		*Ceyx azureus*	Azure Kingfisher			O
Aves	Meliphagidae		*Manorina melanophrys*	Bell Miner			W
Aves	Phasianidae		*Coturnix ypsilophora*	Brown Quail			O
Aves	Acanthizidae		*Acanthiza pusilla*	Brown Thornbill			OW
Amphibia	Myobatrachidae		*Limnodynastes peronii*	Brown-striped Frog			W
Aves	Ardeidae		*Ardea ibis*	Cattle Egret			O
Amphibia	Myobatrachidae		*Crinia signifera*	Common Eastern Froglet			W
Aves	Psittacidae		*Platycercus elegans*	Crimson Rosella			OW
Gastropoda	Camaenidae		*Meridolum corneovirens*	Cumberland Plain Land Snail	E1		O
Aves	Estrildidae		*Taeniopygia bichenovii*	Double-barred Finch			O
Aves	Rallidae		*Gallinula tenebrosa*	Dusky Moorhen			O
Mammalia	Macropodidae		*Macropus giganteus*	Eastern Grey Kangaroo			O
Reptilia	Scincidae		*Eulamprus quoyii*	Eastern Water-skink			W
Aves	Psophodidae		*Psophodes olivaceus*	Eastern Whipbird			W
Aves	Petroicidae		*Eopsaltria australis*	Eastern Yellow Robin			O
Aves	Turdidae	*	*Turdus merula*	Eurasian Blackbird			O
Aves	Rallidae		*Fulica atra*	Eurasian Coot			W
Aves	Cacatuidae		*Eolophus roseicapillus*	Galah			O
Aves	Pachycephalidae		*Pachycephala pectoralis*	Golden Whistler			OW
Aves	Artamidae		*Cracticus torquatus*	Grey Butcherbird			W

Aves	Rhipiduridae		*Rhipidura albiscapa*	Grey Fantail			O
Aves	Pachycephalidae		*Colluricincla harmonica*	Grey Shrike-thrush			W
Aves	Anatidae		*Aythya australis*	Hardhead			O
Aves	Petroicidae		*Microeca fascinans*	Jacky Winter			O
Aves	Monarchidae		*Myiagra rubecula*	Leaden Flycatcher			W
Aves	Cacatuidae		*Cacatua sanguinea*	Little Corella			O
Aves	Phalacrocoracidae		*Microcarbo melanoleucos*	Little Pied Cormorant			O
Aves	Monarchidae		*Grallina cyanoleuca*	Magpie-lark			W
Aves	Charadriidae		*Vanellus miles*	Masked Lapwing			W
Aves	Meliphagidae		*Manorina melanocephala*	Noisy Miner			W
Aves	Oriolidae		*Oriolus sagittatus*	Olive-backed Oriole			OW
Aves	Anatidae		*Anas superciliosa*	Pacific Black Duck			O
Aves	Artamidae		*Strepera graculina*	Pied Currawong			O
Aves	Rallidae		*Porphyrio porphyrio*	Purple Swamphen			W
Aves	Psittacidae		*Trichoglossus haematodus*	Rainbow Lorikeet			W
Aves	Meliphagidae		*Anthochaera carunculata*	Red Wattlebird			W
Aves	Estrildidae		*Neochmia temporalis*	Red-browed Finch			W
Aves	Psittacidae		*Psephotus haematonotus*	Red-rumped Parrot			OW
Aves	Monarchidae		*Myiagra inquieta*	Restless Flycatcher			W
Aves	Petroicidae		*Petroica rosea*	Rose Robin			O
Mammalia	Cervidae	*	*Cervus timorensis*	Rusa deer			O
Aves	Ptilonorhynchidae		*Ptilonorhynchus violaceus*	Satin Bowerbird			O
Aves	Timaliidae		*Zosterops lateralis*	Silvereye			O
Aves	Pardalotidae		*Pardalotus punctatus*	Spotted Pardalote			W
Aves	Threskiornithidae		*Threskiornis spinicollis*	Straw-necked Ibis			O
Aves	Pardalotidae		*Pardalotus striatus*	Striated Pardalote			W
Aves	Acanthizidae		*Acanthiza lineata*	Striated Thornbill			W

Aves	Cacatuidae		*Cacatua galerita*	Sulphur-crested Cockatoo			W
Aves	Maluridae		*Malurus cyaneus*	Superb Fairy-wren			W
Aves	Neosittidae		*Daphoenositta chrysoptera*	Varied Sittella	V		O
Aves	Acanthizidae		*Smicrornis brevirostris*	Weebill			O
Aves	Hirundinidae		*Hirundo neoxena*	Welcome Swallow			O
Aves	Meliphagidae		*Melithreptus lunatus*	White-naped Honeyeater			W
Aves	Ardeidae		*Ardea pacifica*	White-necked Heron			O
Aves	Meliphagidae		*Lichenostomus penicillatus*	White-plumed Honeyeater			OW
Aves	Rhipiduridae		*Rhipidura leucophrys*	Willie wagtail			O
Aves	Acanthizidae		*Acanthiza nana*	Yellow Thornbill			O
Aves	Meliphagidae		*Lichenostomus chrysops*	Yellow-faced Honeyeater			OW
Mammalia	Bovidae	*	*Bos taurus*	European cattle			O
Amphibia	Hylidae		*Litoria verreauxii verreauxii*	Verreaux's Tree Frog (subsp)			O, W
Mammalia	Rhinolophidae		*Rhinolophus megaphyllus*	Eastern Horseshoe-bat			W
Mammalia	Molossidae		*Mormopterus "Species 2"*	Undescribed Freetail Bat			W

Key: E – endangered, M – migratory, V – vulnerable. B – burrow; F – tracks, H – skin, K – dead, O – observed, P – scat, W - heard

-

Appendix B - Threatened and Migratory Biota

Endangered Ecological Communities (EECs) known or predicted from the locality, habitat association and suitable habitat present at the subject site.

