St Patricks Plains Wind Farm

Ark Energy Pty Ltd

FLORA AND FAUNA ASSESSMENT

EXCLUDING AVIFAUNA AND THEIR HABITATS

21st June 2023

For Ark Energy Pty Ltd

313 Macquarie Street, Hobart Tasmania, 7000

03 62319788

admin@northbarker.com.au **www.northbarker.com.au**

SUMMARY

A wind farm development is proposed on the St Patricks Plains area on the eastern Central Plateau in Tasmania. The development will include the construction of up to 47 Wind Turbine Generators (WTGs). The proponent (Ark Energy Pty Ltd) engaged North Barker Ecosystem Services (NBES) to undertake botanical field surveys and fauna habitat assessments (excluding avifauna within this current report) of the project area, and to make recommendations to minimise impacts to threatened natural values, particularly regarding limiting the likelihood of significant impacts to Matters of National Environmental Significance (MNES).

Vegetation

Nineteen TASVEG vegetation units have been recorded within the project area:

- AHF – freshwater aquatic herbland** – 70.15 ha
- AHL – lacustrine herbland** – 2.13 ha
- DAD – *Eucalyptus amygdalina* forest and woodland on dolerite – 345.22 ha
- DDE – *Eucalyptus delegatensis* dry forest and woodland – 1,072.06 ha
- DDP – *Eucalyptus dalrympleana – E. pauciflora* forest and woodland – 531.34 ha
- DGW – *Eucalyptus gunnii* woodland – 21.71 ha
- DPD – *Eucalyptus pauciflora* forest and woodland on dolerite – 1,688.57 ha
- DRO – *Eucalyptus rodwayi* forest and woodland – 134.40 ha
- FAC – cleared land with a canopy (primarily *E. rodwayi* and some *E. pauciflora*) – 264.32 ha
- FAG – agricultural land – 1,089.47 ha (with Er indicating emergent *E. rodwayi* < 5 % cover, and Ep indicating *E. pauciflora* < 5 % cover)
- FPE – permanent easements – 4.30 ha
- FPH – plantations for silviculture (hardwood) – 602.15 ha
- FRG – regenerating cleared land – 328.37 ha
- FUM – extra-urban miscellaneous – 27.53 ha
- GPH – highland *Poa* grassland** – 2,706.09 ha
- MGH – highland grassy sedgeland** – 1,083.63 ha
- MRR – Restionaceae rushland – 3.29 ha
- NLE – *Leptospermum* forest – 6.69 ha
- OAQ – water, sea – 61.90 ha

* Indicates units that correspond to communities listed as threatened under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA).

** Indicates units that correspond to communities listed as threatened under the Tasmanian *Nature Conservation Act 2002*.

Threatened Flora

Our surveys confirmed or established the presence of 23 threatened flora species, with 9 of these not previously recorded within the project area (denoted with an asterisk):

- *Asperula scoparia* ssp. *scoparia* (*Threatened Species Protection Act* [TSPA] rare)
- *Asperula subsimplex* (TSPA rare)
- *Barbarea australis* (TSPA and EPBCA endangered) *
- *Calocephalus lacteus* (TSPA rare)
- *Carex capillacea* (TSPA rare) *
- *Colobanthus curtisiae* (TSPA rare and EPBCA vulnerable)[1]
- *Cryptandra amara* (TSPA endangered) *
- *Eucalyptus gunnii* ssp. *divaricata* (TSPA and EPBCA endangered)
- *Glycine latrobeana* (TSPA and EPBCA vulnerable)
- *Hovea tasmanica* (TSPA rare)
- *Isoetes humilior* (TSPA rare)
- *Leucochrysum albicans* var. *tricolor* (TSPA and EPBCA endangered)
- *Muehlenbeckia axillaris* (TSPA rare)
- *Myosurus australis* (TSPA endangered) *
- *Myriophyllum integrifolium* (TSPA vulnerable) *
- *Pterostylis pratensis* (TSPA and EPBCA vulnerable)
- *Ranunculus pumilio* var. *pumilio* (TSPA rare)
- *Rhodanthe anthemoides* (TSPA rare)
- *Senecio longipilus* (TSPA vulnerable) *
- *Scleranthus fasciculatus* (TSPA vulnerable) *
- *Taraxacum aristum* (TSPA rare) *
- *Trithuria submersa* (TSPA rare)
- *Viola cunninghamii* (TSPA rare) *

An additional 3 species that have been recorded from the project area in the past were not relocated during our surveys but are still considered likely to be present, albeit not expected to be widespread or abundant.

- *Epilobium willisii* (TSPA rare)
- *Isoetes drummondii* ssp. *drummondii* (TSPA rare)
- *Pilularia novae-hollandiae* (TSPA rare)

[1] In addition to the species suspected to be mis-identified below, observations made during our surveys indicate that records of *Colobanthus curtisiae* attributed to grassland habitats within the north of the project area may be misidentifications of *Colobanthus apetalus* and/or *C. affinis* - our observations suggest *Colobanthus curtisiae* may be restricted to rocky outcrops within forested areas in the south

A further two species have accepted records from the project area, but our observations (and an independent assessment) indicate these may have been misidentifications of closely related non-threatened species.

- *Asperula minima* (TSPA rare) – suspected misidentification of *A. pusilla*, *A. conferta* and/or *A. gunnii*
- *Prasophyllum crebriflorum* (TSPA and EPBCA endangered) – suspected misidentification of *P. sphacelatum*

In addition to listed threatened species, our surveys recorded 3 other vascular flora in the project area that we consider to be conservation significant on the basis of few known records within Tasmania (using Natural Values Atlas data and herbarium records).

Weeds

The study area has been found to support several introduced species, with around 70 recorded from the 2019/20 surveys, including 8 species of weeds declared under the *Tasmanian Weed Management Act 1999*.

Threatened Fauna

The project area is known to support at least five threatened fauna:

- Tasmanian devil
- Spotted-tailed quoll
- Eastern quoll
- Ptunarra brown butterfly
- Miena jewel beetle

Based on the survey results and habitat quality assessment, the design process was guided with the intention of minimising impacts to threatened fauna (amongst other things). The design process resulted in the avoidance of:

- 96 % of high-quality habitat for the ptunarra brown butterfly (1,158 of 1,208 ha), 93 % of moderate quality habitat (1,978 of 2,135 ha), and 95 % of low-quality habitat (421 of 444 ha).
- All emergence hole and adult observation locations, and 94 % of mapped potential habitat for the Miena jewel beetle; and
- All known dens with confirmed devil activity, and 96 % of all mapped burrows.

Direct avoidance has thus reduced the potential for significant impacts on threatened fauna considerably, particularly the ptunarra brown butterfly. We recommend some mitigation measures (such as pre-clearance surveys) that should be applied to ensure residual impacts are not significant and prevent the proposal from having an unacceptable impact on the potential persistence or occurrence of threatened fauna in the area.

Conclusions and Recommendations

The project has been determined as a controlled action under the EPBCA (EPBC 2019/8497) and will require assessment and approval under the Act. The Environment Protection Authority Tasmania (EPA) will oversee the assessment in accordance with a bilateral agreement between the State and the Commonwealth under section 45 of the Act.

The Project Specific Guidelines (PSGs) for Preparing an Environment Impact Statement issued by the EPA explicitly requests information on the following MNES (excluding bird species not covered by our scope):

- Tasmanian devils
- Spotted tailed quoll
- Ptunarra brown butterfly

In addition, other values referenced in the PSGs that can include or be related to MNES include:

- Threatened flora and ecological communities
- Wombat burrows (which can potentially provide denning habitat for devils and quolls)

Our results and analyses have established that the proposal can proceed without resulting in a significant impact to these or other MNES. Largely this is due to avoidance of key habitats during the design phase and the capacity to apply mitigation measures required to ensure residual impacts are not significant.

No impacts are anticipated to ecological communities listed under the Commonwealth EPBCA. Very limited impacts are possible to threatened vegetation communities listed under the Tasmanian *Nature Conservation Act 2002*. A very large number of threatened flora are present within the project area, but only a small proportion at risk from the footprint. It may be possible with design changes and mitigation to entirely avoid threatened vegetation communities and flora.

Direct avoidance and a small footprint have significantly reduced the potential for impacts to threatened fauna, but residual impacts can be further reduced by applying the micro-siting and mitigation measures prescribed.

The following recommendations are made regarding general management of the proposal area and to ensure minimal impacts to conservation significant values.

<u>Native Vegetation</u>

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation – the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g., lower condition areas), as well as maintaining variation within a community across the project area (e.g., protecting different facies within a community where fine scale variation is present).
- Where disturbance but not complete clearance of native vegetation is required, such as slashing firebreaks or easements, micro-siting may be useful for selecting those areas that will be the least impacted (or may even benefit) from this modification.
- Similarly, where modification areas required for IDF clearance and overhead reticulation occur within native vegetation, the requisite removal of vegetation should be done as selectively as possible to maintain the vegetation in a manner that as closely approximates the original native TASVEG unit as possible and/or maintains any key habitat values – this is likely to require a targeted vegetation management plan for these sectors, which could be a condition of approval to have completed prior to works.

- In cases of redesign, maximise the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact areas.
- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation (sourced from the local environment, with example species in Appendix K), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc*.

Threatened and Conservation Significant Flora

- Apply the recommended exclusion zones within the constructed disturbance buffer to reduce impacts to *Pterostylis pratensis* and *Senecio longipilus*.
- Undertake micro-siting surveys for threatened flora (with scope for repositioning components of the footprint), within the appropriate season for any aspect of the final footprint and a buffer of 20 m (allowing for inadvertent disturbance prevention).
- Specifically, within the IDF clearance areas, target surveying should be used to identify conservation significant flora that can be selectively avoided on the basis that their small size and ecology will result in their viable persistence in the area after clearance without resulting in an obstruction to the IDF function.
- Outside of the approved/unavoidable impact area, the general areas around threatened and conservation significant flora locations should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 20 m of the footprint – exclusion zones must be specified within the construction contracts and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements.
- Exclusion zones with the component of the footprint attributed to a construction disturbance buffer may in particular be a viable mechanism to further reduce impacts by protecting some values within this buffer (noting complete disturbance within the construction buffer is unlikely to be necessary).
- In addition, a designated construction exclusion zone should be implemented around the location of *Leucochrysum albicans* var. *tricolor*, which is approximately 200 m from the footprint but as a significant population warrants additional protection.
- The margin of the final footprint should be surveyed for *Eucalyptus gunnii* ssp. *divaricata* to a radius of 15 m (the maximum tree protection zone under Australian Standard for the Protection of Trees on Development Sites (AS 4970-2009) – any individuals of the species found within the buffer (and alive) should be protected with

a radial exclusion zone proportional to 12 x diameter at breast height (as per AS 4970-2009).

– For individuals of TSPA listed plants that cannot be avoided, a permit to take threatened flora listed under the TSPA will be required through the *Nature Conservation Act 2002*.

Weeds

- Undertake surveys of the precise works footprint when it is finalised.
- Following the above surveys, prepare and implement a project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environment Management Plan or similar), which amongst other things must adhere to the principles of containment requirements and prescriptions for:
  - Weed removal and treatment prior to, during, and after civil works.
  - Requirements for wash-down and inspections of all site plant, including earth-moving machinery[2].

Threatened Fauna

Devils and quolls

- Avoid impacts to dens/burrows confirmed to support devils based on the current survey results. It is noted however, that if this is not achievable, it may be possible to reassess the status of the dens/burrows closer to works (*i.e.,* the locations may no longer be occupied at that time).
- Implement the recommended den management protocols within the final impact footprint (direct and indirect) to a buffer of 50 metres in the lead up to clearance/disturbance[3].
- Implement roadkill mitigation measures as follows:
  - Internal road use should be limited to daytime hours to the maximum extent possible within the requirements of the project.
  - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
  - For materials that will be transported to the site using roads, this should primarily occur during daytime hours – any transport required outside daytime hours should be subject to a roadkill risk assessment with mitigation if required.
  - During the construction phase, all internal roads within the works area should be monitored (with documentation) for roadkill whenever the roads are being used, with mortalities removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation (as indicated in a traffic assessment report).
  - During operations, a monitoring program (with documentation) should be established on internal roads for roadkill – with the frequency of monitoring to

[2] DPIPWE (2015b)
[3] As per the DPIPWE devil survey guidelines

be established with understanding of how frequent staff will be on site once the site is operational. As part of the program, mortalities would be removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation.

Ptunarra brown butterfly

- Habitat avoidance should be prioritised based on our habitat quality stratification results from high to low.
- Apply the recommended European wasp monitoring strategy.

Miena jewel beetle

- All known potential habitat patches should be excluded from the footprint of the development.
- In addition to avoiding known habitat patches, the host plant *Ozothamnus hookeri* must be considered during micro-siting surveys of the final footprint within the northern half of the project area, to ensure that no potential habitat has currently been overlooked due to the scale of the surveys.
- If all habitats cannot be avoided, an estimate of individuals to be impacted will be required to inform a permit to take under the TSPA (Section 5), with an estimate of individuals likely to require a targeted survey of food plants within the flowering season.

Where complete habitat avoidance is not achievable, an alternative approach may be warranted as follows:

- Conduct an additional survey comparing the density of beetles within the unavoidable impact area to the remaining habitat patches – given that beetle density may fluctuate between years and that the upcoming summer of 2024 will be an alternate year in the species 2-year larval life-cycle, we propose that in lieu of counting beetles, a count of larval bore holes is undertaken instead over the coming winter (2023) – this may in fact be a more reliable measure of the value of the habitat within the impact area, as comparing counts of adult beetles in a given area may be obfuscated by the fact the adults could have moved around to different locations and/or plants once they have emerged from their bore holes and larval stages (notwithstanding that the flowering plants used by the adults represent an important part of the lifecycle too).
- To support the count of larval bore holes, a count (or relative measure of abundance) of *O. hookeri* plants should be collected (concurrently with the bore hole count) within the impact area and patches of habitat outside of the footprint – this will provide a more robust measure of foraging habitat loss/retention than the current habitat patches, which do not account for variable density of the host and foraging plants within each patch.

If the area of habitat to be lost to the footprint is not found to be disproportionately important for bore hole locations (relative measure of abundance for number of beetles) nor for the abundance of food plants (direct measure of habitat availability for adults), the proposed extent of clearance may not be considered a significant loss by the regulator.

Further mitigation is available at the pre-clearance phase to limit the risk of direct impacts to individuals (and thus reduce the overall effect of the habitat loss by not removing these individuals from the breeding population) as follows:

- In the winter of the last even-dated year prior to works commencing (within, or in the immediate vicinity of the known habitat patches, as works beyond this area are irrelevant), all plants found to support larval bore holes of this species should be cut at ground level and translocated to a habitat patch beyond the impact footprint.
- Any larvae within the bore holes can be expected to be able to survive on the wood of the translocated plant until emergence the following summer (Karen Richards pers. comm.) – note this is why the harvesting of the plants must be undertaken in the winter of an even-dated year, as if it was undertaken in the winter of an odd year the larvae could not survive for 18 months on the dead plant and thus would not make it to adulthood.
- Translocation of the habitat plants containing larval bore holes (and presumably larvae within) will require a permit to take threatened wildlife under the TSPA/NCA.

Consideration of Offsets

Vegetation

- If significant residual impacts to threatened native vegetation remain after avoidance and mitigation, offset priorities should be the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve condition of these units could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing landuse for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.

Threatened flora

- After avoidance and mitigation, if residual impacts to threatened native flora are sufficient to require offsets, the site has significant scope to contribute to an improved reservation status of several species. There is also significant scope on site for applying management agreements designed to maintain or improve habitat for threatened flora, including through grazing prescriptions, control of woody plants (within non-forest environments), and ecological burning. As per native vegetation, paid stewardship agreements are recommended as the mechanism for such agreements.
- Based on current impacts, the need for offsets of threatened flora is unlikely, particularly with the option to implement targeted exclusion zones for *Senecio longipilus* and *Pterostylis pratensis*. Specific to these species however, additional consideration of offsets may be warranted if proportional impacts to the overall population estimates cannot be reduced (such as if the recommended exclusion zones aren't applied).
    - For the *Senecio longipilus* the species is considered to be highly suited to seed collection and propagation of replacement plants, noting the construction disturbance buffer post-works would be a highly suitable location for establishing an offset planting, which could be self-sustaining

along the new habitat edges where they occur adjacent to native grasslands on basalt outcrops in particular.

