THE HILLS SHIRE COUNCIL
3 Columbia Court, Norwest NSW 2153
PO Box 7064, Norwest 2153
ABN 25 034 494 656 | DX 9966 Norwest

18 October 2019

Local Government
Independent Pricing and Regulatory Tribunal
PO Box K35
HAYMARKET POST SHOP
SYDNEY NSW 1240

Our Ref: FP251

Dear Sir / Madam,

IPART REVIEW OF DRAFT CONTRIBUTIONS PLAN NO.17 – CASTLE HILL NORTH (FP251)

Thank you for the opportunity to provide comments on IPART's review of draft Contributions Plan No.17 – Castle Hill North. The sections below outline key recommended changes to IPART's revised costings and other general comments regarding IPART's draft assessment report. For clarity, a table including a response to each of IPART's recommendations is also included as Attachment 1.

a. Transport

Intersection Upgrades and Road Widening - Base Costs
It is unclear why the Transport Infrastructure Cost Review prepared by Axess provides a more reasonable estimate of costs than Council's estimates which are generally based on similar local projects and IPART Benchmarks. There is a lack of detailed justification in the Axess Report to support the proposed cost reductions apart from a seemingly arbitrary note that Council's estimates for certain items 'appear high'. Given the scrutiny which IPART applies to costings prepared by or on behalf of Council, it is unclear why IPART has accepted the Axess Report as a more reasonable or accurate cost estimate given the limited justification or supporting evidence contained within.

Whilst Council does not agree with all of Axess' recommendations, Axess' recommended base costs for intersection upgrades and road widening are acceptable to be used as an interim measure. The expedient adoption of the Contributions Plan is critical to Council to ensure that Council is able to levy development within the precinct, once rezoned. However, it is intended that once the Plan has been adopted and the Works Schedule endorsed, detailed designs and costings will be prepared for each item to provide greater certainty with respect to the exact costs for each individual item within the plan. These would be incorporated within a future review of the plan.

Pedestrian Bridges - Base Costs
Council's exhibited base costs for pedestrian bridges were based on tenders for similar structures at Windsor Road and Memorial Avenue. However, the Transport Infrastructure Cost Review prepared by Axess suggests that Council review these costs given the actual construction costs for

these bridges were higher than the original tender prices. Despite this, IPART did not recommend any increase to the base costs for pedestrian bridges within their draft report.

A review has been undertaken of other bridges which more closely reflect the structural features of the proposed bridges within an urban environment such as Castle Hill North (for example, including the installation of lifts). Based on similar precedents at Beecroft, North Parramatta and Kirrawee (refer Attachment 2), it is considered likely that the cost of these structures will be $3.5m each (total cost of $5.4m each including Axess' recommended project management and design allowances and a 30% contingency consistent with IPART's Benchmarks Report). It is noted that this value is also similar to the final construction cost for the Memorial Avenue pedestrian bridge being $3,663,284. It is recommended that the costs for pedestrian bridges be updated accordingly which will increase the cost of pedestrian bridges from $5.4 million (as submitted to IPART) to $10.9 million.

Transport On-Costs

IPART recommends reduced contingency allowances (15%-30%) based on the Transport Infrastructure Cost Review prepared by Axess. As noted previously, Axess' recommendations are based on minimal justification and are contrary to IPART's own recommended standard contingency allowances which recommend a 30% contingency for transport works at the strategic review 'planning' stage. As no detailed designs have yet been completed for transport items under CP17, it is unclear why IPART would recommend an outcome which is contrary to its Benchmark Cost Report and it is considered imperative that a 30% contingency be applied to account for uncertainties in the planning, design and delivery of transport infrastructure.

IPART further recommends that contingency allowances only be applied to base costs for transport items, not design or project management elements of a project. This recommendation is contrary to IPART's recommendation for stormwater and open space projects. Specifically, IPART's own benchmark rates include allowances for project management and design and IPART subsequently recommends that contingency allowances be applied to the benchmark rates (including the design and project management components). It is unclear why IPART has taken a contrary approach for transport infrastructure and it is recommended that a 30% contingency allowance continue to be applied to project management and design costs.

Timing of Capital Works – Road Upgrades

IPART has recommended that Council review the timing of expenditure for certain works items that are currently based on the expected development path for the precinct (e.g. road upgrades).

There is a degree of uncertainty with respect to the timing of land acquisition for Castle Street and Old Castle Hill Road upgrades with negotiations expected to occur over a number of years as redevelopment occurs. To account for this uncertainty, the timing of expenditure for these upgrades was initially distributed in accordance with the expected rate of development for the precinct.

In response to IPART's recommendation, the timing of expenditure for the Castle Street and Old Castle Hill Road upgrades has been amended to occur over a period of approximately 10 years. Land acquisition is to occur incrementally in the initial years as redevelopment occurs followed by the design and construction of the upgrades at the end of the 10 year period. The timing of expenditure for the Holland Road and Glenhaven Road upgrades has also been amended to occur in the same year as the delivery of the Holland Reserve playing fields.

b. Stormwater

Timing of Capital Works – Stormwater

It is not clear from IPART's draft report if there is concern regarding the timing of expenditure for stormwater upgrades. However, it is noted that the timing indicated for storm water upgrades has been based on the development path as it is anticipated these works will be undertaken incrementally as redevelopment occurs. This approach acknowledges that works required over

public land may be limited by connecting drainage works on private property (which would generally be upgraded as part of redevelopment on individual sites) and provides for reduced disturbance and impact during construction. Council is also preparing a stormwater master plan for the Castle Hill Precinct which will involve further investigation and design of stormwater upgrades. Until such work is completed, it is considered the current approach is reasonable.

c. Open Space

Holland Reserve - Base Costs

IPART has recommended changes to base costs for biodiversity offsetting and relocation of telecommunication towers to reflect up to date advice provided by ecological consultants (UBM) and telecommunication providers (Optus and Telstra). It is considered reasonable that these revised costs be applied and that the costs for biodiversity offsetting be further updated to reflect the final Biodiversity Development Assessment Report prepared by UBM Ecological Consultants (refer Attachment 3). The offset costs within the final report equate to $469,587.94.

IPART has also recommended the removal of a contingency allowance for biodiversity offsetting and relocation of telecommunication towers. Whilst Council has received cost *estimates* for biodiversity offsetting and relocation of telecommunication towers, it is possible there may be adjustment to the final costs for these sub-items to account for geotechnical issues, network coverage and site access issues for telecommunication providers and market fluctuations in relation to biodiversity offset costs – these variations are not factored into the base cost estimates. Accordingly, it is strongly recommended that a 20% contingency continue to be applied to these sub-items.

IPART's draft assessment report (page 49) states that Holland Reserve contains critically endangered vegetation. Holland Reserve was initially assumed to accommodate Shale Sandstone Transition Forest (a Critically Endangered Ecological Community) based on Council's high level vegetation mapping. The Biodiversity Development Assessment Report prepared by UBM has confirmed that the proposed playing fields would not impact on any critically endangered ecological communities. Notwithstanding, Council is still required to offset the ecological impact resulting from loss of vegetation through the purchase of biodiversity credits. It is requested that any reference to the presence of Shale Sandstone Transition Forest or other endangered / critically endangered ecological communities at Holland Reserve be removed from IPART's final report.

Holland Reserve - On-Costs

Consistent with Council's recommendation for transport works, it is recommended that a 20% contingency continue to be applied to project management and design allowances for Holland Reserve. This will provide consistency with IPART's approach for stormwater and open space projects and account for risks and uncertainties in the design and delivery of upgrades to Holland Reserve.

d. Cross-Category Considerations

Escalation Factors

Council has extended ABS data up to March 2019 and applied compound annual averages as escalation rates for capital work items (Open Space, Drainage, Transport) as per IPART's recommendation. However, Council disagrees with applying the 15 year compound annual average for land escalation. While compound annual average growth rate is more correct in calculating the growth between the starting and end point, this ignores the volatility Council experiences when acquiring land during this timeframe.

For the period between March 2004 and March 2019, the annual price movements ranged from -11.0% and +19.5%, with a simple annual average of 4.34% over the 15 year period. While the simple average does not account for impact of compounding, it reflects the volatility involved as acquisition prices are subject to market forces at the time. Quite often Council has no control over the timing of land acquisitions and can be acquiring land at any point in the market cycle, before or

after market corrections occur. While the house price has dropped recently, property markets are more volatile than the Producers Price Indices and are less predictable. It is difficult to forecast the most appropriate escalation rate for the next 20 years, especially with the interest rates now at record low with more impending rates cut anticipated in the near future.

Given the volatility in land prices and uncertainty in acquisition timing, Council sees the simple average as a more appropriate measure for escalation rate as this takes into account more data points during the 15 year market cycle, rather than just the beginning and end points as in the compound annual average growth calculation.

IPART has noted this recommendation is consistent with IPART's recent review of Contributions Plan No.12 – Balmoral Road Release Area. However, it is noted that Council was not given an opportunity to respond to this recommendation in CP12 as this recommendation was not included in the Draft Report provided to Council for comment in May 2019. This recommendation was only inserted into the Final Report for Minister's approval.

e. Cost Implications

The cost implications of Council's recommendations would result in the following changes to the plan (refer comparison table below):

Item	Exhibited	IPART Recommendations	Council Revised
Transport	$59,473,217	$54,523,218 **(-$4,949,999)**	$63,058,476 **(+$3,585,259)**
Stormwater	$6,592,651	$5,750,030 **(-$842,621)**	$5,750,030 **(-$842,621)**
Open Space	$11,960,592	$9,433,237 **(-$2,527,356)**	$9,051,809 **(-$2,908,783)**
Administration	$996,450	$878,767 **(-$117,682)**	$1,001,075 **(+$4,625)**
TOTAL	**$79,022,910**	**$70,585,252** **(-$8,437,658)**	**$78,861,390** **(-$161,520)**

Table 1
Comparison of Exhibited, IPART Recommended and Council Revised Costs

A breakdown of these costs is included within the supporting Infrastructure Schedule, Works Schedule and NPV Model provided as Attachments 4 – 6.

Council values the opportunity to be involved in IPART's review process and strongly recommends inclusion of the above recommendations into IPART's final assessment report.

Should you wish to discuss any of the matters raised within this letter or arrange to meet with relevant Council officers, please contact Alicia Iori – Senior Town Planner on 9843 0396.

Yours faithfully

[redacted]

Nicholas Carlton
MANAGER – FORWARD PLANNING

Attachments:

1. Table of Responses to IPART Recommendations
2. Pedestrian Bridge Precedents
3. Final BDAR prepared by UBM Ecological Consultants (October 2019)
4. Revised Infrastructure Schedule
5. Revised Works Schedule
6. Revised NPV Model

ATTACHMENT 1: RESPONSE TO IPART RECOMMENDATIONS FOR CP17

IPART Recommendation	Agree / Disagree	Council Comment
Transport - Works		
Transfer the cost of road upgrades for the Holland Reserve playing fields site from the open space category to the transport infrastructure category.	Agree	Original costs were included within the open space category as these upgrades are linked to the upgrade of Holland Reserve. Notwithstanding this, no objection is raised to transfer of these costs to the transport category.
An increase in the cost of roundabouts of $141,491, reflecting increases in base costs and allowances for project management, design and contingency.	Partly Disagree	No objection to recommended base, project management and design cost estimates, as an interim measure. Objection is raised to proposed contingencies (approx. 17% to 20%) as these are inconsistent with IPART standard contingency allowances for transport works at the strategic review stage. Objection is raised to only applying contingencies to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Refer to additional discussion in Section A of letter.
An increase in the cost of pedestrian bridges of $202,871, reflecting increases in allowances for project management, design and contingency.	Partly Disagree	No objection is raised to recommended project management and design costs. Objection is raised to recommended base costs as IPART report has not taken into account Axess' recommendation to review base costs for pedestrian bridges. Objection is raised to proposed contingency allowances (16.5%) as these are inconsistent with IPART standard contingency allowances for transport works at the strategic review stage. Objection is raised to only applying contingencies to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Refer to additional discussion in Section A of letter.

IPART Recommendation	Agree / Disagree	Council Comment
A reduction in the cost of a signalised intersection (McMullen Avenue/Old Northern Road) of $10,523, reflecting lower base costs.	Partly Disagree	No objection to recommended base, project management and design cost estimates, as an interim measure. Objection is raised to only applying contingency to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Refer to discussion in Section A of letter.
A reduction in the cost of road upgrades at Holland Reserve of $383,486, reflecting lower base costs and lower allowances for project management, design and contingency.	Partly Disagree	No objection recommended base, project management and design cost estimates, as an interim measure. Objection is raised to only applying contingency to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Refer to discussion in Section A of letter.
A reduction in the cost of road upgrades of $3,963,918, reflecting lower base costs and lower allowances for project management, design and contingency.	Partly Disagree	No objection recommended base, project management and design cost estimates, as an interim measure. Objection is raised to only applying contingency to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Refer to discussion in Section A of letter.
Apportion 17% (not 24%) of the cost of the McMullen Avenue/Old Northern Road signalised intersection to CP17.	Agree	Original apportionment was miscalculated. Accordingly, no objection to amended apportionment.
Stormwater - Works		
For stormwater pipes, remove duplicate allowances for project management (7.5%) and design (7.5%) and apply a contingency allowance (30%) to base costs only.	Agree	No objection to removal of duplicate project management and design allowances which are included within IPART Benchmarks. Unclear how contingency could be applied to base costs only when project management and design fees are factored into IPART Benchmarks.

IPART Recommendation	Agree / Disagree	Council Comment
For stormwater pits, use IPART benchmark costs to estimate the base costs of stormwater pits (for various sized pipes), remove additional allowances for project management (7.5%) and design (7.5%), and apply a contingency allowance (30%) to base costs only.	Agree	No objection to use of IPART Benchmarks and removal of duplicate project management and design allowances which are included within IPART Benchmarks. Unclear how contingency could be applied to base costs only when project management and design fees are factored into IPART Benchmarks.
Open Space - Works		
For local open space embellishment costs, remove the additional allowances for project management and design, and apply a 20% contingency allowance to base costs only.	Agree	No objection to removal of duplicate project management and design allowances which are included within IPART Benchmarks and application of 20% contingency consistent with IPART's Benchmarks Report. Unclear how contingency could be applied to base costs only when project management and design fees are factored into IPART Benchmarks.
For Holland Reserve embellishment costs, remove the additional allowances for project management and design and apply a 20% contingency allowance to base costs only.	Agree	No objection to removal of duplicate project management and design allowances which are included within IPART Benchmarks and application of 20% contingency consistent with IPART's Benchmarks Report. Unclear how contingency could be applied to base costs only when project management and design fees are factored into IPART Benchmarks.
Revise the estimates for Holland Reserve site-readiness to reflect the most up-to-date advice from UBM Ecological Consultants about the cost of the biodiversity offset and removal of all allowances.	Agree	No objection to updating of costs. Further recommended to update costs to reflect final report provided by UBM in September 2019.
Revise the estimates for Holland Reserve site-readiness to reflect the most up-to-date advice from the service providers about the cost for the relocation of the telecommunication towers and removal of all allowances.	Agree	No objection to updating of costs to reflect updated advice received by Council.

IPART Recommendation	Agree / Disagree	Council Comment
Application of a 20% contingency allowance to base costs only for all items excluding biodiversity offset and telecommunication towers.	Disagree	No objection to application of 20% contingency consistent with IPART Benchmarks Report. Objection is raised to only applying contingency to base costs as contingency allowances have been applied by IPART to project management and design costs, where these costs are components of IPART Benchmarks (refer stormwater and local open space items). Objection to exclusion of biodiversity offset and telecommunication towers from contingency allowance. Refer to additional discussion in Section C of letter.
Administration		
Calculate the cost of plan administration for CP17 based on 1.5% of the adjusted cost of works.	Agree	No objection to the recalculation of administration costs to reflect updated costs within plan.
Cross-Category Considerations		
Reduce the total cost of land in the plan by 4.1%, in line with the fall in the ABS Residential Property Price Index for Established Houses between June 2017 and June 2018.	Agree	Given the timing of the most recent valuation, no objection is raised to the indexing of land prices to reflect market changes.
Change the base period in the model to 2018-19.	Agree	No objection to recommended change to base year.
Amend the proposed timing of expenditure for some works items.	Partly Disagree	No objection to recommended change to expenditure timing for road upgrades. Objection is raised to changing expenditure timing for storm water upgrades. Refer to further discussion in Sections A and B of letter.
Apply administration costs evenly over the expected life of the plan (20 years), instead of 15 years.	Agree	Original distribution was miscalculated. Accordingly, no objection to amended distribution.
Recalculate all escalation factors using the most recent data from the ABS and a compound annual average growth rate formula instead of a simple average formula.	Partly Disagree	No objection to recommended use of compound annual averages as escalation rates for capital work items. Objection is raised to use of compound annual averages for land. Refer to further discussion in Section D of letter.
Other		

IPART Recommendation	Agree / Disagree	Council Comment
Review the plan within three years to include updated information on planning assumptions, and the scope and cost of works in the plan, including obtaining site specific costs where relevant.	Agree	No objection is raised to review of plan. Council's recommended approach is to adopt most of IPART's recommended changes as an interim measure, with the intention to prepare detailed designs and costings shortly following adoption of the plan which will inform future amendments to the Plan.

ATTACHMENT 2

July 2016

Project update for work on Beecroft Road Pedestrian Bridge, Beecroft

The NSW Government is funding this $5 million project about 50 metres south of the Copeland Road intersection to provide safer access for students and pedestrians near Beecroft Public School.

Roads and Maritime is continuing to deliver the final stage of this project, which includes:

- Installing new pedestrian fences on Beecroft Road
- Installing CCTV cameras and lighting on the bridge
- Building new kerb on Beecroft Road
- Removing an existing pedestrian crossing on the southern side of the intersection
- Landscaping.

Work completed so far includes building foundations, stairs and lift shafts, lifting the bridge span onto the piers, excavating, removing trees, vegetation, establishing a site office and adjusting utilities.

The pedestrian bridge will open to the public on **Tuesday 19 July**.

What happens next?

We will continue to work from **7am** to **6pm** between **Mondays** and **Fridays** and from **7am** to **1pm** on **Saturdays**. There will also be **10 more night shifts** until the end of the project in **late July**. Our working hours will be from **8pm** to **5am** between **Sundays** and **Fridays**.

How will the work affect you?

There will be some noise associated with this work and we will make every effort to minimise it.

Traffic changes

There will be some temporary traffic changes to ensure the work zone is safe.

Lane closures will be in place and may affect travel times. Please keep to speed limits and follow the direction of traffic controllers and signs. For the latest traffic updates, you can call 132 701, visit livetraffic.com or download the Live Traffic NSW App.

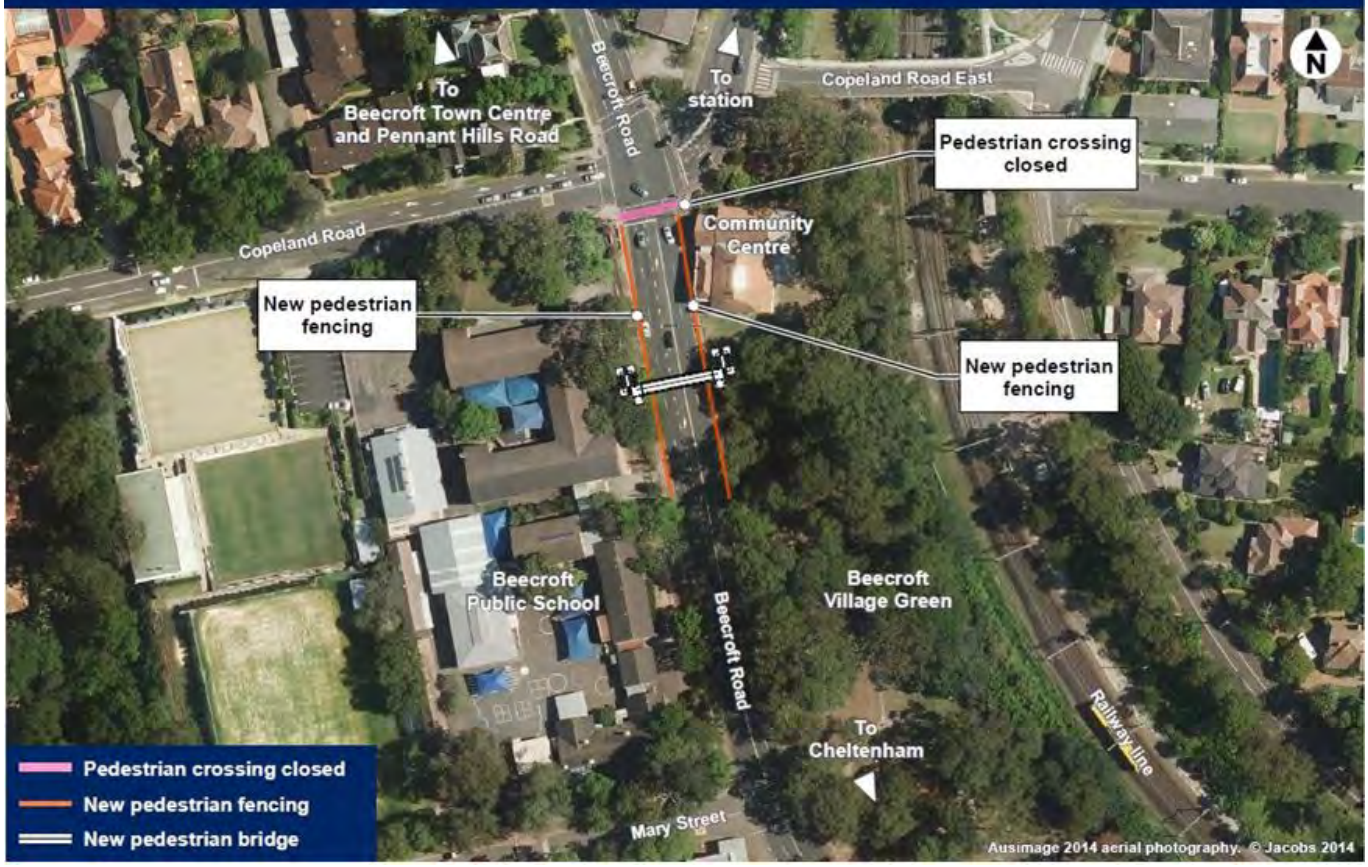
Contact

If you have any questions, please call our delivery partner DownerMouchel on 1800 332 660 or email nsw_projects@downermouchel.com

For more information on our projects, visit rms.nsw.gov.au

Thank you for your patience during this important work.

Pedestrian bridge on Beecroft Road, Beecroft



Translating and Interpreting Service

If you need an interpreter, please call TIS National on **131 450** and ask them to call DownerMouchel on **1800 332 660**.

Arabic
إذا كنتم بحاجة إلى مترجم، الرجاء الاتصال بخدمة الترجمة الخطية والشفهية (TIS National) على الرقم 131 450 ، و الطلب منهم الاتصال بوكالتكم DownerMouchel على الرقم 1800 332 660

Cantonese
若你需要口譯員，請致電 **131 450** 聯絡翻譯和口譯服務署 (TIS National)，要求他們致電 1800 332 660 聯絡 DownerMouchel。

Mandarin
如果你需要口译员，请致电 **131 450** 联系翻译和口译服务署 (TIS National)，要求他们致电 1800 332 660 联系 DownerMouchel。

Greek
Αν χρειάζεστε διερμηνέα, παρακαλείστε να τηλεφωνήσετε στην Υπηρεσία Μετάφρασης και Διερμηνείας (Εθνική Υπηρεσία TIS) στο **131 450** και ζητήστε να τηλεφωνήσουν DownerMouchel στο 1800 332 660.

Russian
Если вам нужен переводчик, то позвоните в Службу письменного и устного перевода (TIS National) по номеру **131 450** и скажите переводчику, что вам нужно позвонить в DownerMouchel по номеру 1800 332 660.

Korean
통역사가 필요하시면 번역통역서비스 (TIS National) 에 **131 450** 으로 연락하여 이들에게 1800 332 660 번으로 DownerMouchel 에 전화하도록 요청하십시오.

Vietnamese
Nếu cần thông ngôn viên, xin quý vị gọi cho Dịch Vụ Thông Phiên Dịch (TIS Toàn Quốc) qua số **131 450** và nhờ họ gọi cho DownerMouchel qua số 1800 332 660.

PROJECT

BRIDGES

North Parramatta Pedestrian Bridge

LOCATION

Pennant Hills Rd, North Parramatta

CLIENT

DownerMouchel / RMS

CONTRACT VALUE

$3.5 million

COMPLETION

May 2018

DESCRIPTION OF WORK

– Supply and installation of steel arch bridge
– Construction of piled foundations, stairs and lift shafts
– Hard and soft landscaping
– Relocation of utilities
– Street lighting, traffic signals and CCTV
– Removal and reinstatement/protection of heritage sandstone pillars

CONTACT US FOR MORE INFORMATION

 (02) 9552 3077  info@christiecivil.com.au

About Christie Civil

Christie Civil is one of the leading civil construction contractors in Sydney. Christie Civil has been undertaking challenging civil and structural projects for over thirty years. Our staff of experienced engineers is able to successfully manage all manner of civil and structural engineering projects to the satisfaction of our clients.

READ MORE

Quick Links

- Home
- Company Details
- Senior Personnel
- Projects
- Contact Us

Contact Details

Unit 4 / 7-29 Bridge Rd STANMORE NSW 2048

(02) 9552 3077

info@christiecivil.com.au

Roads and Maritime Services / PP South - Kirrawee Pedestrian Bridge - RMS.18.0000302514.1113

Contract Award Notice ID RMS.18.0000302514.1113

Publish Date 20-Feb-2019

Category (based on UNSPSC)

83000000 - Public Utilities and Public Sector Related Services

Agency Roads and Maritime Services

Particulars of the goods or services to be provided under this contract

PP South - Kirrawee Pedestrian Bridge

Original Contract Duration 7-Feb-2019 to 14-Nov-2019

Amended Contract Duration 7-Feb-2019 to 17-Mar-2020

Contract Award Notice Details

Contractor Name Christie Civil Pty Ltd

ACN 096455346

ABN 74 096 455 346

Is an Aboriginal or Torres Strait Islander owned business No

Street Address Unit 4 7-29 Bridge Road

Town/City STANMORE

State/Territory NSW

Postcode 2048

Country AUSTRALIA

Other private sector entities involved in, with an interest in or benefiting from this contract

Nil.

Estimated amount payable to the contractor (including GST)

$5,535,183.54 (A project to be undertaken)

Amended estimated amount payable to the contractor (including GST)

$5,987,402.81 (A project to be undertaken)

Any provisions for payment to the contractor for operational or maintenance services

Nil.

Method of Tendering

Multi-Stage

Description of any provision under which the amount payable to the contractor may be varied

The contract includes Variation and Extension of Time clauses under which the amount payable can be varied.

Description of any provisions under which the contract may be renegotiated

Nil.

Summary of the criteria against which the various tenders were assessed

Evaluation Criteria	Weighting
Value for money assessment against evaluation criteria included in the Request for Tender.	

Contract Contains Agency 'PiggyBack' Clause

No

Industrial Relations Details for this Contract

Name of Sub-contractors (incl. ABN & ACN)

-

Applicable Industrial Instruments

-

Location of Work

-

NSW Industrial Relations inspectors routinely audit the employment records of contractors and sub-contractors to all NSW Government contracts. The results of these inspections are published on the NSW Industrial Relations website.

Agency Contact information@transport.nsw.gov.au
State/Territory NSW
Country AUSTRALIA
Email Address information@transport.nsw.gov.au

Back to top

Tenders and schemes

Information

Government agency

Select departmer

Go

Select agenc

Go

2-24 Rawson Place Sydney NSW 2000
nswbuy@finance.nsw.gov.au
1800 679 289
(International +61 2 8229 2322)

ATTACHMENT 3

FINAL DRAFT REPORT

Biodiversity Development Assessment Report

Holland Reserve

Prepared for
The Hills Shire Council

3rd October 2019

Prepared by
UBM Ecological Consultants Pty Ltd

UBM Ecological Consultants P/L
'St Clements'
1238 Bells Line of Road
Kurrajong Heights
Tel/Fax:(02) 4567 7979
ubmc@urbanbushland.com.au
www.urbanbushland.com.au

EXECUTIVE SUMMARY

Background

UBM Ecological Consultants (UBM) has been commissioned by The Hills Shire Council (THSC) to assess the impacts of a proposed Part 5 activity under the *Environmental Planning and Assessment Act 1979* (*EP&A Act*) at Holland Reserve, Glenhaven. Under the NSW *Biodiversity Conservation Act 2016* (*BC Act*), a Part 5 activity that is likely to significantly affect the environment is to be accompanied by either a Species Impact Statement or a Biodiversity Development Assessment Report (BDAR).

The Hills Shire Council's environmental unit has advised that the proposed activity is likely to significantly affect the environment. In this case, Council has opted to commission a BDAR, to be prepared in accordance with the Biodiversity Assessment Method (BAM) established under the *BC Act* Biodiversity Offsets Scheme (BOS).

The Draft Reports have addressed Stage 1 of the BAM by assessing the biodiversity values of the Subject Land (landscape context, native vegetation integrity and habitat suitability for threatened species). In addition, this Final Draft Report addresses Stage 2 (commencing *Section 5*) by providing an impact summary, recommendations for minimising biodiversity impacts and a biodiversity credit report based on the data collected during Stage 1, Oct-Dec 2018 and June-Aug 2019 targeted surveys and the information provided by THSC to date.

As this BDAR is being submitted in final draft form based on a draft layout and limited information provided by THSC, Stage 2 will require significant revision prior to finalising the BDAR at a later date. This final draft BDAR provides a comprehensive assessment of the direct and indirect impacts on biodiversity and threatened entities confirmed present by targeted surveys (incorporating measures taken by THSC to avoid and minimise impacts) and includes a final calculation of the offset requirements (in terms of biodiversity credits) for any residual impacts.

Holland Reserve is a large (~37.5 ha) recreational reserve with frontages to both Holland Road and Bannerman Road. The Reserve has a large playing field with a synthetic cricket pitch located in the centre. Entry and car parking facilities for the playing field are located on Holland Road, which also has picnic facilities, a pavilion and public amenities.

The proposed development is a site-based development located within Holland Reserve (Lot 170 DP 752020). The proposed construction footprint (*i.e.* Development Site) encompasses four (4) playing fields, an extended car park and amenities block. A 15-metre buffer around the Development Site has been allowed for construction purposes and related disturbances. The Development Site together with the buffer is referred to as the Subject Land (*Figure 1-1*).

THSC has advised that the existing sports field off Holland Road will be used for temporary construction purposes and related infrastructure requirements and will include ingress and egress access routes and stockpiles sites. The construction footprint will contribute an additional ~3.64 ha to the ~1.38 ha that is already impacted by the existing playing field, amenities block, pavilion and picnic area off Holland Road (*Figure 2-6*).

The Subject Land is 5.02 hectares (ha) in size and includes public amenities as described above. There are substantial areas of native bushland surrounding the Reserve (*Figure 2-3*). At the time of writing (October 2019) the proposed layout provided by THSC is still in draft form; the final construction footprint is expected to vary from that currently available, which may affect the outcomes of the BDAR.

Results

Vegetation:

A total of six (6) plots were surveyed and assessed in the context of previous broad-scale mapping (THSC 2008; Tozer *et al.* 2010). Two (2) Plant Community Types (PCT's) were identified within the Subject Land , neither of which are associated with any threatened ecological communities:

- PCT 1080 *Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys*, *southern Sydney Basin Bioregion*, which was selected for being the closest matching PCT to the planted areas; and
- PCT 1083 *Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*, which occurs in varying conditions within the Subject Land .

Fauna Habitats:

The vegetated riparian corridors of the watercourses in the Locality are connectivity features that may facilitate the movement of threatened (and other) species across their range (*Figure 2-3*). The riparian corridor of Dooral Dooral Creek is mapped as Terrestrial Biodiversity under *Hills Local Environmental Plan 2012*. The Subject Land is located within a Priority 5 Investment Area under the *Biodiversity Conservation Investment Strategy 2018* (OEH 2018).

The Subject Land was found to contain hollow bearing trees, stags, coarse woody debris, rocky outcrop and crevices (in both naturally occurring rocks and man-made structures), an ephemeral drainage line and a variety of foraging resources including fruits, flowers, seeds, pollen, nectar, seeds, invertebrates and vegetation, which in turn support the presence of vertebrate prey.

Ecosystem Credit Species:

Ecosystem credit species are threatened species for which the likelihood of occurrence or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection. Ecosystem credit species are also referred to as 'predicted threatened species' in the BAM calculator (OEH 2018b). Targeted survey is not required for these species. *Table 4-3* lists the species predicted by the calculator based on the landscape features and vegetation integrity assessment.

One (1) additional ecosystem credit species was added to the predicted species list following desktop review; the Dusky Woodswallow (*Artamus cyanopterus*). A total of 34 ecosystem credit species are identified for the Subject Land , five (5) of which (the Powerful Owl [*Ninox strenua*], Grey-headed Flying-fox [*Pteropus poliocephalus*] foraging, Yellow-bellied Sheathtail-bat [*Saccolaimus flaviventris*], Eastern Bentwing-bat [*Miniopterus schreibersii oceanensis*] foraging and Little Bentwing-bat [*Miniopterus australis*] foraging) were detected during targeted surveys for species credit species (*Section 4.2*) (note that the microbats were recorded with a probable reliability of identification).

Species Credit Species:

Species credit species are threatened species for which the likelihood of occurrence or elements of suitable habitat for the species cannot be confidently predicted by vegetation surrogates and landscape features but can be reliably detected by survey. Species credit species are also referred to as 'candidate threatened species' in the BAM calculator (OEH 2018b). Targeted survey or an expert report is required to confirm presence/absence of these species on the Subject Land , unless the proponent opts to simply assume presence.

This report has undertaken targeted surveys in Oct-Dec 2018, and Jun-Aug 2019 for 40 species credit species. These targeted surveys observed five (5) Dural Land Snails (*Pommerhelix duralensis*), detected calls of the Red-crowned Toadlet (*Pseudophryne australis*), recorded the Southern Myotis (*Myotis macropus*) and Eastern Cave Bat (*Vespadelus troughtoni*) with a probable reliability of identification, and observed mate searching behaviour by a male Powerful Owl (*Ninox strenua*).

Serious and Irreversible Impacts

No ecological communities were identified as being potential SAII entities. Of the candidate species present within the Subject Land (*Table 4-7*), one (1) has been identified by the BAM Calculator as potential SAII entities (*Table 6-1*). At the time of writing (October Ds2019) the Eastern Cave Bat has been detected on site and breeding individuals are assumed present (see *Table 6-1*). The SAII threshold for the Eastern Cave Bat is potential breeding habitat and presence of breeding individuals (TBDC 2018).

The effect of SAII for Part 5 activities is described by OEH (2018g) as follows: "The approval authority can approve a proposal which is likely to have serious and irreversible impacts. The approval authority must take those impacts into consideration and determine whether there are any additional and appropriate measures that will minimise those impacts if approval is to be granted."

Matters of National Environmental Significance:

Commonwealth Significant Impact Assessments were carried out for the two (2) Commonwealth listed species recorded on the Subject Land during the Oct-Dec 2018 surveys: the vulnerable Grey-headed Flying-fox and endangered Dural Land Snail. Given the impact avoidance, minimisation and mitigation measures incorporated by the proposal (see *Table 5-1*) , these assessments concluded that the proposal would NOT have a significant impact on individuals, populations and/or habitat in the Locality of these species and therefore WOULD NOT require referral to the Australian Government Department of the Environment for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the *EPBC Act.*

Assumptions, Predictions and Limitations

At the time of preparation of this Final Draft BDAR (October 2019) the development layout plans were still in draft form, which presents significant limitations to undertaking accurate impact assessments.

A discussion was held with THSC following submission of theV3 Draft BDAR, in relation to including additional efforts on the part of THSC to minimise the impacts on biodiversity values. Subsequently, the impact assessments in *Table 5-1* have been revised to incorporate these additional efforts. For

the purposes of the Final BDAR, and in accordance with the BAM, UBM must make the following assumptions until additional information is provided:

- All impacts that have not yet been addressed by THSC will occur to some degree (*Table 5-1*);
- The Subject Land (including the 15-metre buffer) will be entirely cleared for the purpose of construction and the future vegetation integrity scores were left at zero (0) in the BAM calculator for the entire Subject Land; and
- A revegetation plan utilising a locally native planting program following construction has been proposed.

Biodiversity Credit Report

The credit price required to offset the remaining adverse impacts on biodiversity values estimated by the BAM calculator for this draft BDAR is **$469,587.94** (*Table 8-1,* OEH 2018b).

Note: The BAM calculator provides a predicted market price for biodiversity credits. Its primary purpose is to estimate a pricing curve based on observed biodiversity trades of 'like for like' credits under both the Biodiversity Offset Scheme (BOS) and from BioBanking agreements. It also includes a margin that accounts for the statistical probability that the market credit price paid by the BCT to landholders is higher or lower than predicted and fund administration costs for operating and administering the Biodiversity Conservation Trust. The value presented here is not necessarily the price of offsets that will be required once the BDAR is finalised.

Recommendations

UBM recommends THSC adopt the following measures to avoid and minimise impacts on biodiversity values (*Section 5.2*; *Table 5-1*), including prescribed biodiversity impacts, and mitigate and manage unavoidable impacts (*Section 5.4*):

- For all development works, adherence to the *Guidelines for the Protection of Bushland during Construction*;
- Build retaining walls or terraces or find another engineering solution instead of leaving a bare slope around the fields to minimise ongoing soil disturbance and erosion points;
- Maintain a high standard of hygiene that requires the cleaning of vehicles and other plant equipment. This will ensure the site is free of dirt and debris imported from other sites and will help to minimise the potential spread of weeds as well as bacterial and fungal disease (such as *Phytophthora cinnamomi* and *Chytridiomycosis*);
- Check for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation;

Any revegetation and habitat supplementation work to be implemented post construction will increase future vegetation integrity scores and may reduce the offset cost. However, these works will have to be planned, and accurate areas proposed for revegetation must be provided prior to finalising the BDAR. Currently THSC has proposed that a locally native planting program will be implemented post construction.

UBM advises a post construction adaptive management strategy that consists of follow-up site inspections that target indirect impacts that may be continuing to occur post construction. These include but are not limited to:

- Checking for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation; and
- Monitor success of plantings and infill with new tubestock grown from seed sourced prior to clearing as required.

Plates – Front Cover:

Plate 1 – Rocky outcrop in PCT 1083_Good (Recently burned).
Plate 2 – Scribbly gum in PCT 1083_Good (*Allocasuarina littoralis* dominant)
Plate 3 – Vulnerable (*BC Act*) Powerful Owl (*Ninox strenua*)

Table of Contents

List of Figures

List of Tables

List of Appendices

Certification

I, Judith Rawling Managing Director of UBM Ecological Consultants Pty Ltd, hereby state that this Biodiversity Development Assessment Report for the proposed activity at Holland Reserve, Glenhaven has been prepared in accordance with the Biodiversity Assessment Method established under the NSW *Biodiversity Conservation Act 2016*. Matters of National Environmental Significance have been considered in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The UBM Ecological Consultants project team charged with preparing this Report were:

- Judith Rawling (BA, DipEd, DipEnvStud, MEnvSt Certified Practicing Ecological Consultant
- Yogesh Nair (MSc, BEnvSc, AdvDipAppEnvMngt, Cert 3 Conservation and Land Management); BAM Accredited Assessor (#BAAS18144)
- Jai Green-Barber (B NatSc (AnSc), BSc (Hons), PhD)
- Harriet Gabites (B NatSc [AnSc])
- Jacqueline Britton (BEnvSc)

The UBM Ecological Consultants project team that were involved with the preparation of previous drafts were:

- Kiarrah Smith (B. Zool, BSc Conservation & Wildlife Biology [Hons]; BAM Accredited Assessor (#BAAS18039)
- Jessie Bear (BNatSc[Adv])

OEH Scientific Licence: *SL100315.*

Animal Research Authority: *TRIM 16/1357.*

Revision Control

VERSION	DATE	AUTHORS	DESCRIPTION OF CHANGE
Draft V1	26/09/18	Drafted by Kiarrah Smith. Finalised by Jessie Bear & Yogesh Nair. Checked by Judith Rawling.	N/A.
Draft V2	25/10/18	Kiarrah Smith, Jessie Bear and Yogesh Nair. Checked by Judith Rawling.	Stage 2 updated to include targeted surveys.
Draft V3	18/12/18	Kiarrah Smith, Jessie Bear and Yogesh Nair.	Updated to include Nov-Dec 2018 targeted surveys and Commonwealth assessments.
Final	28/09/19	Yogesh Nair and Jai Green-Barber. Checked by Judith Rawling.	Updated to include August/September field surveys and Assessments Calculation of offsets

VERSION	DATE	ACCREDITED BAM ASSESSOR	SIGNATURE
Final Draft Report	28/09/2019	This BDAR has been supervised and signed off by Accredited BAM Assessor Yogesh Nair. #BAAS18144	

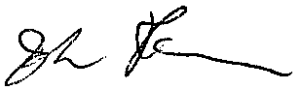
Conflicts of Interest

The Accredited Assessors have signed in agreement to abide by the Accredited BAM Assessor Code of Conduct. The authors declare in accordance with the Assessors Code of Conduct that no actual, perceived, or potential conflicts of interest exist

Disclaimer

The preparation of this Report has been in accordance with the brief provided by the Client and has relied upon the data and results collected at or under the times and conditions specified in the Report. All findings, conclusions or recommendations contained within the Report are based only on the aforementioned circumstances.