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Agnes Banks Woodland in the Sydney Basin Bioregion	Agnes Banks Woodland in the Sydney Basin Bioregion	EEC		Most remnants occur near Agnes Banks in Penrith LGA, on eastern bank of the Hawkesbury River. Occurs on aeolian sands overlaying Tertiary alluviums. Structure varies from low woodland on higher ridges to sedgeland in low-lying depressions. Characteristic species include Eucalyptus sclerophylla, Angophora bakeri and Banksia serrata.	Known within 10km (OEH 2015a)	Not present
Blue Gum High Forest in the Sydney Basin Bioregion	Blue Gum High Forest in the Sydney Basin Bioregion	CEEC	CEEC	Occurs on the Hornsby Plateau, north eastern edge of the Cumberland Plain with most remnants in Hornsby, Ku-ring-gai and Baulkham Hills LGAs. Typically occurs in high rainfall areas on fertile soils derived from Wianamatta shale. Grades into Sydney Turpentine-Ironbark Forest at lower rainfall areas. Moist, tall open forest characterised by Eucalyptus saligna and E. pilularis. Usually has small tree layer of Pittosporum undulatum, Elaeocarpos reticulatus and Allocasuarina torulosa over a low, open shrub layer and an understorey of grasses, herbs and ferns.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion	Blue Mountains Shale Cap Forest in the Sydney Basin Bioregion	EEC	CEEC	Found on deep fertile soils formed on Wianamatta Shale, on moist sheltered sites at lower to middle altitudes of the Blue Mountains and Wollemi areas. Extensive occurrences of shale are at Springwood, Berambing to Kurrajong Heights, Mountain Lagoon and Colo Heights. Characteristic tree species of this ecological community are Eucalyptus deanei, E. cypellocarpa and Syncarpia glomulifera. The structure of the community was originally tall open forest to open forest, depending on site conditions and history, but as a result of partial clearance may now exist as woodland or as groups of remnant trees.	Known within 10km (OEH 2015a)	Not present
Blue Mountains Swamps in the Sydney Basin Bioregion	Blue Mountains Swamps in the Sydney Basin Bioregion	VEEC	EEC	Occurs on the Hornsby Plateau, north eastern edge of the Cumberland Plain with most remnants in Hornsby, Ku-ring-gai and Baulkham Hills LGAs. Typically occurs in high rainfall areas on fertile soils derived from Wianamatta shale. Grades into Sydney Turpentine-Ironbark Forest at lower rainfall areas. Moist, tall open forest characterised by Eucalyptus saligna and E. pilularis. Usually has small tree layer of Pittosporum undulatum, Elaeocarpos reticulatus and Allocasuarina torulosa over a low, open shrub layer and an understorey of grasses, herbs and ferns.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion	Castlereagh Scribbly Gum Woodland in the Sydney Basin Bioregion	VEEC		Occurs almost exclusively on soils derived from Tertiary alluvium, or on sites located on adjoining shale or Holocene alluvium, with known occurrences in the Bankstown, Blacktown, Campbelltown, Hawkesbury, Liverpool and Penrith LGAs. Typically on sandy soils and on slightly higher ground than Castlereagh Ironbark Forest or Shale Gravel Transition Forest (Tozer 2003). Dominated by Eucalyptus parramattensis subsp. parramattensis, Angophora bakeri and E. sclerophylla. A small tree stratum of Melaleuca decora is sometimes present, generally in areas with poorer drainage. It has a well-developed sclerophyllous shrub stratum over a diverse range of forbs.	Known within 10km (OEH 2015a)	Present. Recorded in the eastern parcel of the Lot 1 Subdivision.
Castlereagh Swamp Woodland Community	Castlereagh Swamp Woodland Community	EEC		Occurs Castlereagh and Holsworthy areas on the Cumberland Plain on alluvial soils, often in poorly drained depressions. Low woodland characterised by dense stands of Melaleuca decora along with other canopy trees, such as Eucalyptus parramattensis ssp parramattensis. Poorly developed shrub layer of juvenile melaleucas over waterlogging tolerant groundcover species such as Centella asiatica, Juncus usitatus and Goodenia paniculata.	Known within 10km (OEH 2015a)	Not present
Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	Cooks River/Castlereagh Ironbark Forest in the Sydney Basin Bioregion	EEC		Occurs on the Cumberland Plain with the most extensive stands in Castlereagh and Holsworthy areas. Smaller remnants in Kemps Creek area and eastern section of the Cumberland Plain. Ranges from open forest to low woodland, with a canopy dominated by Eucalyptus fibrosa and Melaleuca decora along with other species of eucalypt. Dense shrubby understorey of Melaleuca nodosa, Lissanthe strigosa and Fabaceae sp over sparse	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
				ground layer of grasses and herbs.		
Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest (federal listing)		Component EECs listed separately	CEEC	Grassy woodlands and forests of the shale hills and plains of the Cumberland Plain and associated transitional communities on shale-gravel soils. Canopy typically dominated by Eucalyptus moluccana, E. tereticornis and/or E. fibrosa. Sparse small tree stratum of young eucalypts and Acacia species and/or shrub layer dominated by Bursaria spinosa may be present. Understorey comprises perennial native grasses, grasslike and non-woody plants.	Known within 10km (OEH 2015a); Community likely to occur within area (DotE 2015)	Not present
Cumberland Plain Woodland in the Sydney Basin Bioregion	Cumberland Plain Woodland in the Sydney Basin Bioregion	EEC	May qualify as CEEC	Grassy woodland/forest endemic to the hills and plains of the Cumberland Plain. Canopy typically dominated by Eucalyptus moluccana and E. tereticornis, with E. crebra, Corymbia maculata and E. eugenoides occurring less frequently. Shrub layer dominated by Bursaria spinosa, and grasses such as Themeda australis and Microlaena stipoides var stipoides.	Known within 10km (OEH 2015a)	Not present
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC		Occurs in coastal areas subject to periodic flooding with standing fresh water for at least part of the year. Typically on silts, muds or humic loams below 20 m elevation in low-lying parts of floodplains, alluvial flats, depressions, drainage lines, backswamps, lagoons and lakes. Structure and composition varies spatially and temporally depending on the water regime, though is usually dominated by herbaceous plants and has few woody species.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Moist Shale Woodland in the Sydney Basin Bioregion	Moist Shale Woodland in the Sydney Basin Bioregion	EEC	May qualify as CEEC	Occurs on clay soils from Wianamatta Shale in the southern half of the Cumberland Plain, and is intermediate between Cumberland Plain Woodland and Western Sydney Dry Rainforest. Similar to Cumberland Plain Woodland but with more mesic shrub understorey. Dominant canopy trees include Forest Red Gum Eucalyptus tereticornis, Grey Box E. moluccana, Narrow-leaved Ironbark E. crebra and Spotted Gum Corymbia maculata. Small trees, such as Hickory Wattle Acacia implexa and Sydney Green Wattle A. parramattensis ssp parramattensis are also common. The shrub layer includes Breynia oblongifolia, Hairy Clerodendrum Clerodendrum tomentosum and Indian Weed Siegesbeckia orientalis ssp orientalis.	Known within 10km (OEH 2015a)	Not present
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	EEC	EEC	Occurs above 4-500m asl on undulating tablelands and plateaus, typically on basic volcanic , fine grained sedimentary substrates or occasionally granite. Associated with accumulations of peaty or organic mineral sediments on poorly drained flats in stream headwaters. Dense, open or sparse layer of shrubs with soft-leaved sedges, grasses and forbs. Only type of wetland that may contain more than trace amounts of mosses (Sphagnum spp.). Small trees may be absent, or present as scattered emergent.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Mount Gibraltar Forest in the Sydney Basin Bioregion	Mount Gibraltar Forest in the Sydney Basin Bioregion	EEC	EEC	Confined to a small number of pockets in the Southern Highlands region mainly near Bowral and Mittagong. Occurs in the Wingecarribee LGA, but may occur elsewhere in the Sydney Basin Bioregion. Restricted to clay soils on microsyenite intrusions in the central parts of the Southern Highlands. Occurs on gentle to steep slopes with correspondingly deep and shallow soils respectively; combined with aspect, these factors contribute to the variability evident in the floral composition of this community (OEH 2013).	Known within 10km (OEH 2015a)	Not present
Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion	Newnes Plateau Shrub Swamp in the Sydney Basin Bioregion	EEC	EEC	Recorded from the local government areas of Lithgow and Blue Mountains City. The community is characteristically dominated by shrubs, with a variable cover of sedges. Shrubs have a dense to open cover, and include Baeckea linifolia, Grevillea acanthifolia subsp. acanthifolia, Epacris paludosa and Leptospermum species. The cover of sedges varies inversely with shrub cover. Floristic composition varies locally in relation to soil moisture gradients within the swamps. With decreasing altitude, Newnes Plateau Shrub Swamp grades into Blue Mountains sedge swamp communities. The transition occurs around Bell and Clarence at approximately 850-950 m above sea level. Blue Mountains sedge swamps typically have less cover of shrubs and a greater cover of sedges (particularly Gymnoschoenus sphaerocephalus) than Newnes Plateau Shrub Swamp. Occurrences on peat may be included in the EPBC Act listed Temperate highland Peat Swamps on Sandstone EEC.	Known within 10km (OEH 2015a)	Not present