- For *Pterostylis pratensis* the most effective offset outcome would be to place a conservation covenant (or similar reservation mechanism) around a concentration of plants, noting the species is poorly reserved as per the NRE listing statement.

Threatened fauna

- The prevention of impacts to potential den sites is considered to be adequate for maintaining the potential population persistence of devils and quoll species in the area. If at some point during construction or mitigation, natal den locations are found and are required to be decommissioned, these should result in an offset – replacement dens from artificial structures are not seen as useful in an environment with so many natural alternatives, so a more beneficial offset may involve a monetary contribution to research and/or species conservation.
- Similarly, roadkill mortalities to threatened fauna, if they are considered to constitute significant residual impacts, may best be offset with a monetary contribution to research and/or species conservation, particularly if it can be linked to roadkill mitigation priorities.
- In terms of the overall loss of potential habitat for devils and quolls, the permanent loss of only 102.79 ha, plus the additional loss of denning suitability within 0.20 ha (but remaining suitable for foraging) is not considered to constitute a significant residual impact (as per the assessments in Section 5.1). If there is a requirement to offset this loss of habitat however, there is limited value to these species in the offset being a covenant of additional land, as this is not considered likely represent a net gain for the species, considering available land is not limiting their populations, and tenure and reservation status have little relationship to devil density[4]. In equivalent scenarios a monetary offset has been accepted as the most beneficial mechanism for loss of habitat, and if required in this scenario could be scaled according to the measured habitat quality and supported density of devils (from available local data).
- After avoidance and mitigation, if residual impacts to ptunarra brown butterfly habitat are sufficient to require offsets, offset priorities should be the highest quality butterfly habitat and, more broadly, the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve habitat for the butterfly could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing land use for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.

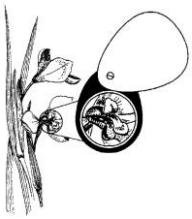
[4] DPIPWE (2010); Cunningham *et al.* (2021)

- If the proportional loss of Miena jewel beetle habitat (or number of individuals) is considered significant following the recommended additional survey work, there is ample scope to undertake replacement planting of the key habitat plant within or supplementary to equivalent habitat patches.

File Control and Contributors

Project	St Patricks Plains Wind Farm
Location	Eastern Central Plateau, Tasmania
Proponent	Ark Energy Pty Ltd
NBES job code	PAS115
NBES project manager	Grant Daniels – 0400 104 649; gdaniels@northbarker.com.au
Field inspections	General flora and fauna: Grant Daniels, Joe Atkinson, Jared Parry, Andrew North, Richard White, Will De Angelis Targeted ptunarra brown butterfly surveys: Grant Daniels, Mark Neyland*, Jo Potter-Craven*, Georgina Andersen, Erin Harris * external to NBES
Field dates	General flora and fauna and reconnaissance: - 22-24/7/2019 - 5/8/2019 - 14-18/10/2019 - 18-22/11/2019 - 9-11/12/2019 - 16-20/12/2019 - 13-17/1/2020 - 27-31/1/2020 - 12-14/1/2022 Ptunarra brown butterfly surveys: - 10-11/3/2020 - 17/3/2020 - 24/3/2020
Reporting	Grant Daniels
Mapping	Jacques Demange, Linda Drummond and Grant Daniels
External consultations	Mark Wapstra, ECOtas – second opinion on identification of flora species Wendy Potts, NRE – consideration of veracity of past flora observations on site Karen Richards, NRE – skink identification, habitat for Miena jewel beetle and presence/absence of adult beetles
Permit to take threatened fauna	DA 20066
Permit to take native flora	DA 18246

Version	Date	Author / Comment
Draft 0.1	16/6/2020	Grant Daniels completed draft for internal review
Version 1.0	18/6/2020	Grant Daniels delivered to client for review
Version 2.0	27/04/2021	Grant Daniels (with NBES staff) delivered to client following design updates associated with new layout – new maps and figures
Version 3.0	24/12/2021	As above
Version 4.0	31/03/2022	As above
Version 5.0	21/6/2022	As above
Version 6.0	23/1/2023	As above
Version 7.0	16/6/2023	NBES updated in response to regulator comments
Version 7.1	21/6/2023	NBES minor updates



List of Acronyms
(excluding measurement units and abbreviations defined within figures or tables)

AHF – freshwater aquatic herbland (TASVEG unit)
AHL – lacustrine herbland (TASVEG unit)
ANOVA – Analysis of variance
DAD – *Eucalyptus amygdalina* forest and woodland on dolerite (TASVEG unit)
DAWE - Department of Agriculture, Water and the Environment, now Department of Climate Change, Energy, the Environment and Water (DCCEEW)
DDE – *Eucalyptus delegatensis* dry forest and woodland (TASVEG unit)
DDP – *Eucalyptus dalrympleana – E. pauciflora* forest and woodland (TASVEG unit)
DGW – *Eucalyptus gunnii* woodland (TASVEG unit)
DFTD – Devil Facial Tumour Disease
DPD – *Eucalyptus pauciflora* forest and woodland on dolerite (TASVEG unit)
DRO – *Eucalyptus rodwayi* forest and woodland (TASVEG unit)
DSEWPaC – Department of Sustainability, Environment, Water, Population and Communities
DPIPWE – Department of Primary Industries, Parks, Water and the Environment, Tasmania, now NRE - Department of Natural Resources and the Environment, Tasmania
EIS – Environmental Impact Statement
EPA – Environment Protection Authority Tasmania
EPBCA – *Environment Protection and Biodiversity Conservation Act 1999*
FAC – cleared land with a canopy (TASVEG unit)
FAG – agricultural land (TASVEG unit)
FPE – permanent easements (TASVEG unit)
FPH – plantations for silviculture (TASVEG unit)
FRG – regenerating cleared land (TASVEG unit)
FUM – extra-urban miscellaneous (TASVEG unit)
GPH – highland Poa grassland (TASVEG unit)
HSD (Tukey test) – Honestly Significant Difference
LUPAA – *Land Use Planning and Approvals Act 1993*
MGH – highland grassy sedgeland (TASVEG unit)
MNES – Matters of National Environmental Significance
MRR – Restionaceae rushland (TASVEG unit)
NBES – North Barker Ecosystem Services
NCA – Tasmanian *Nature Conservation Act 2002*
NLE – *Leptospermum* forest (TASVEG unit)
NRE – Department of Natural Resources and the Environment, Tasmania
NVA – Natural Values Atlas database (DPIPWE, Tasmania)
OAQ – water, sea (TASVEG unit)
RFA – Tasmanian *Regional Forest Agreement 1997*
PC – *Phytophthora cinnamomi*
SPRAT – Species Profile and Threats Database
TSPA – Tasmanian *Threatened Species Protection Act 1995*
WTG – Wind Turbine Generator

TABLE OF CONTENTS AND FIGURES

TABLE OF PLATES

LIST OF TABLES

1 INTRODUCTION

1.1 Background

A wind farm development is proposed on the St Patricks Plains area on the eastern Central Plateau in Tasmania (Figure 1). The development will include the construction of up to 47 Wind Turbine Generators (WTGs). The turbines require a pad on which to be constructed, as well as a hardstand to accommodate a crane during construction. Each turbine also requires an access road. The project will also require a range of ancillary infrastructure, including laydown areas and hardstands; construction compounds; and transmission infrastructure. Three meteorological towers (met masts) have already been constructed for collecting data to assess the feasibility of the proposal (with two to remain through operations). Further detail on the project is contained in the main body of an Environmental Impact Statement (EIS).

The proponent (Ark Energy Pty Ltd) engaged North Barker Ecosystem Services (NBES) to undertake botanical field surveys and fauna habitat assessment (excluding avifauna within this report) of the project area, and to make recommendations to minimise impacts to threatened natural values, particularly regarding limiting the likelihood of significant impacts to Matters of National Environmental Significance (MNES). Subsequently, the current study presents results from surveys completed between 2019 and 2022 of the project area, which is bound by the cadastral parcels of the participating landowners, but within which the proponent specified some areas that will be excluded from development (thus requiring less survey or no surveys at all) (Figure 1).

1.2 Project Area and Existing Environment

1.2.1 Project area and location characteristics

St Patrick's Plains is in the Tasmanian Central Highlands bioregion and the jurisdiction of the Central Highlands Council. The project area and the surrounding local areas have been subject to a long history of human modification and management, including land clearance/conversion, pastoral agriculture, game management, and forest use. Local terrestrial habitats are consequently heterogeneous with varying apparent levels of human influence.

1.2.2 Survey/study area

The project area is effectively defined by the cadastral margins of the participating properties, with the exception of an internal forest reserve (c. 275 ha) that has been excluded from consideration and investigation by the proponent (Figure 1). The remaining 10,043 ha represents the extent of the survey area for our investigations; within this area there were additional internal exclusions nominated by the proponent for the purposes of natural values avoidance (for previously reported values), nature covenants, and buffers around incompatible land uses (e.g. shack villages) – the c. 1,300 ha within these exclusion areas were surveyed in our investigations to the extent where we could map patch-scale values, but were not surveyed to the same level of detail as areas that might contain the development footprint.

1.2.3 Geology

Soils throughout the project area are primarily derived from Jurassic dolerite (geocode Jd 6499), particularly the southern sections (e.g. Christians Marsh) and the northeast (Ripple properties); soils derived from Tertiary basalt (Tb 7499) are more prominent on the properties making up the north-western corner (Wihareja, Allwrights, St Patricks Plains), including low-

profile basalt outcrops emergent from broader basalt plains, which themselves are interspersed with swales of Quaternary depositions (Qh 8499).

1.2.4 Topography and altitude

The project area is around 600 m a.s.l[5] at its lowest point on the section of the Shannon River in the southwest corner on Christians Marsh. The highest point is around 980 m a.s.l on the flanks of a hill in the northwest corner of Ripple North near Poatina Road. Variation in relief is greatest in the southern half of the project area, including relatively incised slopes leading down the Shannon River, moderately steep hills (sometimes forming ridges), interjoining flats and gully bottoms. Relief is far less within the northwest part of the project area, where a large plateau (c. 900 m a.s.l) grades gently to the margins of the Shannon River (c. 880 m a.s.l) and is flanked by modest slopes of small rises (c. 920 m a.s.l).

1.2.5 Climate characteristics[6]

Mean rainfall for the area is around 1000 mm per annum, with a marked seasonal peak in precipitation from May to September. This coincides with the coldest time of year, in which average daily minimums are below 0 ° C and average daily maximum temperatures are below 10 ° C. Average daily maximum temperatures throughout the rest of the year are below 20 ° C, but temperature can be in excess of 30 ° C infrequently.

2 BOTANICAL SURVEY AND FAUNA HABITAT ASSESSMENT

2.1 Background Research – Supporting Data

The following sources were used for biological records from the region to supplement field data collected by NBES:

- Protected Matters database[7] – all matters of national environmental significance that may occur in the area or relate to the area in some way.
- Tasmanian Natural Values Atlas (NVA)[8] – this Department of Primary Industries, Parks, Water and the Environment, Tasmania (DPIPWE) database includes biological records.
- TASVEG 3.0/4.0 (and TASVEG Live) digital data – these layers have been field-truthed during ground surveys.
- Previous assessments on natural values within the project area (by NBES).

2.2 Survey Timing

Ground surveys by NBES ecologists commenced in winter 2019 and concluded in summer 2022, with multi-person field trips varying in duration from 1-5 days undertaken in July, August, October, November, December, January, and March. The 2019 winter trips were primarily for reconnaissance, while the autumn 2020 field trips were for targeted surveys of the ptunarra brown butterfly (*Oreixenica ptunarra*); the distribution of survey effort across the

[5] Above sea level

[6] Using climatological data from the nearest weather station at Liawenee Moor, 41.90°S 146.67°E 1,057m AMSL

[7] EPBCA Protected Matters report, (Commonwealth of Australia) – PMST_ I63KLI

[8] NVA report_ nvr_1_03-Jun-2020 (DPIPWE 2020a) – with the database checked manually at later dates for new records

other surveys was aligned with optimal survey timing for threatened flora species considered to have a high likelihood of being present (based on previous records to a radius of 5 km).

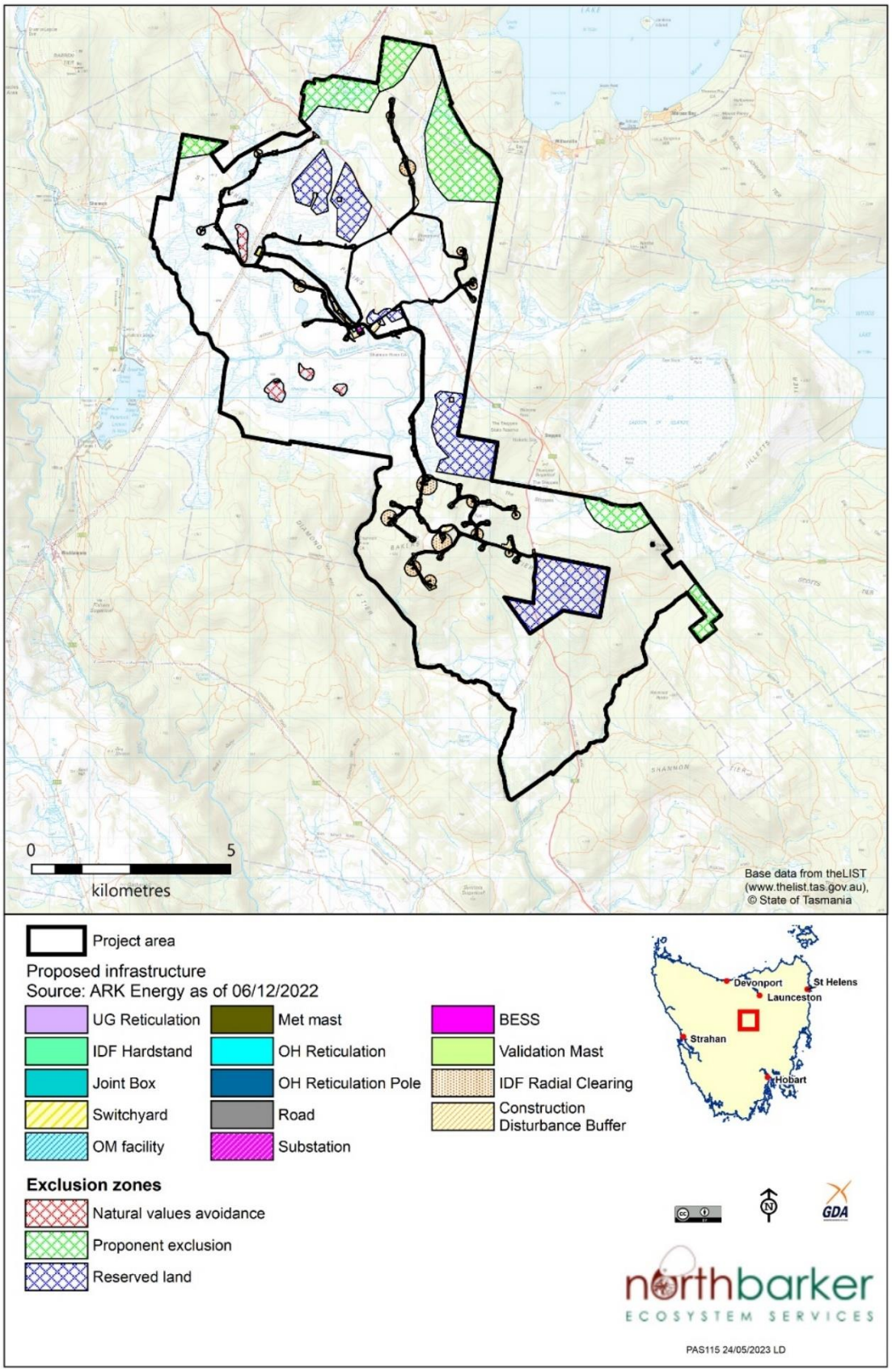


Figure 1: Location of the project area on the eastern Central Plateau

2.3 Flora Methods

Flora field data were recorded using handheld non-differential GPS units with average location accuracy < 10 m.