The Report has been prepared for use by the Client and no responsibility for its use by other parties is accepted by UBM Ecological Consultants Pty Ltd.



Judith Rawling BA, DipEd, DipEnvStud ,MEnvStud, CPEC
Managing Director UBM Ecological Consultants P/L
Member AIB, MESA, MEIANZ, Former Member Executive Council ECA (NSW)

Definition of Terms

Abundance Rating – For species with cover less than or equal to 5%, a count or estimate the number of individuals or shoots of each species within a plot, using the following intervals: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000,1500,2000, etc. Numbers above 20 are estimates only, and the recorded abundance is the upper end of each class (*e.g*. 50 represents an estimated abundance of between 20 and 50). For species with cover greater than 5%, abundance estimates are not required.

APZ – Asset Protection Zone, as prescribed by Planning for Bushfire Protection (Rural Fire Service 2006).

BAM – Biodiversity Assessment Method.

BC Act – *Biodiversity Conservation Act 2016.*

BDAR – Biodiversity Development Assessment Report.

Benchmarks – the quantitative measures that represent the 'best-attainable' condition, which acknowledges that native vegetation within the contemporary landscape has been subject to both natural and human-induced disturbance. Benchmarks are defined for specified variables for each PCT.

BOS – Biodiversity Offsets Scheme.

Buffer Zone – Land within a 1.5-kilometre buffer surrounding the outside edge of the Subject Land .

CEEC – an ecological community specified as critically endangered in Schedule 2 of the BC Act and/or listed as such under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

Connectivity – the measure of the degree to which an area(s) of native vegetation are linked with other areas of native vegetation.

Cover – the percentage of a plot area that would be covered by a vertical projection of the foliage, branches and trunk (*i.e.* all living parts) for each species rooted in or overhanging the plot. Cover is recorded in decimals if less than 1% (0.1, 0.2…), or whole numbers up to 5% (1,2,3…), or to the nearest 5% where greater than 5% cover (5,10,15,20,25…).

Derived Vegetation – PCTs that have changed to an alternative stable state as a consequence of land management practices undertaken since European settlement. Derived communities can have one or more structural components of the vegetation entirely removed or severely reduced (*e.g.* over-storey of grassy woodland), or which have developed new structural components where they were previously absent (*e.g.* shrubby mid-storey in an open woodland system).

Development Footprint – the area of land that is directly impacted on by a proposed development or activity, including access roads, and areas used to store construction materials.

Development Site – an area of land that is subject to a proposed development or activity that is under the environmental legislation.

DLS – Dural Land Snail.

EAH – Environmental Agency Head

EEC – an ecological community specified as endangered in Schedule 2 of the *BC Act*, or listed as such under the *EPBC Act*.

EP&A Act – NSW *Environmental Planning and Assessment Act 1979.*

EPBC Act – Commonwealth *Environment Protection & Biodiversity Conservation Act 1999.*

GHFF – Grey-headed Flying-fox.

Ground Cover – vegetation generally below one (1) metre in height.

Growth Form – the form that is characteristic of a particular flora species at maturity, as identified in Appendix 4 of the BAM Order and the growth form look-up table provided by OEH, available at: https://www.lmbc.nsw.gov.au/bamcalc

ha – hectares

Habitat – an area or areas occupied, or periodically or occasionally occupied, by a species or ecological community, including any biotic or abiotic component.

Intact vegetation – vegetation where all tree, shrub, grass and/or forb structural growth form groups expected for a plant community type are present.

LEP – Local Environmental Plan, here *Hills LEP 2012*

LGA – Local Government Area, here The Hills Shire Council.

Locality – an area within 1.5 kilometres of the Subject Land .

Mid-storey – all vegetation between the over-storey stratum and a height of one (1) metre (typically tall shrubs, under-storey trees and tree regeneration).

Mitchell Landscape - landscapes with relatively homogeneous geomorphology, soils and broad vegetation types, mapped at a scale of 1:250,000

Native vegetation – All plants known to have been established in NSW before European settlement.

OEH – NSW Office of Environment & Heritage.

Offsets – Management actions that are undertaken to achieve a gain in biodiversity values on areas of land to compensate for losses to biodiversity values from the impacts of development.

Over-storey – the tallest woody stratum present (including emergent) above one (1) metre. In a woodland community, the over-storey stratum is the tree layer, and in a shrubland community the over-storey stratum is the tallest shrub layer. Some vegetation types (*e.g*. grasslands) may not have an over-storey stratum.

PCT – a NSW plant community type identified using the PCT classification system described in the BioNet Vegetation Classification.

Reserve – Holland Reserve (also referred to as the 'Subject Property').

Subject Land – is land to which the BAM is applied in Stage 1 of the BDAR to assess the biodiversity values of the land. It includes land that may be a development site, clearing site, proposed for biodiversity certification, or land that is proposed for a biodiversity stewardship agreement.

Subject Property – Holland Reserve (also referred to as the 'Reserve').

Target Weeds –Weeds of National Significance (WoNS, National); weeds listed under the Biosecurity Legislation (State); Priority weeds in the Greater Sydney Local Control Area (Regional), and key environmental weeds that have potential to degrade the ecosystem, presenting a risk to biosecurity.

TEC – threatened ecological community, meaning a CEEC, EEC or vulnerable ecological community listed in Schedule 2 of the *BC Act*.

Threatened species – Critically endangered, endangered or vulnerable species as defined by Schedule 1 of the *BC Act*, or any such listed species under the *EPBC Act.*

UBM – UBM Ecological Consultants Pty Ltd: formerly trading as Urban Bushland Management Consultants (UBMC).

1 INTRODUCTION

1.1 Biodiversity Offsets Scheme & Report Purpose

UBM Ecological Consultants (UBM) has been commissioned by The Hills Shire Council (THSC) to assess the impacts of a proposed Part 5 activity under the *Environmental Planning and Assessment Act 1979* (*EP&A Act*) at Holland Reserve, Glenhaven. Under the NSW *Biodiversity Conservation Act 2016* (*BC Act*), a Part 5 activity that is likely to significantly affect the environment is to be accompanied by either a Species Impact Statement or a Biodiversity Development Assessment Report (BDAR).

The Hills Shire Council's environmental unit has advised that the proposed activity is likely to significantly affect the environment. In this case, the Hills Shire Council has opted to commission a BDAR, to be prepared in accordance with the Biodiversity Assessment Method (BAM) established under the *BC Act* Biodiversity Offsets Scheme (BOS).

The V3 Draft Report addressed Stage 1 of the BAM by assessing the biodiversity values of the Subject Land (landscape context, native vegetation integrity and habitat suitability for threatened species). In addition, this Report addresses Stage 2 (commencing *Section 5*) by providing an impact summary, recommendations for minimising biodiversity impacts and a biodiversity credit report based on the data collected during Stage 1, Oct-Dec 2018 and Jun-Aug 2019 targeted surveys and the information provided by THSC to date.

As this BDAR is being submitted in final draft form based on a draft layout and limited information provided by THSC, Stage 2 will require significant revision prior to finalising the BDAR at a later date. This finalised BDAR provides a comprehensive assessment of the direct and indirect impacts on biodiversity and threatened entities confirmed present by targeted surveys (incorporating measures taken by THSC to avoid and minimise impacts) and includes a final calculation of the offset requirements (in terms of biodiversity credits) for any residual impacts.

Impacts on Matters of National Environmental Significance under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) have been considered separately in *Section 9*, in accordance with the *EPBC Act Significant Impact Guidelines* (DOE 2013).

1.2 Proposed Development Site Footprint

1.2.1 General Site Description

The proposed development is a site-based development located within Holland Reserve (Lot 170 DP 752020). Holland Reserve is a large (~37.5 ha) recreational reserve with frontages to both Holland Road and Bannerman Road. The Dural Pony Club occupies land on the north-western side of the Reserve, with entry off Bannerman Road. This area is fenced and gated and is not open to general Park users. In the south-eastern portion of the Reserve is a large playing field with a synthetic cricket pitch located in the centre. Entry and car parking facilities for the playing field are located on Holland Road, which also has picnic facilities, a pavilion and public amenities.

The playing field and Pony Club have been cleared of most native vegetation. There are however, some remnant trees and areas of native landscaping around the perimeter of these two (2) operational areas, which are separated by substantial areas of native bushland (*Figure 2-6*) characterised by ridgetop heathy woodland, rocky outcrops and steep gullies where Dooral Dooral Creek bisects the Reserve. This bushland is mapped by THSC as having *Biodiversity* significance (*Figure 2-4*). Under *The Hills Local Environmental Plan 2012* Holland Reserve is zoned RE1 Public Recreation.

1.2.2 Construction Footprint

The proposed construction footprint (*i.e.* Development Site) encompasses four (4) playing fields, an extended car park and amenities block. A 15-metre buffer around the Development Site has been allowed for construction purposes and related disturbances. The Development Site together with the buffer is referred to as the Subject Land (*Figure 1-1*).

THSC has stated that the existing sports field off Holland Road will be used for temporary construction purposes and related infrastructure requirements and will include ingress and egress access routes and stockpiles sites. The construction footprint will contribute an additional ~3.64 ha to the ~1.38 ha that is already impacted by the existing playing field, amenities block, pavilion and picnic area off Holland Road (*Figure 2-6*).

The Subject Land is 5.02 hectares (ha) in size and includes public amenities as described above. There are substantial areas of native bushland surrounding the Reserve (*Figure 2-3*). At the time of writing (October 2019) the proposed layout provided by THSC is still in draft form; the final construction footprint is expected to vary from that currently available, which may affect the outcomes of the BDAR.

1.2.3 Operational Footprint

Based on the draft layout the operational footprint will for the most part be limited to the Development Site (*Figure 1-1*). Under the provisions of *Planning for Bushfire Protection* (RFS 2006), an Asset Protection Zone (APZ) is likely to be required to provide protection for the new amenities block and other built structures; however, the issue of bushfire safety has not yet been addressed by Council.

Overall, about 5.02 ha is expected to be directly impacted by the Operational Footprint. Additional indirect impacts are expected such as: an increase in anthropogenic noise and light resulting from the use of the playing fields, as well as an increase in visitation and passive recreational use of the adjoining bushland. Potential impacts to adjacent bushland may include fragmentation by new tracks, trampling, picking native plants and removal of bush rock and timbers.

Figure 1-1: Draft Development Layout – Four (4) Playing Fields

Image source: Nearmap (July 2018). **Data Frame Projection:** GDA Zone 56.

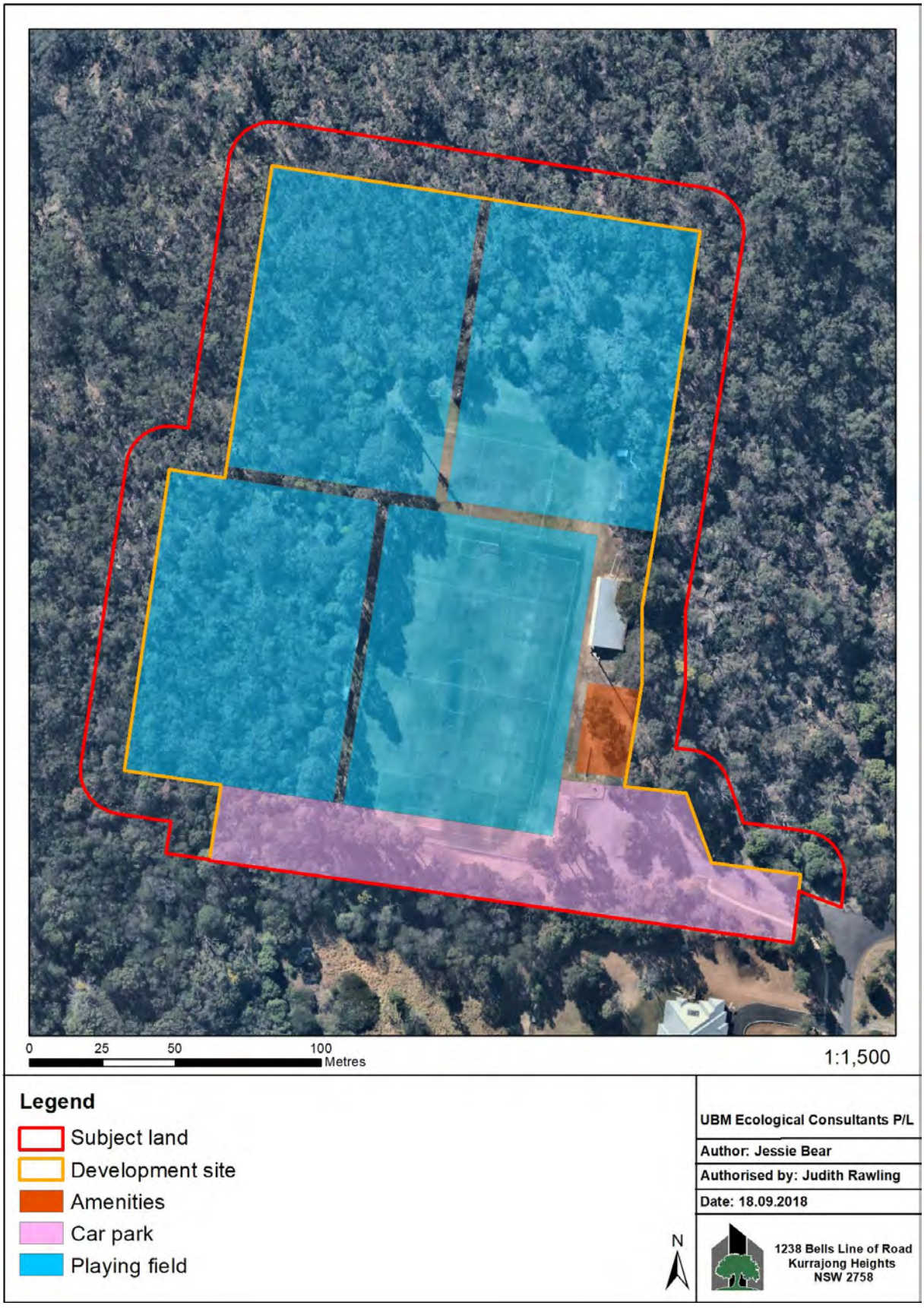
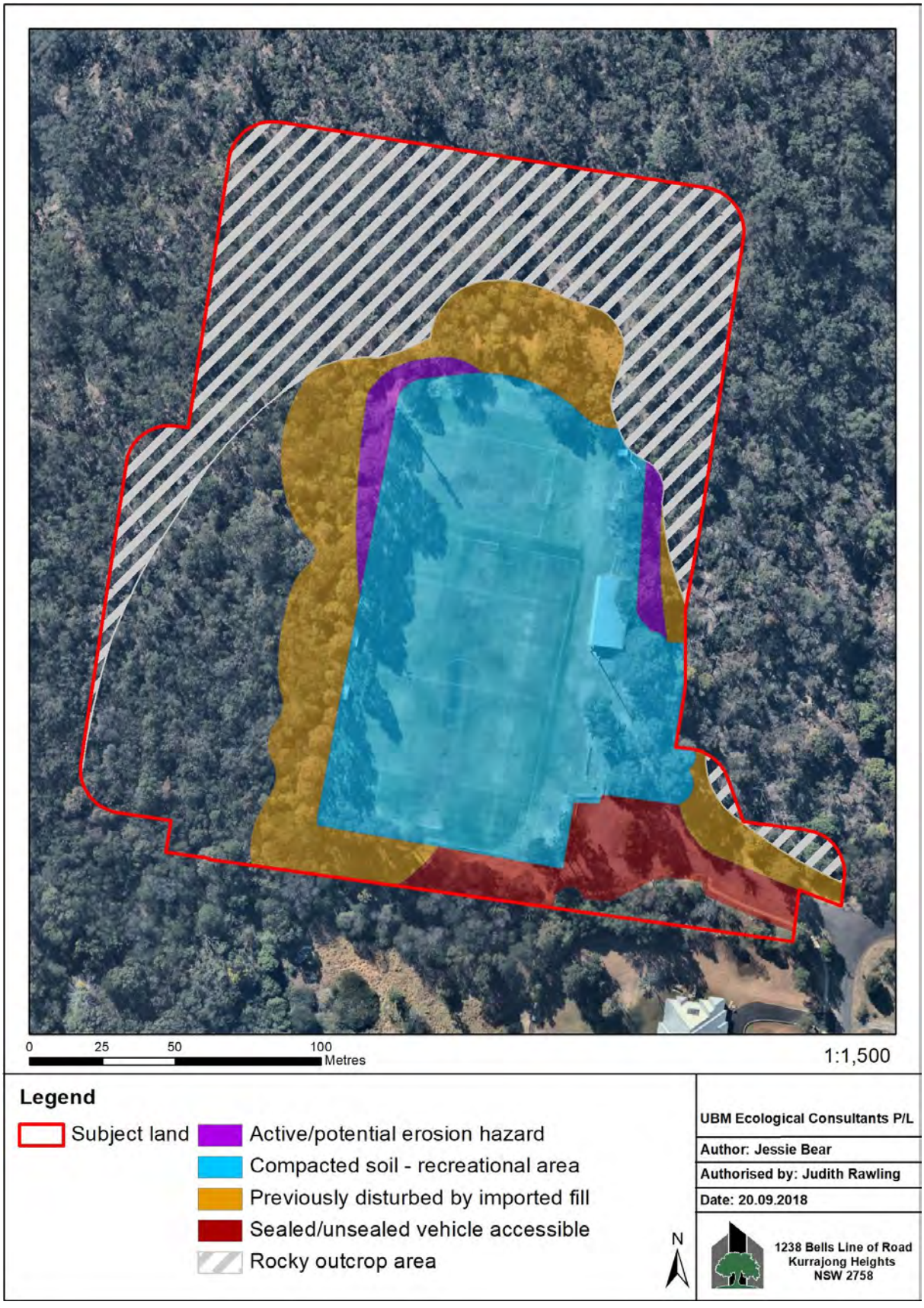


Figure 1-2: Development Site Soil and Geological Observations

Image source: Nearmap (July 2018). **Data Frame Projection:** GDA Zone 56.



1.3 Information Sources for this Report

During the preparation of this Report, relevant databases and other studies were accessed, including previous studies and investigations for the site and Locality. The main sources referenced were:

- NSW BioNet Atlas (NSW Office of Environment & Heritage [OEH] 2018a).
- The Protected Matters Search Tool (DEE 2018).
- BAM Calculator (OEH 2018b).
- BioNet Vegetation Classification (OEH 2018c).
- BioNet Threatened Biodiversity Data Collection (OEH 2019).
- Directory of Important Wetlands in Australia (DEE 2010).
- NSW Scientific Committee Final Determinations (NSW Scientific Committee various dates).
- Commonwealth Final Determinations for threatened species (TSSC Various Dates).
- Office of Environment and Heritage threatened species profiles (OEH various dates).
- PlantNET NSW (Botanic Gardens Trust 2018).
- Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands (Tozer et al. 2010).
- The Hills Shire Council Interactive Vegetation Information System (THSC 2008)
- Flora & Fauna Surveys for Area 1, Native Bushland at Holland Reserve, Glenhaven (UBM 2017a).
- Flora & Fauna Surveys for Area 2, Native Bushland at Holland Reserve, Glenhaven (UBM 2017b).
- Flora & Fauna Surveys for Native Bushland: Area 3 Holland Reserve, Bannerman Road, Kenthurst (UBM 2017c).
- Flora & Fauna Surveys for Native Bushland at Holland Reserve, Bannerman Road, Kenthurst (UBM 2016).

The Bibliography in *Section 11* contains a full list of information sources referred to for this Report. Digital shapefiles for all maps and spatial data have been submitted with this report.

STAGE 1 – BIODIVERSITY ASSESSMENT

2 LANDSCAPE CONTEXT

This section details the landscape features occurring on the Subject Land or within the assessment area (*i.e.* a 1.5 km buffer) surrounding the Subject Land.

Table 2-1: Landscape Features

SUBJECT LAND AREA	5.02 ha *Figure 1-1.*
IBRA BIOREGION & SUBREGION	The Subject Land at Holland Reserve is in the Sydney Basin IBRA (Interim Biogeographic Regionalisation for Australia) Bioregion and within the Yengo IBRA subregion (Figure 2-1; *Figure 2-3*). The Cumberland IBRA subregion is mapped over the north-eastern part of the Reserve, however the IBRA mapping is relatively coarse and all of Holland Reserve is more typical of the landscape found in the Yengo subregion. The Cumberland subregion occurs within the 1.5 kilometre landscape buffer.
LGA & LLS REGION	The Subject Land is located within The Hills Local Government Area (Hills LGA) and within the Greater Sydney Local Land Services jurisdiction.
NSW (MITCHELL) LANDSCAPE	Blaxlands Ridge (total area ~55,406.62 ha, 20% cleared). Description (Department of Environment and Climate Change NSW [DECC] 2002): "Undulating dissected ridges with dendritic drainage network on horizontal Triassic quartz sandstone and shale, a few linear cappings of shale comparable to the Bilpin Ridges landscape, general elevation 190 to 250 metres, local relief 50 metres. Moderate amounts of rock outcrop, thin sand accumulations in joint crevices, red and yellow texture-contrast soils on wider benches underlain by shale. Woodland and forest of grey ironbark (*Eucalyptus paniculata*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Mountain Grey Gum (*Eucalyptus cypellocarpa*) and Sydney Turpentine (*Syncarpia glomulifera*), with diverse shrubs and an understorey of native grasses, including Kangaroo Grass (*Themeda triandra*)."
WATERCOURSES	Dooral Dooral Creek is a fourth order stream at the point where it intersects the Reserve and thereafter flows in a westerly direction to join into Cattai Creek. Multiple unnamed tributaries adjoin Dooral Dooral Creek within the 1.5-kilometre landscape buffer (*Figure 2-3*). The Subject Land contains one (1) first order stream.
WETLANDS	There are no SEPP 14 (Coastal Wetlands) or Ramsar Wetlands within, adjacent to, or downstream of the Subject Land (NSW Department of Planning and Environment [DPE] 2008; Department of the Environment and Energy [DEE] 2015). The closest Nationally Important Wetlands are Longneck Lagoon and Pitt Town Lagoon, ~15.2 km and ~16.5 km downstream (north-west) of the Subject Land respectively (DEE 2015). All other local waterbodies are man-made farm dams (*Figure 2-3*; Crossman & Li 2012), none of which occur in the Subject Land .

CONNECTIVITY FEATURES	The vegetated riparian corridors of the watercourses in the Locality are connectivity features that may facilitate the movement of threatened species across their range (*Figure 2-6*). The riparian corridor of Dooral Dooral Creek is mapped as *Terrestrial Biodiversity* under *Hills Local Environmental Plan 2012*. The Subject Land is located within a Priority 5 Investment Area under the *Biodiversity Conservation Investment Strategy 2018* (OEH 2018).
OUTSTANDING BIODIVERSITY VALUE	No (0) Areas of Outstanding Biodiversity Value declared by the *Biodiversity Conservation Act (BC Act)* occur within the Subject Land or Locality.
GEOLOGICAL SIGNIFICANCE & SOIL HAZARD FEATURES	There are no known caves within the assessment area or Subject Land, but the Subject Land contains extensive outcrops and rock crevices (mapped and described in *Section 4.4*), which are expected to extend along both sides of the riparian corridor of Dooral Dooral Creek and Cattai Creek (to a lesser extent) within and beyond the 1.5 km landscape buffer. The Subject Land lies predominately on Glenorie (gn) Soil Landscape Unit (SLU), with small areas of Hawkesbury (ha) SLU (*Figure 2-5*). Limitations are described as follows: Glenorie – High erosion hazard, localised impermeable and highly plastic subsoil (Chapman & Murphy 1989). Hawkesbury – extreme soil erosion hazard, rock falls, rock outcrops, shallow, stony and highly permeable soils with low soil fertility (Chapman & Murphy 1989). Parts of the Subject Land has been subject to soil disturbance associated with the construction of the existing sports field, roadways and other public amenities (*Figure 1-2*). There is no risk of acid sulfate soils mapped or Geological sites within the Subject Land or Holland Reserve itself (Hills LEP 2012; Cartoscope n.d.). The Subject Land occurs in both the Glenhaven and Hawkesbury Hydrogeological Landscapes (HL) (*Figure 2-3*). The overall salinity hazard in Hawkesbury HL is very low, and in Glenhaven the overall hazard is low (DECCW 2011).
NATIVE VEGETATION COVER	Percent cover of native woody and non-woody vegetation has been estimated for the 1.5 km buffer and within the Subject Land. The percent cover of native vegetation in woody vegetation types is based on native over-storey vegetation, while native ground cover is used to assess cover in non-woody vegetation types (*Figure 2-6*). Total assessment area (Subject Land plus site-based 1.5 km buffer) is 851 ha. Native vegetation cover within the total assessment area (as defined above): 414 ha (~49%, cover class 30–70%). This estimation is based on the most recent available imagery (Nearmaps 2018), existing maps of native vegetation and/or direct observations during site investigations. Native vegetation on the Subject Land is detailed in *Section 3.*

Figure 2-1: Site Map (Planning Features)

Image source: Nearmap (July 2018). **Data Frame Projection:** GDA Zone 56.

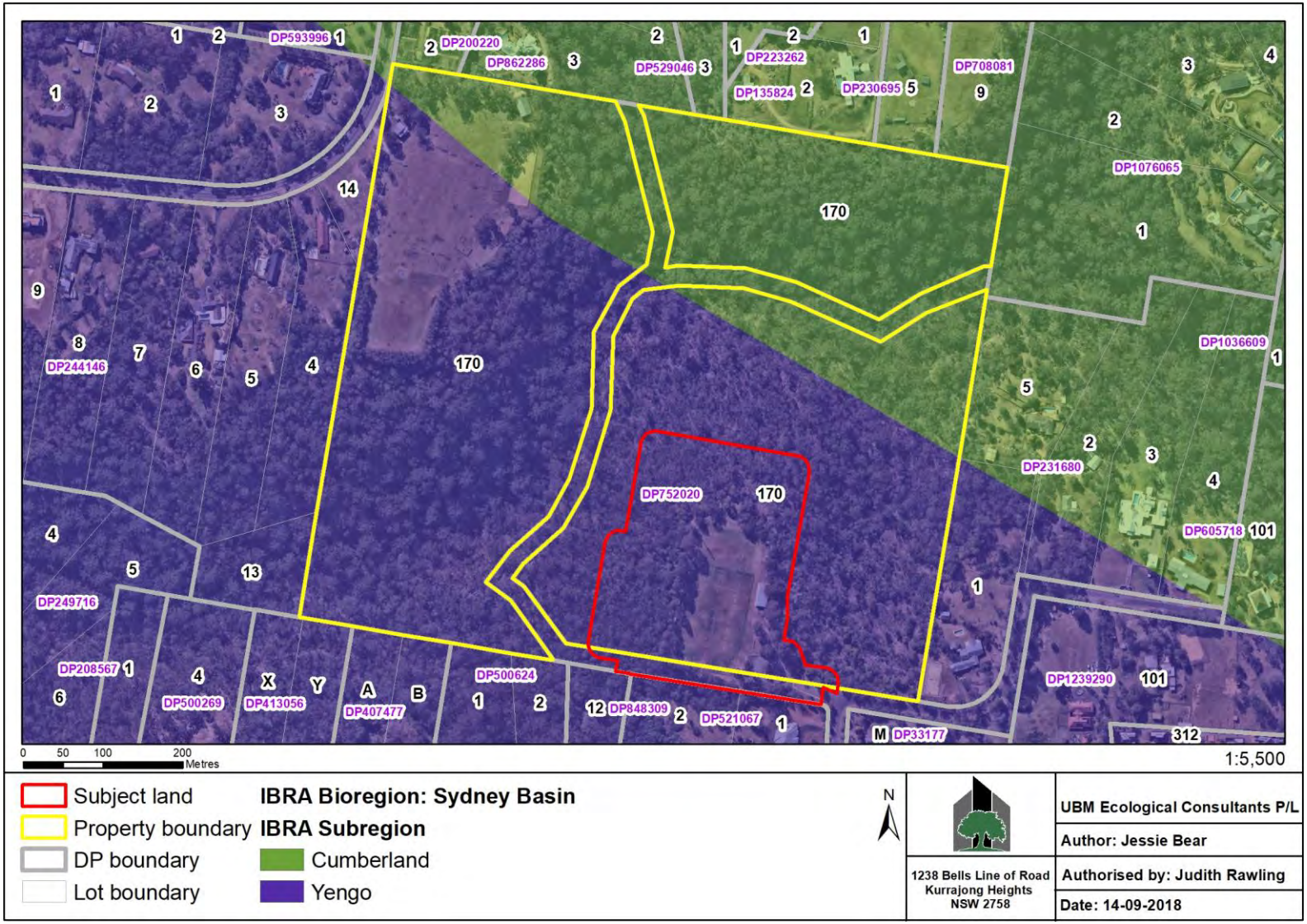


Figure 2-2: Site Map (Physical Features)

Image source: Nearmap (July 2018). **Data Frame Projection:** GDA Zone 56.

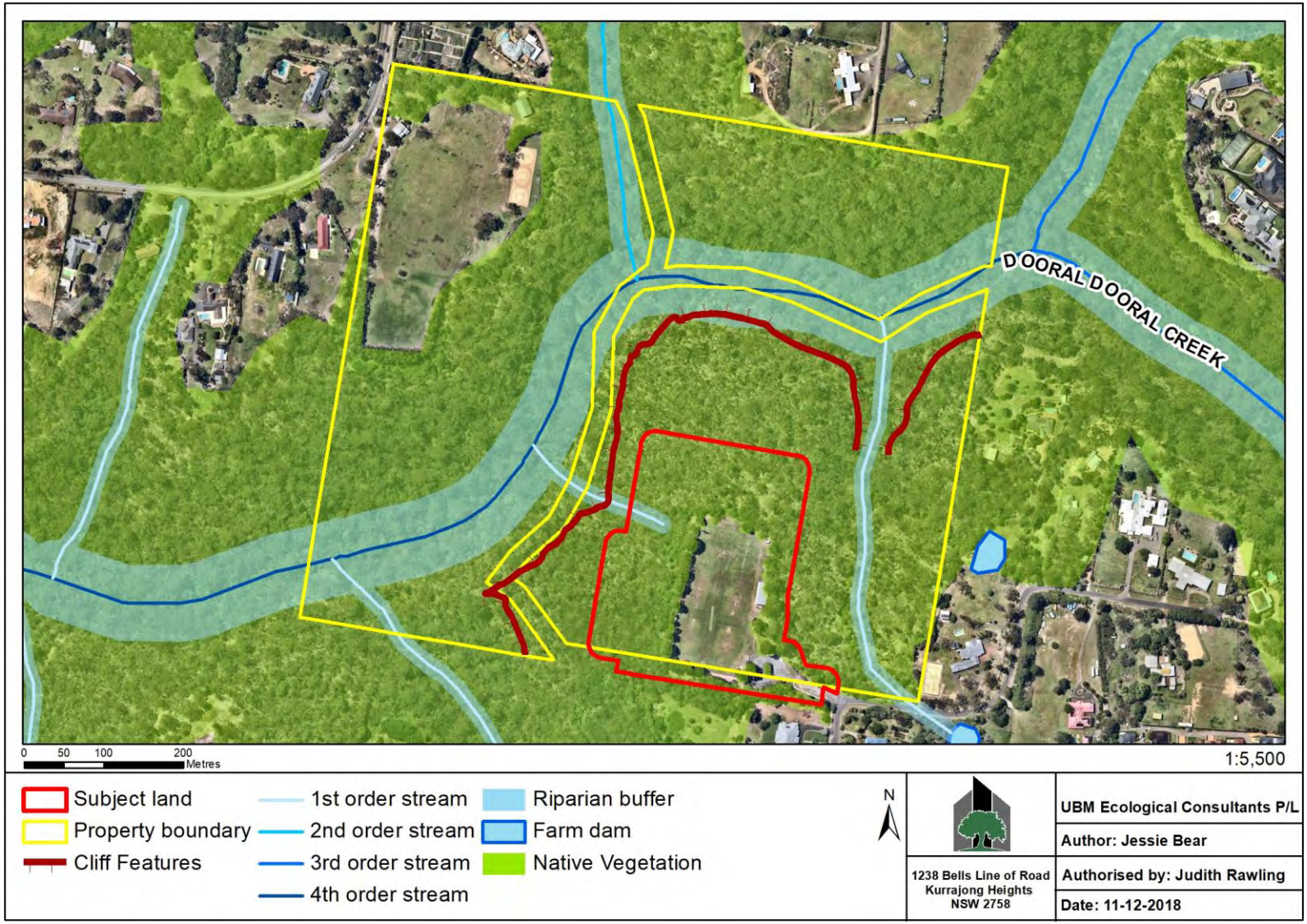


Figure 2-3: Location Map

Image source: Nearmap (July 2018). **Data Frame Projection:** GDA Zone 56.

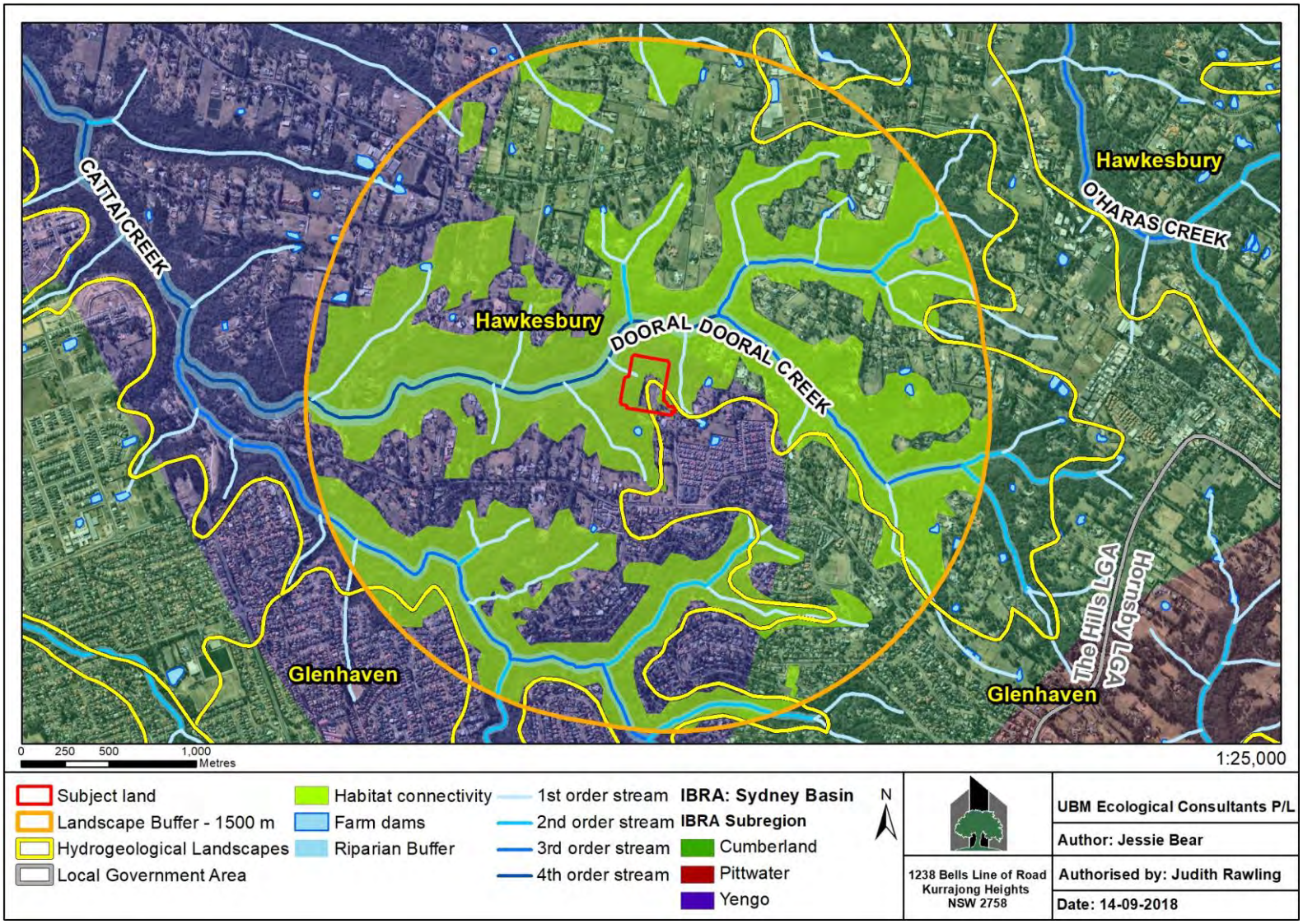


Figure 2-4: Terrestrial Biodiversity (The Hills Shire Council 2012)

Figure 2-5: Soil Landscape Units

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56.