River-Flat Eucalypt Forest on Coastal	River-Flat Eucalypt Forest	EEC		Occurs on flats, drainage lines and river terraces of coastal floodplains where flooding is periodic and	Known within 10km (OEH	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions			soils generally rich in silt, lack deep humic layers and have little or no saline (salt) influence. Occurs south from Port Stephens in the NSW North Coast, Sydney Basin and South East Corner bioregions. Characterised by a tall open canopy layer of eucalypts with variable species composition.	2015a)	
Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion	Robertson Basalt Tall Open-forest in the Sydney Basin Bioregion	EEC	EEC	Typically restricted to occurrences of Robertson Basalt in the southern highlands, also on Cambewarra range to the south. Grows on highly fertile soils derived from basalt, on the slopes of rolling hills in areas of 1000-1600 mm annual rainfall. Open forest or woodland to 30 m tall with a sparse to moderately dense shrub layer and a dense herbaceous ground layer. Dominant tree species include Eucalyptus fastigata, E. viminalis, E. radiata and E. cypellocarpa. Acacia melanoxylon is a common small tree species in this community.	Known within 10km (OEH 2015a)	Not present
Shale gravel Transition Forest in the Sydney Basin Bioregion	Shale gravel Transition Forest in the Sydney Basin Bioregion	EEC	CEEC	"Primarily in the northern section of the Cumberland Plain, also found in Liverpool/;Holsworthy, Bankstown, Yennora, Villawood and Kemps Creek areas. Occurs primarily where shallow deposits from ancient river systems overlay shale soils, but also associated with localised concentrations of iron-hardened gravel. Open forest with canopy dominated by Eucalyptus fibrosa, E. moluccana and E. tereticornis, often with small tree layer of Melaleuca decora over a sparse shrub layer. Grades into Cumberland Plain Woodland where the influence of gravel soil declines, and into Cooks River/Castlereagh Ironbark Forest or Castlereagh Scribbly Gum Woodland where gravel deposits are	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
				thick.		
Shale/Sandstone Transition Forest	Shale/Sandstone Transition Forest	EEC	EEC	Primarily in the northern section of the Cumberland Plain, also found in Liverpool/;Holsworthy, Bankstown, Yennora, Villawood and Kemps Creek areas. Occurs primarily where shallow deposits from ancient river systems overlay shale soils, but also associated with localised concentrations of iron-hardened gravel. Open forest with canopy dominated by Eucalyptus fibrosa, E. moluccana and E. tereticornis, often with small tree layer of Melaleuca decora over a sparse shrub layer. Grades into Cumberland Plain Woodland where the influence of gravel soil declines, and into Cooks River/Castlereagh Ironbark Forest or Castlereagh Scribbly Gum Woodland where gravel deposits are thick.	Known within 10km (OEH 2015a); Community likely to occur within area (DotE 2015)	Present. Recorded within the Lot 1 Subdivision and proposed Southwest biobank in predominately moderate/good condition.
Southern Highlands Shale Woodlands in the Sydney Basin Bioregion	Southern Highlands Shale Woodlands in the Sydney Basin Bioregion	EEC		Confined to a small area in the Wingecarribee LGA, between the Illawarra Escarpment in the east, Burrawang and Bundanoon in the south, Canyonleigh in the west and Berrima and Colo Vale in the north. Occurs on clay soils on Wianamatta Shale, between approx. 60-800 m asl. Typically woodland but also tall open forest, grassy woodland and scrub. Dominant canopy species vary across the range. Shrub layer generally open although may have dense patches and groundlayer typically comprises diverse native grasses and herbs.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion	Southern Sydney sheltered forest on transitional sandstone soils in the Sydney Basin Bioregion	EEC		Restricted to sheltered heads and upper slopes of gullies on transitional zones where sandstone outcrops may exist, but where soils are influenced by lateral movement of moisture, nutrients and sediment from more fertile substrates in an area bounded by Hurstville, Carss Park, Bundeena, Otford, Stanwell Tops, Darkes Forest, Punchbowl Creek and Menai. Open forest dominated by Angophora costata, Eucalyptus piperita and occasional E. pilularis over scattered subcanopy trees, a diverse shrub layer and well-developed groundcover of ferns, forbs, grasses and graminoids. Variable species composition.	Known within 10km (OEH 2015a)	Not present
Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion	Sun Valley Cabbage Gum Forest in the Sydney Basin Bioregion	EEC		Occurs in the Sun Valley in the Blue Mountains City Council local government area; within about 15 hectares. Occurs on soils formed from diatremes (pipes of volcanic material) at Sun Valley. Other diatreme substrates in the area support different dominant tree species and do not have Eucalyptus amplifolia (OEH 2011).	Known within 10km (OEH 2015a)	Not present
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	EEC		Typically occurs below 20m asl on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes on coastal floodplains of NSW. Associated with grey-black clay-loams and sandy loams, saline or sub-saline groundwater. Structure variable from open forests to scrubs or reedlands with scattered trees. Canopy dominated by Casuarina glauca (north of Bermagui) or Melaleuca ericifolia (south of Bermagui). Understorey characterised by frequent occurrences of vines, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregions	EEC		Occurs on plateaus and tablelands between 600-900m asl with loam or clay soils derived primarily from basalt, but may also be derived from mudstones, granites, alluvium and other substrates. Known from Bathurst Regional, Goulburn Mulwaree, Oberon, Palerang, Shoalhaven, Upper Lachlan and Wingecarribee LGAs. Open, variable canopy which may include Ribbon Gum, Narrow-leaved Peppermint, Mountain Gum and Snow Gum, over a sparse shrub layer and dense groundcover of herbs and grass. Community also includes derived native grasslands where trees have been removed.	Known within 10km (OEH 2015a)	Not present
Temperate Highland Peat Swamps on Sandstone	Temperate Highland Peat Swamps on Sandstone		EEC	Occurs on sandstone in temperate highland regions from around 600–1100 m above sea level. Known from the Blue Mountains, Lithgow, Southern Highlands, and Bombala regions. Swamps occurring across a range of locations in the landscape, from hanging swamps to depressions in the landscape, or along watercourses. Wetter parts are occupied by sphagnum bogs and fens, with sedge and shrub associations in the drier parts.	Community known to occur within locality (DotE 2015)	Not present
Upland Basalt Sydney Eucalypt Forests of the Sydney Basin Bioregion			EEC	Generally confined to the Sydney Basin IBRA Bioregion although some occurrences may extend outside the Sydney Basin Bioregion boundary, e.g. the southern extent at Sassafras, east of Nerriga NSW, and patches on the Boyd Plateau and Mt Werong. Generally tall open eucalypt forests found on igneous rock (predominately Tertiary basalt and microsyenite) in, or adjacent to, the Sydney Basin Bioregion.	Community likely to occur within locality (DotE 2015)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
Western Sydney Dry Rainforest and Moist Woodland on Shale	Western Sydney Dry Rainforest and Moist Woodland on Shale	Component EECs listed separately	CEEC	Occurs is generally gullies, sheltered slopes and rugged terrain in isolated patches, largely on the edges of the Cumberland Plain in NSW, with some patches on undulating terrain in the central parts of the Cumberland Plain (DOTE 2015).The dry rainforest occupies the lower slopes and gullies where conditions are more favourable for the development of a rainforest canopy layer. The ecological community grades into the moist woodland form, generally on the upper slopes, also extending onto more gently, undulating terrain. The ecological community may be associated with riparian vegetation (e.g. at Little Wheeny Creek and Redbank creek near Kurrajong and Grose Vale) and creeks and/or drainage lines may cut through the ecological community.	Community likely to occur within locality (DotE 2015)	Not present
Western Sydney Dry Rainforest in the Sydney Basin Bioregion	Western Sydney Dry Rainforest in the Sydney Basin Bioregion	EEC	Components may qualify as CEEC	Restricted to hilly country where it occurs on clay soils derived from Wianamatta shale on sheltered lower slopes and gullies. Very restricted and occurs mostly in the Razorback Range near Picton. Outlying occurrences at Grose Vale and Cattai. Canopy trees include Melaleuca styphelioides, Acacia implexa and Alectryon subcinereus. Shrub layer includes rainforest species Notolaea longifolia, Clerodendrum tomentosum and Pittosporum revolutum. The shrub layer combines with vines to form dense thickets in sheltered locations.	Known within 10km (OEH 2015a)	Not present