2.3.1 Vegetation mapping

In Tasmania, the primary source on the distribution of vegetation is the state-wide TASVEG[9] mapping database (with TASVEG 4.0 being the latest iteration [version 3.1 being the latest at the start of the project], and current distribution data available in the TASVEG Live database version). The compilation of TASVEG has been an iterative process of improvement and refinement upon the original base layer, that was collated from several sources[10]. As a result, data within TASVEG do not completely represent vegetation extent and distribution at a single date. Indeed, some areas are still mapped at a coarser scale than the general 1: 25,000 or based on interpretation of imagery over ten years old[11]. Furthermore, vegetation mapping at any scale can be an exercise in judgement, with an inherent potential for errors in interpretation. Subsequently, it is standard practice to truth TASVEG data using recent imagery and ground sampling[12].

The image interpretation process for the current proposal involved several satellite images accessed via Google Earth Pro[13]. The images had a resolution of no more than 2.5 m, with capture dates ranging from 29/12/2018 to 4/1/2019, with most images captured on the earlier date. Imagery was examined for patterns of tone, texture, colour and contrast to identify homogeneous patches of vegetation (aerial signatures). This was also informed by the interpretation of environmental traits such as slope, aspect and elevation, due to their consistent associations with vegetation units[14]. Patches were then manually assigned to TASVEG units based on correlation with existing polygons within the TASVEG database and evident aerial signatures.

Ground sampling was undertaken over the course of all field visits. Ground sampling involved two or three ecologists traversing the survey area (mostly on foot) in a stratified fashion that ensured ground sampling of the complete range of image signatures. When a patch was ground sampled, the observer assessed the requisite traits of vegetation structure, floristics, geology and environment to discriminate the patch from any other possible TASVEG units using the descriptions and stepwise keys within the online versions of the current TASVEG companion manual[15]. Boundary discrimination was based on image interpretation and aided by point data collected on a hand-held GPS unit. All ground sampling was undertaken during the daytime, mostly in fine weather due to the potential sampling constraints associated with reduced visibility from rain and/or low light.

This combination of image interpretation followed by stratified ground sampling and interpolation is consistent with the DPIPWE guidelines for natural values assessments (section 7, DPIPWE 2015a[16]) as well as the methods applied within vegetation mapping elsewhere[17] and described in ecological manuals[18].

[9] DPIPWE (2020a)
[10] Harris and Kitchener (2005)
[11] Kitchener and Harris (2013)
[12] TVMMP (2013)
[13] Google Earth Pro (2020), March 2020 – DigitalGlobe, TerraMetrics, CNES/ Airbus
[14] Kirkpatrick and Nunez (1980)
[15] Kitchener and Harris (2013)
[16] DPIPWE (2015a)

Following ground sampling and the collation of data, TASVEG units observed on site were cross-referenced against all vegetation communities listed as threatened under the Tasmanian *Nature Conservation Act 2002* (NCA) and/or the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA), as well as conservation priorities for the Central Highlands area under the Tasmanian *Regional Forest Agreement* (RFA).

2.3.2 Floristic surveys, including threatened flora searches

To support the determination of TASVEG units (as per DPIPWE guidelines, 2015a) and provide general floristic data, within each native community at least one full vascular plant species list was taken in representative ¼ ha plots using a Timed Meander Search Procedure[19]; this method requires the observer to continue survey effort until survey yields (new species observations) diminish towards zero. Outside the ¼ ha plots, threatened species observations, and observations of additional non-threatened plant species were noted as encountered while traversing the site and while conducting all other observations – where nodes of additional plants were present, additional plots were undertaken. Surveys for the current assessment (*i.e.* excluding previous work on the site by NBES) included 95 floristic plots distributed across the project area (Figure 2). While outside plots, flora survey effort was applied disproportionately within locations considered likely to contain threatened species habitat (based on NBES knowledge and NRE guidelines) or simply contain species not noted earlier (based on observations of habitat variation at the sub-community scale). In addition, locations of previous threatened flora observations within the project area (based on NVA observation data) were visited for verification of identification and to establish if the species were still present. At least one observation location was visited for each threatened species previously reported from the project area. In total, over 75 % of all previous observation locations for threatened flora were visited. Similar to the defined plots, meandering searches within potential threatened species habitat or at previously reported locations continued until a point in time when it was apparent the likelihood of more observations was too low to warrant further effort.

To further increase the survey effectiveness in capturing threatened flora, the survey timings were chosen to maximise the potential for recording threatened species (based on species known within 5 km), particularly those with narrow windows for identification, such as orchids[20]. Across our 2019, 2020 and 2022 surveys, several days' (> 25) searching has been dedicated primarily to threatened flora.

Declared[21] and environmental weeds, as well as symptomatic evidence of plant pathogens, were searched for and recorded where evident within or close to (such as on an adjacent road) the project area.

Botanical nomenclature follows the current census of Tasmanian plants[22].

[17] The Nature Conservancy (1994)
[18] Kuchler and Zonneveld (2012)
[19] Goff *et al.* (1982)
[20] Wapstra, M. (2018)
[21] Tasmanian *Weed Management Act 1999*
[22] de Salas & Baker (2019)

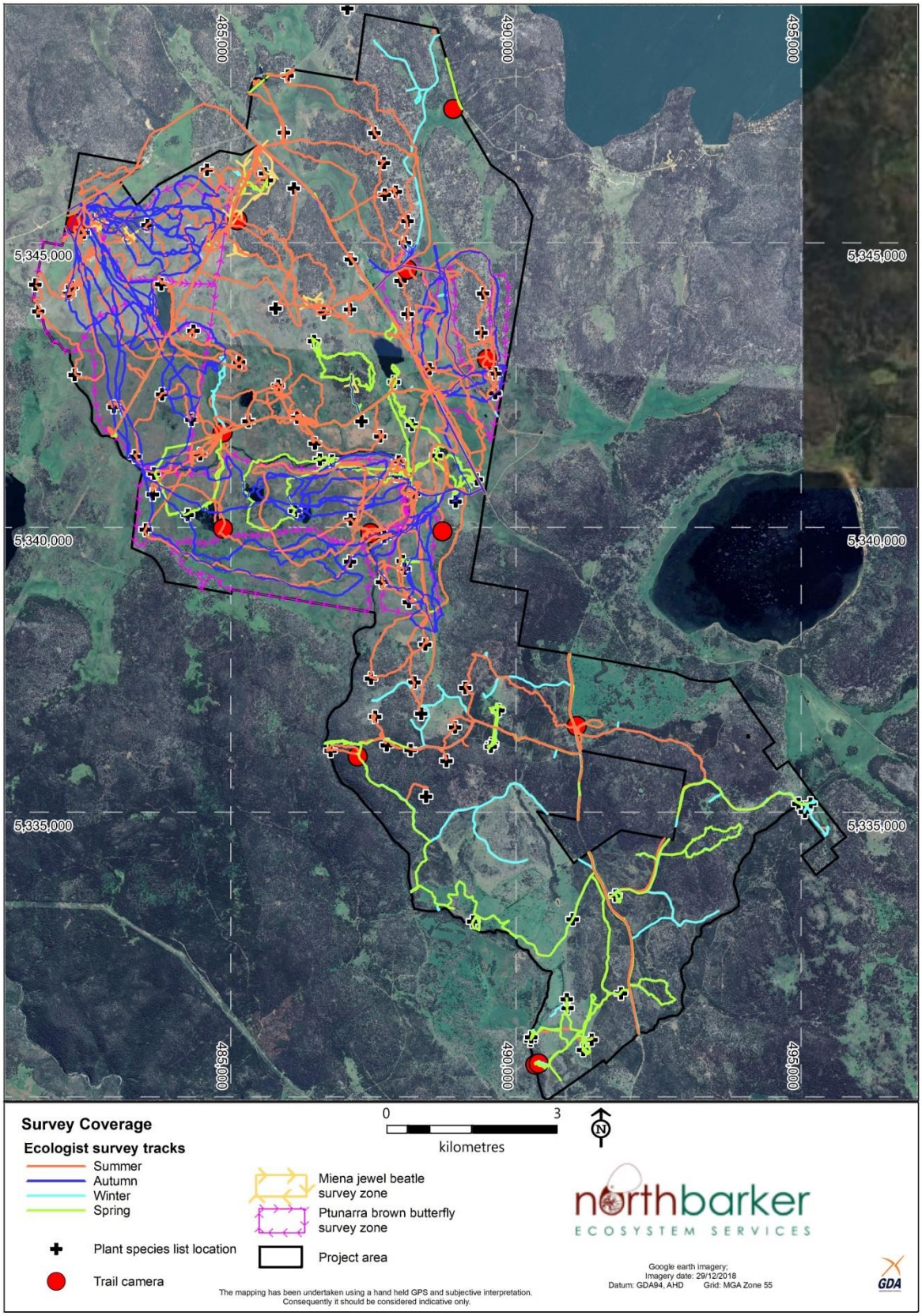


Figure 2: Coverage of flora and fauna survey methods

2.4 Fauna Methods

Observations of habitat suitability for fauna (particularly threatened fauna) were made concurrently with the flora ground surveys across the project area. Particular reference and/or targeted searching was undertaken in relation to:

- The suitability of habitat for, and the presence of dens (including natal dens) of the Tasmanian devil (*Sarcophilus harrisii*), the eastern quoll (*Dasyurus viverrinus*), and spotted-tailed quoll (*Dasyurus maculatus* ssp. *maculatus*);
- Habitat potential and the presence of possible emergence holes of the Miena jewel beetle (*Castiarina insculpta*); and
- Habitat mapping (and eventually targeted seasonal surveys within suitable habitat) for the ptunarra brown butterfly.

2.4.1 Tasmanian devils and quolls

The Department of Agriculture, Water and the Environment (DAWE) (formerly DSEWPaC and now DCCEEW) published guidelines for surveying Tasmanian devils and quolls; these have been largely superseded in relevancy and currency by NRE guidelines relating specifically to surveying with respect to assessing the impacts of development proposals[23]. The major difference is the focus of the NRE guidelines on potential denning opportunities, due to the importance of limiting demographic pressures on the devil in particular in an era of increased mortality because of Devil Facial Tumour Disease (DFTD). In contrast, the DAWE/DCCEEW guidelines were developed to detect presence of a species only[24], which has less utility in determining meaningful impacts from a proposal. As such, our survey for these species used a combination of techniques from both guidelines to establish presence/absence and determine the suitability of habitat for denning.

For presence/absence[25], diurnal searching was undertaken for scats and prints throughout the entire ground survey, with particular attention to potential dispersal routes (e.g., tracks) and soft substrate. Scats in particular are often detectable in latrine sites such as at track junctions and creek crossings[26] and can be differentiated using morphometric traits including colour, shape, size and contents[27]. For further confirmation, remote motion-operated trail cameras were placed at thirteen locations in the project area for between 2 and 60 nights (average 28 nights per camera). The cameras were attached to stakes (or similarly solid surfaces) but directed towards ground level. Some cameras were located at spots with passive evidence of Tasmanian devils (scats) and/or potential denning or lay-up locations.

Characteristics of natal dens for these species include a dry, structurally stable inner chamber, a chamber that is sufficient size for the mother and litter but is not so large as to be un-defendable (which includes an entrance that is a tight fit for the mother), and the presence of nooks and crannies for the young to hide in[28]. Preferable habit characteristics are considered to include direct sun near the den entrance, shelter from predators around the den mouth, a dearth of predators in the area (excluding other devils), an adequate prey base, habitat heterogeneity,

[23] Natural and Cultural Heritage Division (2015)
[24] DSEWPaC (2011)
[25] DSEWPaC (2011); Natural and Cultural Heritage Division (2015)
[26] DSEWPaC (2011)
[27] Triggs (1996)
[28] Mooney (unpublished data)

complex shelter elements (such as cliffs, caves, earth banks and log piles), and friable soil for the burrows[29]. Some of these traits are fine scale habitat attributes, whereas others are landscape scale (or have plausible proxies at the landscape scale). Thus, to determine the denning potential of habitat on site, observers included in our field assessments consideration of the presences of burrows/potential den sites, as well as higher level traits such as hydrology, soil, vegetation structure, *etc*. Whilst it was not an aim of the assessment to undertake a systematic search for all possible den structures, our general survey coverage is in excess of the minimum of 30 % visual coverage recommended in the NRE guidelines[30].

Additional burrows/potential dens are typically found during more detailed pre-clearance searches (NBES unpublished data). To potentially quantify the balance of burrows yet to be found within the footprint, following the field surveys, the probability of further dens/burrows occurring on site has been calculated by utilising the existing survey coverage to develop a formula to predict the likely number of dens yet to be detected. To calculate the probability, all survey tracks were buffered by 10 m (which accounts for the average extent of visibility of ground surveying) and the density of dens/burrows observed per hectare calculated. Using this known quantity, the potential for dens/burrows to occur in areas of the footprint that will be searched with a pre-clearance survey can be extrapolated using the formula:

$$Potential\ unrecorded\ burrows/dens = D * H$$

Where D is number of known dens/burrows per hectare, and H is the extent of potential habitat.

Additional predictive power is available by modelling denning habitat suitability based on vegetation and landscape traits.

2.4.1.1 Denning habitat mapping & denning prediction

Habitat suitability has been modelled by stratifying vegetation based upon the likelihood of it supporting denning structures. Table 1 shows the denning habitat classification and the supporting rationale behind each class. This model has been run for both pre-construction (to detail the level of impact) and post-construction (to highlight the change in potential habitat suitability).

Table 1: Natal den habitat suitability classes for the Tasmanian devil and quoll species

Suitability class for containing natal dens	Rationale
Optimal	This category contains areas deemed optimal for denning opportunities based on field observations and site attributes. Characteristics include: - All areas within 100 m of a recorded burrow or devil observation (other than those areas excluded by unsuitable conditions [see unsuitable conditions below]) – optimal on the basis of existing burrow/s and expected that local traits

[29] Mooney (unpublished data); Natural and Cultural Heritage Division (2015)
[30] Natural and Cultural Heritage Division (2015)

Suitability class for containing natal dens	Rationale
	would be suitable for the presence of additional burrows. - All areas of dry forest TASVEG units (ideal soil and sheltering conditions)[31] other than DRO (associated with poor drainage and high soil moisture compared to other dry forest units. - GPH or GCL within 100 m of native forest units and/or with a dense layer of shrubs (ideal soil and sheltering conditions)[32]. - Silvicultural forest (FPH) areas (ideal soil and sheltering conditions, including the presence of windrows)[33]. - Regenerating cleared land (FRG) within a native mosaic and with optimal soil and sheltering characteristics (including the presence of log piles)[34].
Unsuitable	This class captures all areas that are deemed unsuitable for denning opportunities, based on field observations and site attributes. Characteristics include: - Permanently inundated areas denoted by OAQ on vegetation mapping, including Wihareja Lagoon (these areas being too wet for denning)[35]. - Areas of FAG or FUM > 100 m from native vegetation. These areas are likely too far separated from high prey densities for energetically efficient maternal denning. In addition to this, exposed sites make young devils vulnerable around their dens and are thus not selected by adults[36]. Note FAG and FUM within 100 m of native forest considered suitable but suboptimal; and noting that micro-siting during a den management protocol should overrule the classification of unsuitable if micro-habitats suitable for denning are present within the FAG and/or FUM > 100 m from native forest, including the presence of rock and log piles, or thickets of suitable vegetation within the broader cleared area – these areas should be elevated to consideration as suitable in such scenarios.
Sub-optimal	This category includes remaining areas of intermediate habitat,

[31] Pemberton (1990); Thalmann et al. (2016); Jones & Barmuta (2000); Jones et al. (2023); Godsell (1983)
[32] Thalmann et al. (2016); Jones & Barmuta (2000); Lyall (2017); Fancourt (2016); Troy (2014)
[33] Jones et al. (2023); Lyall (2017)
[34] Pemberton (1990); Thalmann et al. (2016); Fancourt (2016); Jones et al. (2023); Lyall (2017)
[35] Natural & Cultural Heritage Division (2015)
[36] Jones et al. (2023); Andersen et al. (2017)

Suitability class for containing natal dens	Rationale
	including (but not limited to) those with the following traits: - Seasonally inundated lagoons and other wetland habitats not classified as unsuitable (*i.e.*, those that dry out in summer)[37]. - TASVEG units representing communities that can be expected generally to be too moist for optimal denning conditions, including MGH, seasonal examples of AHF and AHL, GPH within 50 m of MGH, MRR, NLE, and DRO. - Exposed grassland (lacking shrub cover) distant (>100 m) from native forest[38]. - FAC vegetation (good shelter at canopy level, but less suitable at ground level)[39].