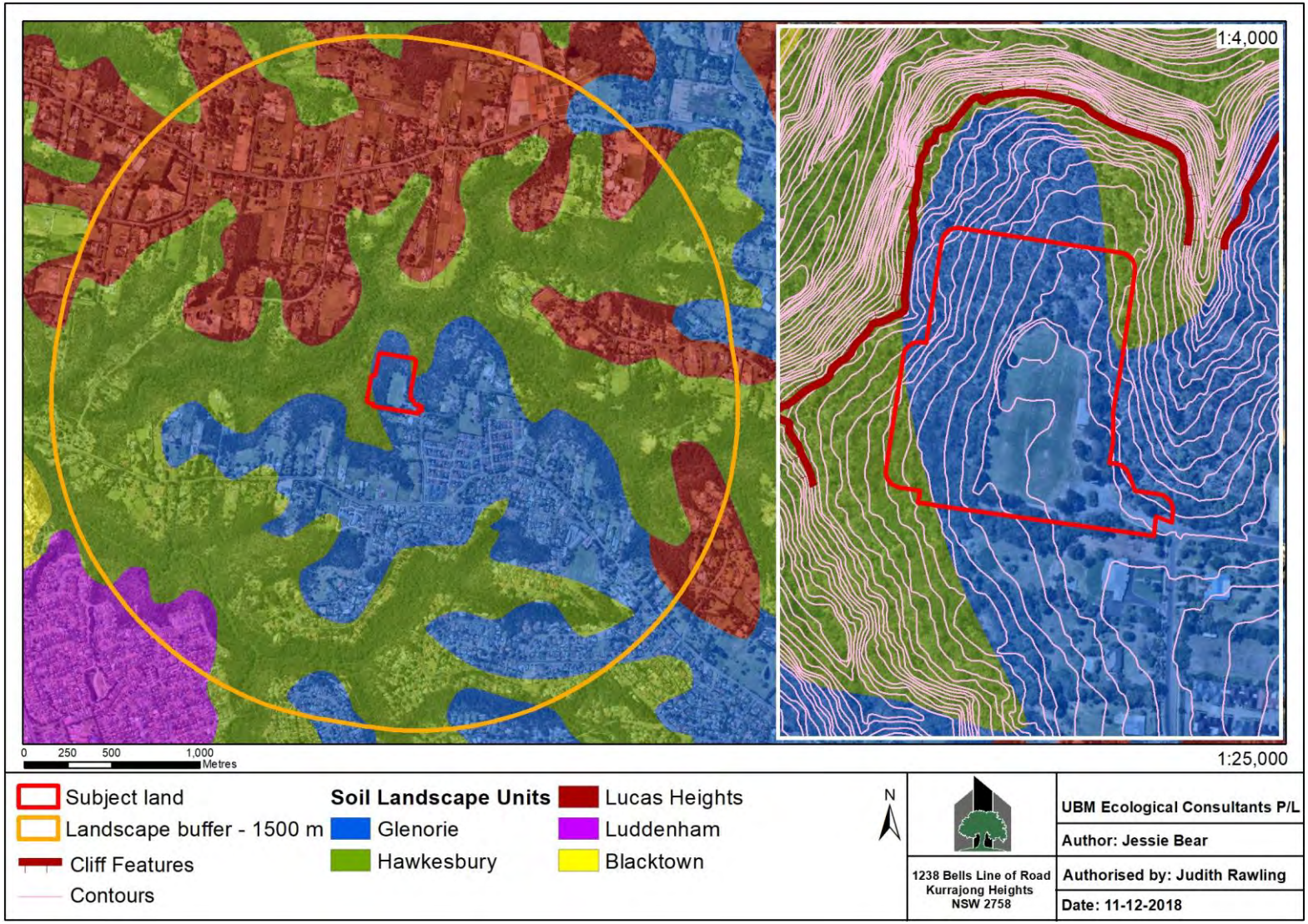
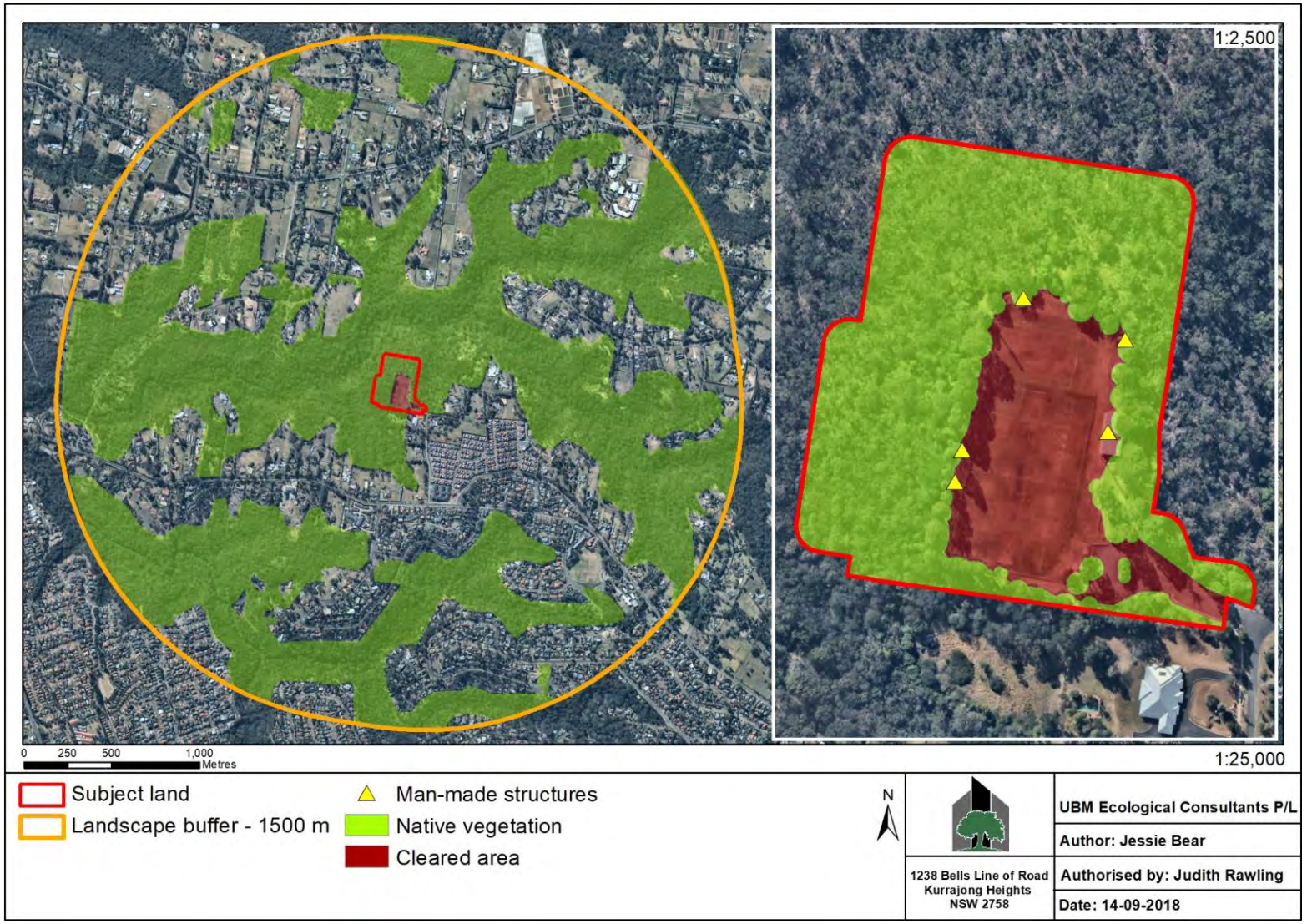


Figure 2-6: Native Vegetation Extent

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56.



3 NATIVE VEGETATION ON THE SUBJECT LAND

3.1 Native Vegetation Cover

The Subject Land contains ~3.64 ha of native vegetation and 1.38 ha of cleared/disturbed land (*Figure 2-6*). The native vegetation cover mapped in *Figure 2-6* was ground-truthed during site investigations by botanist Yogesh Nair on the 3rd, 10th and 17th of September, 2018. The native vegetation extent on the Subject Land includes all areas of native vegetation, including native ground covers and the canopy area of trees. There is no visible difference between the aerial imagery and the mapped native vegetation extent. Native vegetation cover was estimated to be 49% of the 853 ha (1500m buffer) *Figure 2-6*.

Note that some areas mapped as native vegetation contain varying densities of exotic flora, particularly *Lantana camara*, in addition to planted native species and naturally occurring native species. The purpose of mapping native vegetation extent for the Subject Land is to identify the area subject to further assessment. Areas not included in the native vegetation extent (*Figure 2-6*) do not require further assessment under the BAM except where they are proposed for restoration as part of an offset agreement, or they are assessed as habitat for a threatened species. The cleared area is dominated by exotic turf that is regularly mown and maintained as a playing field. The cleared area is not assessed further in this Report. Man-made structures identified in *Figure 1-2* are assessed for habitat suitability in *Section 4.1.3*.

3.2 Vegetation Integrity Assessment

3.2.1 Existing Surveys & Mapping

The Subject Land is mapped as occurring predominately on Glenorie (gn) Soil Landscape Unit (SLU) with small areas of Hawkesbury (ha) SLU in steeper sections (*Figure 2-5*) (Chapman & Murphy 1989). Soil landscape mapping is a broad, regional scale dataset that should be used as a guide.

The vegetation associated with Glenorie SLU is typically wet sclerophyll forest, while dry sclerophyll forest is typically associated with Hawkesbury SLU. The vegetation and presence of significant rocky outcrop in the Subject Land indicates that the underlying SLU is more typical of Hawkesbury rather than Glenorie.

Regional vegetation mapping by Tozer *et al*. (2010) for the former Department of Environment Climate Change & Water (DECCW), has mapped the native vegetation within the Subject Land as *Sydney Turpentine Ironbark Forest* (*STIF*) and *Sydney Hinterland Transition Woodland* (*SHTW*), with patches of vegetation around the south-east corner left unclassified (*Figure 3-1*). These vegetation communities include species such as Turpentine (*Syncarpia glomulifera*), Blackbutt (*Eucalyptus pilularis*), and White Stringybark (*Eucalyptus globoidea*); all species that are commonly found in the Glenorie SLU (Tozer *et al*. 2010; Chapman & Murphy 1989).

Conversely, according to THSC (2008) vegetation mapping the native vegetation communities in the Subject Land are *Sandstone Ridgetop Woodland*, *Sandstone Heath* and *Shale/Sandstone Transition*

Forest (high sandstone influence) (*SSTF*) (*Figure 3-2*). SSTF is a Critically Endangered Ecological Community (CEEC) listed under the NSW *BC Act* and the Commonwealth *EPBC Act.*

UBM previously ground-truthed native vegetation for parts of the current Subject Land in 2017 (UBM 2017a; 2017b), at that time identifying areas of *Sandstone Heath*, *Parkland with Planted Trees* and *Disturbed/Exotic Vegetation* (*Figure 3-3*).

Figure 3-1: Tozer *et al.* (2010) Vegetation Mapping

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56.

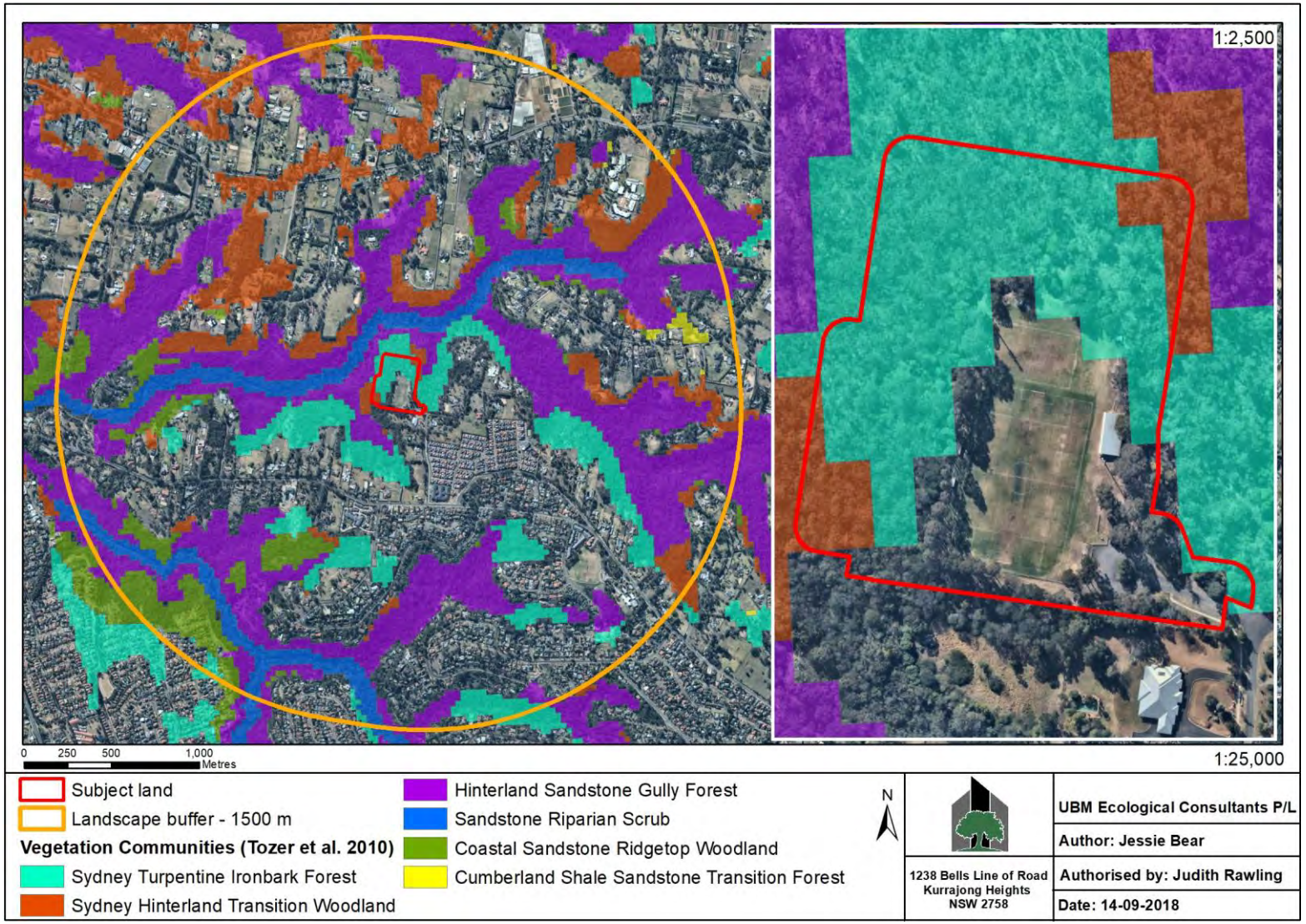


Figure 3-2: Vegetation Communities (THSC 2008)

Data Frame Projection: GDA Zone 56.

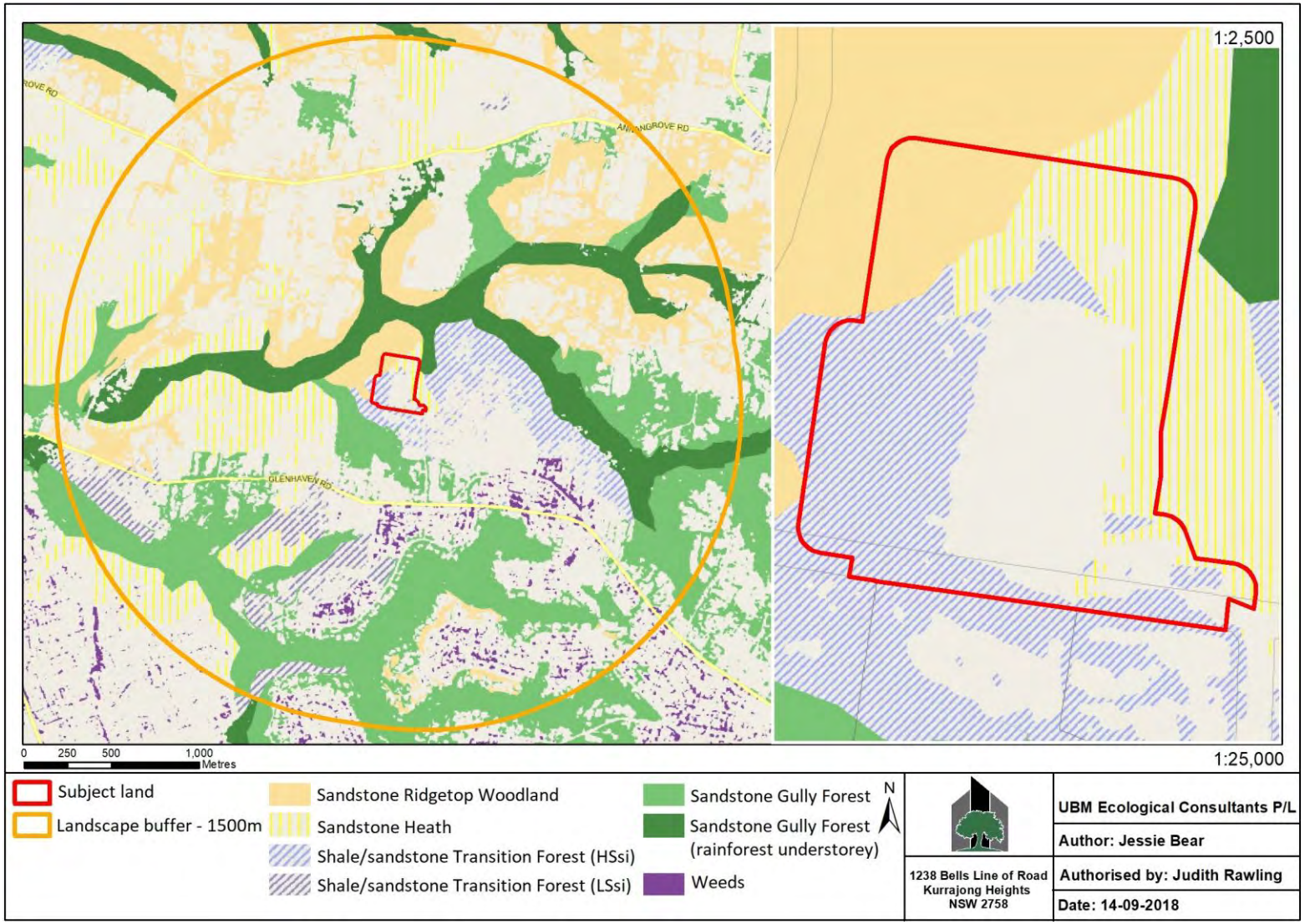


Figure 3-3: Ground-truthed Vegetation (UBM 2017a; 2017b)

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56.

3.2.2 Vegetation Zones & Patch Size

Based on a review of existing information and aerial imagery, native vegetation for the Subject Land was divided into Vegetation Zones (VZs), each of which is defined as an area of native vegetation on the Subject Land that is the same PCT and has a similar broad condition state[1]. The boundaries of VZs were confirmed by random meander during the site investigations as areas with potentially different PCTs and/or condition became apparent. Vegetation Zones are described in *Section 3.2.4.*

The patch size class is greater than 100 ha for all Vegetation Zones identified. Patch size is defined as an area of intact native vegetation that includes all native vegetation with a gap of less than 100 metres from the next area of moderate to good native vegetation (or ≤30 metres for non-woody ecosystems).

3.2.3 Plot-based Floristic Vegetation Survey

The surveys and mapping undertaken for the Subject Land over a period of years identify various vegetation communities based on broad-scale vegetation mapping with limited ground-truthing (Tozer *et al.* 2010; THSC 2008), or do not cover the entire Subject Land (UBM 2017a; 2018b), and do not use the PCT mapping system. For this reason, a plot-based floristic survey of the Subject Land was undertaken to confirm the most likely PCTs on site and to determine vegetation integrity.

Vegetation integrity is the condition of native vegetation assessed for each VZ against the benchmark for the PCT. Vegetation integrity was assessed within each zone identified in *Figure 3-4* using survey plots established around a 50-metre midline as illustrated in *Figure 3-5*. The survey was stratified and targeted to assess the expected environmental variation and address any gaps in existing mapping and site data. All VZs were smaller than two (2) ha in size, and as such, each was sampled with one (1) 20 x 50 metre plot.

Where possible, plots were not permitted to overlap and were placed away from vegetation transitional areas (*i.e.* ecotones), vehicle tracks and their edges, and other disturbed areas that are readily distinguishable from the broad condition state of the VZ. Although plot placement was restricted by VZ boundaries, where possible, plots were placed by walking a random distance into the VZ. The number of plots surveyed is considered adequate to represent the vegetation integrity of each VZ. *Figure 3-4* depicts the location and number of plots surveyed within each VZ. The starting point coordinates and bearing for each of these plots is detailed in *Table 3-1*.

[1] Condition does not necessarily refer only to quality or structure; for example, a PCT may be divided into zones based on the presence or absence of rocky outcrops.

Figure 3-4: Vegetation Zones & Survey Plot Locations

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56

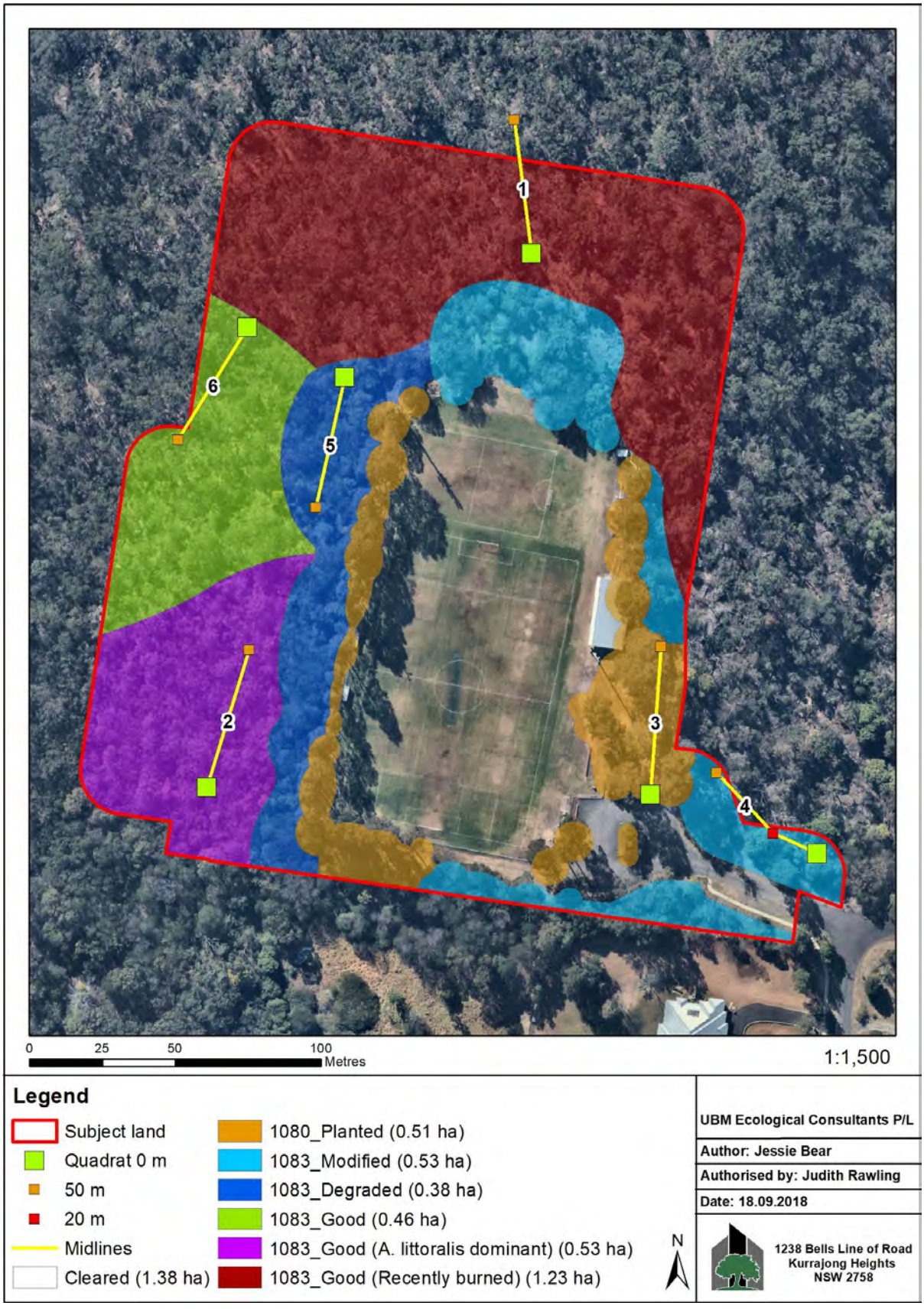


Figure 3-5: Plot Survey Design

Note: Not to scale.

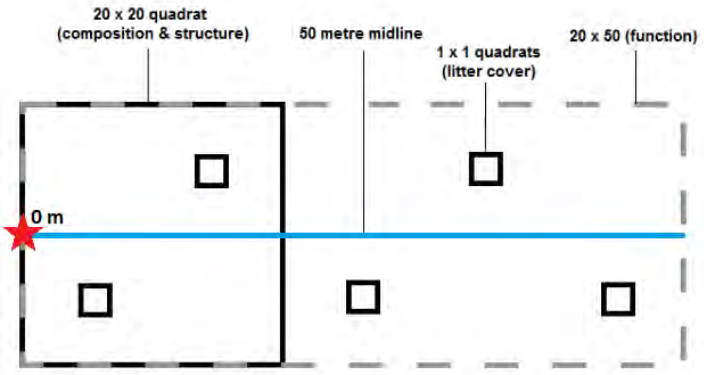


Table 3-1: Plot Coordinates & Bearings

PLOT NO.	BEARING	EASTING 0 m	NORTHING 0 m	EASTING 50 m	NORTHING 50 m
1	352°	313851.4954	6270335.131	313845.5964	6270380.946
2	16°	313740.3376	6270152.246	313754.7226	6270199.343
3	5°	313892.1958	6270149.764	313895.8453	6270200.535
4	294° At 0 m 319° At 20 m	313949.5286	6270129.579	313914.8624	6270157.305
5	193°	313787.4985	6270292.616	313777.5155	6270248.046
6	212°	313754.2393	6270309.942	313730.4156	6270271.314

Composition, structure and function attributes were assessed within each plot against the benchmark data (from the BioNet Vegetation Classification) for the relevant PCT (**note** that the function attributes are not assessed for non-treed vegetation formations[2]).

All plant species occurring within the 20 x 20 metre quadrat were recorded. For each species the stratum, growth form, cover and abundance rating[3] within the quadrat was recorded. Each species was also assigned as 'native' 'exotic' or 'High Threat Exotic' (HTE) according to lists compiled by OEH (2018b).

From this data, composition and structure attributes were calculated. Composition is the number of native species (*i.e.* species richness) within the 20 x 20 metre quadrat in each of the following growth form groups: Tree; Shrub; Grass and grass like; Forb; Fern; Other. Structure is the summed cover of live plant material for native species within the 20 x 20 metre quadrat in each of these six (6) growth form groups. The sum of cover for all High Threat Exotic species was also calculated.

[2] Non-treed vegetation formations are defined under Section 5.3.3 of the BAM Order.

[3] Refer to Definitions.

Additionally, for each plot, the function attributes detailed in *Table 3-2* were collected within the 20 x 50 metre area. **Note:** Litter cover is a function attribute but is only recorded in the five (5) 1 x 1 metre sub-plots (*Table 3-2*).

Plot field data has been included in *Appendix 3* and as a separate MS Excel file submitted with this Report.

Table 3-2: Function Attributes

FUNCTION	DESCRIPTION
NO. OF LARGE TREES	Based on diameter at breast height (DBH) measured at 1.3 metres above the ground. The number of trees ≥50 cm DBH (*i.e.* large tree benchmark for the relevant PCT) is the number of large trees. Presence/absence of the remaining five (5) stem size classes (<5, 5–9, 10–19, 20–29, 30–49 cm), including tree regeneration (<5 cm) was recorded. Only living trees are counted, and for multi-stemmed trees, only the largest living stem is included.
TREE REGENERATION	
TREE STEM SIZE CLASS	
TOTAL LENGTH OF LOGS	Total length in metres of all woody material ≥10 cm in diameter and ≥50 cm in length that is dead and entirely or in part on the ground. Where logs extend outside of the plot, only the length of fallen log that is contained within the plot was recorded.
LITTER COVER	Average percentage ground cover of litter recorded from five (5) 1 x 1 metre sub-plots evenly located at 5, 15, 25, 35 and 45 metres along the midline, and offset from the midline by 5 metres. Litter cover includes leaves, seeds, twigs, branchlets and branches (<10 cm in diameter). Dead material still attached to a living plant (such as a grass) is assessed as litter cover where it is in contact with the ground. Dead material still attached to a living plant that is not in contact with the ground, or litter suspended in the canopies of other plants is not assessed as litter cover. Litter cover is considered as the two-dimensional litter layer and includes litter under the canopies of erect plants.
HOLLOW BEARING TREES	Count of the number of living and dead trees and shrubs with hollows that are visible from the ground. Hollow bearing trees overhanging the plot are included only if the hollow itself overhangs the plot, and the stem which contains the hollow is also within the plot. Hollows are defined as visible cavities with depth, having an entrance width of at least 5 cm and being at least 1 metre above the ground.

Limitations

Plant identifications were made according to nomenclature in PlantNet (2018). Where insufficient diagnostic material was present to assign full binomial nomenclature, species were identified by the genus name followed by a species number. The field surveys were conducted in spring (September 2018) when many of the native flora species were in flower. Where flowers were absent, species identification was based on both floristic and vegetative characteristics, so there was no obvious floristic limitation.

The diversity of the species recorded during the survey is expected to be influenced by seasonal factors, with some species likely to be inconspicuous, or absent from the above-ground population

during particular times of the year. This is particularly true of terrestrial orchids, which can persist for extended periods as dormant underground tubers. Other species (especially those growing in areas of long grass) can be difficult to find unless they are experiencing a period of new growth or they are flowering.

Accuracy in the analysis of spatial data is hindered by geo-referencing the development layout plans provided by THSC in an image format. At the time of the BDAR preparation (October 2019) the development layout plans were still in draft. This draft plan was geo-referenced and used to determine the survey area and areas of impact and may be subject to spatial inaccuracies. To improve the accuracy of spatial data analysis, ideally accurate, spatially exacted development layout plans should be provided. If the final layout were to change from what has been provided then further surveys may be needed as additional features may be present in the additional area.

3.2.4 Plant Community Types

Identification of PCTs on the Subject Land is in accordance with the NSW PCT classification as described in the BioNet Vegetation Classification (OEH 2018c). The most likely PCTs have been identified where vegetation:

a) Has been modified to an extent that it has reduced species richness, or it is missing structural layers,
b) Has been planted for landscaping purposes on disturbed/imported soils; or
c) Has no distinct linear boundary to determine a difference between PCTs on the site.

Threatened Ecological Communities (TECs) have been identified with reference to the OEH's threatened species profiles, NSW Scientific Committee final determinations and BioNet Vegetation Classification (OEH 2018c). PCTs have been described below in *Table 3-3* to *Table 3-8* in relation to their associated VZs.

Table 3-3: VZ 1083_Good

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*
Area (ha)	0.46
Patch Size Class	>100
TEC status	None
Estimate of percent cleared value of PCT	17% cleared
Justification of VZ	PCT 1083_Good is comprised of high quality, intact bushland located south of a narrow bush track that appeared to mark the defensive control line for the fire in 1083_Good (Recently burned).
Species relied upon for identification of vegetation type and relative abundance	*Corymbia gummifera*, *Eucalyptus haemastoma*, *Corymbia eximia*, *Acacia suaveolens, Acacia ulicifolia, Angophora hispida, Banksia serrata, Banksia spinulosa, Bossiaea heterophylla, Leptospermum trinervium, Persoonia levis, Petrophile pulchella, Platysace linearifolia, Caustis flexuosa, Cyathochaeta diandra, Lepyrodia scariosa, Lomandra obliqua* and *Entolasia stricta*.

	The above species were abundant within the vegetation zone and matched the species listed on the BioNet database for the PCT.
General condition	The VZ has an intact vegetation structure (*i.e.* intact canopy, mid-storey and ground layer). The flora diversity and abundance are high. Exotic vegetation is absent. Minimal disturbance was observed in the zone. There are existing walking trails present.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. Further analysis was undertaken, taking into consideration occurrence of potential PCTs in relevant IBRA sub-regions and geology, to determine the most likely PCT.

Table 3-4: VZ 1083_Good (Recently Burned)

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*
Area (ha)	1.23
Patch Size Class	>100
TEC status	None
Estimate of percent cleared value of PCT	17%
Justification of VZ	1083_Good (Recently burned) consists of in-tact bushland that is presently in a successional phase following the 2016 bushfire. The recent fire is likely to have influenced the integrity scores detailed in *Table 3-9*.
Species relied upon for identification of vegetation type and relative abundance	*Acacia suaveolens, Acacia ulicifolia, Angophora hispida, Banksia serrata, Banksia spinulosa, Bossiaea heterophylla, Caustis flexuosa, Corymbia eximia, Corymbia gummifera, Cyathochaeta diandra, Entolasia stricta, Eucalyptus haemastoma, Leptospermum trinervium, Lepyrodia scariosa, Lomandra obliqua, Persoonia levis, Petrophile pulchella, Platysace linearifolia* and *Woollsia pungens*.
General condition	The VZ has an intact vegetation structure (*i.e*. intact canopy, mid-storey and ground layer). The flora diversity and abundance are high. Exotic vegetation is absent. Minimal disturbance was observed in the native vegetation areas of the vegetation zone. There are existing walking trails present.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. Further analysis was undertaken, taking into consideration occurrence of potential PCTs in relevant IBRA sub-regions and geology, to determine the most likely PCT.

Table 3-5: VZ 1083_Good (*Allocasuarina littoralis* dominant)

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*
Area (ha)	0.53
Patch Size Class	>100

TEC status	None
Estimate of percent cleared value of PCT	17%
Justification of VZ	PCT 1083_Good (*A. littoralis* dominant) is comprised of high quality, intact bushland, however the vegetation zone is different from that of 1083_Good in that it is characterised by dense thickets of *A. littoralis.*
Species relied upon for identification of vegetation type and relative abundance	*Angophora hispida, Caustis flexuosa, Cyathochaeta diandra, Entolasia stricta, Eucalyptus haemastoma, Lambertia formosa, Leptospermum trinervium* and *Persoonia levis*.
General condition	This VZ is characterised by scattered native tree layer and a dense mid-storey and ground layer.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. Further analysis was undertaken, taking into consideration occurrence of potential PCTs in relevant IBRA sub-regions, geology and local vegetation communities' data, to determine the most likely PCT. It should be noted that another closely related PCT (PCT 1782) was identified. PCT 1782 has similar floristics to PCT 1083 in this vegetation zone due to the *A. littoralis* being dominant in the mid-storey but PCT 1782 occurs on the Hornsby Plateau. Therefore, the diagnosis of this community as a variant of PCT 1083 is more appropriate based on the surrounding PCTs.

Table 3-6: VZ 1083_Modified

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*
Area (ha)	0.53
Patch Size Class	>100
TEC status	None
Estimate of percent cleared value of PCT	17% cleared
Justification of VZ	PCT 1083_Modified has suffered previous disturbance from the importation of fill for the sports field and/or road construction. There is evidence of weed infestations and weed control having been undertaken in this zone. This zone has also been subject to past illegal dumping events, including a large pile of railway sleepers now performing the role of coarse woody debris.
Species relied upon for identification of vegetation type and relative abundance	*Angophora hispida, Banksia serrata, Eucalyptus haemastoma, Entolasia stricta, Banksia spinulosa, Acacia suaveolens, Cyathochaeta diandra* and *Leptospermum trinervium.*
General condition	The floristics of this vegetation zone has been significantly modified by weed infestation and control and soil disturbance.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. Further analysis was undertaken, taking into consideration occurrence of potential PCTs in relevant IBRA sub-regions and geology, to determine the most likely PCT.

Table 3-7: VZ 1083_Degraded

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Coastal Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*
Area (ha)	0.38
Patch Size Class	>100
TEC status	None
Estimate of percent cleared value of PCT	17%
Justification of VZ	PCT 1083_Degraded has suffered previous disturbance from the importation of fill for the playing field. It is currently characterised by dense weed infestations and patches of the weedy native *Pittosporum undulatum.* There is no evidence of weed control having been undertaken recently.
Species relied upon for identification of vegetation type and relative abundance	*Corymbia eximia.*
General condition	The floristics of this vegetation zone has been significantly modified by weed infestation due to soil disturbance, and possible past land clearing activities.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. Further analysis was undertaken, taking into consideration occurrence of potential PCTs in relevant IBRA sub-regions and geology, to determine the most likely PCT. It should be noted the PCT allocated for this VZ is based on the intact adjacent PCT due to historic human disturbance of vegetation and soils.

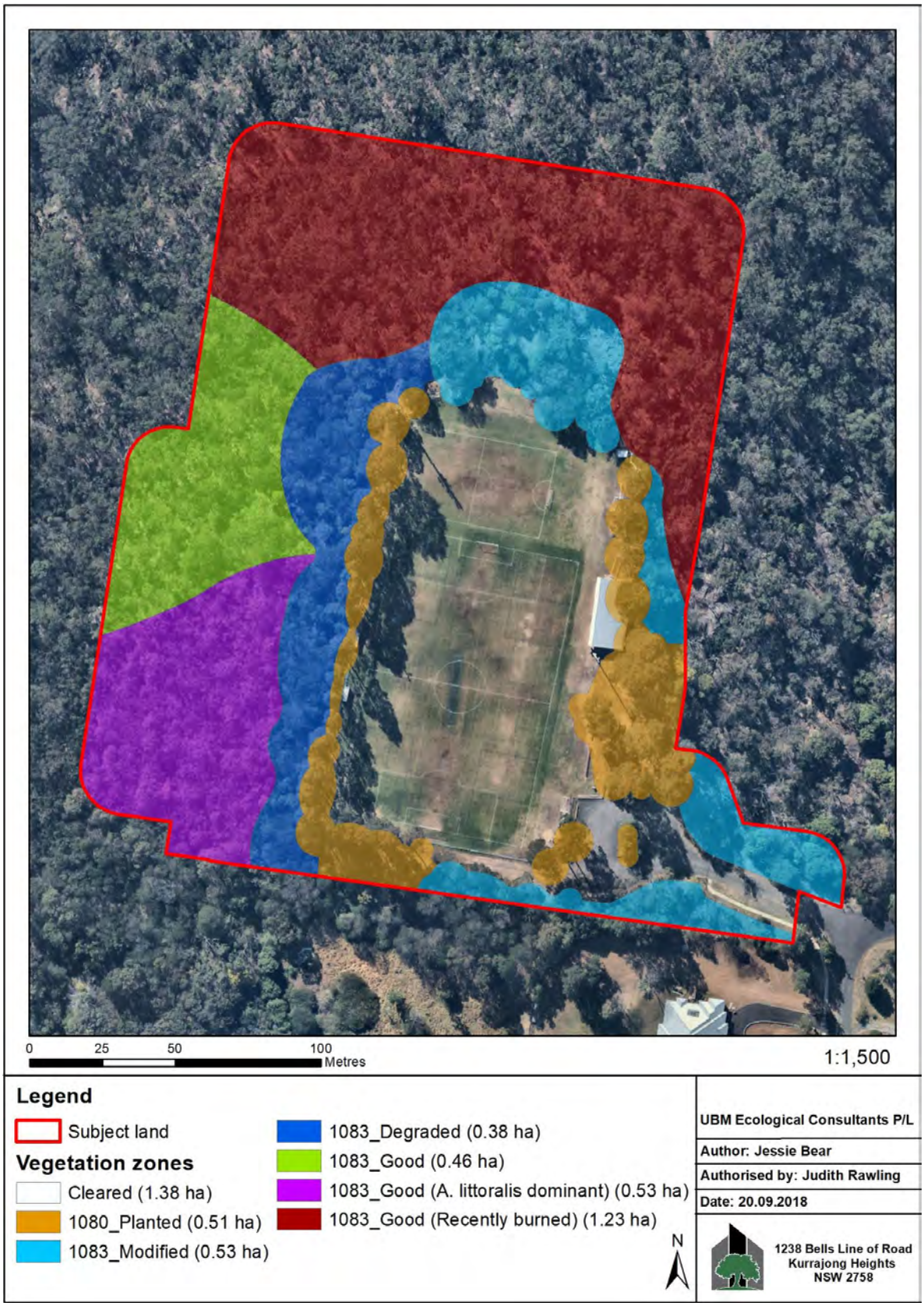
Table 3-8: VZ 1080_Planted

ATTRIBUTE	DESCRIPTION
Formation	Dry Sclerophyll Forests (Shrubby sub-formation)
Vegetation Class	Sydney Hinterland Dry Sclerophyll Forests
PCT Name	*Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion*
Area (ha)	0.51
Patch Size Class	>100
TEC status	None
Estimate of percent cleared value of PCT	15%
Justification of VZ	This area is comprised of planted species indigenous to NSW, mostly of a similar age class, including 8 planted specimens of the endangered (*BC Act*) and vulnerable (*EPBC Act*) Wallangarra White Gum *Eucalyptus scoparia*. Based on the dominant species present, Spotted Gum *Corymbia maculata,* PCT 1080 is the closest match, however PCT 1080 does not occur naturally in the Yengo IBRA subregion. The planted trees are positioned over a highly disturbed and patchy ground cover of maintained exotic and native species (*Appendix 3*). The soil in this zone was imported for the construction of the playing field, and

	much of this zone suffers regular foot traffic and is moderately to highly compacted (*Figure 1-2*).
Species relied upon for identification of vegetation type and relative abundance	*Corymbia maculata*
General condition	The patch of vegetation is characterised by a generally absent shrub layer and low diversity of native ground layer species. There is a significant percentage of exotic grasses due to human disturbances such as landscaping and turfing.
Justification of evidence used to identify PCTs	BioNet Vegetation Classification was utilised to match native flora species from quadrat surveys to assess the likely PCTs. As the VZ is characterised by primarily planted vegetation and exotic species, a PCT was allocated based on the guidelines in the BAM Operational Manual.

Figure 3-6: Ground-truthed PCTs (UBM 2018)

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56



3.2.5 Determining the Vegetation Integrity Score

Data collected within survey plots for each VZ was entered into the BAM calculator to determine the composition score, structure score and function score, from which the current vegetation integrity score was calculated, as detailed in *Table 3-9*.

The vegetation integrity of all VZs is high enough to warrant further assessment of the native vegetation and threatened species habitat in each VZ as detailed in *Section 4*. Note that existing benchmarks for PCTs entered into the calculator were not modified.

Table 3-9: Current Vegetation Integrity Scores

VZ	COMPOSITION CONDITION SCORE	STRUCTURE CONDITION SCORE	FUNCTION CONDITION SCORE	CURRENT VEGETATION INTEGRITY SCORE
1083_Good	88.1	26.1	57.1	50.8
1083_Good (Recently burned)	79.7	5.5	55.5	29
1083_Good (*A. littoralis* dominant)	33.5	51.3	76.8	50.9
1083_Modified	44.4	29.7	64.5	44
1083_Degraded	18.6	30.8	33.9	26.9
1080_Planted	27.8	9.6	22.1	18.1

4 THREATENED SPECIES HABITAT

4.1 Habitat Assessment

The BAM calculator provides a list of predicted species based on the Vegetation Integrity Assessment (*Section 4.2* and *Section 4.3*). However, habitat assessment of the Subject Land is necessary to justify predicted and candidate species presence and estimate their extent on the Subject Land (*Section 4.3.2*), and to consider impacts on threatened and migratory species and habitats not otherwise captured by the BAM, including Commonwealth-listed species (*Appendix 2*).