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area
White Box Yellow Box Blakely's Red Gum Woodland	White Box Yellow Box Blakely's Red Gum Woodland	EEC	CEEC	Occurs on the tablelands and western slopes of NSW, on moderate to highly fertile soils. Found in areas with annual rainfall between 400 - 1200 mm, at altitudes between 170 - 1200 m asl. Open woodland/forest, characterised by Eucalyptus albens, E. melliodora and E. blakelyi. Intact sites are rare, but contain a high species diversity of trees, shrubs, climbers, grasses and particularly herbs. The NSW listing includes sites with/without canopy layer and areas with predominately exotic groundlayer, whereas to meet the federal listing criteria areas must have either intact tree layer and predominately native groundlayer, or an intact ground layer with high species diversity but no remaining tree layer.	Predicted within 10km (DotE 2015)	Not present

Threatened flora known or predicted from the locality, habitat association and likelihood of occurring in the study area.

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in the study area	Notes
Acacia bynoeana	Bynoe's Wattle	E	V	This species is endemic to central eastern NSW, and is currently known from only 34 locations, many of which are only 1-5 plants. This species occurs mainly in heath and dry sclerophyll forest on sandy soils, seeming to prefer open, sometimes slightly disturbed sites such as trail margins, road edges, and in recently burnt open patches. This species flowers from September to March, and fruit matures in November.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable habitat present, but a large and readily detectable species that may be reliably excluded based on survey effort conducted.
Acacia gordonii		E	E	Disjunct populations in the lower Blue Mountains and the South Maroota/Glenorie areas, within the Hawkesbury, The Hills and Blue Mountains LGAs. Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Allocasuarina glareicola		E	E	Primarily restricted to small populations in and around Castlereagh NR (NW Cumberland Plain), but with an outlier population at Voyager Point, Liverpool. Also reported from Holsworthy Military Area. Grows on tertiary alluvial gravels, with yellow clayey subsoil and lateritic soil. Occurs in Castlereagh open woodland.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Not recorded despite targeted field surveys.

Asterolasia elegans		E	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. 7 known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Cryptostylis subulata and the Cryptostylis erecta. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Cynanchum elegans	White-flowered Wax Plant	E	E	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Typical vegetation associations not present and not previosuly recorded in the locality.