2.4.2 Miena jewel beetle[40]

Miena jewel beetle adults are nectar feeders with a very strong (but not exclusive) feeding preference for *Ozothamnus hookeri* (scaly everlastingbush)[41]. The larvae are stem borers, which are dependent solely on *O. hookeri* (which has rarely been found to support boring larvae of other *Castiarina* species[42]). Targeting the flowering food plant (*O. hookeri*) provides the best chance of positive beetle sightings; however, the two-year lifecycle of the beetle means that adults are scarce in alternate years, and the food plant can vary in flowering intensity between years. Therefore, in situations with a paucity of flowering plants and/or if surveys fail to locate adult beetles, the potential for new populations can be strongly indicated by the identification of emergence holes in the stems of *O. hookeri*, followed up by a return survey in latter flowering seasons to confirm adult presence.

The current project area is within the range of the Miena jewel beetle, with one past observation record adjacent to the project area on Waddamana Road. Subsequently, within the present survey, potential habitat for the Miena jewel beetle was mapped at the patch scale using the presence of the food and larval host plant *O. hookeri;* because *O. hookeri* co-occurs with another broadly similar shrub species, *Ozothamnus ericifolius* (often in dense thickets which limit the ease of conclusively determining the absence of one or the other species without a precise, deliberate survey of individual plants, which was beyond the scope of the current assessment of habitat patches), habitat patches with either of these species of *Ozothamnus* were marked as potential habitat for the jewel beetle (noting that our observations confirmed *O. hookeri* was present in most patches, but varied in abundance, which may thus affect habitat suitability for the beetle). In January 2020, a subset of habitat patches with the highest likelihood of supporting the beetle were investigated for emergence holes by Karen Richards and Chris Spencer (at the

[37] Thalmann et al. (2016); Natural & Cultural Heritage Division (2015)
[38] Thalmann et al. (2016); Jones & Barmuta (2000); Lyall (2017); Andersen et al. (2017); Guiler (1970); Troy (2014)
[39] Thalmann et al. (2016); Lyall (2017); Troy (2014)
[40] Ecology notes and survey techniques from Threatened Species Section (2019) and references within
[41] Adults have occasionally been recorded on *Baeckea gunniana* (alpine baeckea)
[42] Pers. comm. Richards and Spencer (2020)

request of North Barker) (Figure 2). The survey was not intended to be definitive or systematic but was intended to facilitate verification of the presence of characteristic emergence holes following earlier NBES observations had established the presence of suspected emergence holes. A subset of the areas was revisited by Richards and Spencer within the 2021 season (an adult-emergence season within the two-year life cycle of the species) to conduct a presence/absence assessment for adults.

2.4.3 Ptunarra brown butterfly

Spring and summer vegetation surveys established the presence of large areas of *Poa* tussock grassy habitats with the potential to support ptunarra brown butterflies (which were known to have two past observation records within the project area). A targeted survey was thus undertaken to establish the presence of the species throughout the project area and attempt to quantify variations in density in relation to habitat types.

2.4.3.1 Survey area

The survey area was defined as 7 broad zones (Figure 2), which covered the majority of potential habitat within the project area[43] and included internal and interzonal variation in the proportion of habitat types and management. Zones were identified to facilitate placing multiple observers across the project area to conduct simultaneous counts to aid identification of areas that supported butterflies more densely than others.

2.4.3.2 Habitat types[44]

- Sedgy grassland with sward of medium-sized tussocks (generally dominated by *Poa gunnii* and equivalent to TASVEG unit MGH) – found in flat, low-lying areas with relatively high moisture levels – considered to have high habitat potential from preliminary assessments.
- Short native grassland (mostly dominated by *Poa clivicola*) with shrub component (mostly dominated by *Hakea microcarpa*) to varying degrees of cover – equivalent to TASVEG unit GPH – widespread on basalt outcrops and flats, this was the most abundant habitat type within each zone and considered to have moderate habitat potential from preliminary assessments.
- Tall tussock grassland – found in seasonally inundated areas on the edges of rivers and wetlands, and within seasonal watercourses – dominated by *Poa labillardierei*, which was present only to a minor degree in the other habitat facies – equivalent in parts to TASVEG units MGH and GPH, depending on broader composition traits – this was the least extensive habitat type across the survey zones and considered to have low to moderate habitat potential from preliminary assessments (largely relating to relative inundation frequency and timing).
- Very short grassland with/without pasture component – generally heavily grazed and contained the least native components, although in some areas represented very short GPH – was most prevalent within the survey zone to the east of the Highland Lakes Road, with minor amounts elsewhere associated with concentrations of pastoral activity – considered to have low habitat potential from preliminary assessments.

[43] With exclusions due to access constraints associated with the timing of the fallow deer hunting season.

[44] Grassy woodland habitats were excluded from the survey as they were considered to be a relatively minor component of the potential habitat on site and not likely to represent the core range of the local population as well as the non-forest habitats – it will be prudent however to consider these habitats in latter consideration of impact avoidance for this species.

2.4.3.3 Timing

Due to interannual variations in the commencement and duration of the flight season for ptunarra brown butterfly adults, it was considered to be critical to monitoring the timing of the start of the season using reconnaissance visits to the project area and a proxy site with a known population on Liawenee Moor. Reconnaissance visits commenced in late February and were conducted every 2-3 days until adult males were observed on the wing, which occurred at the Liawenee Moor site on 4/3/2020. Liawenee Moor is slightly higher altitude than the project area, and given adults emerge earlier at higher altitudes[45], it was estimated that the season would commence in the project area within a few days. From that point, survey days were chosen on the basis of access permissions, weather, and staff scheduling, as well as the desire to spread surveys across the flight season as much as possible. Surveys were undertaken on the 10th, 11th, 17th and 24th of March, which appeared to represent the first, second and third weeks of the adult flight season in the project area. Surveys were limited to between the hours of 10 am and 2 pm, and restricted to fine, mild weather conditions.

Plate 1: Sedgy grassland, potential butterfly habitat type

[45] Threatened Species Section (2020)

Plate 2: Short native grassland with shrub component, potential butterfly habitat type

Plate 3: Tall (inundation prone) tussock grassland, potential butterfly habitat type

Plate 4: Very short grassland, potential butterfly habitat type

2.4.3.4 Survey method

Multiple observers were used on each survey day, with five present on the 10th and 11th, three on the 17th, and four on the 24th.

Around an hour was spent on the first survey morning (the 10th) familiarising observers with the various habitat types and making some captures of flying males to confirm presence on site and to facilitate discussion from the most experienced observers (Mark Neyland and Jo Potter-Craven) as to survey techniques and morphological traits that best discriminate the target species from the closely related silver xenica (*O. lathoniella*). Observers were then distributed to individual survey zones.

Within their allocated survey zone, each observer conducted meandering transects at walking pace. Throughout the transect, survey counts were undertaken in two-minute blocks, which allowed observers to stay within individual habitat facies while meandering. It was later calculated[46] that the observers traversed on average around 100 m per survey. For each two-minute survey, the observer noted: the number of ptunarra brown butterflies seen[47] (discriminating between males and females) and the habitat facies, as well as the time, and if the sun was out (fully clouded survey periods were excluded from later analysis of count numbers

[46] Calculated later from a combination of waypoints, tracklogs and survey notes
[47] With nets available to undertake catch and release if considered necessary to ensure identification

but were very rare on the survey days). In addition, one observer tracked the change in temperature across the entire survey period[48].

Individual observers were allocated different zones on each survey day, to lessen any potential for observer bias within an area.

2.4.3.1 Analysis

One-way analysis of variance (ANOVA) with posthoc Tukey HSD test was used to determine if abundance per survey varied statistically significantly between habitat types, controlling for intra-seasonal variation in butterfly activity by limiting tests of significance to within survey weeks.

2.5 Limitations

Due to seasonal variations in detectability and accurate discrimination (*i.e.* identification of closely related species), there may be some herb, orchid and/or graminoid species present in the survey area that have been overlooked due to flowering at times of the year other than when the surveys were undertaken, or being absent at the time of surveys due to seasonality and/or the absence of requisite germination triggers. This limitation applies within plots as well as the survey area as a whole; as such, plots surveyed early in the season may be missing some seasonal species captured in different plots in the same habitat later in the season. The potential for this limitation to have impacted the detection probability of threatened species in particular has been considered in the interpretation of results and was mitigated by the number and timing of surveys.

To further mitigate survey limitations, field data from the present study were supplemented with data from the Tasmanian Natural Values Atlas[49] and the EPBCA Significant Matters database[50]. All threatened species known or with potential to occur in the local area (5 km radius of the project area) have thus been considered in terms of habitat suitability on site.

Locations of critical elements (e.g., specific survey points, weeds[51], evidence of pathogens, threatened species habitat, *etc.*) were recorded with a handheld non-differential GPS with an average accuracy of 3-10 m.

The fauna assessment in this study excludes avifauna as this is being addressed in a separate assessment by NBES.

The study area is quite large and thus has been surveyed at a scale considered adequate with respect to the proposal and the relative diversity of the landscape. It is possible that micro-siting surveys will be required for particular lifeforms following the finalisation of design elements.

3 BIOLOGICAL VALUES

3.1 Vegetation

Nineteen TASVEG vegetation units have been recorded within the project area, with the current investigation resulting in substantial reattributions from the mapping within the TASVEG database:

[48] Using temperature reports from the nearest weather station at Liawenee Moor, 41.90°S 146.67°E 1057m AMSL

[49] NVA report_ nvr_1_03-Jun-2020 (DPIPWE 2020a) – with the database checked manually at later dates for new records

[50] EPBCA Protected Matters report, (Commonwealth of Australia) – PMST_ I63KLI

[51] Tasmanian *Weed Management Act 1999*

AHF – freshwater aquatic herbland** – 70.15 ha

AHL – lacustrine herbland** – 2.13 ha

DAD – *Eucalyptus amygdalina* forest and woodland on dolerite – 345.22 ha

DDE – *Eucalyptus delegatensis* dry forest and woodland – 1,072.06 ha

DDP – *Eucalyptus dalrympleana – E. pauciflora* forest and woodland – 531.34 ha

DGW – *Eucalyptus gunnii* woodland – 21.71 ha

DPD – *Eucalyptus pauciflora* forest and woodland on dolerite – 1,688.57 ha

DRO – *Eucalyptus rodwayi* forest and woodland – 134.40 ha

FAC – cleared land with a canopy (primarily *E. rodwayi* and some *E. pauciflora*) – 264.32 ha

FAG – agricultural land – 1,089.47 ha (with Er indicating emergent *E. rodwayi* < 5 % cover, and Ep indicating *E. pauciflora* < 5 % cover)

FPE – permanent easements – 4.30 ha

FPH – plantations for silviculture (hardwood) – 602.15 ha

FRG – regenerating cleared land – 328.37 ha

FUM – extra-urban miscellaneous – 27.53 ha

GPH – highland *Poa* grassland** – 2,706.09 ha

MGH – highland grassy sedgeland** – 1,083.63 ha

MRR – Restionaceae rushland – 3.29 ha

NLE – *Leptospermum* forest – 6.69 ha

OAQ – water, sea – 61.90 ha

* Indicates units that correspond to communities listed as threatened under the Commonwealth EPBCA.

** Indicates units that correspond to communities listed as threatened under the Tasmanian *Nature Conservation Act 2002*.

The native vegetation types are described below within groupings derived from similarities in floristics and structure. Vascular plant species lists from sampling points are given in Appendix A. The distribution of TASVEG units recorded within the study area is illustrated in Figure 3.

3.1.1 Aquatic habitats (natural and non-natural)

- AHF – freshwater aquatic herbland – 70.15 ha
- AHL – lacustrine herbland – 2.13 ha
- OAQ – water, sea – 61.90 ha

Freshwater aquatic herblands (AHF) dominate natural shallow waterbodies within the project area (Plates 5 and 6), which range from small, ephemeral pans within non-forest habitats, to large permanent and semi-permanent waterbodies, with varying degrees of desiccation proneness during the summer months (Plate 7). It was the relatively larger and less seasonal waterbodies, including Allwrights and Wihareja lagoons, that were primarily captured by our mapping of AHF for this project, with the very small and ephemeral examples being subsumed by the surrounding vegetation.

AHF on site are typically dominated by *Schoenus fluitans*, *Ornduffia reniformis*, *Isolepis fluitans*, *Myriophyllum simulans*, *Potamogeton tricarinatus*, and the introduced *Juncus bulbosus*, with emergent patches of *Baumea arthrophylla, Eleocharis* species and *Cycnogeton* species in the areas that hold water most permanently. In addition to the dominant species, the shallow edges include bands of *Asperula subsimplex*, tufts of *Lachnagrostis lacunarum*, and various marginal herbs, graminoids and shrubs, including *Ranunculus* spp., *Brachyscome radicans*, *Leptinella reptans*, *Epilobium tasmanicum*, *Hypericum japonicum*, *Liparophyllum exiguum, Lobelia irrigua, Montia australasica, Montia fontana* subsp. *chondrosperma, Myriophyllum pedunculatum, Trithuria submersa* and *Epacris petrophila*. Some of the marginal species are primarily associated with seasonally bare areas of mud, while others occur within a complex perennial sward or lawn. The lawn-like margins of many of the waterbodies correspond to the TASVEG unit lacustrine herbland (AHL) (Plate 8), which was also only mappable to a practical degree in the largest examples. The AHL lawns in the project area are defined by mats of the herbs mentioned above and largely devoid of substantial cover of sedges, shrubs, or grasses, although the patches grade into vegetation dominated by these within a short distance (Plate 9).

Areas mapped as OAQ within the project area included non-natural waterbodies (including farm dams and a large trout dam on St. Patricks Plains) and the Shannon River (Plates 10 and 11. Areas of OAQ are floristically similar to the above aquatic communities (indeed with time the trout dam is likely to be heavily colonised by species typical of natural AHF), however the OAQ classification has been applied to water lacking dominance of vascular macrophytes. These areas do nonetheless contain aquatic plant values, including in the case of the Shannon River values not found in the AHF and AHL observed elsewhere on site, including the threatened species *Barbarea australis*, *Carex capillacea* and *Isoetes humilior*, and riparian shrub species mostly absent from surrounding vegetation types, such as *Melaleuca virens* and *Baeckea gunniana.*

AHF and AHL are listed threatened communities under the NCA, within the wetlands classification. OAQ waterbodies are not equivalent to the NCA listed wetlands due to the paucity of aquatic macrophytes. None of the communities in this grouping meet the definitions of ecological communities listed as threatened under the EPBCA, however Allwrights Lagoon individually is listed under the EPBCA as a nationally important wetland.

Based on current observations, the survey area does not support the EPBCA listed 'alpine sphagnum bogs and associated fens' ecological community, which is predicted as being likely to occur in the area by the Protected Matters Search Tool (PMST) database but is unlikely to have been overlooked and is typically (but not exclusively) found at higher altitudes (more detail in Appendix B).