4.1.1 Desktop Review

Prior to field investigations, a desktop review of previous reports and existing databases was undertaken. The NSW BioNet (OEH 2018a) and Commonwealth Protected Matters Search Tool (DEE 2018) were accessed to identify records of threatened and/or migratory flora and fauna within a 10-kilometre radius of the Subject Land. A list of species output from these searches is included in *Appendix 1* and *Appendix 2*.

A possible observation of the vulnerable Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) is the only previous record of threatened/migratory species within Subject Land (OEH 2018a and UBM 2017a). The broader Subject Property (Holland Reserve) also has records for a probable observation of the Eastern Bentwing-bat, the Powerful Owl (*Ninox strenua*, location denatured), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), and a 1997 record of *Darwinia biflora* (OEH 2018a).

UBM had previously recorded a number of non-threated microbat species on the Subject Land /Property with uncertainty in identification, which may be confused with the following threatened species:

- Eastern Freetail-bat (*Mormopterus norfolkensis*) (UBM 2016; 2017c);
- Southern Myotis (*Myotis macropus*) (UBM 2017c);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (UBM 2016); and
- Eastern Cave Bat (*Vespadelus troughtoni*) (UBM 2017b).

Table 4-1 identifies the number of historical records (OEH 2018a) found for each species within 1.5 km of the Subject Land (including the aforementioned records for the Subject Property and Subject Land).

Table 4-1: Historical records of threatened/migratory species in the Locality

BioNet search parameters: North: -33.59 West: 150.89 East: 151.09 South: -33.79.
*Number of records extracted from the BioNet (OEH 2018a) search data using the 1.5 km buffer applied to the Subject Land.

SPECIES	*NO. RECORDS
FLORA (9)	
Acacia bynoeana, Bynoe's Wattle	1
Darwinia biflora	58
Epacris purpurascens var. *purpurascens*	8

SPECIES	*NO. RECORDS
Eucalyptus sp. Cattai	3
Hibbertia superans	17
Leucopogon fletcheri subsp. *fletcheri*	1
Persoonia hirsuta, Hairy Geebung	1
Pimelea curviflora var. *curviflora*	28
Tetratheca glandulosa	2
INVERTEBRATES (0)	
AMPHIBIANS (1)	
Pseudophryne australis, Red-crowned Toadlet	3
REPTILES (0)	
BIRDS (7)	
Artamus cyanopterus, Dusky Woodswallow	1
Calyptorhynchus lathami, Glossy Black-Cockatoo	8
Daphoenositta chrysoptera, Varied Sittella	1
Hirundapus caudacutus, White-throated Needletail	1
Melithreptus gularis gularis, Black-chinned Honeyeater	1
Ninox strenua, Powerful Owl	9
Tyto novaehollandiae, Masked Owl	1
MAMMALS (7)	
Falsistrellus tasmaniensis, Eastern False Pipistrelle	2
Miniopterus australis, Little Bentwing-bat	5
Miniopterus schreibersii oceanensis, Eastern Bentwing-bat	4
Mormopterus norfolkensis, Eastern Freetail-bat	6
Pteropus poliocephalus, Grey-headed Flying-fox	5
Saccolaimus flaviventris, Yellow-bellied Sheathtail-bat	3
Scoteanax rueppellii, Greater Broad-nosed Bat	4

4.1.2 Field Investigations

A general flora habitat assessment (Walker & Hopkins 1990) of the Subject Land was undertaken on 3rd, 10th and 17th September 2018 by Botanist Yogesh Nair to assess flora habitat suitability. Habitat assessment methodology was based on the recommendations made in Thompson (2013) and OEH (2013). Approximately 13 hours was spent undertaking the combined habitat assessment and plot surveys (*Section 3.2.3*).

A fauna habitat assessment was undertaken by Fauna Ecologist Kiarrah Smith on the 10th September 2018, with an additional habitat assessment undertaken by Ecologist Jessie Bear on the 17th September covering an extended portion of the Subject Land. The method used involved walking a series of parallel transects that were close enough to each other to allow observation of the entire site (*Figure*

4-1). All habitat features (*Table 4-2*) observed either side of the transects were noted, and where appropriate, marked using a GPS (*GPSmap 62s*, Garmin) (*Figure 4-2*). The condition and structure of fauna habitats present was identified, and a consideration of their potential to support locally occurring populations of threatened and migratory fauna was determined. Survey effort was approximately 6 hours. The limitations of this survey are noted on *Table 4-2*.

The following features associated with prescribed biodiversity impacts were also recorded if present:

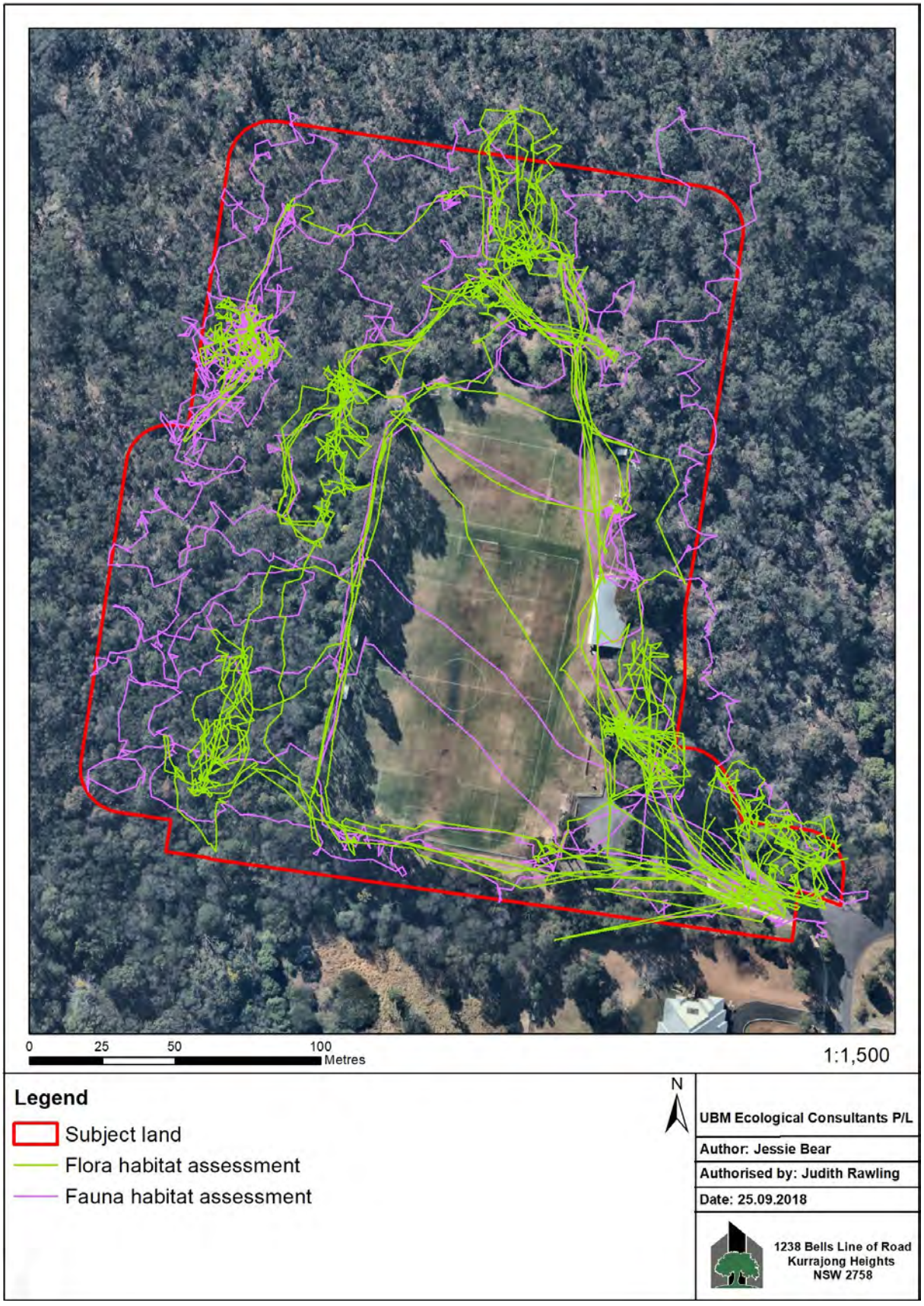
- Karst, caves, crevices and cliffs, including any biological processes that sustain these habitat features and known threats operating on these biological processes;
- Outcrops and scattered rock;
- Human made structures and non-native vegetation; and
- Hydrological processes that sustain and interact with the rivers, streams and wetlands in the locality, including seasonal patterns in volumes and flow paths, as well as baseline water quality data.

In addition, any opportunistic observations of threatened or migratory fauna utilising the Subject Land and adjacent habitat were recorded. This included sightings, calls or signs of fauna presence, such as: Scats; scratches; sap-feeding scars; diggings; nests; dreys; bones; hair; shed skins; tracks; burrows; orts (chewed cones) and feeding pellets. Signs were verified with reference to Triggs (2004).

Knowledge of the habitat requirements and associations of animals recorded in a designated study site can help predict the full range of fauna potentially present therein. For example, if a hollow-associated owl is detected, then there is the potential that, if previously recorded in the vicinity of the Study Area, other owl species with similar nesting requirements may also be present.

Figure 4-1: Flora and Fauna Habitat Assessment Survey Effort

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56



4.1.3 Habitat Features

The Subject Land contains patches of native bushland (VZs 1083_Good, 1083_Good [Recently burned], 1083_Good [*A. littoralis* dominant]), degraded/modified bushland (VZs 1083_Degraded and 1083_Modified), planted vegetation (VZ 1080_Planted) and cleared land (*Figure 2-6*). PCTs 1083 and 1080 have been identified for the Subject Land (*Section 3.2.4*). These are dry-sclerophyll forest communities that contain a variety of foraging resources including fruits, flowers, seeds, pollen, nectar, invertebrates and vegetation, which in turn support the presence of vertebrate prey. *Table 4-2* summarises the habitat features available in each of the VZs.

Table 4-2: Habitat Details

✓ = present. × = absent.

***Note:** Due to the limitations of detecting hollows, nests, mistletoe, *etc.* from the ground perspective, the abundance of these features may be greater than that reported here, particularly in areas with dense understorey vegetation. Weed thickets and steep rock outcrops around perimeters prevented access to some areas, but none were large enough to completely exclude observation of any areas.

HABITAT FEATURE	DESCRIPTION	1083_GOOD	1083_GOOD (Recently burned)	1083_GOOD (*A. littoralis* dominant)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	CLEARED
Hollow trees*	Living trees containing one or more hollows in living and/or dead wood at least 1 metre above the ground and ranging in diameter from 5-19 cm.	≥1	≥8	≥3	×	≥1	×	×
Hollow stags*	Dead trees containing one or more hollows at least 1 metre above the ground and ranging in diameter from 5-19 cm (see plates).	≥1	≥3	≥6	≥4	≥1	≥3	×
Large hollows*	Hollows in live or dead trees that are ≥ 20 cm in diameter.	×	≥3	≥1	≥2	≥1	×	×
Mistletoe*	Living or dead mistletoe in trees.	✓	✓	×	✓	×	✓	×
Logs	Coarse woody debris such as fallen trunks and branches at least 10 cm in diameter and in contact with the ground. Both hollow and non-hollow logs are present.	23.8 m per 1000 sq. m	6.85 m per 1000 sq. m	10.55 m per 1000 sq. m	40.6 m per 1000 sq. m	9.4 m per 1000 sq. m	×	×

HABITAT FEATURE	DESCRIPTION	1083_GOOD	1083_GOOD (Recently burned)	1083_GOOD (*A. littoralis* dominant)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	CLEARED
Leaf litter	Leaf litter accumulations, including woody debris not large enough to be classed as a log.	✓	✓	✓	✓	✓	✓	×
Rock outcrop	Large areas of surface rock embedded in the ground.	Extensive	Extensive	West edge	Moderate	×	×	×
Bush rock	Moveable surface rocks.	✓	✓	✓	✓	×	×	×
Rock crevices	Crevices are relatively small enclosed spaces within rock outcrops and bush rock varying in height, width and depth; distinguished from caves by the lack of a fully dark area where temperature and humidity are elevated.	✓	✓	✓	✓	×	×	×
Rock overhang	Overhangs create shade and shelter but may be distinguished from crevices by their larger size (being accessible to larger animals) and lack of an enclosed space.	✓	✓	×	×	×	×	×
Caves	Enclosed rock overhang large enough to have a fully dark area where temperature and humidity are elevated.	×	×	×	×	×	×	×
Ephemeral water	Streams, ponds and soaks that are temporarily wet after rainfall.	×	×	×	×	Drainage line	×	×
Permanent water	Waterbodies and streams that permanently contain water.	×	×	×	×	×	×	×
Artificial crevices	Crevices in man-made structures that may be used by small fauna, particularly microbats.	×	×	×	✓	×	×	✓
Casuarina/ Allocasuarina spp.	*Casuarina/Allocasuarina* spp. cones favoured by Glossy-black Cockatoos.	✓	✓	✓	✓	✓	×	×

HABITAT FEATURE	DESCRIPTION	1083_GOOD	1083_GOOD (Recently burned)	1083_GOOD (*A. littoralis* dominant)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	CLEARED
Dense groundcover layer	Groundcover vegetation that retains dense structure that may provide shelter for small ground-dwelling species *e.g.* grass trees.	✓	✓	✓	✓	✓	×	×
Shrub layer	Species in the shrub growth form group.	✓	✓	✓	✓	✓	✓	×
Canopy trees	Tall trees.	✓	✓	✓	✓	✓	✓	×
Exfoliating bark	Loose bark on trees that creates crevices on tree trunks and/or accumulations in tree forks.	✓	✓	✓	✓	✓	✓	×
Nests	Stick and mud nests created by birds	×	×	✓	×	×	×	✓
Dreys	Dreys created by ringtail possums (distinguished from nests by the presence of possum scats).	×	×	✓	×	×	×	×
Terrestrial termite mounds	Termite mound on the ground.	×	✓	✓	×	×	×	×
Arboreal termite mounds	Termite mound in trees.	×	✓	✓	✓	×	×	×
Stormwater culverts	Stormwater culverts and pipes.	×	×	×	×	×	×	×
HTE species cover	HTE species cover in plots.	0	0	0	6.7	15.8	25.1	N/A
Exotic species	Presence of species not native to NSW, but not listed as HTE (in plots)	×	×	×	✓	✓	✓	✓
Native species cover	Sum of vegetation cover native to NSW in all strata in plots.	50.4	24.3	100.1	57.6	53.5	20.1	N/A
Native species richness	Number of species native to NSW in all strata in plots.	47	41	22	27	14	16	N/A

HABITAT FEATURE	DESCRIPTION	1083_GOOD	1083_GOOD (Recently burned)	1083_GOOD (*A. littoralis* dominant)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	CLEARED
Burrows	Burrows in the ground created by birds, reptiles or small mammals.	✓	×	×	×	×	×	×
Intact vegetation	All structural layers present.	✓	✓	✓	✓	✓	✓	×
Patch size class	Connectivity to intact vegetation.	>100 ha	>100 ha	>100 ha	>100 ha	>100 ha	>100 ha	N/A

Plates: Habitat Features

Top Left: Hollow in a stag. **Top Right:** Fallen tree trunk (coarse woody debris). **Second Row Left:** Rock crevices. **Second Row Right:** Stick nest built by a bird. **Third Row Left:** Arboreal termite mound that has been repurposed as a nest by a bird. **Third Row Right:** Crevices in a man-made structure that may be used by small fauna. **Bottom Row Left:** Terrestrial termite mound. **Bottom Row Right:** Stick nest in a man-made structure.

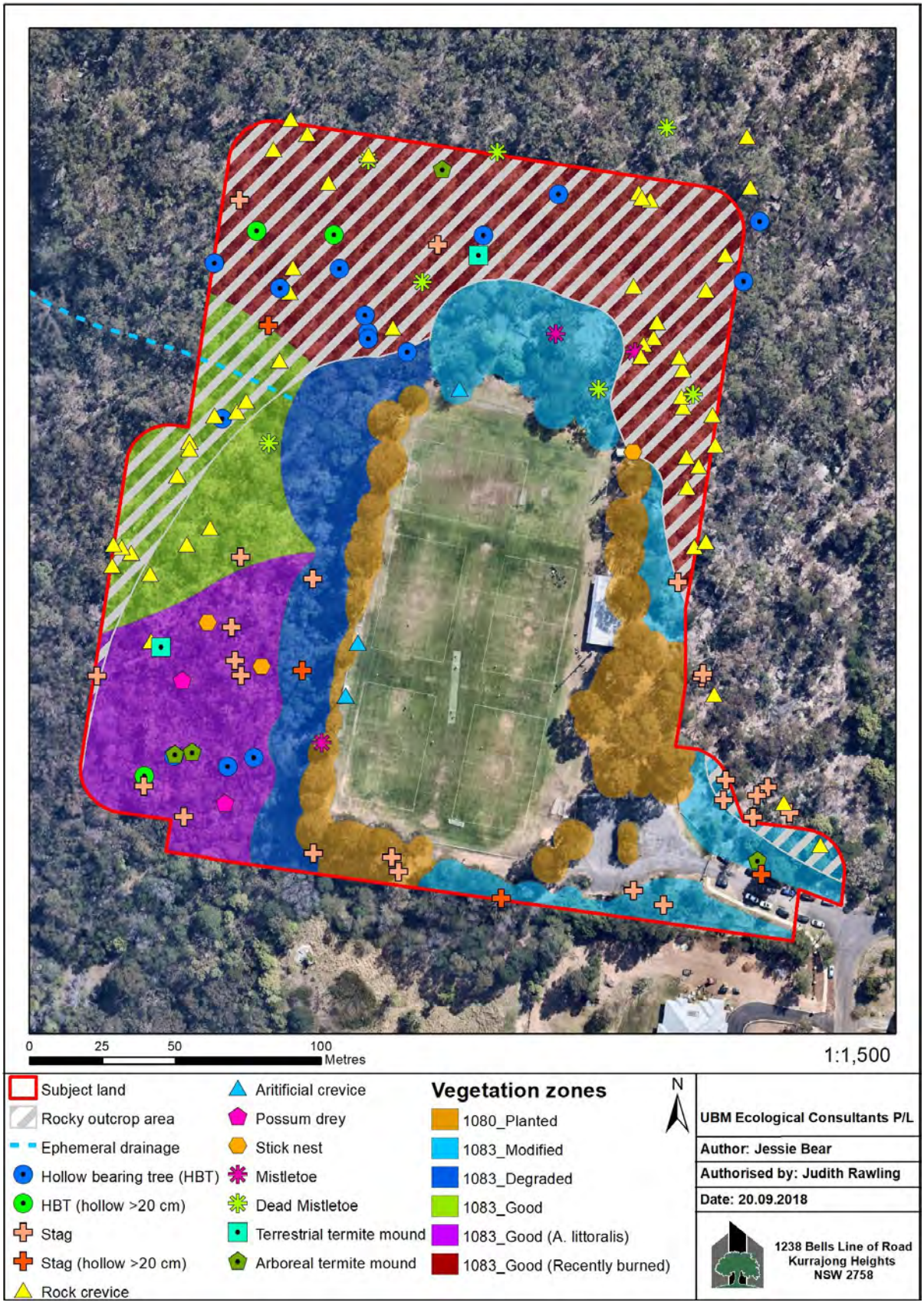







Figure 4-2: Location of Habitat Features

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56. **Note:** There are likely to be many more rock crevices than has been mapped.



4.2 Ecosystem Credit Species

Ecosystem credit species are threatened species for which the likelihood of occurrence or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection. Ecosystem credit species are also referred to as 'predicted threatened species' in the BAM calculator (OEH 2018b). Targeted survey is not required for these species as they are offset within the ecosystem credits. *Table 4-3* lists the species predicted by the calculator based on the landscape context and vegetation integrity assessment.

The assessment of habitat suitability is based on the landscape context, vegetation integrity assessment and habitat assessment undertaken for the Subject Land , supported by information from the Threatened Biodiversity Data Collection, BAM Credit Calculator, and published peer reviewed literature.

Note: Some threatened species are listed as dual credit species for different requirements. For example, the Broad-headed Snake (*Hoplocephalus bungaroides*) is an ecosystem credit species in *Table 4-3* for its foraging habitat and as a species credit species in *Table 4-7* for its breeding habitat.

Additional Ecosystem Credit Species not Predicted by the Calculator

The Dusky Woodswallow (*Artamus cyanopterus*) is an ecosystem credit species that was not predicted by the calculator, but which meets all the criteria (as follows) to be included on the predicted ecosystem credit species list for all six (6) Vegetation Zones identified on site (*Table 4-3*):

- It occurs in the Yengo subregion with no geographic limitations;
- It is associated with both PCTs identified on the Subject Land;
- The native vegetation cover within the Locality (~49%) is greater than the minimum class that is required for the species;
- The patch size class of the Vegetation Zones (>100 ha) is equal to or greater than the minimum specified for that species; and
- Although not a requirement for prediction, it should be noted that there is one (1) historical record of this species in the Locality (*Table 4-1*).

No additional ecosystem credit species were predicted by desktop review. All other species listed by BioNET (OEH 2018a) and the Protected Matters Search Tool (DEE 2018) (*Appendix 1* and *Appendix 2*) either do not occur in the subregion, are vagrants, or do not have suitable habitat on site.

Exclusion from Unsuitable Vegetation Zones

The Glossy-black Cockatoo (*Calyptorhynchus lathami*) and Painted Honeyeater (*Grantiella picta*) are the only ecosystem credit species predicted by the calculator that can be excluded from VZs based on habitat constraints (see justification in *Table 4-3*). All other predicted ecosystem credit species are considered likely to have suitable habitat in their predicted VZs and were not excluded based on habitat constraints or geographic limitations (for species listed in the TBDC that have these), nor Regional vagrancy. Included species require assessment for the impacts of development, including measures taken to avoid and minimise the impacts of development, and the calculation of ecosystem credits to offset any residual impacts (Stage 2 commencing *Section 5*).

Table 4-3: Predicted Ecosystem Credit Species

✓ = Predicted for this VZ, ✕= predicted but excluded for this VZ, - not predicted for this VZ, *not predicted by calculator but predicted by desktop review/field investigations. **BOLD** = species detected during targeted surveys for other species.

SPECIES	1083_GOOD	1083_GOOD (BURNED)	1083_GOOD (*A. LITTORALIS*)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	JUSTIFICATION IF EXCLUDED
FLORA (0)							
INVERTEBRATES (0)							
AMPHIBIANS (0)							
REPTILES (2)							
Hoplocephalus bungaroides, Broad-headed Snake (Foraging)	✓	✓	✓	✓	✓	-	
Varanus rosenbergi, Rosenberg's Goanna	✓	✓	✓	✓	✓	-	
BIRDS (21)							
Anthochaera Phrygia, Regent Honeyeater (Foraging)	✓	✓	✓	✓	✓	✓	
Artamus cyanopterus cyanopterus, Dusky Woodswallow*	✓*	✓*	✓*	✓*	✓*	✓*	
Callocephalon fimbriatum, Gang-gang Cockatoo (Foraging)	✓	✓	✓	✓	✓	✓	
Calyptorhynchus lathami, Glossy Black-Cockatoo (Foraging)	✓	✓	✓	✓	✓	✕	Excluded VZ lacks *Allocasuarina* spp. and *Casuarina* spp. food trees.
Climacteris picumnus victoriae, Brown Treecreeper (eastern subspecies)	✓	✓	✓	✓	✓	-	
Daphoenositta chrysoptera, Varied Sittella	✓	✓	✓	✓	✓	✓	

SPECIES	1083_GOOD	1083_GOOD (BURNED)	1083_GOOD (*A. LITTORALIS*)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	JUSTIFICATION IF EXCLUDED
Glossopsitta pusilla, Little Lorikeet	✓	✓	✓	✓	✓	✓	
Grantiella picta, Painted Honeyeater	×	✓	×	×	×	-	Excluded VZs lack the habitat constraint of mistletoe present at a density of greater than five (5) per hectare.
Haliaeetus leucogaster, White-bellied Sea-Eagle (Foraging)	✓	✓	✓	✓	✓	-	
Hieraaetus morphnoides, Little Eagle (Foraging)	✓	✓	✓	✓	✓	✓	
Lathamus discolor, Swift Parrot (Foraging)	✓	✓	✓	✓	✓	-	
Lophoictinia isura, Square-tailed Kite (Foraging)	✓	✓	✓	✓	✓	✓	
Melanodryas cucullata cucullate, Hooded Robin (south-eastern form)	✓	✓	✓	✓	✓	-	
Melithreptus gularis gularis, Black-chinned Honeyeater (eastern subspecies)	✓	✓	✓	✓	✓	-	
Neophema pulchella, Turquoise Parrot	✓	✓	✓	✓	✓	✓	
Ninox connivens, Barking Owl (Foraging)	✓	✓	✓	✓	✓	✓	
***Ninox strenua*, Powerful Owl (Foraging)**	✓	✓	✓	✓	✓	✓	
Pandion cristatus, Eastern Osprey (Foraging)	✓	✓	✓	✓	✓	-	
Petroica boodang, Scarlet Robin	✓	✓	✓	✓	✓	✓	
Pomatostomus temporalis temporalis, Grey-crowned Babbler (eastern subspecies)	✓	✓	✓	✓	✓	-	
Tyto novaehollandiae, Masked Owl (Foraging)	✓	✓	✓	✓	✓	✓	

SPECIES	1083_GOOD	1083_GOOD (BURNED)	1083_GOOD (*A. LITTORALIS*)	1083_ MODIFIED	1083_ DEGRADED	1080_ PLANTED	JUSTIFICATION IF EXCLUDED
MAMMALS (11)							
Dasyurus maculatus, Spotted-tailed Quoll	✓	✓	✓	✓	✓	✓	
Falsistrellus tasmaniensis, Eastern False Pipistrelle	✓	✓	✓	✓	✓	✓	
Kerivoula papuensis, Golden-tipped Bat	✓	✓	✓	✓	✓	✓	
***Miniopterus australis,* Little Bentwing-bat (Foraging)**	✓	✓	✓	✓	✓	✓	
***Miniopterus schreibersii oceanensis,* Eastern Bentwing-bat (Foraging)**	✓	✓	✓	✓	✓	✓	
Mormopterus norfolkensis, Eastern Freetail-bat	✓	✓	✓	✓	✓	✓	
Petaurus australis, Yellow-bellied Glider	✓	✓	✓	✓	✓	✓	
Phascolarctos cinereus, Koala (Foraging)	✓	✓	✓	✓	✓	✓	
***Pteropus poliocephalus,* Grey-headed Flying-fox (Foraging)**	✓	✓	✓	✓	✓	✓	
***Saccolaimus flaviventris,* Yellow-bellied Sheathtail-bat**	✓	✓	✓	✓	✓	✓	
Scoteanax rueppellii, Greater Broad-nosed Bat	✓	✓	✓	✓	✓	✓	

4.3 Species Credit Species

Species credit species are threatened species for which the likelihood of occurrence or elements of suitable habitat for the species cannot be confidently predicted by vegetation surrogates and landscape features but can be reliably detected by survey.

Table 4-4 lists the species credit species predicted by the BAM calculator (OEH 2018b) that have been entirely excluded from any further assessment based on habitat constraints or geographic limitations (for species listed in the TBDC that have these), regional vagrancy, or substantially degraded habitat.

The species credit species predicted by the BAM calculator (OEH 2018b) that have not been excluded are listed in *Table 4-7* and are known as candidate species credit species. Targeted survey or an expert report is required to confirm presence/absence of candidate species on the Subject Land , unless the proponent opts to simply assume presence (*Section 4.3.1*).

Note: Where a candidate species credit species is considered unlikely to occur in a specific VZ based on the absence of habitat constraints or presence of substantially degraded habitat therein, the excluded VZ has been noted in *Table 4-7* and is not subject to targeted survey for that species.

Additional Species Credit Species not Predicted by the Calculator

Two (2) additional species credit species were found opportunistically on-site: Eight (8) planted (non-locally indigenous) Wallangarra White Gums (*Eucalyptus scoparia*) were located during general field investigations in VZ 1080_Planted, while five (5) Dural Land Snails (*Pommerhelix duralensis*) were observed during spotlighting for other species (*Figure 4-4*). Only the Dural Land Snail was added to the candidate species list; no further assessment is required for the planted *E. scoparia.*

The Dural Land Snail is not currently listed as being associated with PCT 1083, but the flora and substrates that occur therein are similar to the PCTs it is associated with and the ecological associations of this species may not be fully known. Moreover, the Dural Land Snail meets all other criteria (as follows) to be included on the candidate species credit species list (*Table 4-7*):

- It occurs in the Yengo subregion with no geographic limitations;
- The native vegetation cover within the Locality (~49%) is greater than the minimum class that is required for the species; and
- The patch size class of the Vegetation Zones (>100 ha) is equal to or greater than the minimum specified for that species.

All other species listed by BioNET (OEH 2018a) and the Protected Matters Search Tool (DEE 2018) (*Appendix 1* and *2*) either do not occur in the subregion, are vagrants, or do not have suitable habitat on site.

Dural Land Snail within the Subject Land

Table 4-4: Species Credit Species Entirely Excluded from Further Assessment

NAME	JUSTIFICATION FOR EXCLUSION FROM ALL PCTS
FLORA (15)	
Acacia pubescens Downy Wattle	Occurs on alluviums, shales and at the intergrade between shales and sandstones. Occurs in open woodland and forest, in a variety of plant communities, including Cooks River/Castlereagh Ironbark Forest, Shale/Gravel Transition Forest and Cumberland Plain Woodland.
Ancistrachne maidenii	Grows in dry sclerophyll forest on sandstone derived soils; north of Sydney. Habitat requirements appear to be specific, with populations occurring in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes (OEH 2017)
Asterolasia elegans	The Subject Land does not contain the specific habitat requirements for this species which grows on mid-lower slopes in sheltered forest (OEH 2017).
Darwinia fascicularis **subsp. *oligantha* -** endangered population in the Baulkham Hills and Hornsby LGAs	Excluded based on distribution restriction. This endangered population is restricted to the Maroota area of Baulkham Hills and Hornsby Local Government Areas within the Sydney Basin Bioregion. The Maroota population of *Darwinia fascicularis* subsp. *oligantha* is known from 3 remnant sites. The total population appeared to be about 500 individuals in 1999. The population is disjunct and at or near the southern limit of its geographic range (OEH 2011).
Dillwynia tenuifolia	In western Sydney, may be locally abundant particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. May also be common in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (OEH 2017)
Eucalyptus fracta Broken Back Ironbark	Distribution restriction - Confined largely to State Forest. Locally common but restricted to the northern Broken Back Range near Cessnock, NSW (OEH 2017).
Hibbertia procumbens Spreading Guinea Flower	Distribution restriction - Within NSW, known from several locations only on the Central Coast in the Gosford and Wyong local government areas. These

NAME	JUSTIFICATION FOR EXCLUSION FROM ALL PCTS
	populations are at Bumble Hill near Yarramalong in Wyong LGA; Kulnura, Strickland State Forest, Mangrove Mountain, Somersby, Calga/Mt White and Peats Ridge in the Gosford LGA; and near Mogo Creek to the west of Mangrove Creek Dam. It has been recorded in four conservation reserves: Yengo, Popran and Brisbane Water National Parks and the non-production Strickland State Forest (OEH 2017)
Keraudrenia corollata* var. *denticulata* - *endangered population ***Keraudrenia corollata* var. *denticulata*** in the Hawkesbury LGA	Excluded based on distribution restriction. It occurs in the Hawkesbury local government area, disjunct from other populations and at the southern limit of the species' geographic range. All locations for this species within the Hawkesbury local government area are associated with the endangered Sydney Coastal River-flat Forest which does not occur on the Subject Land . Vegetation association includes tall open forest with *Eucalyptus deanei*, *Tristaniopsis laurina*, *Backhousia myrtifolia*, *Commersonia fraseri*, *Rulingia dasyphylla* and *Hibiscus heterophyllus,* which do not occur within the Subject Land .
Lasiopetalum joyceae	Distribution restriction - Has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River (OEH 2018).
***Leionema lamprophyllum* subsp. *obovatum* -** endangered population in the Hunter Catchment	Occurs in dry eucalypt forest on exposed rocky terrain. Population in the Sydney Bioregion restriction to the Hunter Catchment (OEH 2011).
Melaleuca groveana Grove's Paperbark	Grows in heath and shrubland, often in exposed sites, in low coastal hills, escarpment ranges and tablelands on out-copping granite, rhyolite and sandstone on rocky outcrops and cliffs (OEH 2017). It also occurs in dry scrubby open forest and woodlands.
Pimelea curviflora* var. *curviflora	Occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. Populations are known between northern Sydney and Maroota in the north-west (OEH 2017).
Prostanthera cineolifera Singleton Mint Bush	Restricted to only a few localities near Scone, Cessnock and St Albans. Grows in open woodlands on exposed sandstone ridges (OEH 2017).
Pultenaea parviflora	Core distribution is from Windsor to Penrith and east to Dean Park. Outlier populations are recorded from Kemps Creek and Wilberforce. May be locally abundant, particularly within scrubby/dry heath areas within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays (OEH 2017).
Velleia perfoliata	Restricted to the Hawkesbury district and upper Hunter Valley. Found in shallow depressions on Hawkesbury sandstone shelves, on rocky hill sides, under cliffs or on rocky/sandy soils along trails.
FAUNA (9)	
Anthochaera phrygia Regent Honeyeater (Breeding)	The Subject Land is not mapped as containing important breeding habitat for this species (LMBC pers. comm.).
Callocephalon fimbriatum endangered population of the Gang-gang Cockatoo in the Hornsby and Ku-ring-gai LGA's	Excluded population based on a distribution restriction - In New South Wales, the Gang-gang Cockatoo is widely distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes, but the Subject Land is outside the population's natural distribution. It is however, included as a species credit species (*i.e.* not the population) in *Table 4-7.*
Lathamus discolor Swift Parrot (Breeding)	The Subject Land is not mapped as containing important breeding habitat for this species (LMBC pers. comm.).
Litoria booroolongensis Booroolong Frog	The distribution of this species is only predicted for the Yengo sub-region, not known. This species lives along permanent streams with fringing vegetation (TBDC 2018), which do not occur within the Subject Land but may occur in the broader subject property. Occur near cobble banks and other rock structures, as well as vegetation cover on stream edges (TBDC 2018). No permanent stream edges occur within the Subject Land .

NAME	JUSTIFICATION FOR EXCLUSION FROM ALL PCTS
Miniopterus australis Little Bentwing-bat (Breeding)	Maternity sites are usually situated in limestone cave systems (Churchill 2008). The Subject Land contains no caves suitable for breeding. None of the five (5) historical records in the Locality (*Table 4-1*, OEH 2018a) have microhabitat code 'IC – in cave', observation type code 'E nest-roost', or with numbers of individuals >500.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat (Breeding)	The Subject Land contains no caves suitable for breeding. None of the four (4) historical records in the Locality (*Table 4-1*, OEH 2018a) have microhabitat code 'IC – in cave', observation type code 'E nest-roost', or with numbers of individuals >500.
Pandion cristatus Eastern Osprey (Breeding)	Associated with coastal areas, the mouths of large rivers, lagoons and lakes (OEH 2018), which do not occur within or near the Subject Land. Nests are usually within 1 km of the sea (OEH 2018) or 100 metres of a floodplain (TBDC 2018).
Phascolarctos cinereus Koala (Breeding)	Although the subject property contains food tree species that are listed under SEPP 44, there are only five (5) historical records of this species within a 10 km radius of the Subject Land , all of which occur outside the locality. This suggests that there is no local breeding population of koalas.
Pteropus poliocephalus Grey-headed Flying-fox (Breeding)	Although individuals were observed flying over the Subject Land during three (3) nights of spotlighting, and on one occasion were observed feeding in one of the trees located therein, there are no (0) known breeding camps within the Subject Land , and no evidence thereof was found during the current site investigations. Camps are usually found in gullies, close to water in vegetation with a dense canopy (OEH 2017). The closest known roosting camps are Parramatta Park and Gordon, located ~13 km and ~17 km from the Subject Land , respectively, both last surveyed in November 2017, each with an estimated population of 2,500-9,999 individuals (CSIRO & DOE 2018).

4.3.1 Targeted Surveys for Candidate Species Credit Species

The proponent has opted to commission targeted surveys for candidate species credit species rather than assuming they are present or commissioning expert reports. Requirements for targeted surveys include the survey months specified in the BAM Calculator, as well as the survey effort and methods described in the TBDC and guidelines published by the Commonwealth and NSW governments. Where no relevant published guidelines exist, the species survey requirements are based on best practice methods that can be replicated for repeat surveys.

Table 4-5 details the methods used for targeted surveys, while *Table 4-7* lists the methods used for each candidate species credit species and the survey results. Weather conditions during the survey period are detailed in *Table 4-6.*

Table 4-5: Targeted Survey Methods

METHOD	DESCRIPTION
Parallel Transect	The parallel transect survey method requires walking a series of parallel transects that were close enough to each other to allow observation of the entire site. The approach is similar to the parallel field transverse method (*i.e.* parallel transects, as used by Cropper 1993) recommended in the NSW Guide to Surveying Threatened Plants (OEH 2016). Detectability of threatened plants is considered to be high using the parallel field-traverse method, because it systematically covers the entire area of potential habitat within a site and can be applied to a diverse range of species, habitats and sites. A GPS track log of the location of the survey field traversed is provided in *Figure 4-3* to demonstrate that the survey has been

METHOD	DESCRIPTION
	systematic and comprehensive *i.e*. appropriate search effort has been completed within suitable areas of potential habitat.
Random Meander	The parallel transect method could not be applied effectively in most parts of the Subject Land due to landscape features such as large rocky outcrops and drop-offs. Due to these limitations, a random meander method (Cropper 1993) was applied in conjunction with the parallel transect method to undertake a comprehensive threatened flora species survey.
Acoustic Recording	One (1) acoustic call recording device (SongMeter SM2+, Wildlife Acoustics) positioned within target fauna habitat, recording between 7 pm and 7 am. Although automatic call recording is an efficient means of recording calling males, operators should note that a large chorus of a common species may drown out isolated calls of a rarer species on the tape, making identification difficult (Berrill *et al.* 1992 cited in DEWHA 2010c). Recordings of suspected target species calls that cannot be confirmed in house will be forwarded to the Australian Museum for confirmation. SongMeter spectrograms were analysed using Audacity 2.1.0.
Call Playback	Call playback for vocal species after dusk in multiple separate locations within potential habitat (*Figure 4-4*).
Spotlighting	Traverse transects through the Subject Land (*Figure 4-4*) using a spotlight to detect nocturnal fauna in potential habitat after dusk. It should be noted that there was noise and light disturbance from soccer games held in the existing playing field on three (3) spotlighting nights: 9th, 23rd and 24th October 2018.
Area Search	Randomly traverse the Subject Land (*Figure 4-5*); stopping or moving to investigate sightings, calls or signs of fauna presence, which include: Scats; scratches; sap-feeding scars; diggings; nests; dreys; bones; hair; shed skins; tracks; burrows; orts (chewed cones) and feeding pellets. Signs verified with reference to Triggs (2004).
Camera Trapping	Infrared cameras (*SG550V8*, ScoutGuard) recording 24 hrs/day set to a sensitivity level of 'normal', capturing three (3) images when triggered with a one (1) minute recovery time; placed at a height of ~1 m above ground level and angled slightly downwards towards a 'universal bait' of oats, peanut butter and honey.
Ultrasonic Monitoring	Ultrasonic bat call recorders (*AnaBat Express,* Titley Electronics) positioned where predicted 'fly-ways' exist, recording at night. Bat calls were identified by Fauna Ecologist Amanda Lo Cascio using AnalookW (Version 4.1z) with reference to the Pennay *et al*. (2004) and Reinhold *et al.* (2001).
Point Survey	Conducted for varying lengths of time at several habitat-determined positions (*Figure 4-5*). Birds identified visually and/or by their characteristic calls (Morcombe & Stewart 2014; Pizzey & Knight 2013).
Active Search	Carefully turning over or searching in rocks, crevices, logs, hollows, urban refuse, leaf litter and other ground cover (returning these to their original position after inspection). Concentrating on species-specific potential habitat (*e.g.* riparian areas, ridges, caves, man-made structures or around the base of trees).