Dillwynia tenuifolia		V	V	Occurs in western Sydney, predominately the Cumberland Plain as well as the Lower Blue Mountains and north to Yengo. Grows in scrubby/dry heath areas of Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays, and associated transitional communities including Castlereagh Scribbly Gum Woodland.	4 records within 10km (OEH 2015a)	Unlikely	Suitable habitat present, but may be reliably excluded based on survey effort conducted.
Eucalyptus benthamii	Camden White Gum	V	V	Occurs on the alluvial flats of the Nepean River and its tributaries. Known distribution from The Oaks (south) to Grose Wold (north) and Kedumba Valley (west). 2 major subpopulations: in Kedumba Valley and Bents Basin State Recreation Area. Occurs in wet open forest on alluvial flats, in well drained alluvial sands and gravels to 1 m deep.	5 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Unlikely	Broadly suitable habitat present, but a large and readily detectable species that may be reliably excluded based on survey effort conducted.
Eucalyptus nicholii	Narrow-leaved Peppermint, Narrow-leaved Black Peppermint	V	V	Naturally occurs only in New England Tablelands from Nundle to north of Tenterfield. Widely planted as urban street tree. Grows in dry grassy woodland, on shallow and infertile soils, mainly on granite.	Predicted to occur within 10km (DotE 2015a)	Nil	Suitable soil types and geomorphology not present and outside of known range.
Grevillea juniperina subsp. juniperina	Juniper-leaved Grevillea	V		Occurs only within western Sydney in an area bounded by Blacktown, Erskine Park, Londonderry and Windsor. Outlier populations also at Kemps Creek and Pitt Town. Grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium, typically containing lateritic gravels. Occurs in association with Cumberland Plain Woodland, Castlereagh Ironbark Woodland, Castlereagh Scribbly Gum Woodland and Shale/Gravel Transition	2 records within 10km (OEH 2015a) including a substantial population in the Lot 1 Subdivision of the Fernhill estate (EcoLogical,	Unlikely	Suitable habitat present and was recorded nearby in the proposed south west biobank. A large and readily detectable species that may be reliably excluded based on survey effort conducted.

				Forests.	2010).		
Marsdenia viridiflora subsp. viridiflora	Marsdenia viridiflora R. Br. subsp. viridiflora population in the Bankstown, Blacktown, Camden, Campbelltown, Fairfield, Holroyd, Liverpool and Penrith local government areas	EP		Recent records are from Prospect, Bankstown, Smithfield, Cabramatta Creek and St Marys. Previously known north from Razorback Range. A climber that grows in vine thickets and open shale woodland.	17 records within 10km (OEH 2015a)	Unlikely	Suitable habitat present, but a large and readily detectable species that may be reliably excluded based on survey effort conducted.
Melaleuca deanei	Deane's Paperbark	V	V	Occurs from Nowra- St Albans and west to the Blue Mountains, with most records in Ku-ring-gai / Berowra and Holsworthy/Wedderburn areas. Mostly grows on broad flat ridgetops, dry ridges and slopes and strongly associated with low nutrient sandy loam soils, sometimes with ironstone. Grows in heath- open forest, often in sandstone ridgetop woodland communities.	1 record within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Unlikely	Suitable soil types and geomorphology not present.
Micromyrtus minutiflora		E	V	Occurs in Richmond and Penrith areas in western Sydney. Grows in open forest on sandy clay or gravelly soils from Tertiary alluvium. Associated with Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, and other open forest types.	1 record within 10km (OEH 2015a)	Unlikely	Suitable soil types and geomorphology present, however not recorded despite targeted surveys.

Pelargonium sp. Striatellum (G.W.Carr 10345)	Omeo Stork's-bill	E	E	Omeo Storksbill Pelargonium sp. (G.W. Carr 10345), syn. P. striatellum, is a tufted perennial forb known from only 3 locations in NSW, with two on lake-beds on the basalt plains of the Monaro and one at Lake Bathurst. It has a narrow habitat that is usually just above the high-water level of irregularly inundated or ephemeral lakes, in the transition zone between surrounding grasslands or pasture and the wetland or aquatic communities.	Predicted to occur within 10km (DotE 2015a)	Nil	Suitable soil types and geomorphology not present and outside of known range.
Persoonia acerosa	Needle Geebung	V	V	Recorded on central coast and in Blue Mountains, from Mt Tomah to Hill Top (though now believed extinct in Hill Top). Mainly in Katoomba, Wentworth Falls and Springwood areas. Inhabits dry sclerophyll forest, scrubby low woodland and heath on sandstone. Occurs in well-drained soils including sands, laterite and gravels between 550- 1000m asl. May occur in disturbed areas eg roadsides.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Persoonia hirsuta	Hairy Geebung	E	E	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600m above sea level.	2 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Unlikely	Suitable habitat present, but a readily detectable species that may be reliably excluded based on survey effort conducted.

Pimelea curviflora var. curviflora		V	V	Confined to area between north Sydney in the south and Maroota in the north-west. Former range extended to Parramatta River including Five Dock, Bellevue Hill and Manly. Grows on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Often grows amongst dense grasses and sedges. Flowers October to May.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Pimelea spicata	Spiked Rice-flower	E	E	Disjunct populations within the Cumberland Plain (from Mount Annan and Narellan Vale to Freemans Reach and Penrith to Georges Hall) and Illawarra (from Mt Warrigal to Gerroa) (DEC 2005). In the Cumberland Plain region, restricted to areas which support or historically supported Cumberland Plain Woodland. Grows on well-structured clay soils derived from Wianamatta Shale. In the Illawarra, grows on variable soils in close proximity to the coast on hills or coastal headlands. Inhabits coastal woodland or grassland with emergent shrubs (OEH 2013).	1 record within 10km (OEH 2015a); Predicted within 10km (DotE 2015).	Possible	Suitable habitat present and a small, cryptic species that may not have been detected in field surveys
Pomaderris brunnea	Rufous Pomaderris	V	V	Mainly occurs in SW Sydney (Wollondilly and Camden LGAs), with other populations in the Hawkesbury-Wollemi region, near Walcha in the New England tablelands and Gippsland in VIC. In NSW, grows in moist woodland or open forest on clay and alluvial soils on flood plains and creek lines. Near Sydney occurs in open woodland dominated by E. amplifolia with Allocasuarina sp. and Bursaria sp.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable habitat present, but a large and readily detectable species that may be reliably excluded based on survey effort conducted.

				understorey, or on alluvial flats with eucalypts including E. elata, E. piperita and E. punctata (Sutter 2011).			
Pterostylis saxicola	Sydney Plains Greenhood	E	E	Occurs in western Sydney between Picton and Freemans Reach. Grows in small pockets of shallow soil in depressions on sandstone rock shelves above cliff lines. Associated vegetation above these rock shelves is sclerophyll forest or woodland on shale or shale/sandstone transition soils.	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Pultenaea glabra	Smooth Bush-pea, Swamp Bush-pea	V	V	In NSW restricted to higher Blue Mountains in the Katoomba-Hazelbrook and Mt Victoria areas. Unconfirmed sightings in Mt Wilson and Mt Irvine areas. Grows in swamp margins, hillslopes, gullies and creekbanks and occurs within dry sclerophyll forest and tall damp heath on sandstone.	Predicted to occur within 10km (DotE 2015a)	Nil	Suitable soil types and geomorphology not present and outside of known range.
Pultenaea parviflora		E	V	Occurs on the Cumberland Plain, with core distribution from Windsor to Penrith and east to Dean Park, and outliers in Kemps Creek and Wilberforce. Grows in dry sclerophyll woodlands, forest or in grasslands on Wianamatta Shale, laterite or Tertiary alluvium, on infertile sandy to clay soils. Associated communities include Castlereagh Ironbark Forest, Shale Gravel transition Forest and intergrade with Castlereagh Scribbly Gum Woodland.	2 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015).	Unlikely	Suitable habitat present, but a large and readily detectable species that may be reliably excluded based on survey effort conducted.