Plate 5: Typical dominant vegetation of freshwater aquatic herbland (AHF) in project area

Plate 6: Area of emergent *Baumea arthrophylla* within freshwater aquatic herbland (AHF)

Plate 7: Seasonally dry area of freshwater aquatic herbland (AHF)

Plate 8: Lagoon margin dominated by lawn-like lacustrine herbland (AHL)

Plate 9: Lacustrine herbland (AHL) grading abruptly into surrounding shrubby GPH vegetation

Plate 10: Shannon River (OAQ) with obligate riparian species and patchy occurrences of aquatic macrophytes

3.1.2 Dry eucalypt forest and woodland habitats

Dry eucalypt forest and woodland is the most extensive TASVEG group found on site, concentrated within the south and northeast of the project area. The occurrence of tree species varies with aspect and gradients of elevation and inundation, resulting in a complex blending of canopy dominance where these factors have local heterogeneity. At a broader level however, general structure and composition within communities is strongly consistent with the key traits and descriptions for respective units within the TASVEG companion manual[52]. At a very fine scale, environmental or geological traits (such as rock plates) are prominent in some areas, leading to patches of treelessness and local dominance of ephemeral herbs, non-vascular species, grasses, bare ground, or rock – these areas were considered to be too small to map into units such as ORO (lichen lithosphere) or GRP (rockplate grassland) within a project of this scale.

- DPD – *Eucalyptus pauciflora* forest and woodland on dolerite – 1,688.57 ha
- DDP – *Eucalyptus dalrympleana – E. pauciflora* forest and woodland – 531.34 ha

Eucalyptus pauciflora forest and woodland (DPD) is the most widespread and abundant dry sclerophyll unit on site. The occurrences within the project area are almost entirely secondary growth, with evidence of continued forest use in several areas and varying degrees of human disturbance (Plate 11). Mature forest elements are subsequently relatively uncommon and tend to be concentrated in rockier areas or hill tops (Plates 12 and 13). In these areas, particularly in the north of the project area, *E. dalrympleana* becomes more prominent, and where it has meaningful areas of canopy dominance or co-dominance the mapping unit DDP has been applied (Plate 14). A minority of the DDP stands are pure *E. dalrympleana* and these are mostly small patches within the grassland dominated plateau in the northwest. In addition to *E. dalrympleana*, the DPD patches contain localised areas of *E. rodwayi* (typically on the margins of flats) and areas of co-dominant *E. rubida*, which is particularly prominent within southern remnants, where it dominates some stands (but there is not currently a TASVEG unit to differentiate this from DPD). Understorey floristics and structure within these units are consistent with the definitions in the TASVEG manual, with small shrubs such as *Leptecophylla parvifolia, Lomatia tinctoria, Melicytus angustifolius* subsp. *divaricatus* variously prevalent over a mixed ground cover of low shrubs (such as *Tetratheca procumbens* and *Acrothamnus hookeri*), grasses (particularly *Poa gunnii* and *P. clivicola*) and herbs (including *Acaena echinata, Acaena novae-zelandiae, Ajuga australis, Brachyscome spathulata, Colobanthus apetalus, Daucus glochidiatus, Epilobium tasmanicum, Geranium brevicaule, Ranunculus lappaceus, Scleranthus biflorus, Senecio gunnii, S. prenanthoides, Veronica calycina* and *Viola betonicifolia subsp. betonicifolia*).

DPD and DDP do not correspond to listed threatened communities under the NCA or the EPBCA.

- DRO – *Eucalyptus rodwayi* forest and woodland – 134.40 ha

DRO forest and woodland in the project area primarily occurs within characteristic low-lying inundation-prone frost hollows and riparian zones (Plate 15) but is also present to a minor degree on freely draining rises. Some of the patches in the latter situations may have once been merely a localised patch of *E. rodwayi* within a broader patch of forest dominated by other species (*i.e.,* they may be fragments from partial clearance or historical environmental change). Consistent with this, *E. rodwayi* is present as a patchy sub-dominant within areas of DPD in particular. Evident levels of disproportionate clearance are indeed highly apparent for the low-lying occurrences of this community (Plates 16 and 17), as a result of its niche overlapping with areas suitable for grazing. Resultantly, scattered *E. rodwayi* are frequent in areas of cleared land

[52] Kitchener and Harris (2013)

in the south in particular, with areas of FAC (Er) and FAG-Er mapped within the modified land sub-group discussed below.

Understorey floristics and structure within DRO patches on site thus vary in relation to location and disturbance. In riparian situations a dense tall shrub layer of *Leptospermum lanigerum* is present, with smaller shrubs of *Melaleuca pallida*, *Leptecophylla parvifolia*, *Bossiaea cordigera* and *Epacris gunnii*. At ground level, moisture-reliant herbs such as *Gratiola peruviana*, *Centipeda elatinoides* and *Oxalis exilis* are present, in addition to variably dense occurrences of *Juncus* and *Carex* species. Understorey components elsewhere are broadly consistent with the other forest communities on site, with occurrences of common and widespread species such as *Acrothamnus hookeri* and *Leptecophylla parvifolia,* as well as various grasses and herbs. In areas disturbed by surrounding pastoral activities, native understorey elements are sparser and predominantly comprised of herbivore-resistant species such as *Melicytus angustifolius* ssp. *divaricatus* in addition to low-growing herbs and grasses.

DRO does not correspond to a threatened community under the NCA or EPBCA but corresponds to a Central Highlands regional RFA priority *E. rodwayi* forest (RO – priority Y; incorporating the floristic communities DRY-sdROD and DRY-scROD, and DRY-gROD – priority A) [53].

- DAD – *Eucalyptus amygdalina* forest and woodland on dolerite – 345.22 ha

DAD vegetation within the project area is restricted to the southern half of the site, where it occupies mid-slope positions, generally above cleared land or DRO, and below DDE (Plate 18); in some locations it is intermingled with DPD. The DAD community has mostly been spared from recent forestry use throughout the site but has been subject to firewood harvesting and other human disturbance in parts and appears to be primarily second growth from historic clearance. Understorey composition includes a moderately dense small shrub layer comprised of widespread and common species such as *Acacia dealbata, Lomatia tinctoria*, *Pultenaea juniperina*, *Leptecophylla parvifolia*, *Acrotriche serrulata*, and various small herbs, grasses, and ground ferns.

DAD does not correspond to a listed threatened community under the NCA or the EPBCA.

- DDE – *Eucalyptus delegatensis* dry forest and woodland – 1,072.06 ha

DDE is extensive within the project area, being prominent within the south in particular, but also on rises and southeast-facing slopes in the northeast. Native forest harvesting is widespread within this unit across the project (Plate 19), with mature forest elements subsequently limited and disturbance levels often high (Plate 20). Understorey composition varies with location but is often quite sparse due to the prevalence of rocks and boulders, with species such as *Senecio linearifolius* ssp. *denticulatus*, *Hakea lissosperma* and *Olearia viscosa* locally dominant amongst the same suite of widespread species referred to for DPD and DDP.

DDE does not correspond to a listed threatened community under the NCA or the EPBCA.

- DGW – *Eucalyptus gunnii* woodland – 21.71 ha

Consistent with a broader long-term trend across the range of the species, crown dieback is widely evident with stands of *E. gunnii* on site, with dead stags indicating some patches have suffered complete mortality (Plate 21). Consistent with the principles of forestry management in Tasmania, patches with complete canopy mortality have still been mapped as DGW to preserve distribution data and acknowledge the potential for regeneration (albeit this is known to be very

[53] Forest Practices Authority (2005)

low likelihood for this species in this environment). Stands of living DGW within the project area are protected by covenants under the NCA. Understorey composition within live and dead stands are not highly distinctive and simply a subset of common and widespread species from the surrounding communities, such as *Hakea microcarpa, Melicytus angustifolius* subsp. *divaricatus*, *Acrothamnus hookeri*, *Pimelea pygmaea*, *Pultenaea fasciculata*, and *Scleranthus biflorus*, as well as grasses and herbs associated with the adjacent non-forest communities.

DGW does not correspond to a listed threatened community under the NCA or the EPBCA.

- Tasmanian forests and woodlands dominated by black gum or Brookers gum (*Eucalyptus ovata/ E. brookeriana* – not present

Although this ecological community is predicted as being likely to occur on site by the PMST database, it has not been observed within the project area and is not likely to have been overlooked. Nor is the habitat in the project area considered to be highly suitable for the community based on environmental traits and its current mapped distribution at a state-wide level, in which the constituent TASVEG units are largely absent from the highlands, with the nearest purported patch being around 10 km away (Appendix B).

Plate 11: Area of DPD lacking mature forest elements and with a moderately browsed understorey

Plate 12: Area of DPD with large, localised component of mature *E. rubida* in the canopy

Plate 13: Area of DPD with mature gnarled trees on exposed outcrop

Plate 14: Area of DDP within a DPD matrix and straddling a large treeless rockplate

Plate 15: Riparian area of DRO with shrubby understorey

Plate 16: Area of non-riparian DRO with moderately disturbed understorey

Plate 17: Low-lying DRO (/FAC Er) with heavily modified understorey due to cleared land matrix and stock grazing

Plate 18: Area of DAD within a matrix of forest use

Plate 19: DDE forest with a history of harvesting

Plate 20: DDE forest area with a large population of *Senecio linearifolius* ssp. *denticulatus* which is likely to have benefited from past disturbance events

Plate 21: Example of tree mortality in remnant stand of DGW

3.1.3 Native non-forest mosaic: grassland, sedgeland and rushland

- GPH – highland *Poa* grassland – 2,706.09 ha
- MGH – highland grassy sedgeland – 1,083.63 ha
- MRR – Restionaceae rushland – 3.29 ha

These units form a complex mosaic concentrated within the plateau in the northwest of the site, collectively covering over a third of the project area. Boundaries between these units are often diffuse and complicated, with numerous areas having ambiguous composition due to the presence of elements characteristic of multiple units, on account of microscale heterogeneity of soil moisture and drainage in particular.

The GPH highland *Poa* grassland is the most extensive individual unit within the project area. The GPH is concentrated on relatively well-drained parts of the plateau, particularly basalt knolls and outcrops, but also including extensive plains with minimal change in relief. The floristic composition of GPH is broadly consistent across the project area, defined by near complete treelessness and the prevalence of *Poa clivicola* and *Poa gunnii,* with localised patches of *Poa labillardierei*. However, distinctive structural facies are evident, which may correlate to variations in management history, with a degree of environmental influence (some of which may provide some resilience to land use). The most prevalent facies of the GPH community is a woody facies defined by an emergent shrub layer 1-3 m high with up to 80 % cover, mostly in the form of *Hakea microcarpa* (Plates 22-24), but with dominance of *Melicytus angustifolius* subsp. *divaricatus*, *Ozothamnus ericifolius* and *O. hookeri* in places (Plate 25). Low shrubs (< 60 cm) also form a variably dense component of this facies, with *Acrothamnus hookeri, Pimelea pygmaea* and *Exocarpos nanus* being very frequent and widespread (although the latter only becomes readily apparent later in summer when seasonal growth of other species recedes), while others such as *Olearia algida, Muehlenbeckia axillaris, Bossiaea cordigera* and *B. riparia* are more localised but in some places dense. The ground layer of grasses and low shrubs is variously perforated by rocks and patches of bare ground, with the later most prevalent in areas that are heavily grazed areas and/or ostensibly subject to frost heave. Herbs are prevalent throughout the shrubby GPH facies, but subject to strong influences of seasonality and micro niche stratification. Prominent herbs overall include *Acaena novae-zelandiae, Acaena ovina, Ajuga australis, Asperula gunnii, Asperula pusilla, Brachyscome decipiens, Brachyscome spathulata, Chrysocephalum apiculatum, Colobanthus apetalus var. apetalus, Craspedia rosulata, Crassula decumbens var. decumbens, Epilobium tasmanicum, Euchiton japonicus, Geranium brevicaule, Geranium potentilloides var. potentilloides, Leptorhynchos squamatus, Oxalis exilis, Pappochroma bellidioides, Pappochroma pappocromum, Plantago antarctica, Ranunculus lappaceus, Ranunculus pimpinellifolius, Ranunculus pumilio* var. *pumilio, Scleranthus biflorus, Senecio gunnii, Solenogyne gunnii, Stellaria multiflora* subsp*. multiflora, Velleia montana, Veronica calycina, Veronica gracilis, Viola betonicifolia* subsp*. betonicifolia.*

The second most prevalent facies of GPH is a more typical grassland facies that lacks the emergent shrub cover of the woody facies and includes more consistent ground cover of *Poa clivicola* and *P. gunnii* [54] (Plate 26). Low shrub cover in addition to areas with a high proportion

[54] It was noted that the relative dominance of *Poa clivicola* and *P. gunnii* varies between the woody and the grassland facies of GPH. Other than in very localised areas, *Poa clivicola* is the more dominant species in each facies overall, however *P. gunnii* becomes markedly more prevalent within the woody facies. Seemingly the taller *P. gunnii* receives some degree of grazing protection within the woody facies, whereas the ground-hugging *P. clivicola* is more resilient to consistent grazing in open patches. The reverse pertains within the MGH community, where the consistent presence of soil moisture of the

of rocks and/or bare ground are still evident at a landscape scale within the grassland facies (Plates 27 and 28), but there is effectively an absence of larger shrubs (> 1 m) and a tendency towards almost two-dimensional lawn-like areas (Plate 29), some of which blend with areas of non-pasture, between which there can be difficulty discriminating the boundaries.

The least extensive facies of GPH mapped is an inundation facies of tall tussocks (30-60 cm) of *Poa labillardierei* with over 75 % cover (Plate 30). The inundation facies occurs on riparian margins and ephemeral wet places (as opposed to more consistently moist [but perhaps less inundated] MGH discussed below) and is mostly devoid of woody species (with these ostensibly restricted by regular inundation) and relatively species poor compared to the other GPH facies. It does however contain a suite of moisture-reliant species mostly absent from the other facies, such as *Celmisia asteliifolia, Gunnera cordifolia, Hydrocotyle sibthorpioides, Carex capillacea, Carex ovalis* and *Veronica serpyllifolia*. In some areas the inundation facies of GPH is intermingled with clusters of sedges and rushes and grades into units of MGH (Plates 31-32).

The MGH units within the project area are in all cases contiguous with patches of GPH, but the MGH occupies relatively lower parts of the landscape with more consistent moisture and relatively impeded drainage. In such areas the MGH covers broad swathes of flat land (Plates 33 and 34), in some cases functioning as a conduit of water to wetlands. Although differentiated from GPH by the higher proportional cover of non-grass species such as *Carpha alpina, Carex gaudichaudiana, Carex iynx, Carex raleighii, Empodisma minus*, *Baloskion australe* and *Lepidosperma filiforme* [55], the MGH also contains a prominent (> 50 %) sward of grass, primarily tussocks of *Poa gunnii*, with localised patches of *Poa labillardierei*. *Epacris gunnii* and *Almaleea subumbellata* are indicative shrub species present in most patches, with occasional *Epacris lanuginosa* and *Leucopogon pilifer*. Herb species that differentiate the MGH from GPH (at least in terms of their frequency) include *Microseris lanceolata, Montia australasica, Euchiton traversii, Oxalis exilis, Gonocarpus serpyllifolius, Diuris monticola, Gentianella polysperes, Argyrotegium mackayi, Comesperma retusum* and *Craspedia glabrata.*

In one patch within the non-forest mosaic the dominance of rushes (particularly *Baloskion australe*) and the relative paucity of grasses accorded to the definitions of MRR at a mappable scale. Beyond these factors, the MRR is broadly similar in composition and landscape position to the MGH elsewhere. Small patches equivalent to MRR may be present elsewhere within the non-forest mosaic but could not practically be discriminated for mapping in a project of this scale.

GPH and MGH are listed threatened communities under the NCA, but MRR is not. None of these units correspond to listed communities under the EPBCA, including the 'lowland native grasslands of Tasmania' community, which is predicted to occur within the project area by the PMST database but for which the GPH and MGH on site do not meet the key trait relating to altitude, with the EPBCA community restricted to lower altitudes (below 600 m a.s.l.[56]) (Appendix B).

dense sward of non-grass species may provide the taller *P. gunnii* a buffer against grazing pressure, allowing it to obtain dominance over *P. clivicola*, which becomes effectively absent in dense MGH.

[55] It was noted that the prevalence of *L. filiforme* in MGH within this project area was not as great as described in the description in the TASVEG manual and the species was absent from MGH at a local scale in some areas. However, it was observed that the species was consistently present within the MGH at a broader patch scale; in some cases, it may be inhibited by browsing or some other management artefact. Despite the relatively low cover of *L. filiforme*, the presence of several other indicative species and the marked niche separation from the GPH, made the classification as MGH appropriate.