Table 4-6: Daily Weather Conditions During Targeted Surveys

*Weather observations from Meteorological Station #066124 – Parramatta North (Masons Drive) (BOM 2018).

DATE	TEMP. (°C)	WIND (KM/HR)	CLOUD (8th)	RAIN (MM)	MOON (% ILLUMINATED)
05/10/18	12.6–16.0	~15	8	70	22.7
06/10/18	11.2–20.0	~11	8	14	13.4
07/10/18	10.5–18.2	~6	7	1.2	6.3
08/10/18	12.8–22.5	~4	7	6	1.8
09/10/18	10.5–26.8	~6	5	0.4	0.2
10/10/18	15.8–17.0	~7	8	0	1.4
11/10/18	11.6–18.0	~9	7	23	5
12/10/18	10.7–16.5	~4	7	2.8	10.9
13/10/18	8.8–20.2	~6	6	5	18.3
14/10/18	14.5–21.5	~4	8	25	26.9
15/10/18	13.5–22.0	~4	8	6.6	36.3
16/10/18	15.0–24.0	~6	7	2.2	46
17/10/18	15.5–25.3	~2	7	0.8	55.8
18/10/18	15.2–26.0	~2	7	15	65.3
19/10/18	15.5–29.5	~2	8	10	74.2
20/10/18	15.5–31.5	~4	6	0	82.3
21/10/18	14.7–21.2	~11	8	8	89.3
22/10/18	14.0–24.5	~2	7	0	94.7
23/10/18	12.5–30.8	~2	5	0	98.3
24/10/18	15.2–20.2	~19	8	0	-
15/11/18	14.8–24.5	~6	3	0.6	47.4
16/11/18	15.0–21.0	~4	8	4	57.1
17/11/18	12.0–23.0	~2	6	0.6	66.6
19/11/18	11.8–23.4	~4	6	0	84
20/11/18	11.8–27.8	~42	6	0	90.9
21/11/18	18.2–24.0	~11	8	0.2	96.2
22/11/18	15.5–25.0	~9	8	1.8	-
24/11/18	15.0–26.0	~19	2	0	99.7
25/11/18	12.2–25.2	~6	6	0	97.4
26/11/18	12.2–25.0	~9	6	0	92.3
27/11/18	14.8–25.0	~4	6	0	84.6
29/11/18	14.2–23.3	~9	8	29	63.9
10/12/18	19.9–27.8	~7	6	0	7.8

DATE	TEMP. (°C)	WIND (KM/HR)	CLOUD (8th)	RAIN (MM)	MOON (% ILLUMINATED)
03/06/19	14.5-18.0	~2	4	1.0	0.2
15/07/19	7.2-17.7	~19	0	0	98.2
18/07/19	5.8-20.5	~4	0	0	99.5
06/08/19	2.7-21.6	~4	0	0	34.1
13/08/19	4.7-18.3	~2	0	0	96.4
20/08/19	4.8-21.0	~19	0	0	84.9

Figure 4-3: Targeted Flora Survey Effort

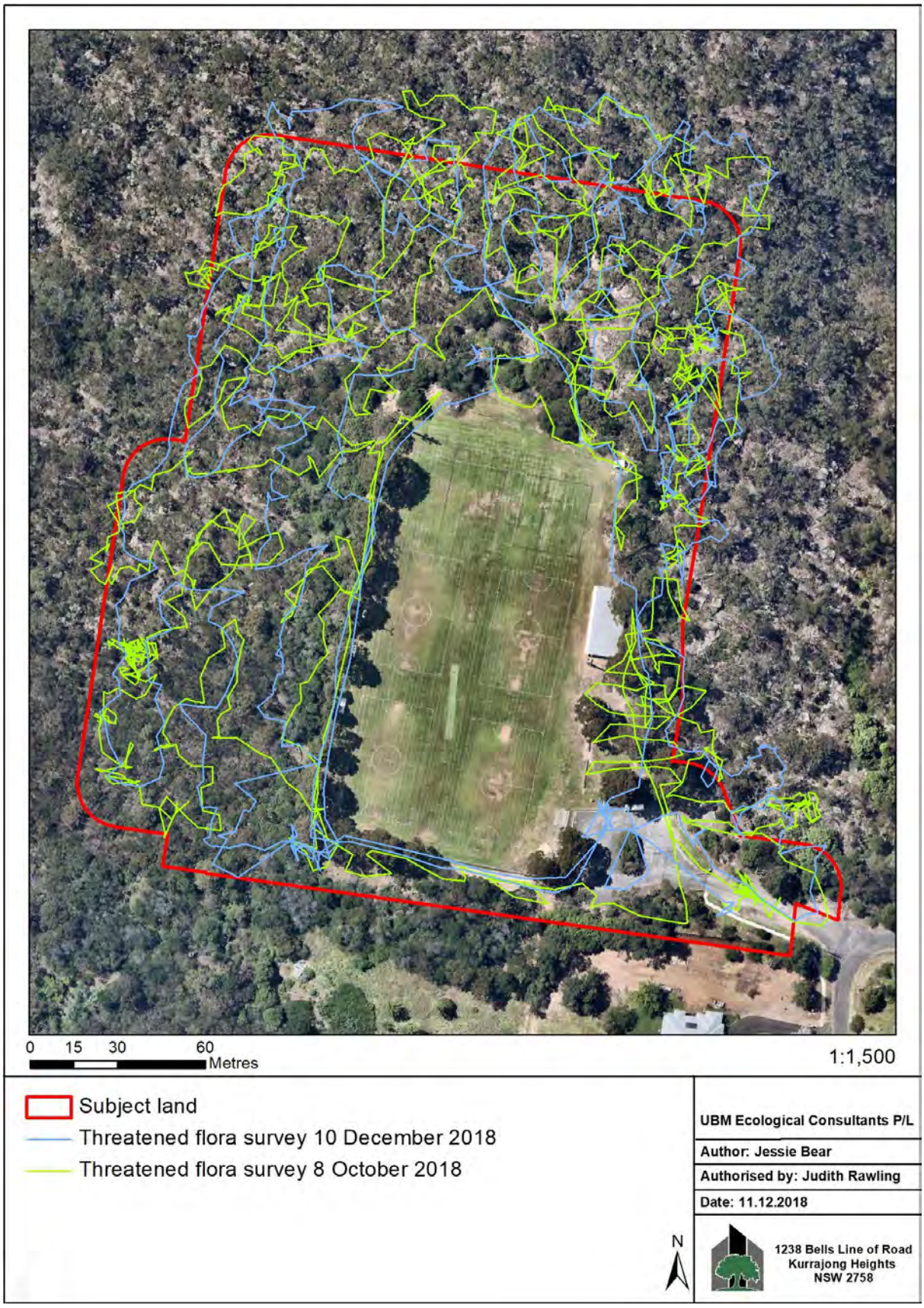


Figure 4-4: Night-time Fauna Survey Effort & Species Observations

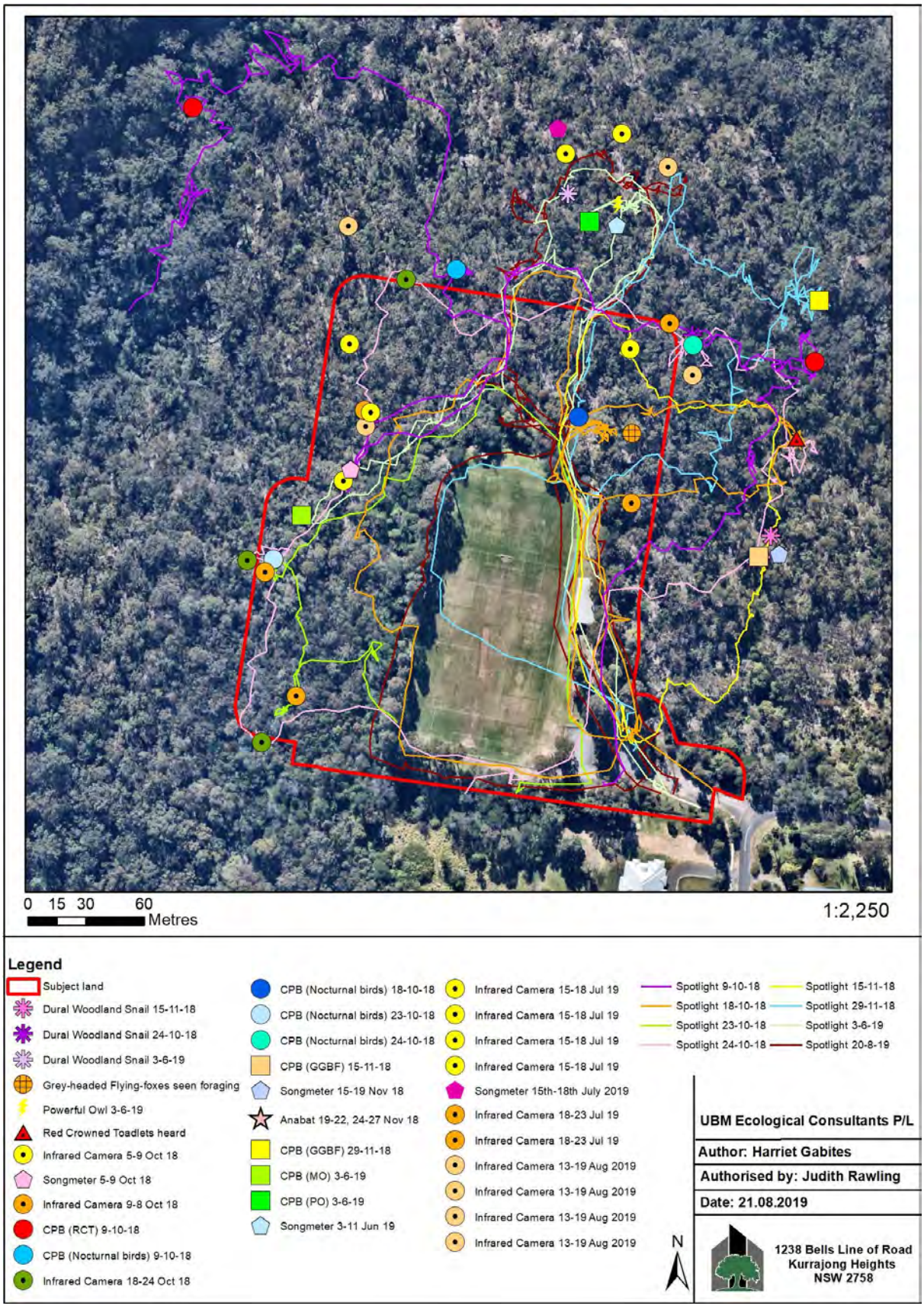


Figure 4-5: Daytime Fauna Survey Effort

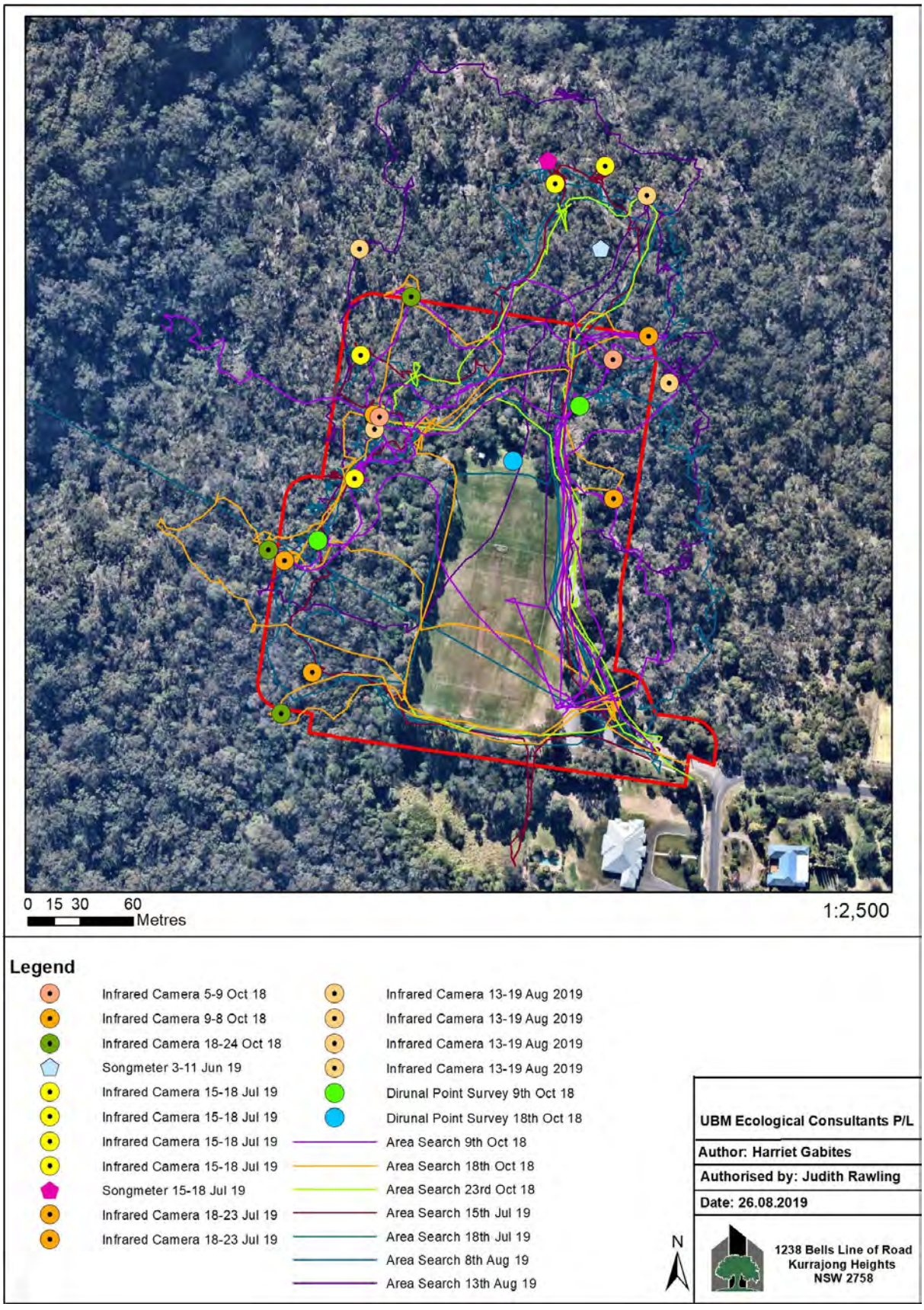


Table 4-7: Candidate Species Credit Species & Targeted Survey Results

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
FLORA (18)			
Acacia bynoeana Bynoe's Wattle	**Included:** Occurs in heath or dry sclerophyll forest on sandy soils, which is present in the Subject Land . *Acacia bynoeana* prefers open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches. Associated overstorey species include Red Bloodwood, Scribbly Gum, Parramatta Red Gum, Saw Banksia and Narrow-leaved Apple (OEH 2017). The Subject Landcontains features associated with *Acacia bynoeana's* preferred habitat.	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Acacia gordonii	**Included:** Grows in dry sclerophyll forest and heathlands amongst or within rock platforms on sandstone outcrops. This species is found within the Hawkesbury, Blue Mountains and Baulkham Hills Local Government Areas (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Acacia gordonii*.	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Callistemon linearifolius Netted Bottle Brush	**Included:** In the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. Grows in dry sclerophyll forest on the coast and adjacent ranges (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Callistemon linearifolious.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Darwinia biflora	**Included:** Recorded in Ku-ring-gai, Hornsby, Baulkham Hills and Ryde Local Government Areas. Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species *include Eucalyptus haemastoma*, *Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Darwinia biflora.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
Darwinia peduncularis	**Included:** It has been recorded from Brooklyn, Berowra, Galston Gorge, Hornsby, Bargo River, Glen Davis, Mount Boonbourwa and Kings Tableland. Usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Darwinia peduncularis.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Epacris purpurascens* var. *purpurascens	**Included:** Recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. Found in a range of habitat types, most of which have a strong shale soil influence (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Epacris purpurascens* var. *purpurascens.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Eucalyptus* sp. *Cattai	**Included:** Occurs in the area between Colo Heights and Castle Hill, north-western Sydney, with historical records from central Sydney. Occurs as a rare emergent tree in scrub, heath and low woodland on sandy soils, usually as isolated individuals or occasionally in small clustered groups. The sites at which it occurs are generally flat and on ridge tops (OEH 2018). The Subject Land contains features associated with the preferred habitat of *Eucalyptus sp. Cattai.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Grevillea parviflora* subsp. *parviflora Small-flower Grevillea	**Included:** Grows in sandy or light clay soils usually over thin shales, often with lateritic ironstone gravels and nodules. Occurs in a range of vegetation types from heath and shrubby woodland to open forest. In Sydney it has been recorded from Shale Sandstone Transition Forest, Sydney Sandstone Ridgetop Woodland and in Cooks River/Castlereagh Ironbark Forest (OEH 2018). The Subject Land contains features associated with the preferred habitat of *Grevillea parviflora* subsp. *Parviflora.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
Grevillea parviflora* subsp. *supplicans	**Included:** Has a very restricted known distribution (approx. 8 by 10 km) and is confined to the north-west of Sydney near Arcadia and the Maroota–Marramarra Creek area, in Hornsby and Baulkham Hills local government areas. Occurs in heathy woodland associations on skeletal sandy soils over massive sandstones (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Grevillea parviflora* subsp. *supplicans.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Hibbertia puberula	**Included:** Distribution extends from Wollemi National Park south to Morton National Park and the south coast near Nowra. Early records of this species are from the Hawkesbury River area and Frenchs Forest in northern Sydney, South Coogee in eastern Sydney, the Hacking River area in southern Sydney, and the Blue Mountains (OEH 2017). Prefers dry sclerophyll woodland communities and low heath on sandy soils or rarely in clay, with or without rocks underneath (Toelken & Miller 2012). The Subject Land contains features associated with the preferred habitat of *Hibbertia puberula.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Hibbertia superans	**Included:** Occurs from Baulkham Hills to South Maroota in the northern outskirts of Sydney, where there are currently 16 known sites. The species occurs on sandstone ridgetops often near the shale/sandstone boundary. Occurs in both open woodland and heathland, and appears to prefer open disturbed areas, such as tracksides (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Hibbertia superans.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Kunzea rupestris	**Included:** Restricted, with most locations in the Maroota - Sackville - Glenorie area and one outlier in Ku-ring-gai Chase National Park, all within the Central Coast botanical subdivision of NSW. Grows in shallow depressions on large flat sandstone rock outcrops Found in short to tall shrubland	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
	(OEH 2017). The Subject Land contains features associated with the preferred habitat of *Kunzea rupestris.*		
Leucopogon fletcheri* subsp. *fletcheri	**Included:** Restricted to north-western Sydney between St Albans in the north and Annangrove in the south, within the local government areas of Hawkesbury, Baulkham Hills and Blue Mountains. Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Leucopogon fletcheri* subsp. *fletcheri.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Melaleuca deanei Deane's Paperbark	**Included:** Occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. The species occurs mostly in ridgetop woodland, with only 5% of sites in heath on sandstone. Grows in wet heath on sandstone; uncommon, in coastal districts from Berowra to Nowra (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Melaleuca deanei.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 10/12/18; 10:20 am start; 4.5 hours	No (0) specimens found = **Excluded.**
Micromyrtus blakelyi	**Included:** Restricted to areas near the Hawkesbury River, north of Sydney. Distribution extends from north of Maroota in the north, to Cowan in the south. All known populations occur within the Baulkham Hills and Hornsby local government areas. Typically occurs within heathlands in shallow sandy soil in cracks and depressions of sandstone rock platforms (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Micromyrtus blakelyi.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
Olearia cordata	**Included:** Distribution is scattered and generally restricted to the south-western Hunter Plateau, eastern Colo Plateau, and the far north-west of the Hornsby Plateau near Wisemans	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
	Ferry east of Maroota. Grows in dry open sclerophyll forest and open shrubland, on sandstone ridges (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Olearia cordata.*		
Persoonia hirsuta Hairy Geebung	**Included:** Has a scattered distribution around Sydney. Found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Persoonia hirsuta.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 10/12/18; 10:20 am start; 4.5 hours	No (0) specimens found = **Excluded.**
Tetratheca glandulosa	**Included:** Restricted to the following Local Government Areas: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Common woodland tree species include: *Corymbia gummifera*, *C. eximia*, *Eucalyptus haemastoma*, *E. punctata, E. racemosa,* and/or *E. sparsifolia*, with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae. Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone (OEH 2017). The Subject Land contains features associated with the preferred habitat of *Tetratheca glandulosa.*	▪ Parallel transects and random meander (Cropper 1993; OEH 2016). o 08/10/18; 8 am start; 7 hours.	No (0) specimens found = **Excluded.**
FAUNA (22)			
Burhinus grallarius Bush Stone-curlew	**Included:** The Subject Land contains the habitat constraint fallen/standing dead timber including logs. This species is associated with open forests that have a sparse grassy ground layer and fallen timber (OEH 2017). **Excluded from 1080_Planted:** Mown grass maintained as parkland, contains no dead timber or logs (OEH 2017).	▪ Area search (DEC 2006). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Spotlighting (DEC 2006). o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours.	No individuals detected = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
		o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours. ▪ Call playback (DEC 2006). o 09/10/18; 2 rounds separated by a 5-minute listening period. o 18/10/18; 8 pm and 9:20 pm; 2 rounds at each start time separated by a 5-minute listening period. o 23/10/18; 8:05 pm; 2 rounds separated by a 5-minute listening period. o 24/10/18; 8:15 pm; 2 rounds separated by a 5-minute listening period. ▪ Acoustic recording (DEC 2006). o 05/10/18–08/10/18; 42.2 hours. o 15/11/18–17/11/18; 29 hours. ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	
Callocephalon fimbriatum Gang-gang Cockatoo (Breeding)	**Included:** The Subject Land is more typical of this species' autumn and winter habitat (dry open eucalypt forest) but there are suitably sized nesting hollows (> 9 cm) therein, which are potential breeding habitat. Breeding habitat for this species has been included for further survey based on the precautionary principal (OEH 2017).	▪ Area search (DEC 2004; DEWHA 2010a). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Acoustic recording (DEC 2004; DEWHA 2010a). o 05/10/18–08/10/18; 7 hours (dusk and dawn only). o 15/11/18–17/11/18; 5 hours (dusk and dawn only). ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	Although hollows of suitable size are available, no individuals were detected and therefore no breeding habitat is considered to be present on the Subject Land (TBDC 2018) **= Excluded.**
Calyptorhynchus lathami Glossy Black-Cockatoo (Breeding)	**Included:** Inhabits open forests. The Subject Land contains *Allocasuarina* spp. foraging resources (OEH 2017; NSW Scientific Committee 2008) as well as potential breeding habitat in the form of living or dead tree with hollows greater	▪ Acoustic recording (DEWHA 2010a). o 03/06/19–04/06/19; 12 hours. o 15/06/19–18/06/19; 36 hours ▪ Area search for hollows (DEC 2004).	No individuals detected, no chewed cones (orts) were observed = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
	than 15 cm diameter and greater than 5 m above ground (TBDC 2018). **Excluded from 1080_Planted:** Contains no hollow-bearing trees and lacks stands of *Allocasuarina* spp. food trees (OEH 2017).	o 15/06/19; 9:00 am start; 3 hours. o 18/06/19; 9:00 am start; 3 hours ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	
Cercartetus nanus Eastern Pygmy-possum	**Included:** Associated with sclerophyll forest. Foraging resources in the form of banksias, eucalypts and bottlebrushes are present on the Subject Land. Shelter resources in the form of tree hollows, dreys, and dense groundcover vegetation (*e.g.* grass trees) are also present (OEH 2017).	▪ Spotlighting (DSEWPaC 2011b) o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours. o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours.	No individuals detected = **Excluded.**
Chalinolobus dwyeri Large-eared Pied Bat	**Included:** The Subject Land contains the habitat constraint of being within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops or crevices. This species forages for insects and is found in open forest areas containing gullies (OEH 2017).	▪ Ultrasonic monitoring (DEWHA 2010b; OEH 2018d). o 19/11/18–22/11/18; 2 Anabats x 4 nights o 24/11/18–27/11/18; 2 Anabats x 4 nights	No individuals detected = **Excluded.**
Haliaeetus leucogaster White-bellied Sea-Eagle (Breeding)	**Included:** Widely distributed in New South along the east coast. The Subject Land contains terrestrial habitats that may be used for foraging by the White-bellied Sea-eagle such as heathland and woodland. Breeding habitat consists of mature tall open forest, open forest, tall woodland, and swamp sclerophyll forest close to foraging habitat. Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts' (OEH 2017).	▪ Area search (DEWHA 2010a). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Point survey (DEWHA 2010a). o 09/10/18; 2 x 10-minute points. o 18/10/18; 1 x 10-minute point. ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	The Subject Land is not considered to contain breeding habitat because no large stick nests were observed and no individuals were detected during survey (TBDC 2018) = **Excluded.**
Heleioporus australiacus Giant Burrowing Frog	**Included:** Occurs in dry sclerophyll forest, but not on clay-based soil. The Subject Land contains leaf litter, rocks, ground vegetation, which may be used by this species. There is one 1st order stream on the Subject Land and other streams in the broader subject property (OEH 2017).	▪ Spotlighting under wet conditions/within one (1) week of heavy rainfall (DEWHA 2010c). o 09/10/18; 6:30 pm start; 2.5 hours o 18/10/18; 7:20 pm start; 2.5 hours o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours.	No individuals detected = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
	Excluded from 1080_Planted: Mown grass maintained as parkland present on clay fill soil, which this species does not occur on. Leaf litter cover in this VZ is the lowest recorded for the Subject Land.	o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours.	
Hieraaetus morphnoides Little Eagle (Breeding)	**Included**: Uses open eucalypt forest. Builds a stick nest in tall living trees within a remnant patch and preys on birds, reptiles, mammals and insects (OEH 2017).	▪ Area search (DEWHA 2010a). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Point survey (DEWHA 2010a). o 09/10/18; 2 x 10-minute points. o 18/10/18; 1 x 10- minute point. ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	The Subject Land is not considered to contain breeding habitat because no large stick nests were observed and no individuals were detected during survey (TBDC 2018) = **Excluded.**
Hoplocephalus bitorquatus Pale-headed Snake	**Included:** Found in dry eucalypt forest and shelters in tree hollows and loose bark, which are present on the Subject Land (OEH 2017).	▪ Spotlighting after rainfall and on humid nights (TBDC 2018). o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours.	No individuals detected = **Excluded.**
Hoplocephalus bungaroides Broad-headed Snake (Breeding)	**Included:** The Subject Land contains shelter sites in the form of sandstone rock crevices and tree hollows. This species preys on small lizards, small mammals and frogs (OEH 2017). Habitat constraint for breeding is rocky areas including escarpments, outcrops and pagodas within the Sydney Sandstone geologies (TBDC 2018).	▪ Active diurnal search (DEWSPaC 2011a). o 6/08/19; 9:00 am start; 3 hours. o 13/08/19; 9:00 am start; 3 hours. ▪ Active nocturnal search (DEWSPaC 2011a). o 20/08/19; 5:30 pm start; 2.5 hours. ▪ Camera trap rock crevice watching o 13/08/19- 19/08/19; 42 hours.	No individuals detected = **Excluded.**
Litoria aurea Green and Golden Bell Frog	**Included:** The Subject Land contains the following habitat constraints: ephemeral wet areas (drainage line); and being within 1 km of wet areas and waterbodies (OEH 2017). The Subject Land also contains refuge habitat in the form of dense groundcovers, logs, and rocks (DECC 2008).	**Note:** Although optimal survey period according to the TBDC is November–March, DEWHA (2010c) notes this species calls from September–January. As such the October surveys listed below are included in the survey effort for this species.	No individuals detected = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
		▪ Spotlighting within one (1) week of heavy rainfall (DEWHA 2010c). o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours. ▪ Call playback (DEWHA 2010c). o 09/10/18; 2 rounds separated by a 5-minute listening period at each of 2 points. o 15/11/18; 2 rounds separated by a 5-minute listening period. o 29/11/18; 2 rounds separated by a 5-minute listening period. ▪ Acoustic recording (DEWHA 2010c). o 05/10/18–08/10/18; 42.2 hours. o 15/11/18–17/11/18; 29 hours.	
Lophoictinia isura Square-tailed Kite (Breeding)	**Included:** Found in open forests, particularly timbered watercourses. Preys on passerine birds. Breeding is from July to February, with nest sites generally located along or near watercourses, in a fork or on large horizontal limbs (OEH 2017).	▪ Area search (DEWHA 2010a). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Point survey (DEWHA 2010a). o 09/10/18; 2 x 10- minute points. o 18/10/18; 1 x 10-minute point. ▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	The Subject Land is not considered to contain breeding habitat because no large stick nests were observed, and no individuals were detected during survey (TBDC 2018) = **Excluded.**
Myotis Macropus Southern Myotis	**Included:** The Subject Land contains the habitat constraints: Hollow-bearing trees; being within 200 meters of a riparian zone and waterbodies and has artificial structures. Dense foliage is also present, though foraging habitat only exists in waterbodies on the broader subject property not the Subject Land (OEH 2017).	▪ Ultrasonic monitoring (DEWHA 2010b; OEH 2018d). o 19/11/18–22/11/18; 2 Anabats x 4 nights o 24/11/18–27/11/18; 2 Anabats x 4 nights	Detected with a probable reliability of identification during the recent surveys. Included based on the precautionary principle.

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
			Species polygon = A (3.64 ha, *Figure 4-6*).
Ninox connivens Barking Owl (Breeding)	**Included:** Occurs in open forest, including fragmented remnants. Roosts in tree canopies and dense midstorey trees, and preys on small mammals, birds and invertebrates (OEH 2018). The Subject Land contains the breeding habitat constraint of having living or dead trees with hollows greater than 20 cm diameter and greater than 4 m above the ground (TBDC 2018).	▪ Spotlighting (DEWHA 2010a). o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours. ▪ Call playback (DEWHA 2010a). o 09/10/18; 2 rounds separated by a 5-minute listening period. o 18/10/18; 8 pm and 9:20 pm; 2 rounds at each start time separated by a 5-minute listening period. o 23/10/18; 8:05 pm; 2 rounds separated by a 5-minute listening period. o 24/10/18; 8:15 pm; 2 rounds separated by a 5-minute listening period. ▪ Acoustic recording (DEWHA 2010a). o 05/10/18–08/10/18; 42.2 hours. o 15/11/18–17/11/18; 29 hours.	Although hollows of suitable size are available, no individuals were detected and therefore no breeding habitat is considered to be present on the Subject Land (TBDC 2018) = **Excluded.**
Ninox strenua Powerful Owl (Breeding)	**Included:** Inhabits open sclerophyll forest. Roosts in dense canopy or midstorey trees, and preys on arboreal mammals (OEH 2017). Potential breeding habitat is present within the Subject Land, that being living or dead trees with hollow greater than 20 cm diameter (TBDC 2018).	▪ Spotlighting (DEWHA 2010a). o 03/06/19; 6:30 pm start; 2.5 hours. o 20/08/19 ▪ Call playback (DEWHA 2010a). o 03/06/19; 2 rounds separated by a 5-minute listening period. ▪ Acoustic recording (DEWHA 2010a). o 03/06/19–04/06/19; 12 hours. o 15/06/19–18/06/19; 36 hours	A single male was recorded calling on the morning of the 6th October and the 15th and 17th November, and a male was heard calling persistently on multiple nights during spotlighting and on recordings between June-August 2019. A male responded immediately to call playback on the 3rd of

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
		▪ Area search for hollows (DEC 2004). o 15/06/19; 9:00 am start; 3 hours. o 18/06/19; 9:-- am start; 3 hours ▪ Camera trap stag watching. o 15/07/19–23/07/19; 56 hours.	June 2019. No active hollows were observed during stag watching. This suggests that the Subject Land is likely to be used to search for mates however, nesting is likely to occur in hollows outside the surveyed area. **Species polygon = A (3.64 ha,** *Figure 4-6*).
Petaurus norfolcensis Squirrel Glider	**Included:** Coastal habitat is forest with heath understorey, shelters in tree hollows and feeds on *Acacia* gum, eucalypt sap, nectar, honeydew, invertebrates and pollen (OEH 2017).	▪ Spotlighting (DSEWPaC 2011b) o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours. o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours.	No individuals detected = **Excluded.**
Petrogale penicillata Brush-tailed Rock-wallaby	**Included:** The Subject Land contains the habitat constraint of being within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or cliff lines. The Subject Land contains outcrops, overhangs and crevices (OEH 2017).	▪ Area search (DSEWPaC 2011b). o 09/10/18; 2:30 pm start; 2 hours o 18/10/18; 4 pm start; 2 hours o 23/10/18; 6:35 pm start; 1 hour. ▪ Camera trapping (DSEWPaC 2011b). o 05/10/18–09/10/18; 2 cameras x 4 nights. o 09/10/18–18/10/18; 3 cameras x 9 nights. o 18/10/18–24/10/18; 3 cameras x 6 nights. ▪ Spotlighting (DSEWPaC 2011b) o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours. o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours.	No individuals detected = **Excluded.**

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
		▪ Opportunistic survey during plot-based floristic survey and habitat assessment.	
Phascogale tapoatafa Brush-tailed Phascogale	**Included:** The Subject Land contains the habitat constraint of hollow-bearing trees. This species lives in dry sclerophyll open forest, uses rough-barked trees with DBH at least 25 cm, and feeds on invertebrates, nectar and small vertebrates (OEH 2018).	▪ Spotlighting (DSEWPaC 2011b) o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 2.5 hours. o 23/10/18; 7:35 pm start; 1 hour. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours. ▪ Camera trapping (DSEWPaC 2011b). o 05/10/18–09/10/18; 2 cameras x 4 nights. o 09/10/18–18/10/18; 3 cameras x 9 nights. o 18/10/18–24/10/18; 3 cameras x 6 nights.	No individuals detected = **Excluded.**
Pommerhelix duralensis Dural Land Snail	**Included:** Opportunistically observed during spotlighting for other species. Although not currently listed as being associated with PCT 1083, the flora and substrates that occur therein are similar to the PCTs the Dural Land Snail is associated with and the ecological associations of this species may not be fully known. Moreover, the Dural Land Snail meets all other criteria to be included on the candidate species credit species list (*Section 4.3*). The Subject Land contains the habitat constraints of leaf litter, rocks and logs (TBDC 2018). **Excluded from 1080_Planted:** Mown grass maintained as parkland and frequently trampled. Leaf litter cover in this VZ is the lowest recorded for the Subject Land and the VZ contains no logs or rocks. Given the level of disturbance and degradation, VZ 1080_Planted is not likely to be used by this species. **Excluded from 0.18 ha of 1083_Degraded:** The 0.18 ha of 1083_Degraded that has been excluded is greater than 50 metres from rocks, which is a habitat constraint for this species.	▪ Spotlighting. o 24/10/18; 7:30 pm start; 2 hours. o 15/11/18; 8:30 pm start; 2 hours. o 29/11/18; 8:30 pm start; 1.16 hours. o 3/06/19; 6:30 p, start; 1 hour.	A total of five (5) active individuals were detected during spotlighting for other species on the 24th of October 2018, 15th of November 2018, and 3rd of June 2019. **Species polygon = 2.83 ha** (*Figure 4-8*).

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
	Excluded from 0.11 ha of 1083_Modified: The 0.11 ha of 1083_Modified that has been excluded is greater than 50 metres from rocks and/or isolated from potential habitat by roads.		
Pseudophryne australis Red-crowned Toadlet	**Included:** Inhabits periodically wet drainage lines below sandstone ridges within open forests. The Subject Land contains an ephemeral drainage line (and is close to others on the subject property), as well as shelter in the form of rocks, leaf litter, logs and dense groundcovers (OEH 2017). **Excluded from 1080_Planted:** Mown grass maintained as parkland on clay fill soil. This VZ lacks suitable shelter habitat in the form of rocks, logs and dense groundcover. Additionally, leaf litter cover in this VZ is the lowest recorded for the Subject Land. Red-crowned Toadlets are largely restricted to the immediate vicinity of suitable breeding habitat (OEH 2017).	▪ Spotlighting after heavy rainfall (NPWS 2001). o 09/10/18; 6:30 pm start; 2.5 hours. o 18/10/18; 7:20 pm start; 0.5 hours ▪ Active search along ridges and stream beds, and at the bases of trees (NPWS 2001). o 09/10/18; 5–10 points. o 18/10/18; 15 points. ▪ Call playback including loud retort (NPWS 2001). o 09/10/18; 2 rounds separated by a 5-minute listening period at each of 2 points. o 18/10/18; loud retort. ▪ Acoustic recording (NPWS 2001). o 05/10/18–08/10/18; 42.2 hours. o 15/11/18–17/11/18; 29 hours.	Confirmed calls first detected on the bank of the first order stream east of the Subject Land on the 18/10/18, and during subsequent surveys for other species. Identification from acoustic recording verified by Jodie Rowley from the Australian Museum. **Species polygon = (3.13 ha,** *Figure 4-7*).
Tyto novaehollandiae Masked Owl (Breeding)	**Included:** Lives in dry eucalypt forests and preys on small mammals. The Subject Land contains hollow-bearing trees that are greater than 20 cm in diameter (TBDC 2018).	▪ Spotlighting (DEWHA 2010a). o 03/06/19; 6:30 pm start; 2.5 hours. o 20/08/19 ▪ Call playback (DEWHA 2010a). o 03/06/19; 2 rounds separated by a 5-minute listening period. ▪ Acoustic recording (DEWHA 2010a). o 03/06/19–04/06/19; 12 hours. o 15/06/19–18/06/19; 36 hours ▪ Area search for hollows (DEC 2004). o 15/06/19; 9:00 am start; 3 hours. o 18/06/19; 9:00 am start; 3 hours ▪ Camera trap stag watching. o 15/07/19–23/07/19; 56 hours.	No individuals detected = **Excluded**.

SPECIES	JUSTIFICATION FOR INCLUSION/EXCLUSION	METHODS (REFER TO *Table 4-5*)	RESULTS & SPECIES POLYGON
Vespadelus troughtoni Eastern Cave Bat	**Included:** The Subject Land contains the habitat constraint of being within 2 km of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, and within 2 km of old buildings or sheds. Little is known about this species (OEH 2017).	▪ Ultrasonic monitoring (DEWHA 2010b; OEH 2018d). o 19/11/18–22/11/18; 2 Anabats x 4 nights o 24/11/18–27/11/18; 2 Anabats x 4 nights	Detected with a probable reliability of identification during the recent surveys. Included based on the precautionary principle. **Species polygon = A (3.64 ha,** *Figure 4-6*).

4.3.2 Species Polygons

For those species credit species determined to be present or assumed to be present, a species polygon was used to identify the area, or count and location of the suitable habitat for the species on the Subject Land.

Count is only used for flora species where the unit of measure is a count (or estimation) of individual plants, according to the Threatened Biodiversity Data Collection. The species polygon is to be established by the location of the individual plant or group of plants, and a 30-metre buffer area around the outside of the individual plant or group of plants.

Where the unit of measure is area, the species polygon is used to measure the area and location of suitable habitat.

Where a species is assumed to be present, the species polygon must encompass either:

a) the fauna/flora habitat or number of individuals assumed to be present on the development site based on an expert report, or

b) the entire Vegetation Zone/s within which the candidate species is predicted to use/occur, based on habitat suitability assessment.

Species polygons that have been assigned to multiple species as noted in *Table 4-7* are illustrated in *Figure 4-6.* The Red-crowned Toadlet has a unique species polygon (*Figure 4-7*). The Dural Land Snail has a unique species polygon (*Figure 4-8*).

Species counts, species polygons and biodiversity risk weightings for species credit species detected on site or assumed present are detailed in *Table 4-8,* along with the vegetation integrity of the VZs mapped in species polygons. Species with a biodiversity risk weighting of '3' are candidate Serious and Irreversible Impact (SAII) species, which are further discussed in *Section 6.1*.