Pultenaea villifera	Pultenaea villifera Sieber ex DC. population in the Blue Mountains local government area	E		Patchy distribution across NSW. The known population of P. vilifera occurs in the Blue Mountains LGA from a few small sites in the Springwood-Woodford Area including the Blue Mountains National Park (OEH 2013). Grows in dry sclerophyll forest and woodlands on sandy soil, preferring sheltered spots (OEH 2013).	1 record within 10km (OEH 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Rhizanthella slateri	Eastern Underground Orchid	V	E	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (OEH 201). Currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Flowers during October and November (Harden 1993).	Predicted to occur within 10km (DotE 2015a)	Possible	Suitable habitat present and a small, cryptic species that may not have been detected in field surveys
Streblus pendulinus	Siah's Backbone, Sia's Backbone, Isaac Wood		E	On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest (ATRP 2010).On Norfolk Island, the species is found in a variety of forest types, though it is rare (DNP 2010).	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.
Tetratheca glandulosa	Glandular Pink-bell	V	V	Restricted to The Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong LGAs. Associated with shale-sandstone transition habitat (shale-cappings over sandstone). Occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils generally	Predicted to occur within 10km (DotE 2015a)	Unlikely	Suitable soil types and geomorphology not present.

				shallow, yellow, clayey/sandy loam, commonly with lateritic fragments. Vegetation varies from heath to open forest and is broadly equivalent to Sydney Sandstone Ridgetop Woodland community.			
Thelymitra sp. Kangaloon (D.L.Jones 18108)	Kangaloon Sun-orchid		CE	Only known from three locations near Robertson in the Southern Highlands. Grows in seasonally swampy sedgeland on grey silty clay loam at 600–700 m above sea level. Flowers in late October and early November.	Predicted to occur within 10km (DotE 2015a)	Nil	Suitable soil types and geomorphology not present and outside of known range.
Zieria murphyi	Velvet Zieria	V	V	Found in the Blue Mountains at Mt Tomah and on the southern tablelands where it has been recorded in Morton National Park in the Bundanoon area. Grows in gullies in dry sclerophyll forest with sandy soil. Associated species include Eucalyptus stricta, Dillwynia sericea and Lomandra longifolia	1 record within 10km (OEH 2015a)	Unlikely	Suitable soil types and geomorphology not present.

All information in this table is taken from NSW OEH and Commonwealth DotE Threatened Species profiles (OEH, 2013a; DotE 2013a) unless otherwise stated. The codes used in this table are: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community.

Threatened fauna known or predicted from the locality, habitat association and likelihood of occurring in the study area.

Scientific name	Common Name	TSC Act status	EPBC Act status	Habitat Association	Nature of record	Likelihood of occurrence in study area	Notes
Birds							
Anthochaera phrygia	Regent Honeyeater	CE	E	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	3 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable habitat present within study area
Botaurus poiciloptilus	Australasian Bittern	E	E	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly Typha spp.and Eleocharis spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	1 record within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable habitat present within the study area

Burhinus grallarius	Bush Stone-curlew	E		Scattered distribution across NSW. Inhabits lowland grassy woodland and open forest and, in coastal areas, Casuarina and Melaleuca woodlands, saltmarsh and mangroves. Requires a low, sparse groundcover, some fallen timber and leaf litter, and a general lack of a shrubby understory (OEH 2013).	1 record within 10km (OEH 2015a), last recorded 1996	Unlikely	Suitable habitat not present within the study area
Callocephalon fimbriatum	Gang-gang Cockatoo	V		This species is nomadic, spending summer in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests and winter at lower altitudes in drier more open eucalypt forest and woodlands, particularly in coastal areas. This species nests in hollow-bearing trees close to water with breeding taking place between October and January. Breeding usually occurs in tall mature sclerophyll forests that have a dense understorey, and occasionally in coastal forests.	12 records within 10km (OEH 2015a)	Possible	Suitable habitat present within study area
Calyptorhynchus lathami	Glossy Black-Cockatoo	V		Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of Allocasuarina species. Prefers woodland and open forests, rarely away from Allocasuarina. Roost in leafy canopy trees, preferably eucalypts, usually <1km from feeding site. Nests in large (approx. 20cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins 1999).	1 record within 10km (OEH 2015a)	Possible	Suitable habitat present within study area

Chthonicola sagittata	Speckled Warbler	V		Within NSW most frequently reported from the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits a wide range of Eucalyptus-dominated communities with a grassy understorey, a sparse shrub layer, often on rocky ridges or in gullies. Sedentary and requires large, relatively undisturbed remnants to persist in an area. Forages on the ground for seeds and insects, and nests in a slight hollow in the ground or at the base of a low dense plant.	2 records within 10km (OEH 2015a)	Possible	Suitable habitat present within study area
Daphoenositta chrysoptera	Varied Sittella	V		Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	13 records within 10km (OEH 2015a); Recorded within study area (Birdata 2013)	Possible	Suitable habitat present within study area. Has been recorded before in the adjacent Eastern Precinct.
Ephippiorhynchus asiaticus	Black-necked Stork	E		In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney. Breeding recorded as far south as Buladelah, though most breeding in NSW occurs in the north-east. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet	1 record within 10km (OEH 2015a), last recorded 1994	Unlikely	Infrequently occurs in the Sydney region.

				heathland, farm dams and shallow floodwaters. Will also forage in inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.			
Glossopsitta pusilla	Little Lorikeet	V		Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands Eucalyptus albens and E. melliodora are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3cm) hollows in living, smooth-barked eucalypts, especially Eucalyptus viminalis, E. blakelyi and E. dealbata. Most breeding records are from the western slopes.	1 record within 10km (OEH 2015a), last recorded 2005	Possible	Suitable habitat present within study area
Ixobrychus flavicollis	Black Bittern	V		Occurs from southern NSW to Cape York and the Kimberley, and southwest WA. Inhabits terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves as long as there is permanent water.	1 record within 10km (OEH 2015a), last recorded 1995	Possible	Suitable habitat present within study area