[56] Department of the Environment, Water, Heritage and the Arts (2010)

Plate 22: Emergent *Hakea microcarpa* typical of much of the woody facies of GPH in the project area

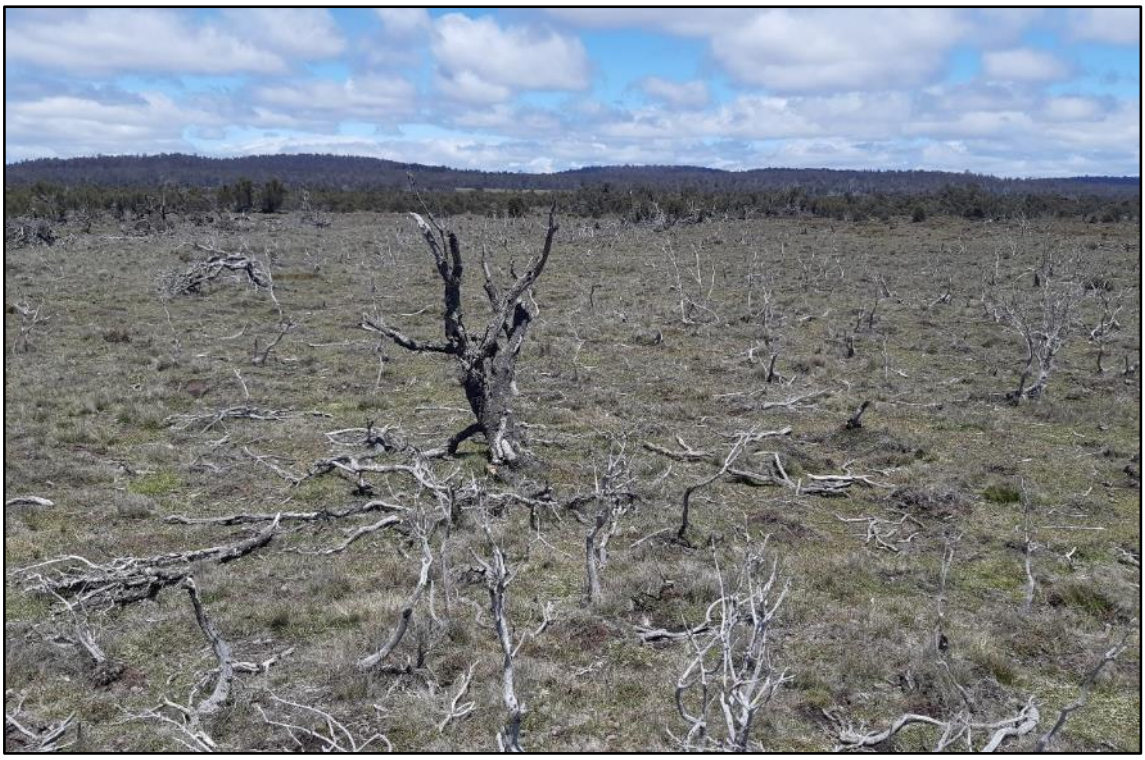


Plate 23: Dense healthy regrowth of *Poa gunnii* following a patch burn within an area of *Hakea* dominated woody facies of GPH

Plate 24: Relatively open area of *Hakea* dominated woody facies GPH, with the *Hakea* pruned by herbivores

Plate 25: Emergent *Ozothamnus* spp. dominate a minor component of the woody facies of GPH in the project area

Plate 26: Productive area of grassland facies GPH

Plate 27: Grassland facies GPH, but with relatively high cover of low shrubs

Plate 28: Grassland facies GPH, but with relatively high cover of low shrubs

Plate 29: Lawn-like area of closely grazed grassland facies GPH

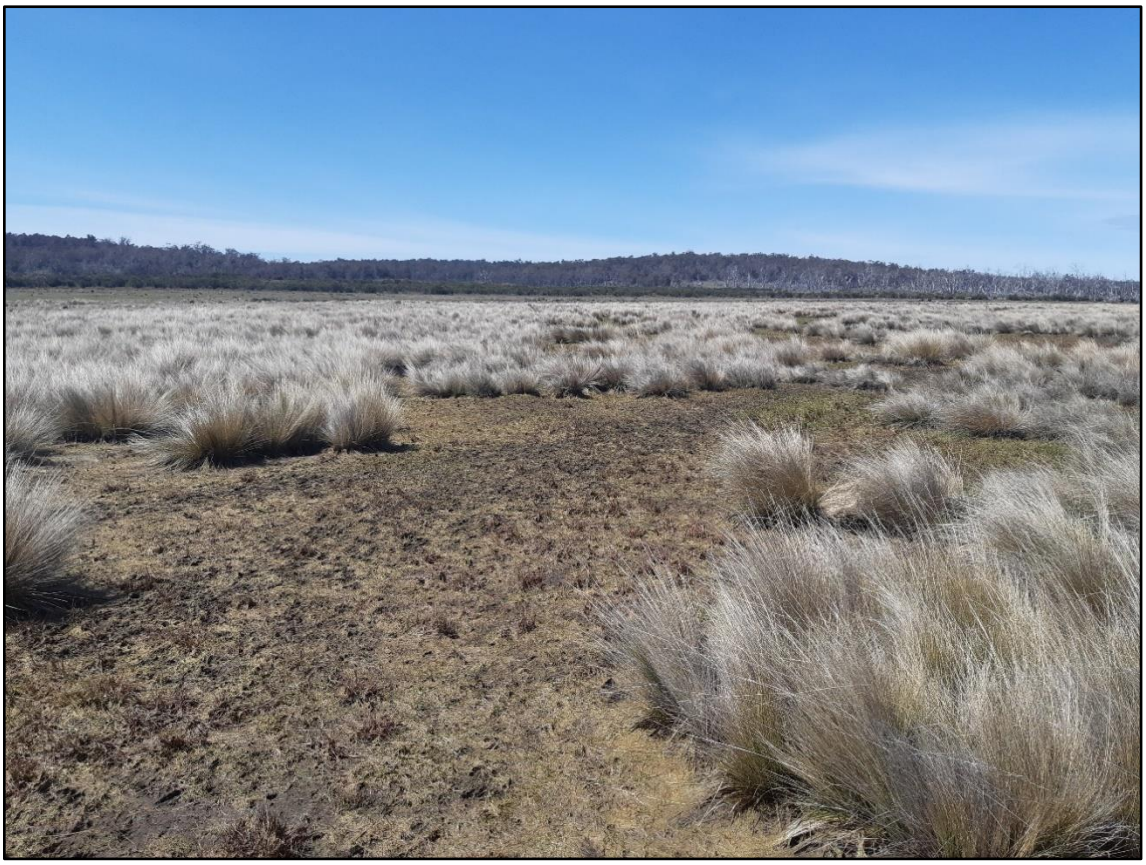


Plate 30: Inundation facies of GPH within seasonal wetland

Plate 31: Riparian mosaic of inundation facies of GPH with MGH and rushland elements

Plate 32: Confluence of inundation facies of GPH (right middle-ground) with MGH (left middle-ground) and grassland facies GPH (right foreground)

Plate 33: Extensive plain of MGH grassy sedgeland

Plate 34: Extensive plain of MGH grassy sedgeland

3.1.4 Non-eucalypt forest

- NLE – *Leptospermum* forest – 6.69 ha

In the forested areas away from the areas of non-forest mosaic, the most-poorly drained habitats include some small patches dominated by *Leptospermum lanigerum* over 10 m tall, consistent with the definition of *Leptospermum* forest (NLE). The NLE is relatively species poor in terms of woody plants, with the occasional emergent eucalypt and sparse small shrubs of *Leptecophylla parvifolia*. The ground layer includes a high cover of moss and closely browsed grasses and herbs, including *Schoenus apogon*, *Hydrocotyle hirta, Hypericum japonicum, Leptinella reptans* and *Lobelia pedunculata.*

NLE does not correspond to a listed threatened community under the NCA or the EPBCA but the examples on site correspond to the floristic community SWAMP-E1 which is inadequately reserved in the region (but adequately reserved elsewhere in Tasmania) – priority B [57].

Plate 35: Remnant patch of NLE with south of project area

[57] Forest Practices Authority (2005)

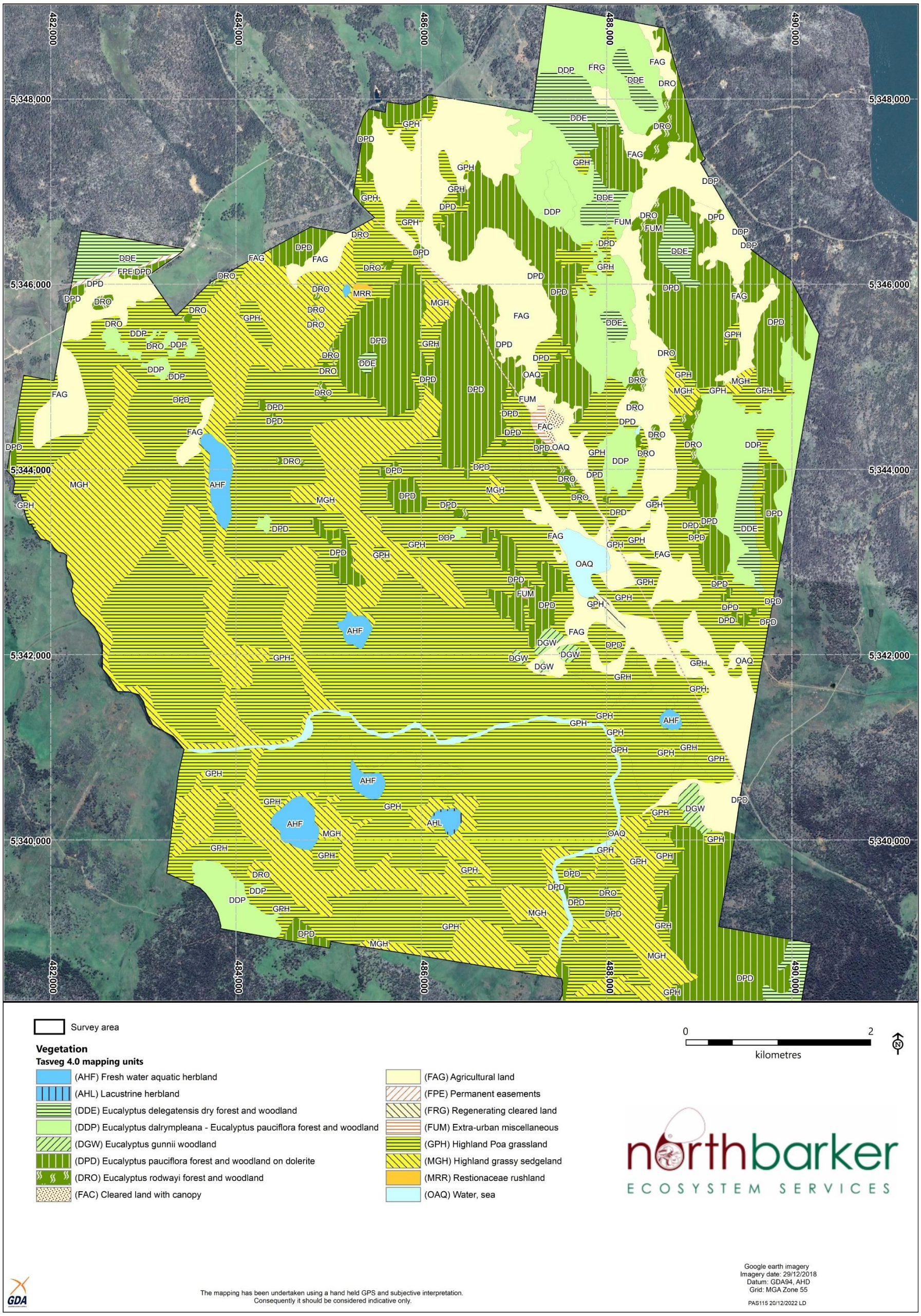


Figure 3a: Distribution of verified vegetation types within survey area (northern section)

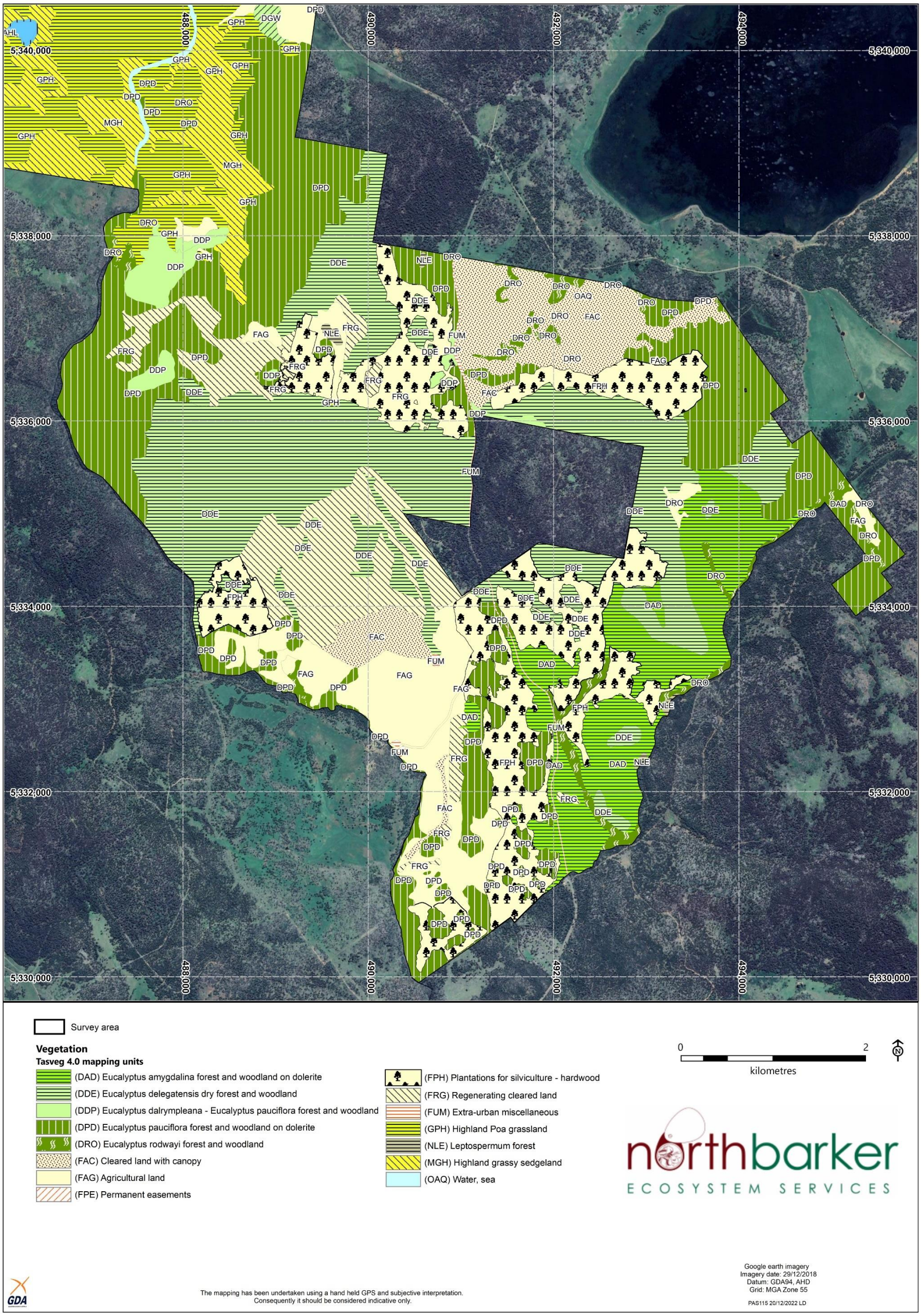


Figure 3b: Distribution of verified vegetation types within survey area (southern section)

3.2 Threatened and Conservation Significant Flora

3.2.1 Threatened flora

The 2019, 2020 and 2022 surveys documented 354 vascular plant species (including 68 exotics) within the project area (Appendix C). Our surveys confirmed or established the presence of 23 threatened flora species, with 9 of these not previously recorded within the project area (denoted with an asterisk) (Figure 4):

- *Asperula scoparia* ssp. *scoparia* (TSPA rare)
- *Asperula subsimplex* (TSPA rare)
- *Barbarea australis* (TSPA and EPBCA endangered) *
- *Calocephalus lacteus* (TSPA rare)
- *Carex capillacea* (TSPA rare) *
- *Colobanthus curtisiae* (TSPA rare and EPBCA vulnerable)[58]
- *Cryptandra amara* (TSPA endangered) *
- *Eucalyptus gunnii* ssp. *divaricata* (TSPA and EPBCA endangered)
- *Glycine latrobeana* (TSPA and EPBCA vulnerable)
- *Hovea tasmanica* (TSPA rare)
- *Isoetes humilior* (TSPA rare)
- *Leucochrysum albicans* var. *tricolor* (TSPA and EPBCA endangered)
- *Muehlenbeckia axillaris* (TSPA rare)
- *Myosurus australis* (TSPA endangered) *
- *Myriophyllum integrifolium* (TSPA vulnerable) *
- *Pterostylis pratensis* (TSPA and EPBCA vulnerable)
- *Ranunculus pumilio* var. *pumilio* (TSPA rare)
- *Rhodanthe anthemoides* (TSPA rare)
- *Senecio longipilus* (TSPA vulnerable) *
- *Scleranthus fasciculatus* (TSPA vulnerable) *
- *Taraxacum aristum* (TSPA rare) *
- *Trithuria submersa* (TSPA rare)
- *Viola cunninghamii* (TSPA rare) *

An additional 3 species that have been recorded from the project area in the past were not relocated during our surveys but are still considered likely to be present, albeit not expected to be widespread or abundant.