Figure 4-6: Category A Species Polygon (All VZs)

Note: Species with this species polygon are identified in *Table 4-7.*

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56

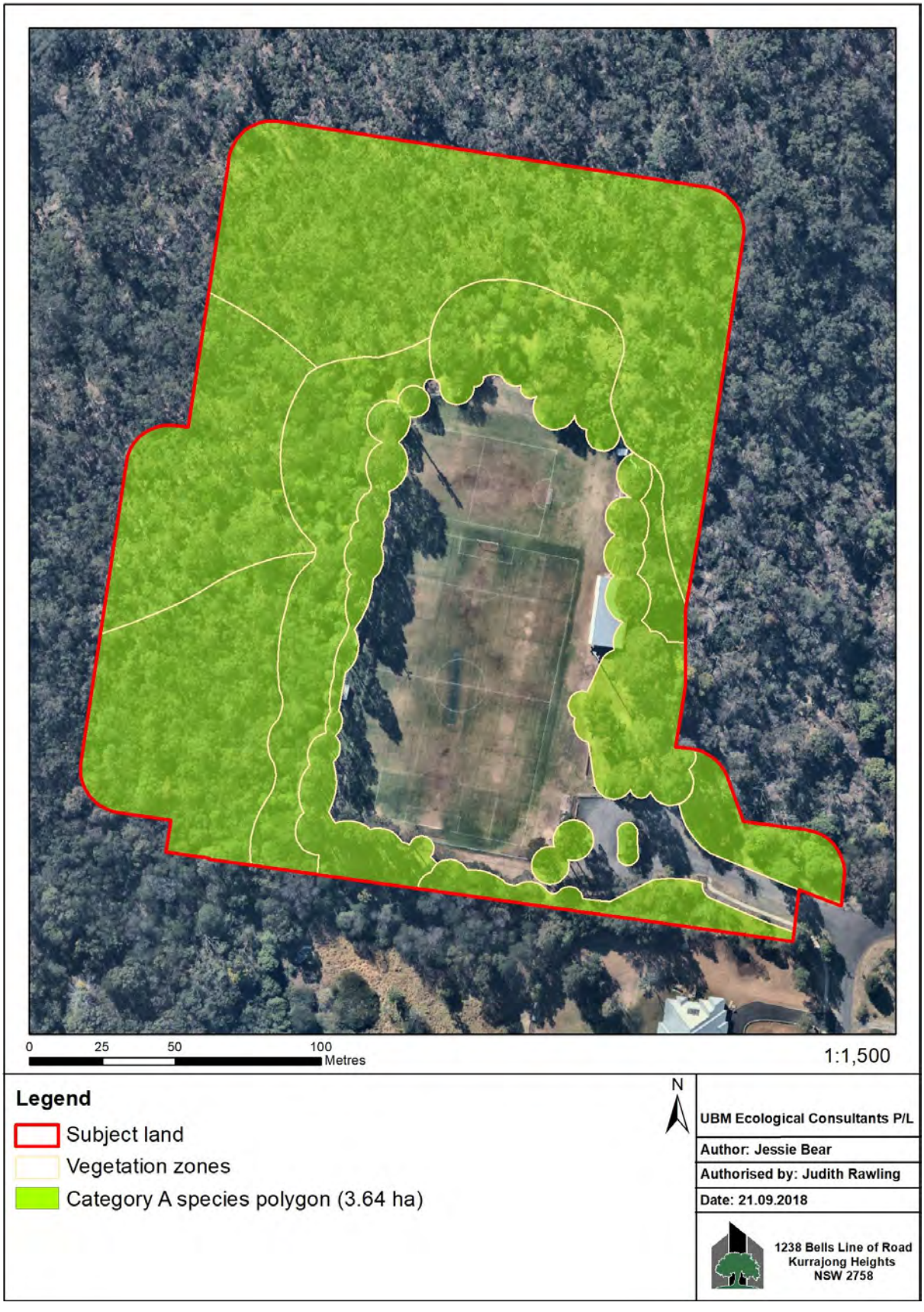


Figure 4-7: Red-crowned Toadlet Species Polygon (All VZs except 1080_Planted)

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56

Figure 4-8: Species Polygon for Dural Land Snail

Note: Read map in conjunction with species description in *Table 4-7*

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56

Table 4-8: Biodiversity Risk Weighting & Species Polygons/Counts

Source: OEH (2019).

Species credits for threatened species

Vegetation zone name	Habitat condition (vegetation integrity) loss	Area / Count	Biodiversity risk weighting	Candidate SAII	Species credits
Myotis macropus / Southern Myotis (Fauna)					
1083_Good	50.8	0.46	2	False	12
1083_Modified	44.0	0.53	2	False	12
1080_Planted	18.1	0.51	2	False	5
1083_Degraded	26.9	0.38	2	False	5
1083_Good-Burned	29.0	1.23	2	False	18
1083_Good-Allo	50.9	0.53	2	False	13
				Subtotal	**65**
Ninox strenua / Powerful Owl (Fauna)					
1083_Good	50.8	0.46	2	N/A	12
1083_Modified	44.0	0.53	2	N/A	12
1080_Planted	18.1	0.51	2	N/A	5
1083_Degraded	26.9	0.38	2	N/A	5
1083_Good-Burned	29.0	1.23	2	N/A	18
1083_Good-Allo	50.9	0.53	2	N/A	13
				Subtotal	**65**

Pommerhelix duralensis / Dural Woodland Snail (Fauna)					
1083_Modified	44.0	0.42	2	False	9
1083_Good	50.8	0.46	2	False	12
1083_Degraded	26.9	0.19	2	False	3
1083_Good-Burned	29.0	1.23	2	False	18
1083_Good-Allo	50.9	0.53	2	False	13
				Subtotal	**55**
Pseudophryne australis / Red-crowned Toadlet (Fauna)					
1083_Good	50.8	0.46	1.5	False	9
1083_Modified	44.0	0.53	1.5	False	9
1083_Degraded	26.9	0.38	1.5	False	4
1083_Good-Burned	29.0	1.23	1.5	False	13
1083_Good-Allo	50.9	0.53	1.5	False	10
				Subtotal	**45**
Vespadelus troughtoni / Eastern Cave Bat (Fauna)					
1083_Good	50.8	0.46	3	True	18
1083_Modified	44.0	0.53	3	True	17
1080_Planted	18.1	0.51	3	True	7
1083_Degraded	26.9	0.38	3	True	8
1083_Good-Burned	29.0	1.23	3	True	27
1083_Good-Allo	50.9	0.53	3	True	20
				Subtotal	**97**

4.4 Prescribed Biodiversity Impacts

The BAM Operational manual states that "Prescribed impacts are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss (Section 6.7 of the BAM). These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. In general, these types of impacts identify habitat or features of the environment that are irreplaceable. Stage 1 of the BAM seeks to identify if the proposal is likely to result in any prescribed impacts that must be included in the BAR (OEH 2018f)."

"The BAM does not provide an approach to determine the number and class of biodiversity credits that are required under a BAR for a prescribed impact. However, the additional prescribed impacts on biodiversity may be considered by a consent authority when they determine the biodiversity credits required to be retired (or other conservation measures required to be taken) under a planning approval (OEH 2018f)."

Prescribed biodiversity impacts are described below in *Table 4-9* and depicted in *Figure 4-9*.

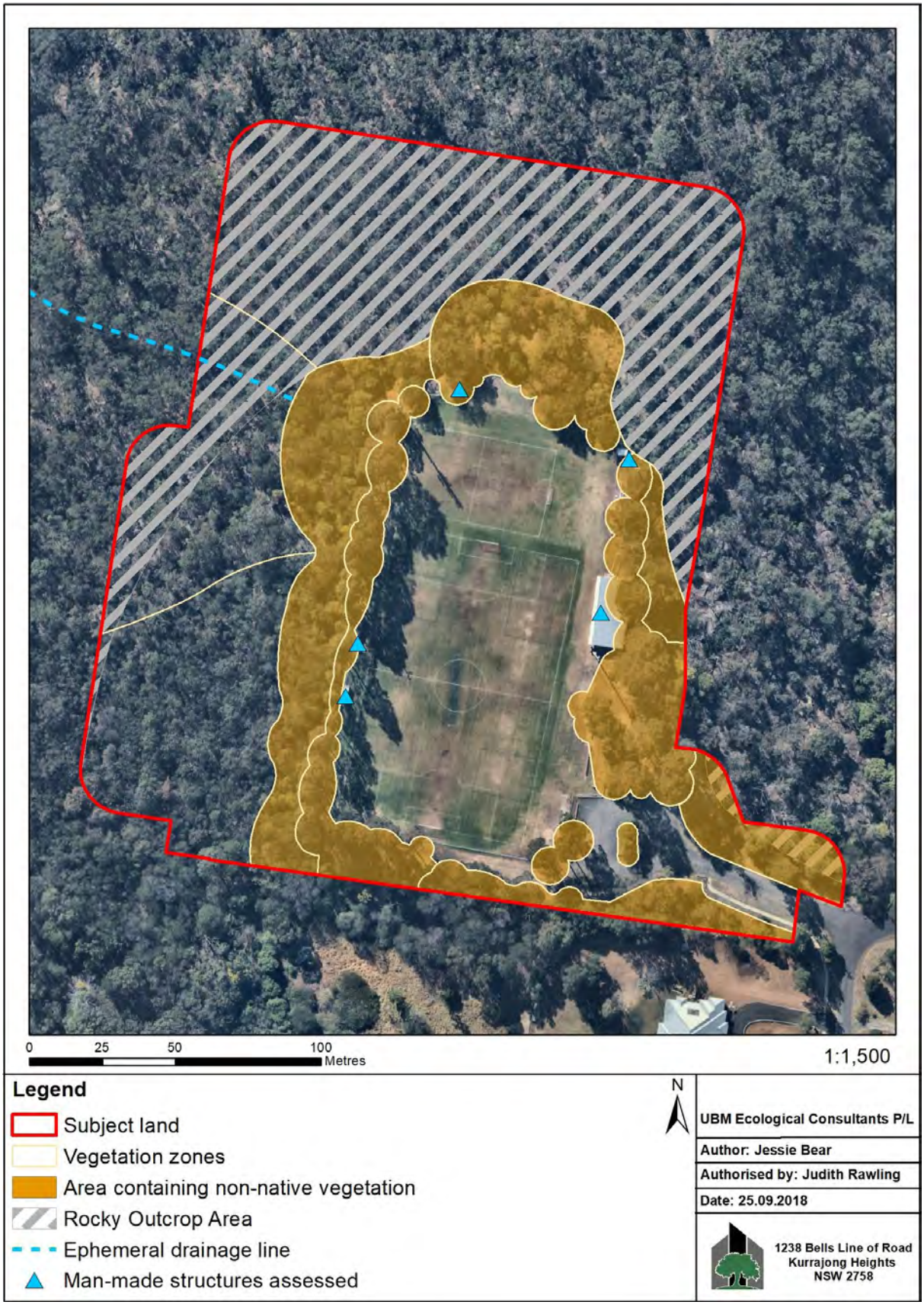
Table 4-9: Prescribed Biodiversity Impacts within the Subject Land

FEATURE	PRESENT?	LOCATION	CHARACTERISTICS & POTENTIAL IMPACT	THREATENED ENTITIES USING FEATURE	SECTION PRESCRIBED IMPACT IS ADDRESSED
Karst, caves, crevices, cliffs, and other geologically significant feature	✓	*Figure 4-2*	Removal of ~1.52 ha of rocky outcrop containing rock crevices and overhangs	Dural Land Snail, Southern Myotis, Eastern Cave Bat, Other cave roosting microbats, Reptiles	*Section 5.2 Table 5-1*
Rocks	✓	*Figure 4-9*	Removal of ~1.52 ha of rocky outcrop containing exposed rock surfaces and loose rocks.	Southern Myotis, Eastern Cave Bat, Other cave roosting microbats, Reptiles	*Section 5.2 Table 5-1*
Human-made structure	✓	*Figure 4-9*	Removal of three (3) or more small man-made structures that may contain roosting crevices	Microbats	*Section 5.2 Table 5-1*
Non-native vegetation	✓	HTE's and other exotic vegetation occurs to varying degrees in VZs	Removal of ~1.42 ha of native vegetation containing non-native species.	Powerful Owl, Birds Mammals	*Section 5.2 Table 5-1*

FEATURE	PRESENT?	LOCATION	CHARACTERISTICS & POTENTIAL IMPACT	THREATENED ENTITIES USING FEATURE	SECTION PRESCRIBED IMPACT IS ADDRESSED
		1080_Planted, 1083_Modified, 1083_Dergraded.			
Hydrological process	✓	*Figure 4-2*	Removal or pollution of the ephemeral drainage line, or pollution (including sedimentation) of waterbodies downstream.	Red-crowned Toadlet, Dural Woodland Snail, Amphibians	*Section 5.2 Table 5-1*
Wind farm development	×	N/A	N/A	N/A	N/A

Figure 4-9: Location of Prescribed Biodiversity Impacts

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56



STAGE 2 – IMPACT ASSESSMENT

5 AVOID & MINIMISE IMPACTS

5.1 Assumptions, Predictions and Limitations to Impact Assessment

At the time of the Final Draft BDAR preparation (October 2019) the development layout plans are still in draft, which presents significant limitations to undertaking accurate impact assessments. *Section 5.2* describes THSC efforts to minimise and avoid impacts and provides recommendations for THSC to consider adopting during the planning process.

A discussion was held with THSC following submission of the V3 Draft BDAR, in relation to including additional efforts on the part of THSC to minimise the impacts on biodiversity values. Subsequently, the impact assessments in *Table 5-1* was revised to incorporate these additional efforts. For the purposes of the Final Draft BDAR, and in accordance with the BAM, UBM must make the following assumptions until additional information is provided:

- All impacts that have not yet been addressed by THSC will occur to some degree (*Table 5-1*);
- The Subject Land (including the 15-metre buffer) will be entirely cleared for the purpose of construction and the future vegetation integrity scores were left at zero (0) in the BAM calculator for the entire Subject Land; and
- A revegetation plan utilising a local native planting program following construction has been proposed.

5.2 Efforts to Avoid & Minimise Impacts on Biodiversity Values

THSC have demonstrated efforts to avoid and minimise impact on biodiversity values, including prescribed biodiversity impacts, in accordance with Chapter 8, by:

- Selecting an area that would have less impact on geological and hydrological features important to threatened species *e.g.* frogs, based on preliminary flora and fauna surveys (UBM 2017a; 2017b);
- Allowing a 15-metre buffer for construction disturbance;
- Choosing to locate their stockpiles and any other construction related facilities on the existing playing field;
- Locating the carpark and associated amenities in areas containing no biodiversity values or where the native vegetation is in the poorest condition;
- Utilising retaining walls to minimise the impact and to reduce construction footprint;
- Prior to construction works commencing, all trees likely to be impacted by the works will have the appropriate protection measures installed to protect them;

- Selectively retaining hollow bearing trees where possible;
- Immediately prior to vegetation clearing and the felling of known habitat trees for construction purposes (where present), a pre-clearance survey will be undertaken by a qualified Ecologist or Wildlife Spotter Catcher to identify and relocate fauna that may be disturbed, injured or killed during clearing (*e.g.* nesting birds, roosting microbats);
- If the removal of identified habitat trees is necessary, a slow-drop method will be used, and a qualified Ecologist, Fauna Spotter/Catcher or member of WIRES will be present to ensure that any fauna encountered while clearing are removed to a carer or relocated to a nearby safe site;
- Undertake clearing in stages[4], felling trees without hollows at least one (1) day prior to trees with hollows to encourage animals using nearby hollows to leave the area prior to felling hollow bearing trees;
- Determining the most appropriate timing for scheduling works (particularly vegetation clearing) to avoid critical life cycle events such as breeding, nursing and hibernating;
- Restricting machinery access routes to areas of existing disturbance;
- Implementing sediment runoff controls for duration of works;
- If excavation (cut and fill) is required, ensuring that any soil imported into the site is certified as weed-free (VENM - Virgin Excavated Natural Material);
- Controlling Target (Priority) Weeds identified in UBM (January 2019) as a matter of priority before, during and after construction to prevent the spread of weeds within and between adjacent native vegetation communities;
- Harvesting seeds from the construction footprint prior to clearing to be propagated and used in the rehabilitation phase;
- Implementing vegetation rehabilitation program for disturbed areas following construction using floristically and structurally diverse locally indigenous trees and shrubs, thus retaining local landscape character and habitat connectivity for small bushland birds following the removal of weedy shrubs;
- Controlling lighting for minimum time required during operation to minimise impact on residents and environment;
- Relocating habitat features such as bush rock, logs and tree hollows from the construction site and incorporate these into post-construction landscaping;
- Undertaking regular programs for feral animal control program (rabbits/deer); and

[4] As per Roads & Maritime Clearing and Grubbing Guidelines.

- Installing nest boxes[5] or sculptured hollows[6] (specifically targeting threatened hollow-dependant fauna in the Region, *e.g.* microbats and Yellow-bellied Gliders) will be undertaken by a qualified Ecologist or Arborist to mitigate the loss of hollow-bearing canopy trees and stags from the Subject Land.

UBM recommends THSC adopt the following measures to avoid and minimise impacts on biodiversity values (*Table 5-1*), including prescribed biodiversity impacts, and mitigate and manage unavoidable impacts (*Section 5.4*):

- For all development works, adherence to the *Guidelines for the Protection of Bushland during Construction*;
- Maintain a high standard of hygiene that requires the cleaning of vehicles and other plant equipment. This will ensure the site is free of dirt and debris imported from other sites and will help to minimise the potential spread of weeds as well as bacterial and fungal disease (such as *Phytophthora cinnamomi* and *Chytridiomycosis*); and
- Check for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation.

Any revegetation and habitat supplementation work to be implemented post construction will increase future vegetation integrity scores and may reduce the required offset cost. However, these works will have to be planned, and accurate areas proposed for revegetation must be provided prior to finalising the BDAR.

5.3 Unavoidable Impacts

Table 5-1 details the preliminary assessment of the impacts unable to be avoided within the Subject Land and surrounds in accordance with Sections 9.1 and 9.2 of the BAM, based on the preliminary information provided by THSC regarding the proposed development.

Residual impacts are impacts on biodiversity values remaining after all reasonable measures have been taken to avoid and minimise the impacts of development. Under the BAM, an offset requirement is calculated for the residual impacts that are not prescribed biodiversity impacts.

[5] Constructed species-specific nest boxes and tree mounting kits may be purchased [Nest Boxes Australia http://www.nestingboxes.com.au/epages/shsh6893.sf/en_AU/?ObjectPath=/Shops/shsh6893/Products/106].
[6] *Sydney Arbor Trees*: http://www.sydneyarbor.com.au/habitat-creation.html.

Table 5-1: Unavoidable Impacts

KTP = Key threatening process listed under the *BC Act* and/or *EPBC Act.*

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
DIRECT IMPACTS					
Clearing native vegetation	KTP. All strata and growth form groups, plus leaf litter.	~3.64 ha (*Figure 2-6*). It is assumed that the proposal will result in total clearing of the Subject Land .	Once. Prior to and/or during construction. Permanent. As no specific plans have been supplied it is assumed that cleared areas will not be permitted to regenerate and no planting will take place post-construction.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Loss of local biodiversity, as well as potential sheltering, foraging and breeding habitat for associated threatened entities. These species are expected to persist in the remaining bushland of Holland Reserve and surrounds. Clearing may directly injure or kill threatened entities and may also disrupt established home ranges. The future vegetation integrity score is assumed to be zero (0) for all VZs.
Removal of hollow-bearing stags and live trees	KTP. Dead and living trees containing hollows.	≥18 hollow stags and ≥13 live trees with hollows <20 cm in diameter. ≥4 hollow stags and ≥3 live trees with hollows ≥20 cm in diameter. *Figure 4-2.*	Once. Prior to and/or during construction. Where possible hollow bearing trees will be retained and supplementary installation of nest boxes and artificial hollows will be undertaken.	Broad-headed Snake, Glossy Black-Cockatoo, Brown Treecreeper, Little Lorikeet, Turquoise Parrot, Powerful Owl, Masked Owl, Spotted-tailed Quoll, Eastern False Pipistrelle, Golden-tipped Bat, Little Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Glider, Greater Broad-nosed Bat, Southern Myotis.	Loss of potential breeding and refuge habitat. Hollows are a limited resource that take a long time to form. Some of the associated threatened are restricted to areas with hollows. There may be increased competition for hollows in the remaining bushland surrounding the Subject Land .

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
Removal of coarse woody debris	KTP. Hollow and non-hollow logs.	15,090 m (extrapolated from plot data per vegetation zone and summed across all zones).	Once. Prior to and/or during construction. Where possible, logs will be retained or salvaged during construction and supplementary installation of logs will be undertaken post construction.	Rosenberg's Goanna, Spotted-tailed Quoll, Red-crowned Toadlet, Brown Treecreeper, Dusky Woodswallow, Hooded Robin, Turquoise Parrot, Scarlet Robin, Dural Land Snail.	Loss of potential breeding, foraging and refuge habitat, as well as biological processes associated with woody decay (*e.g.* nutrient cycling). Coarse woody debris is a limited resource, the importance of which is often undervalued so that it is removed for firewood.
Removal of termite mounds	Arboreal and terrestrial	≥4 arboreal and ≥2 terrestrial termite mounds.	Once. Prior to and/or during construction. Permanent.	Rosenberg's Goanna, Brown Treecreeper.	Loss of potential breeding and/or foraging habitat, as well as biological processes associated with woody decay (*e.g*. nutrient cycling). Termite mounds are a limited resource and a critical habitat component for Rosenberg's Goannas (OEH 2017).
Injury or death	Direct physical harm caused during clearing.	Uncertain – Possible but unlikely. A pre-clearance survey will be undertaken prior to clearing to identify and relocate fauna and flora where possible. The slow drop method will be	Once. Prior to and/or during construction. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Reduced local population and genetic diversity. Individual suffering.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
		used for identified habitat trees. Clearing will be undertaken in stages, felling trees without hollows first.			
Disruption of established home range	Removal of resources within established home range.	Limited. Where possible habitat features such as logs and bush rock will be relocated either within or outside of construction footprint.	Once. Prior to and/or during construction.	All fauna species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Increased competition for resources in remaining bushland. Habitat fragmentation. Death owing to inability to move to a new home range or find/access suitable habitat.
Loss of genetic material	Death of flora and fauna.	Limited. Seed collection will be undertaken prior to vegetation clearing and a pre-clearance survey will be undertaken to	Once. Prior to and/or during construction. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Permanent loss of genetic material from the local population, which could result in a minor impact to genetic diversity. This impact is more significant while the candidate species in *Table 4-7* are assumed present. The local population of a threatened species may already be suffering from a lack of genetic diversity resulting in inbreeding depression and…

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
		identify and relocate fauna and flora.			
PRESCRIBED IMPACTS					
Loss of habitat connectivity	Isolation of suitable habitat patches or reduction in wildlife corridor width resulting from clearing and increased anthropogenic disturbances.	~25-35% reduction in corridor width resulting in an increase in edge:core habitat ratio. THSC has no intention to disrupt connectivity.	Ongoing. During construction and operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	The Dooral Dooral creek riparian corridor will become narrower by approximately 100 metres, reducing the core bushland area and increasing edge effects such as light and noise pollution during operation. Some species may avoid the edge habitat, increasing competition for resources and disrupting home ranges. Gene flow may be restricted to sub-populations no longer connected by suitable habitat to facilitate dispersal, this includes movement of floristic genes by pollinators and seed dispersers. This may cause a decrease in genetic diversity.
Barriers to movement	Construction of barriers and increased anthropogenic disturbances that pose an obstacle or barricade to movements that maintain life cycles.	Obstacles and barriers erected by the proposal may include cleared land, fences, edge effects, roads, domestic animals, people.	Ongoing. During construction and operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Some species may avoid the edge habitat, increasing competition for resources and disrupting home ranges. Gene flow may be restricted to sub-populations no longer connected by suitable habitat to facilitate dispersal, this includes movement of floristic genes by pollinators and seed dispersers. This may cause a decrease in genetic diversity.
Impacts on water quality, water	Removal of ephemeral	One (1) ephemeral	Ongoing. During construction and	All flora species not excluded in *Table 4-7,*	The ephemeral drainage to be removed may facilitate the movement and/or breeding of

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
bodies and hydrological processes.	drainage line, alteration of local infiltration and runoff patterns, potential for pollution.	drainage line (*Figure 4-2*). Other impacts uncertain.	operation. Permanent. It is assumed that chemicals or nutrients will be applied to maintain the playing field.	as well as the following fauna: Giant Burrowing Frog, Red-crowned Toadlet.	threatened amphibians and would no longer be available for these uses. Local catchment dynamics outside the Subject Land will be slightly altered permanently by the proposal by changing infiltration and runoff patterns, which could impact all adjacent flora, which rely on water. There is potential for pollution of neighbouring waterbodies through erosion and sedimentation of materials eroded from the Subject Land , as well as run-off of any chemicals or nutrients applied to maintain the field. A reduction in water quality could exterminate the local population of Red-crowned Toadlets.
Removal of man-made structures	It is assumed that all existing structures will be demolished.	There are five (5) man-made structures within the Subject Land , at least three (3) of which contain crevices that are potential roosting habitat and one (1) on which a stick nest was built.	Once. During construction. Uncertain. It is unknown whether and to what extent the demolished structures will be replaced.	Eastern False Pipistrelle, Little Bentwing-bat, Eastern Bentwing-bat, Eastern Freetail-bat, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat, Eastern Cave Bat (potential SAII species).	Loss of potential roosting and/or breeding habitat. Any individuals roosting in man-made structures at the time of their demolition may be injured or killed. Note that man-made structures are widespread in the broader urbanised locality.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
Clearing non-native vegetation	Exotic flora species exist in varying densities amongst patches of native vegetation.	~1.42 ha of native vegetation containing exotic flora will be cleared.	Once. During construction. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Loss of potential sheltering, foraging and/or breeding habitat for associated threatened fauna species or their prey. These species are expected to persist in the remaining bushland of Holland Reserve and surrounds. Clearing may directly injure or kill threatened entities and may also disrupt established home ranges. Potential benefit to Locality by reducing available weed propagules, which could invade and degrade areas of native vegetation to be retained.
Destruction of karst, caves, crevices, cliffs and other geological features of significance	Rock crevices and overhangs only.	Variable coverage in an area of 1.52 ha (*Figure 6-1*). It is assumed that all crevices and overhangs in this area will be destroyed.	Once. During construction. Permanent.	Broad-headed Snake, Spotted-tailed Quoll, Red-crowned Toadlet, Large-eared Pied Bat (potential SAII species), Dural Land Snail, Eastern Cave Bat (potential SAII species).	Loss of potential sheltering, basking, foraging and/or breeding habitat for associated threatened fauna species.
Removal of bush rock and rock outcrops	KTP. Bush rock is defined as moveable surface rocks, while rock outcrop is defined as large areas of	Variable coverage in an area of 1.52 ha (*Figure 6-1*). It is assumed that all bush rock and rock outcrop in this	Once. During construction. Permanent.	Broad-headed Snake, Spotted-tailed Quoll, Red-crowned Toadlet, *Persoonia hirsuta, Melaleuca deanei,* Dural Land Snail.	Loss of potential sheltering, basking, foraging and/or breeding habitat for associated threatened fauna species. Two (2) associated threatened flora species are identified as being adversely affected by the KTP bush rock removal.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
	surface rock embedded in the ground.	area will be removed.			
Vehicle strikes	Animals hit by vehicles, including bicycles.	Animals may be hit by vehicles driving through the existing carpark (to be expanded), plant equipment during construction, bicycles riding through bushland and mowers used for field maintenance.	Ongoing. During construction and operation. Permanent.	It is acknowledged that all fauna species have the potential to be hit by vehicles but many are highly mobile and actively avoid highly modified habitat or anthropogenic disturbance. The most likely fauna to be impacted are the following terrestrial species, particularly during dispersal: Red-crowned Toadlet, Dural Land Snail, Broad-headed Snake, Rosenberg's Goanna, Spotted-tailed Quoll, Koala.	Vehicle strikes can result in injury or death of fauna.
Turbine strikes	N/A. No turbines will be erected by the proposal.	N/A	N/A	N/A	N/A
INDIRECT IMPACTS					

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
Erosion and sedimentation	Movement of soil from the Subject Land to adjacent terrestrial and aquatic habitats.	Limited. Erosion and sedimentation control measures will be implemented during construction. .	Rainfall events. During construction. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Loss of fertile topsoil. Sedimentation may alter vegetation community composition outside the Subject Land by transporting weed propagules. Sedimentation will alter soil profile outside the Subject Land by providing additional nutrients and clay soil, which will in turn affect lifecycle and local distribution of native species adapted to low nutrient sandstone habitat. Increased sedimentation and turbidity in neighbouring waterbodies may decrease water quality downstream of the development, which may impact pollution-sensitive entities such as the Red-Crowned Toadlet.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
Inadvertent impact on adjacent habitat or vegetation	Physical damage caused by people and plant equipment.	The proposal has allowed for construction disturbance in a 15-metre buffer that forms part of the Subject Land . Vehicle and person access routes will be restricted to the extent of the Subject Land by temporary exclusion fencing.	Ongoing. During construction. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Given the controls that will be in place during construction, inadvertent impacts on adjacent habitat are unlikely to occur.
Reduced viability of adjacent habitat due to edge effects including noise, dust or light spill	Edge effects include: light and noise pollution, weed invasion, wind, predators, trails, pollution, dust, altered	The Proposal will increase the edge:core habitat ratio. The Proposal will increase noise and light in an area estimated to be ~100m to	Ongoing. During construction and operation. Permanent.	The effect of edge effects on many threatened species is uncertain but it may be assumed edge effects could affect all ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including	Increased edge:core habitat ratio. Reduction in core habitat area with edge effects (e.g. light and noise) penetrating deeper into the bushland patch. This may reduce habitat quality or affect habitat use or movements of some species.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
	moisture, wind and temperature.	the North and West, and ~30m to the South and East of the Subject Land. Both noise and light will be controlled and limited.		potential SAII entities (*Table 6-1*) through alteration of habitat quality and extent.	
Transport of weeds and pathogens from the site to adjacent vegetation	Seeds and propagules of exotic plants spreading into adjacent bushland.	Weed control will be undertaken before, during and after construction.	Ongoing. Gradual. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Weeds will establish in disturbed areas that are cleared for construction within the Subject Land and areas of fill soil that are left exposed. These weeds may spread to adjacent bushland, degrading habitat for all threatened entities. Combined with erosion and unmanaged stormwater run-off, this impact has potential to introduce weeds to the native riparian corridor of Dooral Dooral Creek outside the Subject Land , as the proposed development is located close to where the gradient of the gully becomes steep, enabling weeds to cascade and colonise the area rapidly. Introducing weeds to the native riparian corridor (observed by UBM in 2017) will exponentially harm biodiversity downstream of the development.
Increased risk of starvation, exposure and loss	Due to clearing of resources and disruption	Uncertain.	Once. During construction. Uncertain.	All fauna species not excluded in *Table 4-3* and *Table 4-7,* including	Death and individual suffering. Increased competition for resources in remaining bushland.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
of shade or shelter	of established home ranges.			potential SAII entities (*Table 6-1*).	
Loss of breeding and foraging habitats	Destruction or disturbance of limited suitable breeding habitats	Uncertain	Once. During construction. Permanent.	All fauna species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Increased competition for suitable breeding and foraging habitat in remaining bushland. Failure to successfully reproduce. Reduction in the size of the local population.
Trampling of threatened flora species	Accidental trampling of flora by people.	Uncertain. It is assumed that no exclusion fencing will be erected during construction and public users of the playing field will continue to have free access to	Ongoing. During construction and operation. Permanent.	*Persoonia hirsuta, Melaleuca deanei*	Inappropriate fencing may result in an increase in human activity in the bushland that could include illegal dumping incidents, trampling native flora and wearing new tracks into the vegetation, as well as bush rock and log removal. These activities may destroy associated threatened flora or degrade their habitat.
Inhibition of nitrogen fixation and increased soil salinity	Introduction of factors that inhibit nitrogen fixation or increase salinity in the adjacent bushland.	Uncertain.	Ongoing. During construction and operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	The proposal is unlikely to significantly inhibit nitrogen fixation. However, the factors that can affect biological nitrogen fixation that may be altered by the proposal include: excessive moisture from and unmanaged stormwater run-off; erosion and sedimentation altering the soil profile and providing additional nutrients and clay soil; fertiliser drift; and weed invasion. Inhibition of nitrogen fixation may degrade habitat for all species.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
					The overall salinity hazard in Hawkesbury HL is very low, and in Glenhaven the overall hazard is low (DECCW 2011).
Fertiliser drift	Fertilisers applied to the playing field may be washed into the adjacent bushland.	Uncertain. It is assumed that fertiliser will be used to maintain the green playing field.	Ongoing. During operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Pollution of neighbouring terrestrial and aquatic habitats. Habitat degradation. Fertiliser drift may affect biological nitrogen fixation which can degrade the habitat for all species.
Rubbish dumping	Anthropogenic waste littered and dumped or blown/washed into bushland.	Uncertain. It is assumed that bins will be provided during construction and operation to encourage responsible disposal of waste.	Ongoing. During construction and operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Pollution of aquatic and terrestrial habitats with plastics. Inhibition of vegetation growth buy rubbish.
Wood collection	Collection of logs and woody debris from adjacent bushland for firewood.	Uncertain.	Ongoing. During operation. Permanent.	Rosenberg's Goanna, Spotted-tailed Quoll, Red-crowned Toadlet, Brown Treecreeper, Dusky Woodswallow, Hooded Robin, Turquoise Parrot,	Loss of potential breeding, foraging and refuge habitat, as well as biological processes associated with woody decay (*e.g.* nutrient cycling). Coarse woody debris is a limited resource, the importance of which is often undervalued.

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
				Scarlet Robin, Dural Land Snail.	
Bush rock removal and disturbance	Collection or displacement of bush rock in adjacent bushland.	Uncertain.	Ongoing. During operation. Permanent.	Broad-headed Snake, Spotted-tailed Quoll, Red-crowned Toadlet, *Persoonia hirsuta, Melaleuca deanei,* Dural Land Snail.	Loss of potential sheltering, basking, foraging and/or breeding habitat for associated threatened fauna species. Two (2) associated threatened flora species are identified as being adversely affected by the KTP bush rock removal.
Increase in predatory species populations	Increase in the abundance of native or exotic predators in adjacent bushland.	Uncertain. The proposal is unlikely to directly increase the regional abundance of predators but may alter their distribution by increasing the edge:core habitat ratio causing a local increase in core bushland.	Ongoing. During operation. Permanent.	All fauna species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	Facilitation of predators to hunt in bushland that was previously core habitat by increasing the edge:core habitat ratio. Death and/or movement of prey species away from previously suitable habitat.
Increase in pest animal populations	Increase in the abundance of pest animals in adjacent bushland.	Uncertain. The proposal is unlikely to directly increase the	Ongoing. During operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,*	Facilitation of pests to live in bushland that was previously core habitat by increasing the edge:core habitat ratio. Consumption of associated threatened flora by herbivorous pests. Increased competition for foraging resources. Habitat

IMPACT	NATURE	EXTENT	FREQUENCY, TIMING & DURATION	ASSOCIATED THREATENED ENTITIES	CONSEQUENCE
		regional abundance of pest species but may alter their distribution by increasing the edge:core habitat ratio causing a local increase in core bushland.		including potential SAII entities (*Table 6-1*).	degradation. Support for exotic predator persistence. Death and/or movement of prey species away from previously suitable habitat.
Altered fire regime	Change to vegetation composition, structure or moisture levels resulting in more or less frequent fires.	Uncertain.	Ongoing. During construction and operation. Permanent.	All ecosystem and species credit species not excluded in *Table 4-3* and *Table 4-7,* including potential SAII entities (*Table 6-1*).	It is uncertain how the proposal may alter the existing fire regime and unknown whether the existing fire regime is appropriate for the local ecosystem. The proposal may alter the existing fire regime by affecting surface water flows. It is assumed that the adjacent bushland will not need to be thinned for APZ purposes. Any alterations to the existing fire regime may have either a negative or positive impact depending on the flora or fauna species. Some flora require fire to

Figure 5-1: Final Project Footprint & Indirect Impacts

Note: UBM requires a finalised construction plan from THSC to produce this figure.

5.4 Mitigating and Managing Residual Impacts

In accordance with the BAM (OEH 2017b), the proponent must identify measures to mitigate or manage impacts that are unable to be avoided in accordance with the guidelines for mitigating and managing impacts on biodiversity values at Subsection 9.3.2 and Subsection 9.3.3 of the BAM.

UBM recommends the measures detailed in *Section 5.2* and welcomes additional measures initiated by THSC to mitigate and manage unavoidable impacts.

5.5 Adaptive Management Strategy

THSC has advised the following post construction rehabilitation strategies will be implemented:

- Control of Priority Weeds;
- Planting and monitoring of harvest seeds propagated from the Construction Footprint;
- Locally native planting program for disturbed areas to be maintained;
- Relocation of habitat features such as logs and bush rock;
- Use of felled trees with hollows for logs as supplemented habitat; and
- Installation of nest boxes or sculptured hollows.

UBM advises a post construction adaptive management strategy that consists of follow-up site inspections that target indirect impacts that may be continuing to occur post construction. These include but are not limited to:

- Checking for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation;
- Monitor success of plantings and infill with new tubestock grown from seed sourced prior to clearing as required; and
- If an unexpected threatened species is found, all work must stop, and Council must be notified. OEH is to be contacted for advice on how to proceed.

6 IMPACT SUMMARY

6.1 Serious & Irreversible Impacts

Species and ecological communities with a 'very high' biodiversity risk weighting will be a potential serious and irreversible impact (SAII). These 'potential SAII entities' are identified within the BAM calculator (OEH 2018b). Serious and irreversible impacts are depicted in *Figure 6-1*.

The determination of serious and irreversible impacts on biodiversity values is to be made by the consent authority in accordance with the principles set out in the *BC Regulation*. To assist the consent authority, the guidance document *Guidance to assist a decision-maker to determine a serious and irreversible impact* includes criteria that enable the application of the four principles set out in clause 6.7 of the *BC Regulation* to identify the species and ecological communities that are likely to be the subject of serious and irreversible impacts.

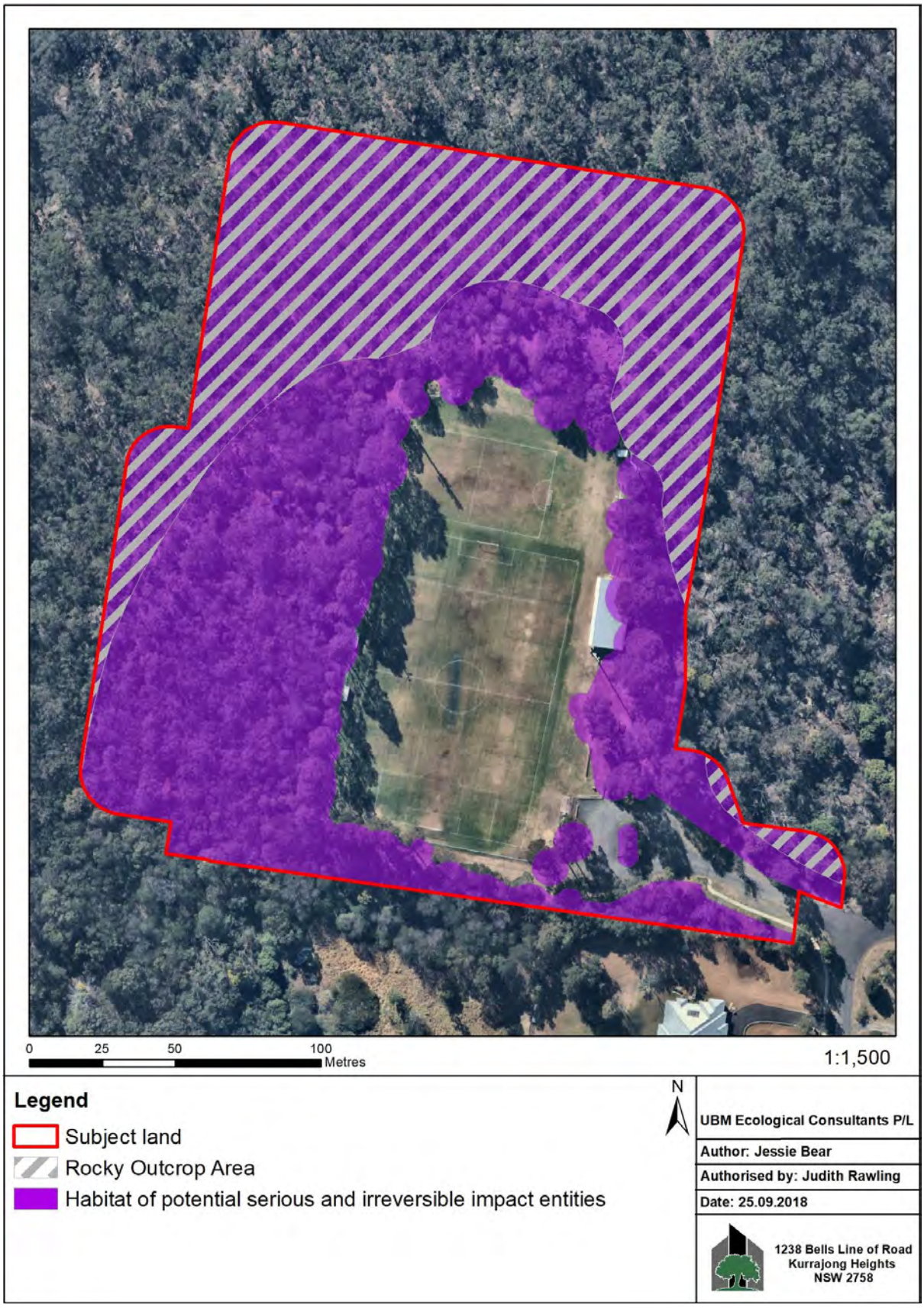
No ecological communities were identified as being potential SAII entities. Of the candidate species present within the Subject Land (*Table 4-7*), one (1) has been identified by the BAM Calculator as potential SAII entities (*Table 6-1*). The threshold information was extracted from TBDC (2018) but the size of the local populations of potential SAII entities are currently unknown.