				Roosts by day in trees or within reeds on the ground. Nests in branches overhanging water and breeds from December to March.			
Lathamus discolor	Swift Parrot	E	E	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. Eucalyptus robusta, Corymbia maculata and C. gummifera dominated coastal forests are also important habitat.	6 records within 10km (OEH 2015a); Predicted within 10km(DotE 2015)	Possible	Suitable habitat present within study area
Limosa limosa	Black-tailed Godwit	V	M; C,J,K	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. It has also been found around muddy lakes and swamps, wet fields and sewerage treatment works.	1 record within 10km (OEH 2015a), last recorded 1982	Possible	Suitable habitat present within the study area

Lophoictinia isura	Square-tailed Kite	V		Occurs across NSW, resident in North, northeast and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100m of ephemeral/permanent watercourse. Large home range > 100 km2.	5 records within 10km (OEH 2015a)	Possible	Suitable habitat present within study area
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V		Considered a sedentary species, but local seasonal movements are possible. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Nests on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs.	1 record within 10km (OEH 2015a)	Possible	Suitable habitat present within study area
Neophema pulchella	Turquoise Parrot	V		Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important	1 record within 10km (OEH 2015a), last recorded 1982	Possible	Suitable habitat present within study area

				foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.			
Ninox connivens	Barking Owl	V		Occurs from coast to inland slopes and plains, though is rare in dense, wet forests east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. Roosts along creek lines in dense, tall understorey foliage (e.g. in Acacia and Casuarina), or dense eucalypt canopy. Nests in hollows of large, old eucalypts including Eucalyptus camaldulensis, Eucalyptus albens, Eucalyptus polyanthemos and Eucalyptus blakelyi. Birds and mammals important prey during breeding. Territories range from 30 to 200 hectares.	1 record within 10km (OEH 2015a), last recorded 2002	Possible	Suitable habitat present within study area
Ninox strenua	Powerful Owl	V		Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large	8 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat in the study area

				home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.			
Petroica boodang	Scarlet Robin	V		In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	1 record within 10km (OEH 2015a), last recorded 1998	Possible	Suitable habitat present within study area
Petroica phoenicea	Flame Robin	V		Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	3 records within 10km (OEH 2015a)	Possible	Suitable habitat present within study area

Rostratula australis	Australian Painted Snipe	E	V,M	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Predicted within 10km (DotE 2015)	Possible	Suitable habitat present within study area
Stagonopleura guttata	Diamond Firetail	V		Typically found west of the Great Dividing Range, but populations also occur in drier coastal areas including W Sydney, Hunter, Clarence and Snowy River valleys. Occurs in grassy eucalypt woodlands including Box Gum and Snow Gum communities, as well as open forest, mallee and natural and derived grasslands. Often found in riparian areas and occasionally in lightly wooded farmland. Nests in shrubby understorey or higher up under nests of other species.	1 record within 10km (OEH 2015a), last recorded 1990	Possible	Suitable habitat present within study area
Tyto novaehollandiae	Masked Owl	V		Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Roosts and breeds in large (>40cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	12 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat in the study area
Tyto tenebricosa	Sooty Owl	V		Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west.	1 record within 10km (OEH 2015a), last recorded 2003	Possible	Suitable foraging habitat in the study area

				Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nest in large (>40cm wide, 100cm deep) tree hollows in unlogged/unburnt gullies within 100m of streams or in caves.			
Mammals							
Cercartetus nanus	Eastern Pygmy-possum	V		Occurs along the east coast of NSW, and inland to the Pillaga, Dubbo, Parkes and Wagga Wagga. Inhabits range of habitats from coastal heath and woodland though open and closed forests, subalpine heath and rainforest (Tulloch and Dickman 1995). Inhabits rainforest, sclerophyll forests and heath. Banksia spp. and myrtaceous shrubs and trees are favoured food sources and nesting subject sites in drier habitats. Diet mostly pollen and nectar from Banksia spp., Eucalyptus spp., Callistemon spp. and insects (Ward and Turner 2008). Nests in hollows in trees, under the bark of Eucalypts, forks of tea-trees, abandoned bird nests and Xanthorrhoea bases (Ward and Turner 2008, Tulloch and Dickman 2006).	1 record within 10km (OEH 2015a), last recorded 2004	Unlikely	Limited foraging habitat in the study area

Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	5 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable foraging habitat in the study area
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	7 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable foraging habitat in the study area
Miniopterus australis	Little Bentwing-bat	V		Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Willi Willi, near Kempsey. Outside breeding season roosts in caves, tunnels and mines and has been recorded in a tree hollow on one occasion. Forages for insects beneath the canopy of well-timbered habitats (Churchill 2008, Hoye and Hall 2008).	1 record within 10km (OEH 2015a), last recorded 2012	Possible	Suitable foraging habitat in the study area

Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	11 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat in the study area
Mormopterus norfolkensis	Eastern Freetail-bat	V		Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	6 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat and potential roost sites in study area
Myotis macropus	Southern Myotis	V		Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008)	9 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat and potential roost sites in the study area

Petaurus australis	Yellow-bellied Glider	V		Occurs along the east coast to the western slopes of the Great Dividing Range. Inhabits a variety of forest types but prefers tall mature eucalypt forest with high rainfall and rich soils. Relies on large hollow-bearing trees for shelter and nesting, with family groups of 2-6 typically denning together. In southern NSW its preferred habitat at low altitudes is moist gullies and creek flats in mature coastal forests. Mostly feeds on sap, nectar and honeydew.	7 records within 10km (OEH 2015a)	Unlikely	Preferred tall, moist forest foraging habitat not present and probably too few hollow-bearing trees to maintain a local population.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	1 record within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Nil	No suitable rocky escarpment habitat
Phascolarctos cinereus	Koala	V	V	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	19 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015a	Possible	Suitable foraging habitat in the study area
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	Predicted within 10km (DotE 2015)	Unlikely	No suitable coastal forest with sandy soils

Pseudomys novaehollandiae	New Holland Mouse, Pookila		V	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	Predicted within 10km (DotE 2015)	Unlikely	Preferred forest on sandy soils with thick groundcover are not present
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	14 records within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable foraging habitat in the study area
Scoteanax rueppellii	Greater Broad-nosed Bat	V		Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards 2008, Churchill 2008).	3 records within 10km (OEH 2015a)	Possible	Suitable foraging habitat and potential roost sites in the study area
Reptile							