- *Epilobium willisii* (TSPA rare)
- *Isoetes drummondii* ssp. *drummondii* (TSPA rare)
- *Pilularia novae-hollandiae* (TSPA rare)

[58] In addition to the species suspected to be mis-identified below, observations made during our surveys indicate that records of *Colobanthus curtisiae* attributed to grassland habitats within the north of the project area may be misidentifications of *Colobanthus apetalus* and/or *C. affinis* - our observations suggest *Colobanthus curtisiae* may be restricted to rocky outcrops within forested areas in the south.

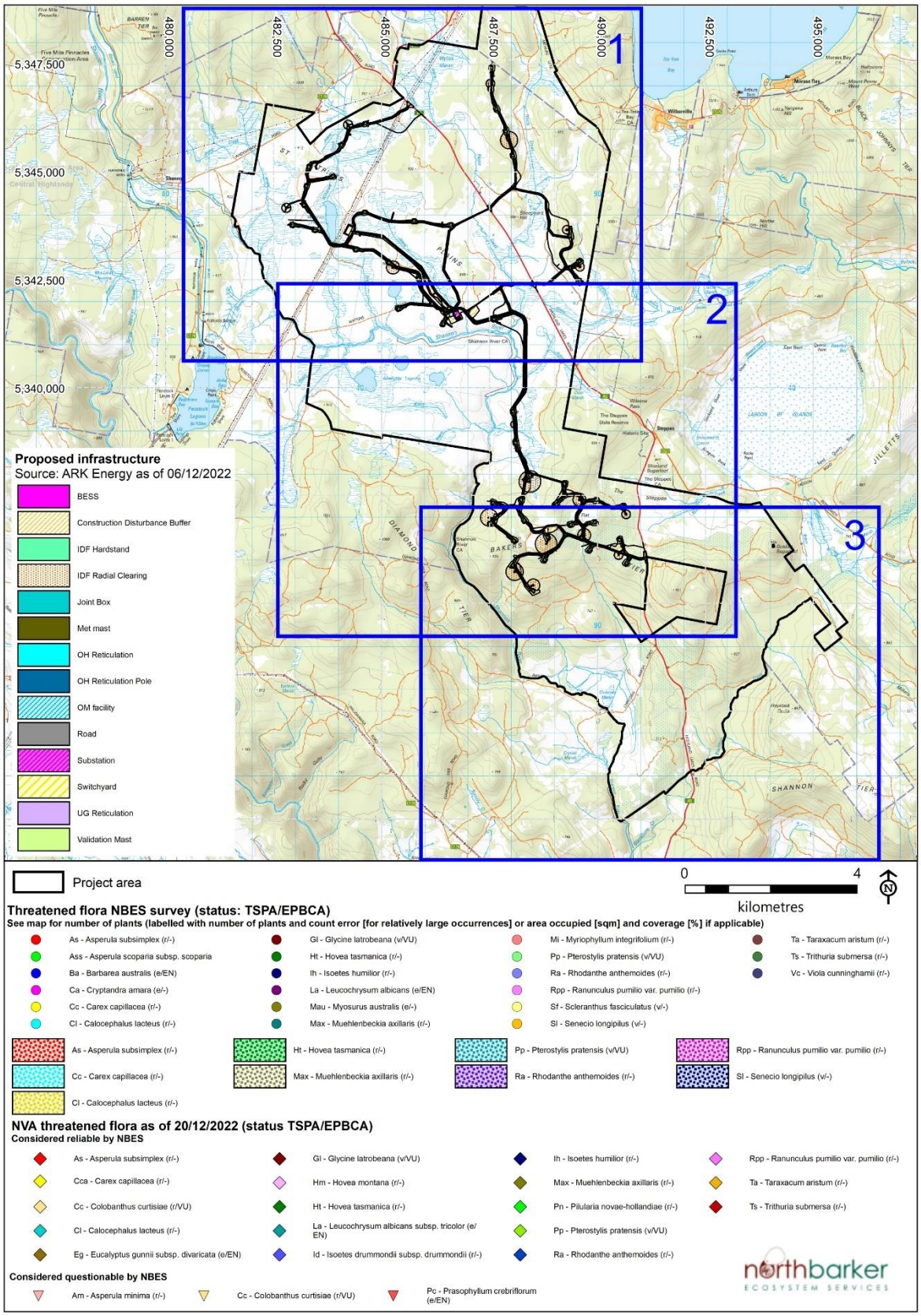


Figure 4a: Reference index and legend for maps of distribution of threatened flora

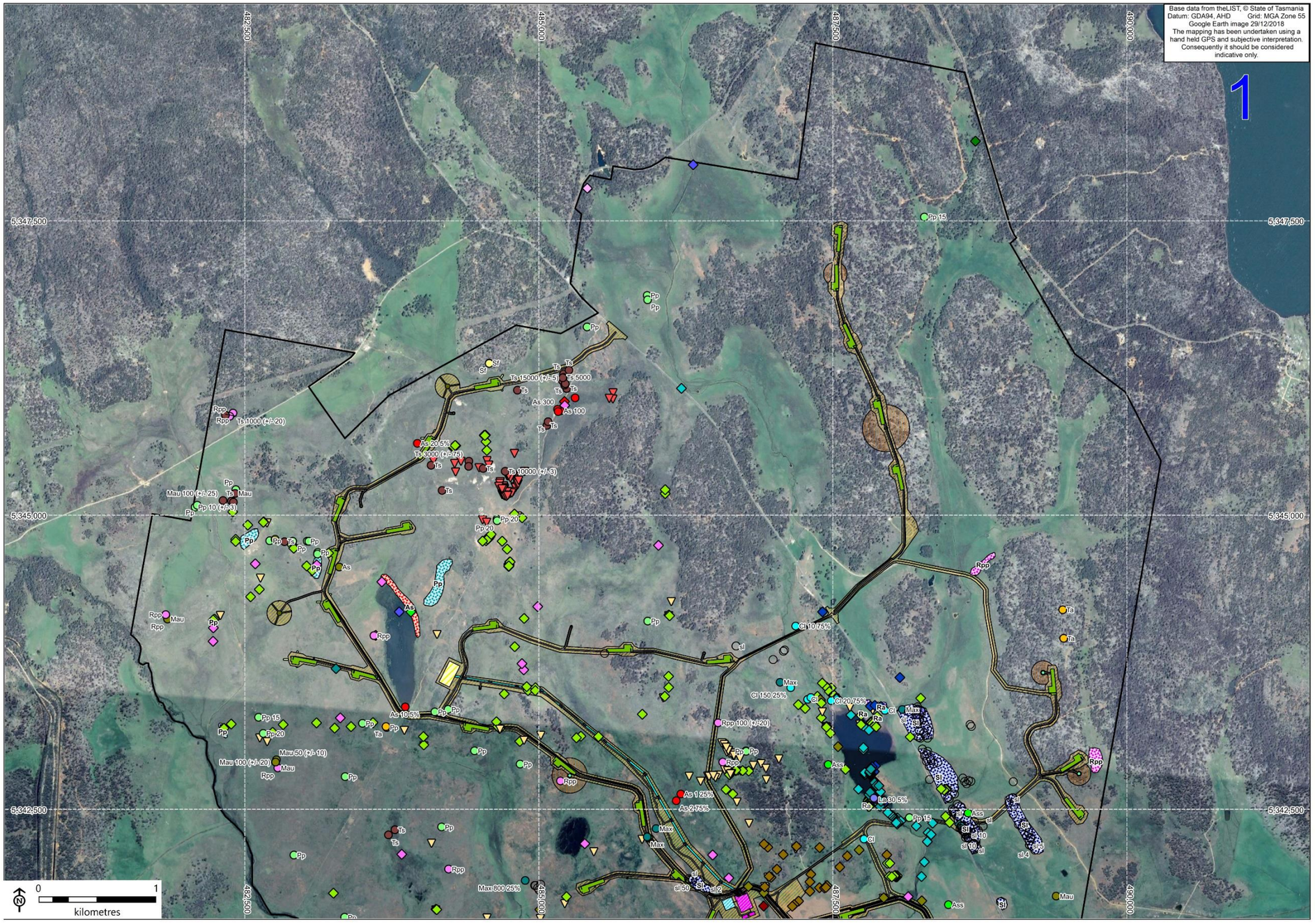


Figure 4b: Distribution of threatened flora within north of project area

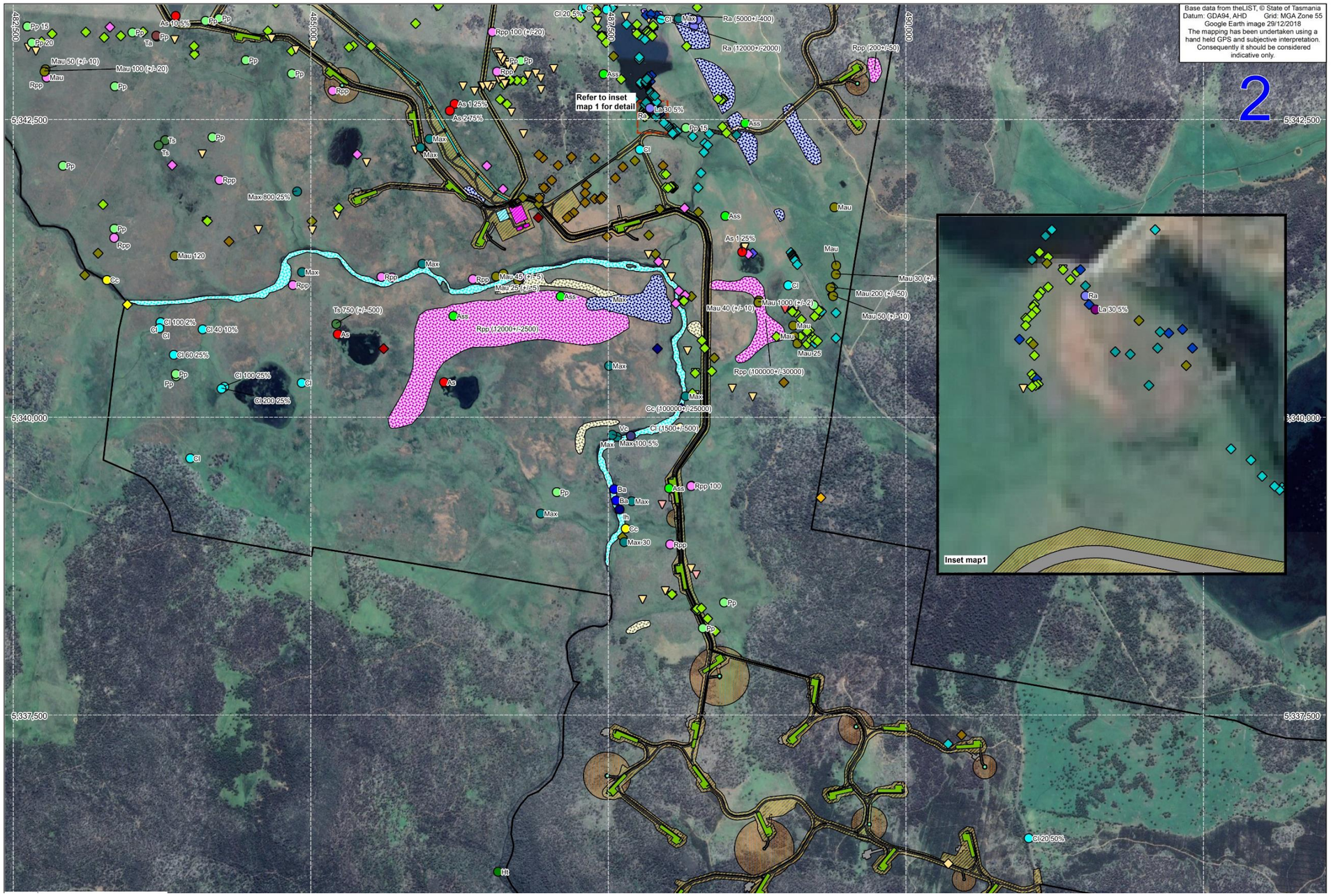


Figure 4c: Distribution of threatened flora within centre of project area

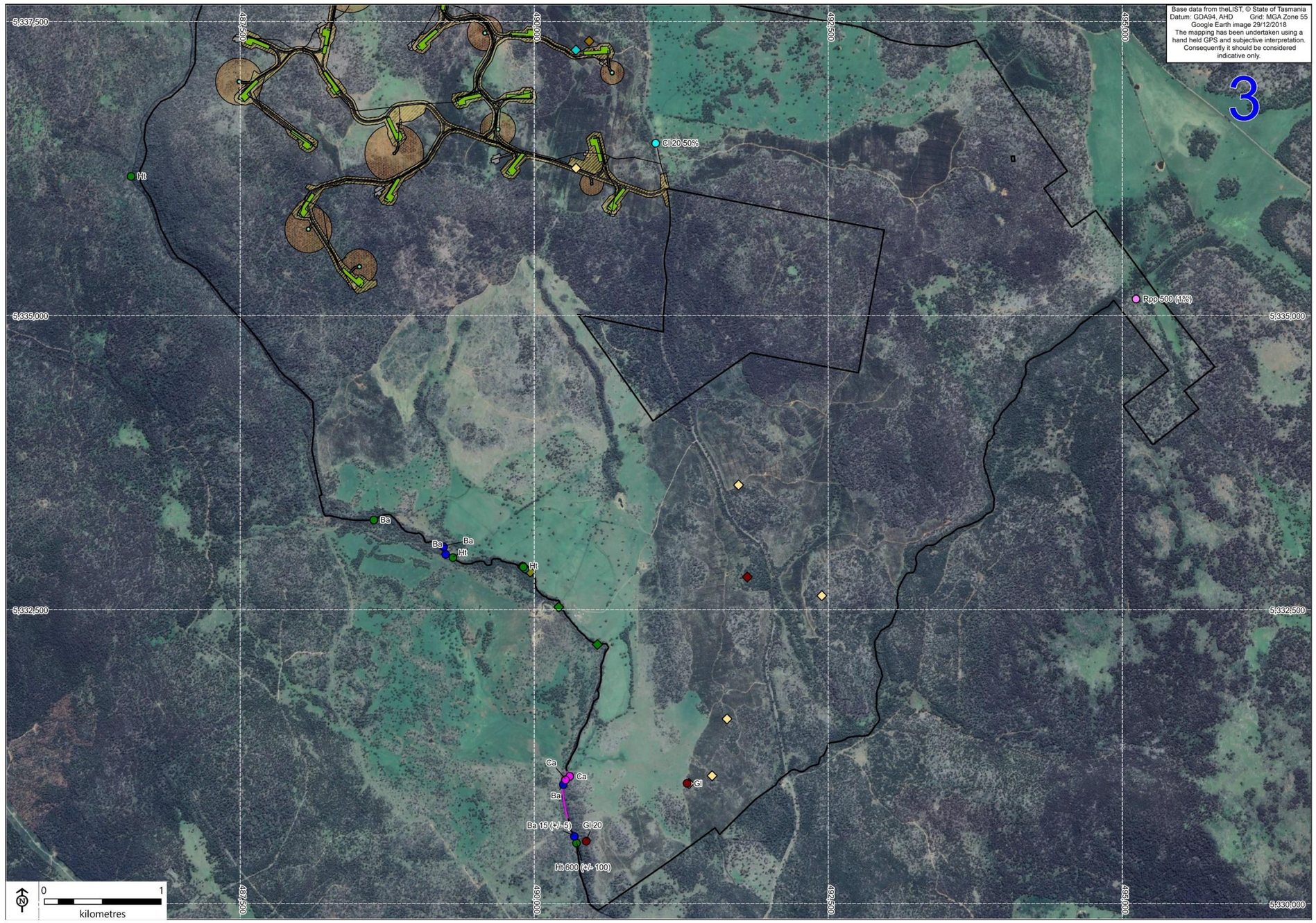


Figure 4d: Distribution of threatened flora within south of project area

Table 2: Threatened flora species with observations (Tasmanian Natural Values Atlas) or predicted habitat (EPBCA Protected Matters database) from within a 5 km radius of the site [59]