The effect of SAII for Part 5 activities is described by OEH (2018g) as follows: "The approval authority can approve a proposal which is likely to have serious and irreversible impacts. The approval authority must take those impacts into consideration and determine whether there are any additional and appropriate measures that will minimise those impacts if approval is to be granted."

Table 6-1: Potential Serious and Irreversible Impact Entities

SPECIES	DISCUSSED	THRESHOLD (extracted from TBDC 2018)
Vespadelus troughtoni Eastern Cave Bat	*Table 4-9, Section 5.2, Section 5.3, Table 5-1*	SAII threshold is potential breeding habitat and presence of breeding individuals (TBDC 2018). Potential breeding habitat is PCTs associated with the species within 100 m of rocky areas, caves, overhangs crevices, cliffs and escarpments, or old mines or tunnels, old buildings and sheds within the potential habitat (TBDC 2018). Eastern Cave Bats were detected with a probable reliability of identification during the recent surveys. Given that potential breeding habitat is present on the Subject Land and little is known about this species (OEH 2017), as well as the fact that no trapping was undertaken to identify whether or not breeding individuals are present, based on the precautionary principle breeding individuals are assumed present.

Figure 6-1: Location of Serious and Irreversible Impacts Within the Subject Land



6.2 Summary of Impacts Requiring Offset

Impacts requiring offsets are detailed in *Table 5-1*. Areas and impacts requiring offset are depicted in *Figure 6-2*, while habitat features are depicted in *Figure 4-2*.

- Clearing native vegetation containing hollow bearing trees, stags, coarse woody debris, crevices and rocks; and
- Clearing non-native vegetation (mixed with native vegetation) containing hollow bearing trees, stags, coarse woody debris, crevices and rocks.

6.3 Summary of Impacts and Areas not Requiring Offset

Impacts not requiring offsets are detailed in *Table 5-1* and depicted in *Figure 6-2*.

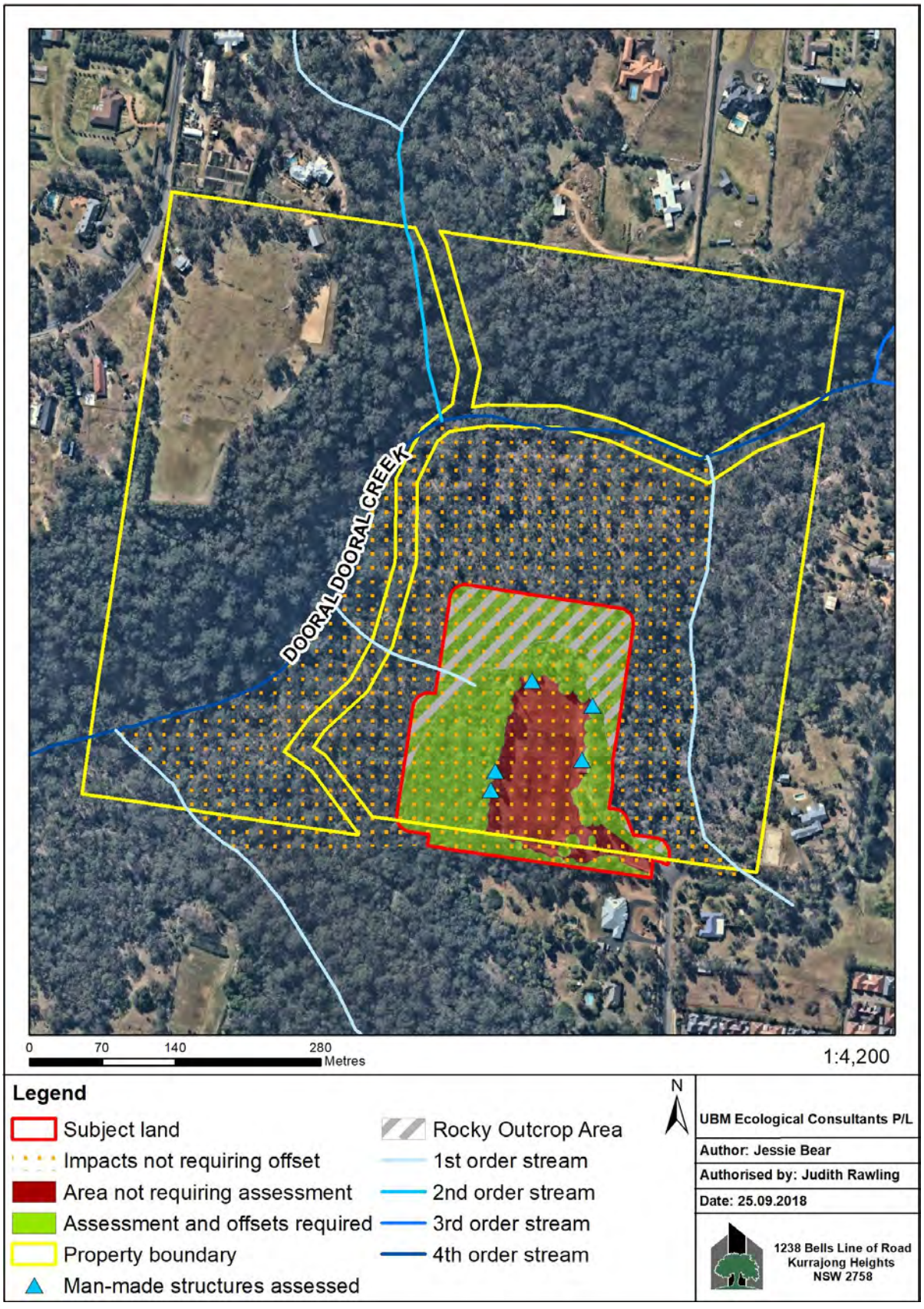
Impacts not requiring offset includes the removal of man-made structures.

Areas not requiring offsets include:

- Alteration to local catchment hydrological processes;
- Potential erosion;
- Potential increased sedimentation in native vegetation;
- Lack of weed control;
- Potential damage to surrounding vegetation by construction plant;
- Permanent loss of genetic material;
- Anthropogenic damage to bushland; and
- Reduced connectivity.

Figure 6-2: Impact Summary

Image source: Nearmaps (July 2018). **Data Frame Projection:** GDA Zone 56



7 ECOSYSTEM CREDITS & SPECIES CREDITS

7.1 Credits and Credit Classes

The biodiversity credit report is the report produced by the credit calculator that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site.

Ecosystems requiring offset are listed in *Table 7-1*, along with areas and number of credits required. The species that are assumed present or confirmed that require offset are listed in *Table 7-2*, along with areas/counts and number of credits required.

Note: The vegetation integrity score for all areas is assumed to be zero (0) following construction (*Section 5.1*).

Table 7-1: Ecosystem Credit Summary and Credit Classes

Ecosystem credit summary

PCT	TEC	Area	Credits
1080-Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion	Not a TEC	0.5	3
1083-Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion	Not a TEC	3.1	45

Credit classes for 1080

Like-for-like options

Class	Trading group	HBT	IBRA region
Sydney Hinterland Dry Sclerophyll Forests This includes PCT's: 612, 621, 624, 1080, 1081, 1086, 1159, 1246, 1255, 1327, 1328, 1614, 1622, 1628, 1631, 1634, 1640, 1664, 1666, 1667, 1789, 1790, 1912	Sydney Hinterland Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	No	Yengo , Cumberland, Hunter, Kerrabee, Pittwater, Wollemi and Wyong. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Credit classes for 1083

Like-for-like options

Class	Trading group	HBT	IBRA region
Sydney Coastal Dry Sclerophyll Forests This includes PCT's: 1083, 1138, 1156, 1181, 1183, 1250, 1253, 1619, 1620, 1621, 1623, 1624, 1625, 1627, 1632, 1636, 1638, 1642, 1643, 1681, 1776, 1777, 1778, 1780, 1782, 1783, 1785, 1786, 1787	Sydney Coastal Dry Sclerophyll Forests - < 50% cleared group (including Tier 7 or higher).	Yes	Yengo , Cumberland, Hunter, Kerrabee, Pittwater, Wollemi and Wyong. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Table 7-2: Species Credit Summary

Species credit summary

Species	Area	Credits
Myotis macropus / Southern Myotis	3.6	65
Ninox strenua / Powerful Owl	3.6	65
Pommerhelix duralensis / Dural Woodland Snail	2.8	55
Pseudophryne australis / Red-crowned Toadlet	3.1	45
Vespadelus troughtoni / Eastern Cave Bat	3.6	97

Note: Species credit species 'like-for-like' options are to purchase credits only for the identified species to offset for that species anywhere in NSW. This table will be included in the finalised BDAR.

7.2 Variation Rules

According to the OEH (2017c) the Biodiversity Conservation Regulation 2017 contains variation rules that provide some flexibility by allowing offsetting with a broader suite of biodiversity that is the same or more threatened than the biodiversity impacted. The use of the variation rules to allow offsetting must be approved by the consent authority through conditions of consent.

Before applying the variation rules, the proponent must demonstrate to the consent authority that they have been unable to find like-for-like credits after following the reasonable steps, set out in the *Ancillary rules: Reasonable steps to seek like-for-like biodiversity credits*.

The variation rules cannot be applied by proponents for impacts on some threatened entities, listed in the *Ancillary rules: impacts on threatened entities excluded from variation*. All critically endangered entities are included on this list. This restriction does not apply to the Biodiversity Conservation Trust.

8 BIODIVERSITY CREDIT REPORT

The biodiversity credit report is the report produced by the credit calculator that sets out the number of biodiversity credits and provides a final credits price required to offset the remaining adverse impacts on biodiversity values at a development site. *Table 8-1* below is extracted from the BAM calculator (OEH 2018b).

Note: The BAM calculator provides a predicted market price for biodiversity credits. Its primary purpose is to estimate a pricing curve based on observed biodiversity trades of 'like for like' credits under both the Biodiversity Offset Scheme (BOS) and from BioBanking agreements. It also includes a margin that accounts for the statistical probability that the market credit price paid by the BCT to landholders is higher or lower than predicted and fund administration costs for operating and administering the Biodiversity Conservation Trust. The value presented here is not necessarily the price of offsets that will be required once the BDAR is finalised.

Table 8-1: Ecosystem and Species Credits Report

Ecosystem credits for plant communities types (PCT), ecological communities & threatened species habitat

IBRA sub region	PCT common name	Baseline price	Dynamic coefficient	Market coefficient	Risk premium	Administrative cost	Methodology adjustment factor	Price per credit	No. of ecosystem credits	Final credits price
Yengo	**1083 -** Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion **Note: This PCT has trades recorded**	$2,752.39	0.71782200	2.32666494	19.99%	$20.00	1.0000	$3,639.95	45	$163,797.64
Yengo	**1080 -** Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion **Warning: This PCT has NO trades recorded**	$4,421.71	0.71782200	2.32666494	19.99%	$20.00	1.0000	$5,107.30	3	$15,321.91
								Subtotal (excl. GST)		**$179,119.55**
								GST		**$17,911.96**
								Total ecosystem credits (incl. GST)		**$197,031.50**

Species credits for threatened species

Species profile ID	Species	Threat status	Price per credit	Risk premium	Administrative cost	No. of species credits	Final credits price
10549	***Myotis macropus*** (Southern Myotis)	Vulnerable	$725.00	19.9900%	$20.00	65	$57,845.29
10562	***Ninox strenua*** (Powerful Owl)	Vulnerable	$506.66	19.9900%	$20.00	65	$40,816.19
10692	***Pseudophryne australis*** (Red-crowned Toadlet)	Vulnerable	$506.66	19.9900%	$20.00	45	$28,257.36
10829	***Vespadelus troughtoni*** (Eastern Cave Bat)	Vulnerable	$725.00	19.9900%	$20.00	97	$86,322.97
20283	***Pommerhelix duralensis*** (Dural Woodland Snail)	Endangered	$506.66	19.9900%	$20.00	55	$34,536.77
						Subtotal (excl. GST)	**$247,778.58**
						GST	**$24,777.86**
						Total species credits (incl. GST)	**$272,556.44**
						Grand total	**$469,587.94**

ENVIRONMENT PROTECTION & BIODIVERSITY CONSERVATION ACT 1999

9 COMMONWEALTH *EPBC ACT* ASSESSMENTS

As part of the Commonwealth *EPBC Act*, an assessment of whether the proposal is likely to have a significant impact using the criteria detailed in the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* Policy Statement (DOE 2013) was carried out for the two (2) Commonwealth listed species recorded on the Subject Land during the Oct-Dec 2018 surveys and Jun-Aug surveys: the vulnerable Grey-headed Flying-fox (GHFF) and endangered Dural Land Snail (DLS).

Commonwealth assessments are needed until the Bilateral Agreement made under section 45 of the *EPBC Act* relating to environmental assessment (DOE 2015) is updated and reinstated between the NSW and Commonwealth Governments in relation to the *BC Act*.

Significant Impact Criteria for Vulnerable Species

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species;
- reduce the area of occupancy of an important population;
- fragment an existing important population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of an important population;
- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- introduce disease that may cause the species to decline; or
- interfere substantially with the recovery of the species.

Grey-headed Flying Fox Significant Impact Assessment

Roosting camps of this social species are typically located close to water, in stands of native vegetation such as mangrove, rainforest, *Melaleuca, Casuarina* or introduced trees (Churchill 2008). Site fidelity to camps is high, and some camps have been used for over a century (OEH 2017). They will forage up to 50 km from their camp, including in urban and suburban areas; with Myrtaceae plant species making up almost half of their foraging species, with a preference shown for *Eucalyptus*, *Melaleuca* and *Banksia*, as well as *Grevillea*, Lily Pilly and figs (Churchill 2008; OEH 2017).

With regard to the Study Area, the closest known roosting camp is ~10 km away at Parramatta Park; last surveyed May 2018 with an estimated population of 10,000-15,999 individuals (CSIRO & DOE

2018). This species is frequently recorded in the Region. When in flower, canopy trees in the Study Area provide potential foraging habitat for the GHFF.

With reference to the Significant Impact Criteria for Vulnerable Species (above), it is unlikely that the proposal will result in a significant impact on GHFF given:

- The Study Area has not been identified as critical habitat for GHFF;
- No GHFF camps have been identified within the Study Area;
- It is likely that the GHFF utilizes the Study Area for foraging purposes only, on occasion;
- The proposal will not result in the erection of any barriers to the dispersal, foraging or interbreeding needs of GHFF;
- This species is highly mobile and adaptable to utilizing exotic flora species for foraging;
- The relatively small area of potential habitat to be impacted;
- Parts of the area that may be affected by the proposal are subject to weed invasion and anthropogenic disturbance; and
- The relatively large amount of potential habitat in the remainder of Holland Reserve, and the Dooral Dooral Creek riparian corridor.

Giving consideration to the Significant Impact Criteria for Vulnerable Species, it is considered that the proposal in Holland Reserve, Glenhaven, would NOT have a significant impact on Grey-headed Flying-fox individuals, populations or habitats in the Locality and therefore WOULD NOT require referral to the Australian Government Department of the Environment for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the *EPBC Act.*

Significant Impact Criteria for Critically Endangered and Endangered Species:

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of a population;
- reduce the area of occupancy of the species;
- fragment an existing population into two or more populations;
- adversely affect habitat critical to the survival of a species;
- disrupt the breeding cycle of a population;
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- introduce disease that may cause the species to decline; or
- interfere with the recovery of the species.

Dural Land Snail Significant Impact Assessment

This species shows a strong affinity for communities in the interface region between shale-derived and sandstone-derived soils (OEH 2018). Feed primarily upon the hyphae and fruiting bodies of native fungi (OEH 2018). Preferred sheltering habitat is under rocks or inside curled-up bark but will also shelter beneath leaves and light woody debris (OEH 2018). Known to aestivate (enter a state of dormancy) in response to unfavourable environmental conditions; secretes an epiphragm to protect against desiccation (OEH 2018).

With reference to the Significant Impact Criteria for Critically Endangered and Endangered Species (above), it is unlikely that the proposal will result in a significant impact on the DLS given:

- The majority of individuals found during targeted surveys were located outside the area the be impacted by the proposal; only one (1) was found within the Subject Land;
- Only 2.83 ha of partially modified and degraded potential habitat will be impacted by the proposal;
- There is a relatively large amount of potential habitat in the remainder of Holland Reserve and the Dooral Dooral Creek riparian corridor;
- Connectivity to potential habitat will remain intact around the perimeter of the Subject Land;
- Invasive flora and fauna are already established in the Subject Land and the proposal includes control of weeds to prevent degradation of potential DLS habitat; and
- A pre-clearance survey will be undertaken immediately prior to vegetation clearing to translocate any DLS individuals to nearby habitat out of harm's way, thereby minimising risk of directly impacting local population numbers.

Giving consideration to the Significant Impact Criteria for Critically Endangered and Endangered Species, it is considered that the proposal in Holland Reserve, Glenhaven, would NOT have a significant impact on Dural Land Snail individuals, populations and/or habitat in the Locality and therefore WOULD NOT require referral to the Australian Government Department of the Environment for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the *EPBC Act.*

10 CONCLUSION

UBM Ecological Consultants (UBM) has been commissioned by The Hills Shire Council (THSC) to assess the impacts of a proposed Part 5 activity under the *Environmental Planning and Assessment Act 1979* (*EP&A Act*) at Holland Reserve, Glenhaven. Under the NSW *Biodiversity Conservation Act 2016* (*BC Act*), a Part 5 activity that is likely to significantly affect the environment is to be accompanied by either a Species Impact Statement or a Biodiversity Development Assessment Report (BDAR).

The Hills Shire Council's environmental unit has advised that the proposed activity is likely to significantly affect the environment. In this case, Council has opted to commission a BDAR, to be prepared in accordance with the Biodiversity Assessment Method (BAM) established under the *BC Act* Biodiversity Offsets Scheme (BOS).

The Draft Reports have addressed Stage 1 of the BAM by assessing the biodiversity values of the Subject Land (landscape context, native vegetation integrity and habitat suitability for threatened species). In addition, this Final Draft Report addresses Stage 2 (commencing *Section 5*) by providing an impact summary, recommendations for minimising biodiversity impacts and a biodiversity credit report based on the data collected during Stage 1, Oct-Dec 2018 and Jun-Aug 2019 targeted surveys and the information provided by THSC to date.

As this BDAR is being submitted in final draft form based on a draft layout and limited information provided by THSC, Stage 2 will require significant revision prior to finalising the BDAR at a later date. This final draft BDAR provides a comprehensive assessment of the direct and indirect impacts on biodiversity and threatened entities confirmed present by targeted surveys (incorporating measures taken by THSC to avoid and minimise impacts) and includes a final calculation of the offset requirements (in terms of biodiversity credits) for any residual impacts.

Holland Reserve is a large (~37.5 ha) recreational reserve with frontages to both Holland Road and Bannerman Road. The Reserve has a large playing field with a synthetic cricket pitch located in the centre. Entry and car parking facilities for the playing field are located on Holland Road, which also has picnic facilities, a pavilion and public amenities.

The proposed development is a site-based development located within Holland Reserve (Lot 170 DP 752020). The proposed construction footprint (*i.e.* Development Site) encompasses four (4) playing fields, an extended car park and amenities block. A 15-metre buffer around the Development Site has been allowed for construction purposes and related disturbances. The Development Site together with the buffer is referred to as the *Subject Land* (*Figure 1-1*).

THSC has advised that the existing sports field off Holland Road will be used for temporary construction purposes and related infrastructure requirements and will include ingress and egress access routes and stockpiles sites. The construction footprint will contribute an additional ~3.64 ha to the ~1.38 ha that is already impacted by the existing playing field, amenities block, pavilion and picnic area off Holland Road (*Figure 2-6*).

The Subject Land is 5.02 hectares (ha) in size and includes public amenities as described above. There are substantial areas of native bushland surrounding the Reserve (*Figure 2-3*). At the time of writing

(October 2019) the proposed layout provided by THSC is still in draft form; the final construction footprint is expected to vary from that currently available, which may affect the outcomes of the BDAR.

Results

Vegetation:

A total of six (6) plots were surveyed and assessed in the context of previous broad-scale mapping (THSC 2008; Tozer *et al.* 2010). Two (2) Plant Community Types (PCT's) were identified within the Subject Land, neither of which are associated with any threatened ecological communities:

- PCT 1080 *Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys*, *southern Sydney Basin Bioregion*, which was selected for being the closest matching PCT to the planted areas; and
- PCT 1083 *Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion*, which occurs in varying conditions within the Subject Land.

Fauna Habitats:

The vegetated riparian corridors of the watercourses in the Locality are connectivity features that may facilitate the movement of threatened (and other) species across their range (*Figure 2-3*). The riparian corridor of Dooral Dooral Creek is mapped as Terrestrial Biodiversity under *Hills Local Environmental Plan 2012*. The Subject Land is located within a Priority 5 Investment Area under the *Biodiversity Conservation Investment Strategy 2018* (OEH 2018).

The Subject Land was found to contain hollow bearing trees, stags, coarse woody debris, rocky outcrop and crevices (in both naturally occurring rocks and man-made structures), an ephemeral drainage line and a variety of foraging resources including fruits, flowers, seeds, pollen, nectar, seeds, invertebrates and vegetation, which in turn support the presence of vertebrate prey.

Ecosystem Credit Species:

Ecosystem credit species are threatened species for which the likelihood of occurrence or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection. Ecosystem credit species are also referred to as 'predicted threatened species' in the BAM calculator (OEH 2018b). Targeted survey is not required for these species. *Table 4-3* lists the species predicted by the calculator based on the landscape features and vegetation integrity assessment.

One (1) additional ecosystem credit species was added to the predicted species list following desktop review; the Dusky Woodswallow (*Artamus cyanopterus*). A total of 34 ecosystem credit species are identified for the Subject Land , five (5) of which (the Powerful Owl [*Ninox strenua*], Grey-headed Flying-fox [*Pteropus poliocephalus*] foraging, Yellow-bellied Sheathtail-bat [*Saccolaimus flaviventris*], Eastern Bentwing-bat [*Miniopterus schreibersii oceanensis*] foraging and Little Bentwing-bat [*Miniopterus australis*] foraging) were detected during targeted surveys for species credit species (*Section 4.2*) (note that the microbats were recorded with a probable reliability of identification).

Species Credit Species:

Species credit species are threatened species for which the likelihood of occurrence or elements of suitable habitat for the species cannot be confidently predicted by vegetation surrogates and

landscape features but can be reliably detected by survey. Species credit species are also referred to as 'candidate threatened species' in the BAM calculator (OEH 2018b). Targeted survey or an expert report is required to confirm presence/absence of these species on the Subject Land, unless the proponent opts to simply assume presence.

This report has undertaken targeted surveys in Oct-Dec 2018, and Jun-Aug 2019 for 40 species credit species. These targeted surveys observed five (5) Dural Land Snails (*Pommerhelix duralensis*), detected calls of the Red-crowned Toadlet (*Pseudophryne australis*), recorded the Southern Myotis (*Myotis macropus*) and Eastern Cave Bat (*Vespadelus troughtoni*) with a probable reliability of identification, and observed mate searching behaviour by a male Powerful Owl (*Ninox strenua*).

Serious and Irreversible Impacts

No ecological communities were identified as being potential SAII entities. Of the candidate species present within the Subject Land (*Table 4-7*), one (1) has been identified by the BAM Calculator as potential SAII entities (*Table 6-1*). At the time of writing (October 2019) the Eastern Cave Bat has been detected on site and breeding individuals are assumed present (see *Table 6-1*). The SAII threshold for the Eastern Cave Bat is potential breeding habitat and presence of breeding individuals (TBDC 2018).

The effect of SAII for Part 5 activities is described by OEH (2018g) as follows: "The approval authority can approve a proposal which is likely to have serious and irreversible impacts. The approval authority must take those impacts into consideration and determine whether there are any additional and appropriate measures that will minimise those impacts if approval is to be granted."

Matters of National Environmental Significance:

Commonwealth Significant Impact Assessments were carried out for the two (2) Commonwealth listed species recorded on the Subject Land during the Oct-Dec 2018 surveys: the vulnerable Grey-headed Flying-fox and endangered Dural Land Snail. Given the impact avoidance, minimisation and mitigation measures incorporated by the proposal (*Section 5.2*), these assessments concluded that the proposal would NOT have a significant impact on individuals, populations and/or habitat in the Locality of these species and therefore WOULD NOT require referral to the Australian Government Department of the Environment for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the *EPBC Act.*

Assumptions, Predictions and Limitations

At the time of preparation of the Final Draft BDAR (October 2019) the development layout plans were still in draft form, which presents significant limitations to undertaking accurate impact assessments.

A discussion was held with THSC following submission of theV3 Draft BDAR, in relation to including additional efforts on the part of THSC to minimise the impacts on biodiversity values. Subsequently, the impact assessments in *Table 5-1* have been revised to incorporate these additional efforts. For the purposes of the Final BDAR, and in accordance with the BAM, UBM must make the following assumptions until additional information is provided:

- All impacts that have not yet been addressed by THSC will occur to some degree (*Table 5-1*);

- The Subject Land (including the 15-metre buffer) will be entirely cleared for the purpose of construction and the future vegetation integrity scores were left at zero (0) in the BAM calculator for the entire Subject Land; and
- A revegetation plan utilising a locally native planting program following construction has been proposed.

Biodiversity Credit Report

The credit price required to offset the remaining adverse impacts on biodiversity values estimated by the BAM calculator for this draft BDAR is **$469,587.94** (*Table 8-1,* OEH 2018b).

Note: The BAM calculator provides a predicted market price for biodiversity credits. Its primary purpose is to estimate a pricing curve based on observed biodiversity trades of 'like for like' credits under both the Biodiversity Offset Scheme (BOS) and from BioBanking agreements. It also includes a margin that accounts for the statistical probability that the market credit price paid by the BCT to landholders is higher or lower than predicted and fund administration costs for operating and administering the Biodiversity Conservation Trust. The value presented here is not necessarily the price of offsets that will be required once the BDAR is finalised.

Recommendations

UBM recommends THSC adopt the following measures to avoid and minimise impacts on biodiversity values (*Section 5.2*; *Table 5-1*), including prescribed biodiversity impacts, and mitigate and manage unavoidable impacts (*Section 5.4*):

- For all development works, adherence to the *Guidelines for the Protection of Bushland during Construction*;
- Build retaining walls or terraces or find another engineering solution instead of leaving a bare slope around the fields to minimise ongoing soil disturbance and erosion points;
- Maintain a high standard of hygiene that requires the cleaning of vehicles and other plant equipment. This will ensure the site is free of dirt and debris imported from other sites and will help to minimise the potential spread of weeds as well as bacterial and fungal disease (such as *Phytophthora cinnamomi* and *Chytridiomycosis*);
- Check for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation;

Any revegetation and habitat supplementation work to be implemented post construction will increase future vegetation integrity scores and may reduce the offset cost. However, these works will have to be planned, and accurate areas proposed for revegetation must be provided prior to finalising the BDAR. Currently THSC has proposed that a locally native planting program will be implemented post construction.

UBM advises a post construction adaptive management strategy that consists of follow-up site inspections that target indirect impacts that may be continuing to occur post construction. These include but are not limited to:

- Checking for sedimentation and erosion hotspots post construction to mitigate impacts on local hydrological processes and surrounding vegetation; and
- Monitor success of plantings and infill with new tubestock grown from seed sourced prior to clearing as required.

11 BIBLIOGRAPHY

Benson D. H. (1992). *The natural vegetation of the Penrith* 1:100,000 map sheet. *Cunninghamia* **2,** 541–96

Benson, D., Howell, J. & McDougall, L. (1996). *Mountain Devil to Mangrove.* (Royal Botanic Gardens Sydney).

Benson, D.H., & Howell, J. (1990). *Taken for granted: the bushland of Sydney and its suburbs.* Kangaroo Press, Sydney.

Botanic Gardens Trust (2018). PlantNET - The Plant Information Network System of Botanic Gardens Trust, Sydney, Australia (version 2.0) http://plantnet.rbgsyd.nsw.gov.au

Cartoscope (n.d.). *Geological Sites of NSW.* Available at: http://www.geomaps.com.au/scripts/geositeslist.php

Chapman & Murphy (1989). *Soil landscapes of the Sydney 1:100 000 Sheet [Report].* Soil Conservation Service NSW, Sydney.

Churchill, S. (2008). *Australian Bats, 2nd Edition.* Jacana Books, Crows Nest, Sydney.

Cogger, H. C. (2014). *Reptiles & Amphibians of Australia (Seventh Edition).* CSIRO Publishing, Collingwood, Victoria.

Cropper, S. (1993). *Management of Endangered Plants*. CSIRO. Melbourne.

Crossman, S. & Li, O. (2012). *Surface Hydrology Lines (Regional). Geoscience Australia and state governments collaboration.* Available at: http://www.ga.gov.au/metadata-gateway/metadata/record/83107/

CSIRO & DOE (2018). *Interactive Flying-fox Web Viewer: National Flying-Fox Monitoring Programme.* CSIRO and the Department of the Environment. Available at: http://www.environment.gov.au/biodiversity/threatened/species/flying-fox-monitoring

Department of Environment and Climate Change (DECC) (2008). *Best practice guidelines Green and golden bell frog habitat.* Available at: https://www.environment.nsw.gov.au/resources/threatenedspecies/08510tsdsgreengoldbfbpg.pdf

Department of Environment and Climate Change (DECC) (2008). *Recovery plan for the koala (Phascolarctos cinereus).* Department of Environment and Climate Change, Sydney, NSW.

Department of Environment and Climate Change NSW (DECC) (2002). *Descriptions for NSW (Mitchell) Landscapes Version 2, based on descriptions compiled by Dr. Peter Mitchell.* NSW Office of Environment & Heritage, Sydney.

Department of Environment and Conservation (DEC) (2004). *Threatened Species Survey and Assessment: Guidelines for Developments and Activities (Working Draft).* New South Wales Department of Environment and Conservation, Hurstville, NSW.

Department of Environment and Conservation (DEC) (2006). *Recovery Plan for the Bush Stone-curlew Burhinus grallarius.* DEC, Sydney.

Department of Sustainability, Environment, Water Populations and Communities (2011). *Environment Protection and Biodiversity Conservation Act Online Databases.* http://www.environment.gov.au/about-us/environmental-information-data/databases-applications*now Dept. Conservation & Energy

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011a). *Survey guidelines for Australia's threatened reptiles.* Available online: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-reptiles-guidelines-detecting-reptiles-listed

Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) (2011b). *Survey guidelines for Australia's threatened mammals.* Available online: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-mammals-guidelines-detecting-mammals-listed

Department of the Environment (DOE) (2013). *Matters of National Environmental Significance. Significant impact guidelines 1.1. Environment Protection and Biodiversity Conservation Act 1999.* Department of the Environment, Canberra.

Department of the Environment (DOE) (2015). *Bilateral Agreement between the Commonwealth of Australia and the State of New South Wales relating to Environmental Assessment.* Commonwealth of Australia. Available at: http://www.environment.gov.au/protection/environment-assessments/bilateral-agreements/nsw

Department of the Environment and Energy [DEE] (2010). *Directory of Important Wetlands.* Available at: http://www.environment.gov.au/cgi-bin/wetlands/search.pl?smode=DOIW

Department of the Environment and Energy [DEE] (2018). *Protected Matters Search Tool.* Available at: http://www.environment.gov.au/webgis-framework/apps/pmst/pmst.jsf

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2010a). *Survey guidelines for Australia's threatened birds.* Available online: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2010b). *Survey guidelines for Australia's threatened bats.* Available online**:** http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-bats-guidelines-detecting-bats-listed-threatened

Department of the Environment, Water, Heritage and the Arts (DEWHA) (2010c). *Survey guidelines for Australia's threatened frogs.* Commonwealth of Australia. Available online: http://www.environment.gov.au/resource/survey-guidelines-australias-threatened-frogs-guidelines-detecting-frogs-listed-threatened

Fairley, A. (2004). *Seldom Seen, Rare Plants of Greater Sydney*. Reed New Holland Sydney.

Gleeson, J. & Gleeson, D. (2012). *Reducing the impacts of development on wildlife.* CSIRO Publishing, Collingwood, VIC.

Harden, G. (Ed) (1992, 1993, 2000 & 2002). *Flora of New South Wales Vols. 1 (2nd ed.), 2 (2nd ed.), 3 and 4*. NSW University Press, Kensington.

James, T., McDougall, L., & Benson, D. (1999). *Rare Bushland Plants of Western Sydney*. Royal Botanic Gardens, Sydney.

Keith DA (2004). *Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT*. NSW Department of Environment and Conservation, Sydney

Law, B., Chidel, M., Mong, A. (2005). *Life under a sandstone overhang: the ecology of the eastern cave bat Vespadelus troughtoni in northern New South Wales.* Australian Mammology. 27(2). 137-145.

Morcombe, M., & Stewart, D. (2014). *The Michael Morcombe and David Stewart eGuide to the Birds of Australia.* Mydigitalearth.com.

NSW Department of Environment, Climate Change and Water (2011). *Hydrogeological Landscapes for the Hawkesbury-Nepean Catchment Management Authority, Western Sydney.* Spatial Data available at: https://datasets.seed.nsw.gov.au/dataset/western-sydney-hydrogeological-landscapes-may-2011-first-editionf20fe

NSW Department of Planning and Environment [DPE] (2008). *State Environmental Planning Policy no. 14 - Coastal Wetlands.* Available online: https://www.seed.nsw.gov.au/

NSW Office of Environment and Heritage (OEH) (2016). *NSW Guide to Surveying Threatened Plants*. Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/guide-surveying-threatened-plants-160129.pdf

NSW Office of Environment and Heritage (OEH) (2017-2018). *Threatened Species Profiles.* Office of Environment & Heritage, NSW Government. Available at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/

NSW Office of Environment and Heritage (OEH) (2017b). *Biodiversity Assessment Method.* State of New South Wales. Available at: http://www.environment.nsw.gov.au/biodiversity/assessmentmethod.htm

NSW Office of Environment and Heritage (OEH) (2017c). *The offset rules.* Available at: https://www.environment.nsw.gov.au/biodiversity/offsetrules.htm.

NSW Office of Environment and Heritage (OEH) (2018a). *BioNet Atlas of NSW Wildlife Database*. http://www.bionet.nsw.gov.au/

NSW Office of Environment and Heritage (OEH) (2018b). *BAM Calculator.* Available at: https://www.lmbc.nsw.gov.au/bamcalc

NSW Office of Environment and Heritage (OEH) (2018c). *BioNet Vegetation Classification.* Available at: http://www.environment.nsw.gov.au/research/Visclassification.htm

NSW Office of Environment and Heritage (OEH) (2018d). 'Species credit' threatened bats and their habitats NSW survey guide for the Biodiversity Assessment Method. Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Threatened-species/species-credit-threatened-bats-survey-guide-180466.pdf

NSW Office of Environment and Heritage (OEH) (2018e). *List of experts to prepare expert reports.* Available at: https://www.environment.nsw.gov.au/biodiversity/experts.htm

NSW Office of Environment and Heritage (OEH) (2018f). *Biodiversity Assessment Method Operational Manual Stage 1.* Available at https://www.environment.nsw.gov.au/research-and-publications/publications-search/biodiversity-assessment-method-operational-manual-stage-1

NSW Office of Environment and Heritage (OEH) (2018g). *Serious and irreversible impacts.* Available at: https://www.environment.nsw.gov.au/biodiversity/seriousirreversibleimpacts.htm

NSW Office of Environment and Heritage (OEH) (2019). *Threatened Biodiversity Data Collection*, Bionet. Available at: https://www.environment.nsw.gov.au/asmslightprofileapp/account/login?ReturnUrl=%2fAtlasApp%2fDefault.aspx

NSW Rural Fire Service (2016). *Planning for Bushfire Protection*. Available at: https://www.rfs.nsw.gov.au/plan-and-prepare/building-in-a-bush-fire-area/planning-for-bush-fire-protection

NSW Scientific Committee (2008). *Glossy Black-Cockatoo Calyptorhynchus lathami - Review of Current Information in NSW*. Available at: https://www.environment.nsw.gov.au/resources/nature/schedules/GlossyBlackCockatoo.pdf

NSW Scientific Committee (2015). *Preliminary Determination for Dusky Woodswallow Artamus cyanopterus cyanopterus*. NSW Scientific Committee, Hurstville, NSW.

Pennay, M., Law, B. & Reinhold, L. (2004). *Bat calls of NSW: Region based guide to the echolocation calls of Microchiropteran bats.* NSW Department of Environment and Conservation, Hurstville.

Pizzey, G. and Knight, F. (2003) *The Field Guide to the Birds of Australia 7th edition*. Harper Collins, Pymble, NSW.

Pizzey, G. and Knight, F. (2013). *Pizzey & Knight Birds of Australia Digital Edition V1.* Gibbon Multimedia.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001). *Key to the bat calls of southeast Queensland and north-east New South Wales*. Forest Ecosystem Research and Assessment Technical paper 2001-07, Department of Natural Resources and Mines, Queensland.

Robinson, L. (1991). *A Field Guide to the Native Plants of Sydney*. Kangaroo Press, Sydney.

The Hills Shire Council (2008). *Vegetation Classification Mapping*. Available at: http://mapping.thehills.nsw.gov.au/intramaps80pub/

Thompson, W. (2013) *Sampling rare or elusive species. Concepts. Design and Technique for estimating population parameters.* Island Press. Brisbane.

Threatened Species Scientific Committee (various dates). *Threatened species Conservation Advice.* Established under the *Environment Protection and Biodiversity Conservation Act 1999.*

Toelken, H.R. & Miller, R.T. (2012). *Notes on* Hibbertia *(Dilleniaceae) 8. Seven new species, a new combination and four new subspecies from subgen.* Hemistemma*, mainly from the central coast of New South Wales.* Board of the Botanic Gardens and State Herbarium, Adelaide, South Australia.

Tozer, M.G (2003). The native vegetation of the Cumberland Plain, western Sydney: systematic classification and field identification of communities*,* in *Cunninghamia* (8) 1, 2003**.**

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

Triggs, B. (2004). *Tracks, Scats and Other Traces: A Field Guide to Australian Mammals*. Oxford University Press, Melbourne.

UBM Ecological Consultants (2016). *Flora & Fauna Surveys for Native Bushland at Holland Reserve, Bannerman Road, Kenthurst.* Unpublished Report for The Hills Shire Council.

UBM Ecological Consultants (2017a). *Flora & Fauna Surveys for Area 1, Native Bushland at Holland Reserve, Glenhaven.* Unpublished Report for The Hills Shire Council.

UBM Ecological Consultants (2017b). *Flora & Fauna Surveys for Area 2, Native Bushland at Holland Reserve, Glenhaven.* Unpublished Report for The Hills Shire Council.

UBM Ecological Consultants (2017c). *Flora & Fauna Surveys for Native Bushland: Area 3 Holland Reserve, Bannerman Road, Kenthurst.* Unpublished Report for The Hills Shire Council.

Walker, J. & Hopkins, M.S. (1990). Vegetation. In: *Australian Soil and Land Survey Field Handbook*. R.C. McDonald, R.F. Isbell, J.G. Speight, J. Walker and M.S. Hopkins. Inkata Press, Melbourne.

12 APPENDICES

Appendix 1: BioNET Database Search (OEH 2018a)

Data from the BioNet Atlas website, which holds records from a number of custodians. The data are only indicative and cannot be considered a comprehensive inventory and may contain errors and omissions. Copyright the State of NSW through the Office of Environment and Heritage.

Search criteria: Public Report of all Valid Records of Threatened (listed on *TSC Act* 1995), Commonwealth listed, CAMBA listed, JAMBA listed or ROKAMBA listed Entities in selected area [North: -33.59 West: 150.89 East: 151.09 South: -33.79] returned a total of 3,905 records of 97 species. Report generated on 12/09/2018 8:08 AM.