Hoplocephalus bungaroides	Broad-headed Snake	E	V	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	Predicted within 10km (DotE 2015)	Nil	Preferred rocky escarpment habitat not present.
Frogs							
Heleioporus australiacus	Giant Burrowing Frog	V	V	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as 2 populations with a 100km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	Predicted within 10km (DotE 2015)	Unlikely	Preferred ridgetop habitats on sandy soils not present
Litoria aurea	Green and Golden Bell Frog	E	V	Formerly occurred from Brunswick Heads to victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing cumbungi (Typha spp.) or spike rushes (Eleocharis spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. Gambusia holbrooki is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	1 record within 10km (OEH 2015a); Predicted within 10km (DotE 2015)	Possible	Suitable foraging habitat and potential breeding habitat in the study area

Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	Predicted within 10km (DotE 2015)	Unlikely	Preferred rocky stream habitats on slopes and plateaus not present
Mixophyes balbus	Stuttering Frog, Southern Barred Frog (in Victoria)	E	V	Occurs along the east coast of Australia. Has undergone a massive range reduction particularly in the south of its range: within the Sydney Basin, White (2008a) located only 3 populations south of Sydney (Macquarie Pass and Mt Werong) and Daly et al. (2002, in White 2008a) found only 2 extant populations between Macquarie Pass and Victoria. Inhabits rainforest and wet, tall, open forest. Shelter in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. The species does not occur in areas where the riparian vegetation has been disturbed or where there have been significant upstream human impacts (Mahony et al 1997).	Predicted within 10km (DotE 2015)	Unlikely	Preferred rocky stream habitats in rainforest not present
Mixophyes iteratus	Giant Barred Frog, Southern Barred Frog	E	E	Occurs on the coast and ranges from south-eastern QLD to the Hawkesbury River in NSW, particularly in Coffs Harbour - Dorrigo area. Forage and live amongst deep, damp leaf litter in rainforest, moist eucalypt forest and nearby dry eucalypt forest. Breed in shallow, flowing rocky streams. Within Sydney Basin, confined to small populations in tall, wet forest in the	Predicted within 10km (DotE 2015)	Unlikely	Preferred rocky stream habitats in rainforest not present

				Watagan Mountains north of the Hawkesbury and the lower Blue Mountains (White 2008b).			
Pseudophryne australis	Red-crowned Toadlet	V		Restricted to Sydney Basin, from Nowra to Pokolbin and west to Mt Victoria. Inhabits heathland and open woodland on Hawkesbury and Narrabeen Sandstones, within 100m of ridgelines. Breeds in ephemeral feeder creeks or flooded depressions, requiring unpolluted water between 5.5 and 6.5 pH. Shelters under rocks, amongst masses of dense vegetation or leaf litter. Populations restricted to immediate vicinity of breeding areas.	14 records within 10km (OEH 2015a)	Unlikely	Preferred ridgetop habitats on sandy soils not present
Fish							
Macquaria australasica	Macquarie Perch	V	E	Occurs in the upper reaches of the Lachlan, Murrumbidgee and Murray Rivers, and in parts of the Hawkesbury and Shoalhaven catchment areas.Inhabits river and lake habitats, especially the upper reaches of rivers and their tributaries. Requires clear water with deep, rocky holes and abundant cover (including aquatic vegetation, woody debris, large boulders and overhanging banks). Spawning occurs in spring and summer in shallow upland streams or flowing sections of river systems.	Predicted within 10km (DotE 2015); Found in the Hawkesbury/Nepean CMA	Unlikely	Preferred clear, deep, rocky streams are not present

Prototroctes maraena	Australian Grayling		V,M	Occurs in coastal rivers and streams south from the Shoalhaven River. Inhabits estuarine waters and coastal seas as larvae/juveniles, and freshwater rivers and streams as adults. Most of their lives are spent in freshwater rivers and streams in cool, clear waters with a gravel substrate and alternating pool and riffle zones, however can also occur in turbid water. The species can penetrate well inland, being recorded over 100 km inland from the sea. (Backhouse et al 2008).	Predicted within 10km (DotE 2015)	Unlikely	Preferred clear, rocky streams are not present
Invertebrates							
Archaeophya adamsi	Adam's emerald dragonfly	E (FM Act)		The species is only known from a few sites in the greater Sydney region. Larvae have been found in small creeks with gravel or sandy bottoms, in narrow, shaded riffle zones with moss and rich riparian vegetation. Adult dragonflies generally fly away from the water to mature before returning to breed. Males congregate at breeding sites and often guard a territory. Females probably lay their eggs into the water.	Found in the Hawkesbury/Nepean CMA (DPI 2015)	Unlikely	Preferred shady, gravel streams are not present
Austrocordulia leonardi	Sydney Hawk Dragonfly	E (FM Act)		The Sydney hawk dragonfly has a very restricted distribution. The known distribution of the species includes three locations in a small area south of Sydney, from Audley to Picton. The species is known from the Hawkesbury-Nepean, Georges River, Port Hacking and Karuah drainages. The Sydney hawk dragonfly has specific habitat requirements, and has only ever been collected from deep and shady riverine pools with cooler water. Larvae are	Found in the Hawkesbury/Nepean CMA (DPI 2015)	Unlikely	Preferred deep, clear streams are not present

				found under rocks where they co-exist with Austrocordulia refracta.			
Meridolum corneovirens	Cumberland Plain Land Snail	E		Occurs within a small area of the Cumberland Plain, from Richmond and Windsor to Picton. Found primarily under litter of bark, leaves and logs, or in loose soil around grass clumps within Cumberland Plain Woodland. Has also been found under rubbish. Feeds on fungus. During periods of drought can burrow into the soil to escape the dry conditions.	51 records within 10km (OEH 2015a)	Present	Live individuals or shells recorded in two locations in the Lot 1 subdivision and a further one location in the study area

Notes:
Marine and littoral threatened species (particularly shorebirds) which are restricted to coastal or estuarine environments were excluded from the threatened biota table.
Wildlife Atlas records: only records from 1980 or later were considered. The date of the last record is included for any species which have not been recorded within the last 20 years.

All information in this table is taken from NSW OEH and Commonwealth DotE Threatened Species profiles (OEH, 2013a; DotE 2013b) unless otherwise stated. The codes used in this table are: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population; CEEC – Critically Endangered Ecological Community; EEC – Endangered Ecological Community.

GHD

133 Castlereagh St Sydney NSW 2000

-

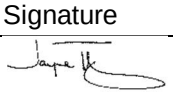
T: +61 2 9239 7100 F: +61 2 9239 7199 E: sydmail@ghd.com.au

© GHD 2015

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

\\ghdnet\ghd\AU\Sydney\Projects\22\16709\WP\208568.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0.	B Harrington/R Hamer	J Tipping		Dan Williams		30/10/13
	M Weerakoon B Harrington	J Tipping		Dan Williams		26/05/2015

www.ghd.com