Legislative Classification: CE = Critically Endangered; E1/E = Endangered Species; V = Vulnerable; C = CAMBA Migratory; J = JAMBA Migratory; K = KAMBA Migratory; P = Protected.
Species listed under the Sensitive Species Data Policy may have their locations denatured: 3 = rounded to 0.01°; 2 = rounded to 0.1°.

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	RECORDS
FLORA (39)				
Acacia bynoeana	Bynoe's Wattle	E1,P	V	41
Acacia clunies-rossiae	Kanangra Wattle	V,P		1
Acacia gordonii		E1,P	E	7
Acacia pubescens	Downy Wattle	V,P	V	21
Callistemon linearifolius	Netted Bottle Brush	V,P,3		2
Darwinia biflora		V,P	V	669
Darwinia peduncularis		V,P		20
Dillwynia tenuifolia		V,P		6
Dillwynia tenuifolia	*Dillwynia tenuifolia* Sieber ex D.C. in the Baulkham Hills local government area	E2,V,P		6
Epacris purpurascens var. *purpurascens*		V,P		298
Eucalyptus camfieldii	Camfield's Stringybark	V,P	V	16
Eucalyptus nicholii	Narrow-leaved Black Peppermint	V,P	V	7
Eucalyptus scoparia	Wallangarra White Gum	E1,P	V	3
Eucalyptus sp. *Cattai*		E4A,P	CE	80
Galium australe	Tangled Bedstraw	E1,P		6
Genoplesium baueri	Bauer's Midge Orchid	E1,P,2	E	4
Grammitis stenophylla	Narrow-leaf Finger Fern	E1,P,3		4
Grevillea juniperina subsp. *juniperina*	Juniper-leaved Grevillea	V,P		9

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	RECORDS
Grevillea parviflora subsp. *supplicans*	Small-leaf Spider Flower	E1,P		12
Hibbertia superans		E1,P		245
Isotoma fluviatilis subsp. *fluviatilis*		P	X	3
Kunzea rupestris		V,P	V	1
Lasiopetalum joyceae		V,P	V	22
Leptospermum deanei		V,P	V	13
Leucopogon fletcheri subsp. *fletcheri*		E1,P		27
Melaleuca biconvexa	Biconvex Paperbark	V,P	V	1
Melaleuca deanei	Deane's Paperbark	V,P	V	45
Persoonia hirsuta	Hairy Geebung	E1,P,3	E	47
Persoonia mollis subsp. *maxima*		E1,P	E	79
Persoonia nutans	Nodding Geebung	E1,P	E	1
Pimelea curviflora var. *curviflora*		V,P	V	157
Pimelea spicata	Spiked Rice-flower	E1,P	E	40
Pomaderris brunnea	Brown Pomaderris	E1,P	V	1
Pomaderris prunifolia	*P. prunifolia* in the Parramatta, Auburn, Strathfield and Bankstown Local Government Areas	E2		2
Pterostylis nigricans	Dark Greenhood	V,P,2		1
Pterostylis saxicola	Sydney Plains Greenhood	E1,P,2	E	2
Pultenaea parviflora		E1,P	V	1
Syzygium paniculatum	Magenta Lilly Pilly	E1,P	V	19
Tetratheca glandulosa	Black-eyed Susan	V,P		222
INVERTEBRATES (2)				
Meridolum corneovirens	Cumberland Plain Land Snail	E1		51
Pommerhelix duralensis	Dural Land Snail	E1	E	42
AMPHIBIANS (3)				
Heleioporus australiacus	Giant Burrowing Frog	V,P	V	7
Litoria aurea	Green and Golden Bell Frog	E1,P	V	4
Pseudophryne australis	Red-crowned Toadlet	V,P		49
REPTILES (1)				
Varanus rosenbergi	Rosenberg's Goanna	V,P		2

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	RECORDS
BIRDS (36)				
Anthochaera phrygia	Regent Honeyeater	E4A,P	CE	4
Apus pacificus	Fork-tailed Swift	P	C,J,K	8
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V,P		83
Botaurus poiciloptilus	Australasian Bittern	E1,P	E	1
Calidris ruficollis	Red-necked Stint	P	C,J,K	1
Callocephalon fimbriatum	Gang-gang Cockatoo population in the Hornsby and Ku-ring-gai Local Government Areas	E2,V,P,3		17
Callocephalon fimbriatum	Gang-gang Cockatoo	V,P,3		29
Calyptorhynchus lathami	Glossy Black-Cockatoo	V,P,2		36
Chthonicola sagittata	Speckled Warbler	V,P		314
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V,P		4
Daphoenositta chrysoptera	Varied Sittella	V,P		29
Epthianura albifrons	White-fronted Chat	V,P		1
Falco hypoleucos	Grey Falcon	E1,P,2		1
Falco subniger	Black Falcon	V,P		1
Gallinago hardwickii	Latham's Snipe	P	J,K	3
Glossopsitta pusilla	Little Lorikeet	V,P		24
Haliaeetus leucogaster	White-bellied Sea-Eagle	V,P		6
Hieraaetus morphnoides	Little Eagle	V,P		8
Hirundapus caudacutus	White-throated Needletail	P	C,J,K	30
Hirundo rustica	Barn Swallow	P	C,J,K	1
Ixobrychus flavicollis	Black Bittern	V,P		5
Lathamus discolor	Swift Parrot	E1,P,3	CE	19
Lophoictinia isura	Square-tailed Kite	V,P,3		14
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V,P		1
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V,P		6
Neophema pulchella	Turquoise Parrot	V,P,3		3
Ninox connivens	Barking Owl	V,P,3		12
Ninox strenua	Powerful Owl	V,P,3		302
Petroica boodang	Scarlet Robin	V,P		7
Petroica phoenicea	Flame Robin	V,P		4

SCIENTIFIC NAME	COMMON NAME	BC ACT STATUS	EPBC ACT STATUS	RECORDS
Petroica rodinogaster	Pink Robin	V,P		1
Polytelis swainsonii	Superb Parrot	V,P,3	V	2
Ptilinopus superbus	Superb Fruit-Dove	V,P		4
Stagonopleura guttata	Diamond Firetail	V,P		1
Tyto novaehollandiae	Masked Owl	V,P,3		9
Tyto tenebricosa	Sooty Owl	V,P,3		4
MAMMALS (14)				
Chalinolobus dwyeri	Large-eared Pied Bat	V,P	V	2
Dasyurus maculatus	Spotted-tailed Quoll	V,P	E	8
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V,P		37
Miniopterus australis	Little Bentwing-bat	V,P		28
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V,P		132
Mormopterus norfolkensis	Eastern Freetail-bat	V,P		67
Myotis macropus	Southern Myotis	V,P		43
Petauroides volans	Greater Glider	P	V	3
Petaurus australis	Yellow-bellied Glider	V,P		54
Phascolarctos cinereus	Koala	V,P	V	5
Pteropus poliocephalus	Grey-headed Flying-fox	V,P	V	133
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V,P		30
Scoteanax rueppellii	Greater Broad-nosed Bat	V,P		38
Vespadelus troughtoni	Eastern Cave Bat	V,P		1

Appendix 2: Matters of National Environmental Significance

Note: Search conducted within a 10 km buffer of the Subject Land .

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat known to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat likely to occur within area

Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat likely to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Petrogale penicillata Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Other		
Pommerhelix duralensis Dural Land Snail [85268]	Endangered	Species or species habitat known to occur within area

Plants		
Name	Status	Type of Presence
Acacia bynoeana Bynoe's Wattle, Tiny Wattle [8575]	Vulnerable	Species or species habitat known to occur within area
Acacia gordonii [5031]	Endangered	Species or species habitat known to occur within area
Acacia pubescens Downy Wattle, Hairy Stemmed Wattle [18600]	Vulnerable	Species or species habitat known to occur within area
Allocasuarina glareicola [21932]	Endangered	Species or species habitat likely to occur within area
Asterolasia elegans [56780]	Endangered	Species or species habitat likely to occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat may occur within area

Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Cynanchum elegans White-flowered Wax Plant [12533]	Endangered	Species or species habitat likely to occur within area
Darwinia biflora [14619]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus sp. Cattai (Gregson s.n., 28 Aug 1954) [89499]	Critically Endangered	Species or species habitat known to occur within area
Genoplesium baueri Yellow Gnat-orchid [7528]	Endangered	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat may occur within area
Lasiopetalum joyceae [20311]	Vulnerable	Species or species habitat likely to occur within area
Leptospermum deanei Deane's Tea-tree [21777]	Vulnerable	Species or species habitat known to occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat likely to occur within area
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat likely to occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345) Omeo Stork's-bill [84065]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat known to occur within area
Persoonia mollis subsp. maxima [56075]	Endangered	Species or species habitat known to occur within area
Pimelea curviflora var. curviflora [4182]	Vulnerable	Species or species habitat known to occur within area
Pimelea spicata Spiked Rice-flower [20834]	Endangered	Species or species habitat known to occur within area
Pterostylis gibbosa Illawarra Greenhood, Rufa Greenhood, Pouched Greenhood [4562]	Endangered	Species or species habitat may occur within area

Pterostylis saxicola Sydney Plains Greenhood [64537]	Endangered	Species or species habitat likely to occur within area
Pultenaea parviflora [19380]	Vulnerable	Species or species habitat known to occur within area
Syzygium paniculatum Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat known to occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Hoplocephalus bungaroides Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]		Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Monarcha trivirgatus Spectacled Monarch [610]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Appendix 3: Holland Reserve Vegetation Plot Data 2018

BAM PLOT DATA: PLOT 1 – 1083_Good (Recently burned)

BAM Site - Field Survey							
Date:	3.9.2018	**Survey Name:**	Holland Reserve, Glenhaven	**Veg Zone ID:**	1083_Good (Recently Burned)	**Recorders**	Y. Nair & K. Smith
Zone:	Zone 56	**Datum:**	GDA94	**Plot ID:**	1	**Plot dimensions:**	20 x 50m
Easting:	313851.4954	**Northing:**	6270152.246	**IBRA region:**	Sydney Basin	**Midline bearing from 0:**	352°
Vegetation Class:		Sydney Coastal Dry Sclerophyll Forests					**Confidence: H** M L
Plant Community Type:		1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion					**Confidence: H** M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	5
	Shrubs	19
	Grasses etc.	9
	Forbs	5
	Ferns	1
	Other	1
Sum of cover of native vascular plants by growth form group	Trees	7.7
	Shrubs	6.8
	Grasses etc.	7.3
	Forbs	1.7
	Ferns	0.1
	Other	0.6
High Threat Weed Cover:		0.1

BAM Attribute (1000 m2 plot)		
DBH	**# stems count**	**# stems with Hollows**
80 + cm	-	-
50-79 cm	1	1
30-49 cm	4	2
20-29 cm	10	-
10-19 cm	10	-
5-9 cm	16	-
<5cm	46	-
Length of Logs (m)	6.85	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	5,99,98,98,84	0,0,0,1,0	15,0,0,0,0	80,0,1,1,15
Average of 5 subplots	76.8	0.2	3	19.4

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
S	*Acacia linifolia*	N	0.3	10	Mid-storey
S	*Acacia suaveolens*	N	0.1	2	Mid-storey
S	*Acacia terminalis*	N	0.2	20	Mid-storey
S	*Acacia ulicifolia*	N	1	70	Mid-storey
F	*Actinotus helianthi*	N	0.2	5	Ground
M	*Angophora hispida*	N	3	8	Mid-storey
G	*Austrostipa pubescens*	N	0.1	3	Ground
F	*Axonopus fissifolius*	E	0.1	1	Ground
T	*Banksia serrata*	N	0.1	30	Mid-storey
S	*Banksia spinulosa*	N	0.1	2	Mid-storey
S	*Boronia ledifolia*	N	0.1	2	Ground
S	*Bossiaea heterophylla*	N	0.3	20	Ground
R	*Caustis flexuosa*	N	5	100	Ground
E	*Cheilanthes sieberi*	N	0.1	15	Ground
S	*Conospermum longifolium*	N	0.1	4	Mid-storey
T	*Corymbia eximia*	N	0.2	3	Over-storey
T	*Corymbia gummifera*	N	0.4	4	Over-storey
V	*Cyathochaeta diandra*	N	0.6	10	Ground
F	*Dianella caerulea*	N	0.1	10	Ground
F	*Dianella prunina*	N	0.2	7	Ground
S	*Dillwynia floribunda*	N	0.1	6	Mid-storey
G	*Entolasia stricta*	N	0.1	5	Ground
G	*Eragrostis brownii*	N	0.2	30	Ground
T	*Eucalyptus haemastoma*	N	4	2	Over-storey
F	*Hovea linearis*	N	0.2	10	Mid-storey
S	*Kunzea ambigua*	N	0.4	30	Mid-storey
V	*Lepidosperma laterale*	N	0.2	5	Ground
S	*Leptospermum parvifolium*	N	0.1	1	Mid-storey
S	*Leptospermum trinervium*	N	0.3	6	Mid-storey
R	*lepyrodia scariosa*	N	0.1	10	Ground
R	*Lomandra filiformis* subsp. *coriacea*	N	0.5	15	Ground
R	*Lomandra obliqua*	N	0.5	20	Ground
S	*Lomatia silaifolia*	N	1	5	Ground
S	*Persoonia levis*	N	1	6	Mid-storey
S	*Petrophile pulchella*	N	0.2	2	Mid-storey
S	*Philotheca hispidula*	N	0.4	6	Ground
S	*Phyllanthus hirtellus*	N	0.1	1	Ground
S	*Platysace linearifolia*	N	0.5	20	Ground
Z	*Woollsia pungens*	N	0.5	20	Ground
X	*Xanthorrea media*	N	0.6	20	Ground
F	*Xanthosia pilosa*	N	1	25	Ground

PLOT 1 – 0m

PLOT 1 – 50m

BAM PLOT DATA: PLOT 2 – 1083_Good (*Allocasuarina littoralis* dominant)

BAM Site - Field Survey							
Date:	3.9.2018	Survey Name:	Holland Reserve, Glenhaven	Veg Zone ID:	1083_Good (Allocasuarina littoralis dominant)	Recorders	Y. Nair & K. Smith
Zone:	Zone 56	Datum:	GDA94	Plot ID:	2	Plot dimensions:	20 x 50m
Easting:	313740.3376	Northing:	6270152.246	IBRA region:	Sydney Basin	Midline bearing from 0:	16°
Vegetation Class:		Sydney Coastal Dry Sclerophyll Forests					Confidence: H M L
Plant Community Type:		1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion					Confidence: H M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	3
	Shrubs	8
	Grasses etc.	7
	Forbs	1
	Ferns	2
	Other	1
Sum of cover of native vascular plants by growth form group	Trees	40.7
	Shrubs	6.6
	Grasses etc.	52.2
	Forbs	0.2
	Ferns	0.2
	Other	0.2
High Threat Weed Cover:		0

BAM Attribute (1000 m2 plot)		
DBH	# stems count	# stems with Hollows
80 + cm		
50-79 cm	2	2
30-49 cm	1	1 (+ 1 stag)
20-29 cm	2	1 stag
10-19 cm	2	
5-9 cm	57	
<5cm	67	
Length of Logs (m)	1055	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	95,95,97,98,100	0,0,1,0,0	0,0,0,0,0	0,0,0,0,0
Average of 5 subplots	97	0.2	0	0

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
T	*Allocasuarina littoralis*	N	40	50	Mid-storey
M	*Angophora hispida*	N	0.2	4	Mid-storey
G	*Austrostipa pubesens*	N	0.1	4	Ground
V	*Caustis flexuosa*	N	1	30	Ground
V	*Cyathocaeta diandra*	N	50	1500	Ground
F	*Dianella caerulea*	N	0.2	15	Ground
G	*Entolasia stricta*	N	0.2	5	Ground
T	*Eucalyptus haemastoma*	N	0.5	4	Over-storey
S	*Lambertia formosa*	N	0.3	5	Mid-storey
R	*Lepidosperma laterale*	N	0.6	20	Ground
S	*Leptospermum trinervium*	N	5	25	Mid-storey
S	*Leucopogon microphyllus*	N	0.3	6	Mid-storey
E	*Lindsaea linearis*	N	0.1	4	Ground
E	*Lindsaea microphylla*	N	0.1	1	Ground
R	*Lomandra filiformis* subsp. *coriacea*	N	0.2	4	Ground
S	*Persoonia levis*	N	0.5	6	Mid-storey
S	*Persoonia linearis*	N	0.1	1	Mid-storey
S	*Phyllanthus hirtellus*	N	0.2	15	Ground
S	*Pittosporum undulatum*	N	0.1	10	Mid-storey
S	*Pultenaea tuberculata*	N	0.1	1	Ground
V	*Schoenus melanostachys*	N	0.1	2	Ground
X	*Xanthorroea media*	N	0.2	3	Ground

PLOT 2 – 0m

PLOT 2 – 50m

BAM PLOT DATA: PLOT 3 – 1080_Planted

BAM Site - Field Survey							
Date:	10.9.2018	**Survey Name:**	Holland Reserve, Glenhaven	**Veg Zone ID:**	1080_Planted	**Recorders:**	Y. Nair & J. Bear
Zone:	Zone 56	**Datum:**	GDA94	**Plot ID:**	3	**Plot dimensions:**	20 x 50m
Easting:	313892.1958	**Northing:**	6270149.764	**IBRA region:**	Sydney Basin	**Midline bearing from 0:**	5°
Vegetation Class:		Sydney Hinterland Dry Sclerophyll Forests					**Confidence:** H M L
Plant Community Type:		1080: Red Bloodwood - Grey Gum shrubby open forest on shale-sandstone interface of the lower Shoalhaven valleys, southern Sydney Basin Bioregion					**Confidence:** H M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	4
	Shrubs	3
	Grasses etc.	4
	Forbs	3
	Ferns	0
	Other	2
Sum of cover of native vascular plants by growth form group	Trees	13.6
	Shrubs	5.2
	Grasses etc.	0.4
	Forbs	5.2
	Ferns	0
	Other	0.2
High Threat Weed Cover:		25.1

BAM Attribute (1000 m2 plot)		
DBH	**# stems count**	**# stems with Hollows**
80 + cm		
50-79 cm	2	
30-49 cm	Present	
20-29 cm		
10-19 cm	Present	
5-9 cm		
<5cm		
Length of Logs (m)	0	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	85, 60, 15, 5, 100	2,25,85,95,0	0,0,0,0,0	0,0,0,0,0
Average of 5 subplots	53	41.4	0	0

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
D	*Aristida ramosa*	N	0.1	1	Ground
S	*Baeckea diosmifolia*	N	0.1	3	Mid-storey
S	*Callistemon citrinus*	N	5	10	Mid-storey
F	*Cenchrus clandestinum*	HTE	25	250	Mid-storey
F	*Conyza bonariensis*	E	0.1	7	Ground
T	*Corymbia maculata*	N	12	7	Over-storey
V	*Cyperus gracilis*	N	0.1	20	Ground
F	*Dichondra repens*	N	0.5	25	Ground
D	*Ehrharta erecta*	HTE	0.1	10	Ground
F	*Einadia hastata*	N	0.1	15	Ground
T	*Eucalyptus scoparia*	N	0.5	1	Over-storey
T	*Eucalyptus sideroxylon*	N	1	1	Over-storey
L	*Glycine microphylla*	N	0.1	1	Ground
F	*Malva sylvestris*	E	0.1	20	Ground
D	*Microlaena stipoides*	N	0.1	6	Ground
F	*Modiola caroliniana*	E	0.1	5	Ground
K	*Muellerina eucalyptoides*	N	0.1	1	Mid-storey
F	*Paronychia brasiliana*	E	0.1	10	Ground
D	*Paspalidium distans*	N	0.1	5	Ground
S	*Pittosporum undulatum*	N	0.1	2	Mid-storey
F	*Plantago lanceolata*	E	0.1	3	Ground
S	*Senna septemtrionalis*	E	0.1	3	Mid-storey
S	*Sida rhombifolia*	E	0.1	10	Mid-storey
F	*Solanum nigrum*	E	0.1	1	Ground
T	*Stenocarpus sinuatus*	N	0.1	1	Mid-storey
F	*Veronica plebeia*	N	0.1	1	Ground

PLOT 3 – 0m

PLOT 3 – 50m

BAM PLOT DATA: PLOT 4 – 1083_Modified

BAM Site - Field Survey							
Date:	10.9.2018	Survey Name:	Holland Reserve, Glenhaven	Veg Zone ID:	1083_Modified	Recorders	Y. Nair & J. Bear
Zone:	Zone 56	Datum:	GDA94	Plot ID:	4	Plot dimensions:	20 x 50m
Easting:	313949.5286	Northing:	6270129.579	IBRA region:	Sydney Basin	Midline bearing from 0:	294°
Vegetation Class:		Sydney Coastal Dry Sclerophyll Forests					Confidence: H M L
Plant Community Type:		1083: Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion					Confidence: H M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	7
	Shrubs	6
	Grasses etc.	6
	Forbs	5
	Ferns	2
	Other	1
Sum of cover of native vascular plants by growth form group	Trees	46.6
	Shrubs	6.3
	Grasses etc.	3.5
	Forbs	0.5
	Ferns	0.6
	Other	0.1
High Threat Weed Cover:		6.4

BAM Attribute (1000 m2 plot)		
DBH	# stems count	# stems with Hollows
80 + cm		
50-79 cm		
30-49 cm	1	3 stags
20-29 cm	Present	2 stags
10-19 cm	Present	
5-9 cm	Present	
<5cm	Present	
Length of Logs (m)	40.6	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	75,100,100,80,90	0,0,10,0,4	1,0,0,0,0	25,0,0,10,1
Average of 5 subplots	89	2.8	0.2	7.2

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
T	*Acacia parramattensis*	N	0.1	1	Mid-storey
S	*Acacia suaveolens*	N	0.1	1	Mid-storey
F	*Acetosa sagittata*	HTE	0.3	20	Ground
E	*Adiantum hispidulum*	N	0.1	5	Ground
F	*Agapanthus* ssp.	E	0.1	3	Ground
F	*Ageratina adenophora*	HTE	0.3	30	Ground
T	*Allocasuarina littoralis*	N	15	12	Mid-storey
M	*Angophora hispida*	N	0.3	5	Mid-storey
F	*Asparagus aethiopicus*	HTE	0.1	4	Ground
L	*Asparagus asparagoides*	HTE	0.2	15	Ground
T	*Banksia serrata*	N	1	5	Mid-storey
S	*Banksia spinulosa*	N	0.5	5	Mid-storey
F	*Cardamine hirsuta*	E	0.1	15	Ground
L	*Cassytha pubescens*	N	0.1	1	Mid-storey
F	*Cestrum parqui*	HTE	0.1	3	Ground
F	*Commelina cyanea*	N	0.1	1	Ground
F	*Conyza bonariensis*	E	0.1	12	Ground
T	*Corymbia maculata*	N	0.1	1	Over-storey
V	*Cyathochaeta diandra*	N	0.1	3	Ground
F	*Dianella caerulea* var. *producta*	N	0.1	6	Ground
G	*Ehrharta erecta*	HTE	0.1	5	Ground
F	*Einadia hastata*	N	0.1	20	Ground
G	*Entolasia marginata*	N	0.1	2	Ground
G	*Entolasia stricta*	N	0.1	5	Ground
T	*Eucalyptus haemastoma*	N	0.1	1	Over-storey
F	*Euphorbia peplus*	E	0.2	40	Ground
F	*Gamochaeta americana*	E	0.2	40	Ground
T	*Glochidion ferdinandi*	N	30	50	Mid-storey
F	*Hydrocotyle sibthorpioides*	N	0.1	10	Ground
G	*Imperata cylindrica*	N	3	300	Ground
S	*Kunzea ambigua*	N	5	40	Mid-storey
S	*Lantana camara*	HTE	5	30	Mid-storey
S	*Leptospermum trinervium*	N	0.1	1	Mid-storey
Z	*Leucopogon microphyllus*	N	0.1	1	Mid-storey
S	*Ligustrum sinense*	HTE	0.1	3	Mid-storey
G	*Microlaena stipoides*	N	0.1	10	Ground
S	*Ochna serrulata*	HTE	0.2	20	Ground
D	*Oplismenus aemulus*	N	0.1	10	Ground
F	*Oxalis perennans*	N	0.1	15	Ground
F	*Parietaria judaica*	E	0.1	10	Ground
E	*Pellaea falcata*	N	0.5	50	Ground
E	*Pellaea viridis*	E	0.1	5	Ground
S	*Pittosporum undulatum*	N	0.5	5	Mid-storey
S	*Senna pendula* var. *glabrata*	HTE	0.2	20	Mid-storey
F	*Solanum mauritianum*	E	0.1	4	Ground
F	*Solanum nigrum*	E	0.1	3	Ground
F	*Solanum seaforthianum*	HTE	0.1	1	Ground
F	*Sonchus asper*	E	0.1	2	Ground
F	*Verbena bonariensis*	E	0.2	30	Ground

PLOT 4 – 0m

PLOT 4 – 50m

BAM PLOT DATA: PLOT 5 – 1083_Degraded

BAM Site - Field Survey							
Date:	10.9.2018	Survey Name:	Holland Reserve, Glenhaven	Veg Zone ID:	1083_Degraded	Recorders:	Y. Nair & J. Bear
Zone:	Zone 56	Datum:	GDA94	Plot ID:	5	Plot dimensions:	20 x 50m
Easting:	313787.499	Northing:	6270292.616	IBRA region:	Sydney Region	Midline bearing from 0:	193°
Vegetation Class:		Sydney Coastal Dry Sclerophyll Forests					Confidence: H M L
Plant Community Type:		Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion					Confidence: H M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	4
	Shrubs	3
	Grasses etc.	2
	Forbs	3
	Ferns	1
	Other	1
Sum of cover of native vascular plants by growth form group	Trees	27.3
	Shrubs	17.2
	Grasses etc.	8
	Forbs	0.8
	Ferns	0.1
	Other	0.1
High Threat Weed Cover:		15.7

BAM Attribute (1000 m2 plot)		
DBH	# stems count	# stems with Hollows
80 + cm		
50-79 cm		
30-49 cm		
20-29 cm		
10-19 cm		
5-9 cm	Present	
<5cm	Present	
Length of Logs (m)	9.4	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	100, 50, 60, 85, 100	0,50,40,15,0	0,0,0,0,0	0,0,0,0,0
Average of 5 subplots	79	21	0	0

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
S	*Acacia implexa*	N	5	12	Mid-storey
T	*Acacia parramattensis*	N	2	2	Mid-storey
F	*Acetosa sagittata*	HTE	0.2	20	Ground
F	*Ageratina adenophora*	HTE	0.2	14	Ground
T	*Allocasuarina littoralis*	N	25	20	Mid-storey
T	*Allocasuarina torulosa*	N	0.2	4	Mid-storey
L	*Asparagus asparagoides*	HTE	0.1	4	Ground
F	*Brassica fruticulosa*	E	0.2	30	Ground
F	*Cestrum parqui*	HTE	0.1	5	Mid-storey
E	*Cheilanthes sieberi*	N	0.1	1	Ground
F	*Cirsium vulgare*	E	0.1	10	Ground
F	*Conyza bonariensis*	E	0.1	10	Ground
T	*Corymbia eximia*	N	0.1	1	Over-storey
G	*Ehrharta erecta*	HTE	5	400	Ground
F	*Einadia hastata*	N	0.5	20	Ground
F	*Euphorbia peplus*	E	0.2	15	Ground
S	*Kunzea ambigua*	N	0.2	6	Mid-storey
S	*Lantana camara*	HTE	10	30	Mid-storey
G	*Microlaena stipoides*	N	5	3000	Ground
F	*Modiola caroliniana*	E	0.1	4	Ground
D	*Oplismenus aemulus*	N	3	120	Ground
F	*Oxalis perennans*	N	0.2	50	Ground
F	*Pavonia hastata*	E	0.1	25	Ground
S	*Pittosporum undulatum*	N	12	20	Mid-storey
S	*Senna pendula* var. *glabrata*	HTE	0.1	4	Mid-storey
S	*Sida rhombifolia*	E	0.2	6	Ground
F	*Sigesbeckia orientalis* subsp. *orientalis*	N	0.1	3	Ground
F	*Solanum mauritianum*	E	0.1	4	Ground
F	*Solanum seaforthianum*	HTE	0.1	1	Ground
F	*Sonchus oleraceus*	E	0.1	2	Ground
F	*Stellaria media*	E	0.1	15	Ground
F	*Trifolium repens*	E	0.1	2	Ground
F	*Verbena bonariensis*	E	0.1	8	Ground
X	*Xanthorrhoea media*	N	0.1	1	Ground

PLOT 5 – 0m

PLOT 5 - 50m

BAM PLOT DATA: PLOT 6 – 1083_Good

BAM Site - Field Survey							
Date:	17.09.18	Survey Name:	Holland Reserve, Glenhaven	Veg Zone ID:	1083_Good	Recorders	Y. Nair & J. Bear
Zone:	Zone 56	Datum:	GDA94	Plot ID:	6	Plot dimensions:	20 x 50m
Easting:	313754.2393	Northing:	6270309.942	IBRA region:	Sydney Basin	Midline bearing from 0:	212°
Vegetation Class:		Sydney Coastal Dry Sclerophyll Forests					Confidence: H M L
Plant Community Type:		Red Bloodwood - scribbly gum heathy woodland on sandstone plateaux of the Sydney Basin Bioregion					Confidence: H M L
EEC:	None						

BAM Attribute (400 m2 plot)		Sum Values
Count Native Richness	Trees	5
	Shrubs	26
	Grasses etc.	8
	Forbs	6
	Ferns	0
	Other	1
Sum of cover of native vascular plants by growth form group	Trees	12.5
	Shrubs	26.4
	Grasses etc.	8.6
	Forbs	2.5
	Ferns	0
	Other	0.3
High Threat Weed Cover:		0

BAM Attribute (1000 m2 plot)		
DBH	# stems count	# stems with Hollows
80 + cm		
50-79 cm		
30-49 cm	Present	2
20-29 cm	Present	
10-19 cm	Present	
5-9 cm	Present	
<5cm	Present	
Length of Logs (m)	23.8	

BAM Attribute (1 x 1 m plots)	Litter cover (%)	Bare ground cover (%)	Cryptogam cover (%)	Rock cover (%)
Subplot score (% in each)	100,95,80,25,90	0,0,0,45,0	0,0,0,0,0	0,5,20,30,10
Average of 5 subplots	78	9	0	13

GF Code	Species	N, E or HTE	Cover	Abundance	Stratum
S	*Acacia suaveolens*	N	0.3	20	Mid-storey
F	*Actinotus minor*	N	0.2	15	Ground
T	*Allocasuarina littoralis*	N	0.5	8	Mid-storey
T	*Angophora hispida*	N	3	12	Mid-storey
S	*Banksia ericifolia*	N	4	7	Mid-storey
S	*Banksia marginata*	N	0.5	4	Mid-storey
S	*Boronia ledifolia*	N	0.1	1	Ground
S	*Bossiaea heterophylla*	N	0.3	25	Ground
S	*Brachyloma daphnoides*	N	1	20	Ground
L	*Cassytha pubescens*	N	0.1	2	Mid-storey
V	*Caustis flexuosa*	N	5	150	Ground
S	*Conospermum longifolium* subsp. *longifolium*	N	0.1	1	Mid-storey
T	*Corymbia eximia*	N	1	2	Over-storey
T	*Corymbia gummifera*	N	7	7	Over-storey
V	*Cyathochaeta diandra*	N	2	20	Ground
F	*Dianella prunina*	N	0.1	1	Ground
S	*Dillwynia floribunda*	N	0.2	10	Mid-storey
G	*Entolasia stricta*	N	0.3	25	Ground
T	*Eucalyptus haemastoma*	N	1	1	Over-storey
S	*Grevillea buxifolia*	N	3	6	Mid-storey
S	*Grevillea speciosa*	N	0.5	4	Mid-storey
S	*Hakea dactyloides*	N	0.5	6	Mid-storey
S	*Hovea linearis*	N	0.2	8	Mid-storey
S	*Kunzea ambigua*	N	0.2	2	Mid-storey
S	*Lambertia formosa*	N	0.3	4	Mid-storey
S	*Lasiopetalum ferrugineum*	N	0.3	40	Mid-storey
V	*Lepidosperma* cf. *laterale*	N	0.1	6	Ground
S	*Leptospermum trinervium*	N	4	16	Mid-storey
R	*Lepyrodia scariosa*	N	0.5	20	Ground
S	*Leucopogon microphyllus*	N	0.2	10	Mid-storey
R	*Lomandra filiformis* subsp. *coriacea*	N	0.4	30	Ground
R	*Lomandra gracilis*	N	0.1	3	Ground
R	*Lomandra obliqua*	N	0.2	30	Ground
S	*Lomatia silaifolia*	N	0.3	14	Ground
S	*Patersonia glabrata*	N	0.5	10	Ground
F	*Patersonia sericea*	N	1	12	Ground
S	*Persoonia levis*	N	4	8	Mid-storey
S	*Persoonia pinifolia*	N	0.2	1	Mid-storey
S	*Petrophile pulchella*	N	0.5	8	Mid-storey
S	*Phyllanthus hirtellus*	N	0.2	16	Ground
S	*Pittosporum undulatum*	N	0.1	1	Mid-storey
S	*Platysace linearifolia*	N	0.1	1	Ground
S	*Pultenaea flexilis*	N	0.3	7	Mid-storey
S	*Pultenaea tuberculata*	N	0.2	3	Ground
S	*Woollsia pungens*	N	5	50	Ground
X	*Xanthorrhoea media*	N	0.3	3	Ground
F	*Xanthosia pilosa*	N	0.5	30	Ground

PLOT 6 – 0m

PLOT 6 – 50m

Appendix 4: Opportunistic Fauna Recorded During Targeted Surveys (UBM 2018 & 2019)

Observation Type:

A	Stranding/Beaching	**H**	Hair, feathers or skin	**R**	Road kill
AR	Acoustic Recording	**I**	Subfossil/Fossil remains	**S**	Shot
B	Burnt	**K**	Dead	**T**	Trapped or netted
C	Cat kill	**M**	Miscellaneous	**U**	Anabat
D	Dog Kill	**N**	Not located	**V**	Fox kill
E	Nest/Drey/Roost	**O**	Observed	**W**	Heard call
F	Tracks or scratchings	**OW**	Observed & Heard Calls	**X**	In scat
FB	Burrow	**P**	Scat	**Y**	Bone, teeth, shell
G	Crushed cones	**Q**	Camera	**Z**	In raptor/owl pellet

*Introduced species **BOLD = Threatened species**

Note that some bat species overlap in both call frequency and structure, making identification problematic in some cases. The degree of confidence or reliability associated with call identifications (*Table 12-1*) will depend on the quality of the recordings as well as the activity of the bat at the time of recording and flight direction. In some instances, a particular species may be identified with confidence, while at other times identification will be less certain (Pennay *et al*. 2004).

Table 12-1: Reliability of Bat Call Identification

DEFINITE (DF)	One or more calls where there is no doubt about the identification of the species.
PROBABLE (PR)	Most likely to be the species named, low probability of confusion with species that use similar calls.
POSSIBLE (PO)	Call is comparable with the named species, with a moderate to high probability of confusion with species that have similar calls.

FAMILY	SCIENTIFIC NAME	COMMON NAME	OBS. TYPE
FROGS (7)			
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog	W
	Litoria peronii	Peron's Tree Frog	W
	Litoria phyllochroa	Leaf-green Tree Frog	W
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	W
	Limnodynastes peronii	Brown-striped Frog	W
	Pseudophryne australis	**Red-crowned Toadlet**	W,AR
	Uperoleia laevigata	Smooth Toadlet	W
REPTILES (4)			
Agamidae	*Intellagama lesueurii*	Eastern Water Dragon	O
Elapidae	*Demansia psammophis*	Yellow-faced Whip Snake	O

FAMILY	SCIENTIFIC NAME	COMMON NAME	OBS. TYPE
Gekkonidae	*Underwoodisaurus milii*	Thick-tailed Gecko	O
Varanidae	*Varanus varius*	Lace Monitor	O
BIRDS (34)			
Acanthizidae	*Acanthiza pusilla*	Brown Thornbill	W
Aegothelidae	*Aegotheles cristatus*	Australian Owlet-nightjar	W
Alcedinidae	*Dacelo novaeguineae*	Laughing Kookaburra	W
Artamidae	*Cracticus torquatus*	Grey Butcherbird	W
	Strepera graculina	Pied Currawong	W
Cacatuidae	*Cacatua galerita*	Sulphur-crested Cockatoo	W
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	W
Charadriidae	*Vanellus miles*	Masked Lapwing	AR
Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper	W
Columbidae	*Leucosarcia melanoleuca*	Wonga Pigeon	W
	Macropygia amboinensis	Brown Cuckoo-Dove	W
Corvidae	*Corvus coronoides*	Australian Raven	W
Cuculidae	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	W
	Eudynamys orientalis	Eastern Koel	W
Hirundinidae	*Hirundo neoxena*	Welcome Swallow	O
Maluridae	*Malurus* sp.	Unidentified Fairy-wren	W
Meliphagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	W
	Anthochaera chrysoptera	Little Wattlebird	W
	Caligavis chrysops	Yellow-faced Honeyeater	W
Menuridae	*Menura novaehollandiae*	Superb Lyrebird	W
Nectariniidae	*Dicaeum hirundinaceum*	Mistletoebird	W
Oriolidae	*Oriolus sagittatus*	Olive-backed Oriole	W
Pachycephalidae	*Pachycephala pectoralis*	Golden Whistler	W
Pardalotidae	*Pardalotus punctatus*	Spotted Pardalote	W
Petroicidae	*Eopsaltria australis*	Eastern Yellow Robin	W
Psittacidae	*Alisterus scapularis*	Australian King-parrot	W
	Glossopsitta concinna	Musk Lorikeet	W
	Platycercus elegans	Crimson Rosella	W
Psophodidae	*Psophodes olivaceus*	Eastern Whipbird	W
Pycnonotidae	**Pycnonotus jocosus*	*Red-whiskered Bulbul	W
Rhipiduridae	*Rhipidura albiscapa*	Grey Fantail	W
Strigidae	*Ninox novaeseelandiae*	Southern Boobook	W

FAMILY	SCIENTIFIC NAME	COMMON NAME	OBS. TYPE
	Ninox strenua	**Powerful Owl**	AR
Turdidae	**Turdus merula*	*Eurasian Blackbird	W
Turnicidae	*Turnix varius*	Painted Button-quail	Q
MAMMALS (19)			
Canidae	**Canis lupus familiaris*	*Domestic Dog	O
	**Vulpes vulpes*	*Fox	O
Emballonuridae	***Saccolaimus flaviventris***	**Yellow-bellied Sheathtail-bat**	U(Pr)
Leporidae	**Oryctolagus cuniculus*	*Rabbit	O
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	Q,P
Molossidae	*Austronomus australis*	White-striped Freetail-bat	U(Df)
	Mormopterus planiceps	Little Mastiff-bat	U(Pr)
	Mormopterus ridei	Eastern Free-tailed Bat	U(Df)
Petauridae	*Petaurus breviceps*	Sugar Glider	O,W
Phalangeridae	*Trichosurus vulpecula*	Common Brushtail Possum	O,P
Pteropodidae	***Pteropus poliocephalus***	**Grey-headed Flying-fox**	O
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	Q
Vespertilionidae	*Chalinolobus gouldii*	Gould's Wattled Bat	U(Df)
	Vespadelus regulus/ ***Miniopterus schreibersii oceanensis***	Eastern Forest Bat/ **Eastern Bentwing-bat**	U(Pr)
	Myotis macropus/ *Nyctophilus* sp.	**Southern Myotis**/ *Nyctophilus* Species	U(Pr)
	Vespadelus pumilus	Eastern Forest Bat	U(Df)
	*Vespadelus pumilus/****Miniopterus australis***	Eastern Forest Bat/**Little Bentwing-bat**	U(Pr)
	*Vespadelus vulturnus/****V. troughtoni****/V. pumilus*	Little Forest Bat/**Eastern Cave Bat**/Eastern Forest Bat	U(Pr)
	Vespadelus troughtoni*/V. pumilus*	**Eastern Cave Bat**/Eastern Forest Bat	U(Pr)
INVERTEBRATES (3)			
Athoracophoridae	*Triboniophorus graeffei*	Red-triangle Slug	O
Camaenidae	***Pommerhelix duralensis***	**Dural Land Snail**	O
Parastacidae	*Cherax* sp.	Unidentified Yabby	O