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
Confirmed as present in project area by NBES				
Asperula scoparia subsp. *scoparia* prickly woodruff	rare/ -	-	*Asperula scoparia* subsp. *scoparia* is widespread in Tasmania and is mainly found in native grasslands and grassy forests, often on fertile substrates such as dolerite-derived soils. Forested sites are usually dominated by *Eucalyptus globulus* and *E. viminalis* (lower elevations) and *E. delegatensis* (higher elevations). Occasional within the project area, with scattered plants (< 10) observed in grassy and rocky locations in the northern half of the project area (Plate 36). It may be more widespread than current mapping indicates at the plant is tiny and inconspicuous within grassy vegetation – it is unlikely however to be present in abundance based on our findings.	The project area contains no forests dominated by *Eucalyptus globulus* or *E. viminalis*, however there are several patches of *E. delegatensis* dominated forest (DDE). The DDE in the south of the project area is very rocky and located largely in a mosaic of plantations. This rocky habitat is not suitable for this species. Habitat is modelled as all areas of grassland (GPH), and all DDE forest on dolerite and basalt north of the confluence of Ripple Creek and the Shannon River.
Asperula subsimplex water woodruff	rare/ -	-	*Asperula subsimplex* occurs in sites with impeded drainage including damp grasslands, floodplains and sometimes in grassy forest and woodland along drainage depressions (even at the outfall of artificial dams). Prolific at a localised scale within the project area, with hundreds of plants in seasonally wet depressions and wetland margins, with some locations supporting dozens of stems per square metre. The plants varied markedly with seasonal inundation, with early season flooding resulting in strongly etiolated submerged plants (Plate 37), which later in the season reverted to tightly clustered mats as the water receded (Plate 38). A total of over 30,000 m^2 extent of occurrence was observed in the project area.	Habitat for this species may occur within micro-topographical variations across the landscape and is difficult to map with any great certainty. As a conservative measure, potential habitat is likely to occur in grassland and sedgy grassland (GPH and MGH) habitats within 10 m of waterways and marshland and a 10 m radius of wetland vegetation communities (AHF, AHL).
Barbarea australis riverbed wintercress	endangered/ ENDANGERED	-	*Barbarea australis* is a riparian species found near river margins, creek beds and along flood channels adjacent to the river. It tends to favour the slower reaches and has not been found on steeper sections of rivers. It predominantly occurs in flood deposits of silt and gravel deposited as point bars and at the margins of base flows, or more occasionally or between large cobbles on sites frequently disturbed by fluvial processes. Some of the sites are a considerable distance from the river, in flood channels scoured by previous flood action, exposing river pebbles. Most populations are in the Central Highlands, but other populations occur in the north-east and upland areas in the central north. Not previously known within the project area (known within 5 km – Appendix E). A total of around 20 plants were observed at several locations on the Shannon River (Plate 39), mostly in the far south of the project area on the boundary of Christians Marsh, but also with a couple of plants on the Shannon boundary of St. Patricks Plains and Allwrights. It is noted that the species is best discriminated by the weed *B. intermedia* by seed and fruit attributes that are not present all year round, and that not every plant could be visited with perfect timing within the scope of this assessment. As such, some plants have been	Beyond the Shannon River, there is no suitable habitat present in the project area. As this species occurs on the margins of the river bed and within the creek bed, habitat for this species has been modelled by applying a 10 m buffer on the Shannon River.

[59] Natural Values Report # 1_03-Jun-2020, DPIPWE, 2020a; EPBCA Protected Matters report PMST_I63KLI
[60] Tasmanian *Threatened Species Protection Act 1995,* Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
[61] Threatened Species Section (2020)
[62] Total available habitat/Potential extent of occurrence is a broad level estimate of areas that may contain habitat niches that may provide areas of occupation for threatened flora species – it cannot be assumed that species will have complete occupation of their potential extent of occurrence, nor that potential for occurrence within the modelled overall extent will be uniformly suitable at a finer scale – e.g. plants can be expected to have finer niches within the overall mapped potential extent of occurrence; a minority of plants could also occur outside of habitat with these preferred defintions.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			attributed to this species on the basis of confirming seeds and fruits of morphologically similar plants elsewhere in the project area. It is also noted that even some of those plants that were confirmed with fruit and seed traits had occasional upper stem leaves with two pairs of lateral lobes, which is more typically associated with *B. intermedia* but is acceptable within the definition of *B. australis* and seen as less important than reproductive characteristics.	
Calocephalus lacteus milky beautyheads	rare/ -	-	*Calocephalus lacteus* occurs in open, dry sites in lowland areas of eastern and northern Tasmania and on lower altitudes of the Central Plateau. It requires bare ground for recruitment and may benefit from disturbance. It is often found on roadsides and beside tracks. Prolific at a moderately broad scale within the project area, with some extensive patches present in the grassland and sedgeland habitats (with estimates of hundreds of plants), where is it resilient to grazing and occurs in relatively moist niches (Plate 40).	The habitat niche for this species may occur in a wide range of habitats, but is largely confined to grassland habitats and roadside verges. The potential habitat is defined as all areas of grassland (GPH) and a buffer of 30 m where it borders sedgy grassland (MGH) as well as a 10 m buffer on all roads in grassy habitats.
Carex capillacea yellowleaf sedge	rare/ -	-	*Carex capillacea* is found in the Central Highlands in marshy habitats, extending to short alpine herb fields associated with snow patches. An extensive occurrence (> 100,000 plants estimated) was found during our assessment, all of which occurs in the marshy margins of the Shannon River (Plate 41).	Within the project area, only the Shannon River is considered likely to support this species. All other areas of marshland/wetland were surveyed with no further observations. This species is relatively distinctive and conspicuous and is unlikely to have been overlooked if present elsewhere. Potential habitat for this species is thus modelled as a 10 m buffer on the Shannon River.
Colobanthus curtisiae grassland cupflower	rare/ VULNERABLE	-	When first described, *Colobanthus curtisiae* was understood to occur in native grassland and grassy woodland (the type location is a grassy *E. pauciflora* woodland on a small basalt hill) but also extending to subalpine low vegetation (Ben Lomond area). This species is now known to occur in lowland grasslands and grassy woodlands but is also prevalent on rocky outcrops and margins of forest on dolerite on the Central Highlands (including disturbed sites such as log landings and snig tracks) (Appendix E). A large number of records for this species from within the non-forest habitats were investigated during our surveys, only to find plants that better fit the description of *Colobanthus apetalus* (and to a lesser degree *C. affinis*) (Plate 42). After several unsatisfactory attempts at finding *C. curtisiae* at reported locations (many of which were supported by notes suggesting the species was abundant across the grassland plateau) we engaged ECOtas for a second opinion on the identification of our *Colobanthus* collections (Appendix D). The assessment from ECOtas supported our stance that the identification of *Colobanthus curtisiae* from grassland habitats within the project area is likely to be erroneous and if *C. curtisiae* is present within the project area it is thought to be restricted to rocky outcrops within forest areas in the south, which is consistent with the above habitat description. Based on this consideration, we suggest there are limited numbers of *C. curtisiae* present within the project area (< 100) rather than the thousands to millions of plants that are present if the grassland plateau individuals are attributed to this taxon. DPIPWE have chosen not to re-determine the attribution of NVA records from the grassland area but have put a note on all these records suggesting they may be mostly *C. apetalus*.	External consultation (Appendix D) supports our assessment that the records located on the grassland plateau are likely to be erroneous. As a result of this, habitat is likely to be confined to the south of the project area. Potential habitat is thus defined as a radius of 200 m from existing records within the same habitat, but restricted to records in the south of the project area. These occurrences are in *Eucalyptus amygdalina* forest and woodland on dolerite (DAD) and *Eucalyptus pauciflora* forest and woodland on dolerite (DPD).
Cryptandra amara pretty pearlflower	endangered/ -	-	*Cryptandra amara* grows in some of the driest areas of the State and is typically associated with fertile rocky substrates (e.g., basalt). Its habitat ranges from near-riparian rock plates to grasslands or grassy woodlands.	Given the distinctive nature of this species, additional occurrences are unlikely to have been overlooked in the project area. As such, the potential habitat for this species is defined as a 500 m of all known

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			Not previously known from the project area (known from within 5 km). Observed at one location supporting 10 plants on a shallow rocky bank of the Shannon River on Christians Marsh (Plate 43), adjacent to cleared land. May be more abundant in that area but unlikely to be widespread elsewhere through the site.	records within the same habitat - *Eucalyptus pauciflora* forest and woodland on dolerite (DPD). There is no areas of native grassland within 500 m of records of this species.
Eucalyptus gunnii subsp. *divaricata* Miena cider gum	endangered/ ENDANGERED	-	*Eucalyptus gunnii* subsp. *divaricata* dominates open woodland and woodland with grassy/heathy/shrubby understoreys on dolerite around the Great Lake region on the Central Plateau (Appendix E). The most characteristic forms are found towards the exposed edges of treeless flats, which tend to be poorly drained and prone to severe frost (the species is the most frost-tolerant of any eucalypt). It also extends to adjacent rocky slopes, often dominated by *E. delegatensis*. The recorded altitude range is 865-1,150 m above sea level. Unfortunately, there has been significant dieback of trees of *E. gunnii* subsp. *divaricata*, coupled with browsing of regeneration, so many sites are marked by dead stags and dying trees, with little prospect of replacement. Trees of this species with varying degrees of death and dieback were well mapped on the project area prior to our assessment and no new observations were made. Some observations were made of individuals attributed to *E. gunnii* subsp. *gunnii*. Some locations previously reported to support the species were confirmed as no longer having plants present (either from death, fall, or removal), including 3 NVA recorded locations on the margin of the footprint.	Habitat for this species within the project area is highly unlikely to extend beyond its known range. As *Eucalyptus* trees are distinctive within the landscape, additional occurrences are unlikely to have been overlooked. Habitat is modelled as the current extent of *Eucalyptus gunnii* woodland (DGW) and individual *E. gunnii* subsp. *divaricata* records.
Glycine latrobeana clover glycine	vulnerable/ VULNERABLE	-	*Glycine latrobeana* occurs in a range of habitats, geologies and vegetation types. Soils are usually fertile but can be sandy when adjacent to or overlaying fertile soils. The species mainly occurs on flats and undulating terrain over a wide geographical range, including near-coastal environments, the Midlands, and the Central Plateau (Appendix E). It mainly occurs in grassy/heathy forests and woodlands and native grasslands. A small number of plants (< 50) were observed within forest remnants in the far south of the project area (Plate 44). May be found at other locations within the project area.	We have a high level of confidence that thus species is unlikely to occur far beyond the current known extent, which is confined to the southern extent of the project area. The potential habitat is therefore defined by a 500 m radius of known records within the same habitat, which in the case of this species is *Eucalyptus pauciflora* forest and woodland on dolerite (DPD) and *Eucalyptus amygdalina* forest and woodland on dolerite (DAD).
Hovea tasmanica rockfield purplepea	rare/ -	-	*Hovea tasmanica* occurs in central and north-eastern regions. It is usually found on dry, rocky ridges or slopes (mostly dolerite) in forest and riverine scrub. Observed to be prolific (hundreds of plants) on the steep rocky banks of the Shannon River through Christians Marsh in the southern half of the project area (Plates 45 and 46). Unlikely to have been overlooked elsewhere in the project area.	As this species is highly distinctive, it is unlikely to occur far beyond the current known extent. The potential habitat is therefore defined by a 200 m radius of known records within the same habitat, which in the case of this species is *Eucalyptus pauciflora* forest and woodland on dolerite (DPD).
Isoetes humilior veiled quillwort	rare/ -	-	*Isoetes humilior* occurs in still waters and slow-moving sections of running water around the Central Highlands. It frequently occurs with *Isoetes gunnii* and the two species may be intermingled within the same clump. Previously reported from the project area in the early 90s from a stretch of the Shannon River between St. Patricks Plains and Allwrights (where it was noted as "common") and confirmed as still present in this part of the river during our surveys (Plate 47). May be present at other locations in the river but was not observed elsewhere during our assessment.	Based on the habitat requirements of this species, all areas of permanent wetland, as well as the Shannon River are considered as potential habitat for this species. Habitat for this species is thus modelled as a 10 m buffer of all AHF and AHL vegetation (inclusive) and a 10 m buffer of the Shannon River.
Leucochrysum albicans var. *tricolor* grassland paperdaisy	endangered/ ENDANGERED	-	*Leucochrysum albicans* var. *tricolor* occurs in the west and on the Central Plateau and the Midlands (Appendix E), mostly on basalt soils in open grassland. This species would have originally occupied *Eucalyptus pauciflora* woodland and tussock grassland, though most of this habitat is now converted to improved pasture or cropland. Uncommon within the project area, with a localised occurrence around the St. Patricks	Given the distinctive nature of this species, additional occurrences are unlikely to have been overlooked in the project area. As such, the potential habitat for this species is defined as a radius of 100 m of all known records within grassland habitat (GPH).

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			Plains trout dam (adjacent to Highland Lakes Road) verified as still extant during our assessment (Plate 48). It is considered a low likelihood that the species exists elsewhere within the project area unless it has been heavily suppressed by grazing.	
Muehlenbeckia axillaris matted lignum	rare/ -	-	*Muehlenbeckia axillaris* is predominantly found in moist gravely or rocky places on the Central Plateau, extending out to the west, north-west and lower reaches of the South Esk River. Prolific at a moderately broad scale within the project area, with tens of thousands of square metres extent of occurrence and numerous locations supporting dense mats hugging rocks and the ground (Plate 49). Was mostly noted growing in mid-slope bands around the margins of basalt outcrops in the northern half of the project area, but also with minor occurrences along the margins of the Shannon River in the southern half.	Habitat for this species is difficult to define as it was recorded in various habitats, however most records were on mid-slopes of basalt outcrops. Potential habitat is defined as a 100 m buffer of known records in similar habitats (predominantly GPH on basalt or dolerite). The slopes of the Shannon River valley as it rises to the grassland plateau may also provide suitable habitat.
Myosurus australis southern mousetail	endangered/ -	-	Prior to our surveys for this project, *Myosurus australis* had only been recorded twice in Tasmania, from a dolerite rockplate amongst basalt just north of Penstock Lagoon on the Central Plateau in 2005, and prior to that was only from a small hillside soak near Jericho in 1970. Our surveys found *M. australis* to be relatively frequent and widespread within shallow, seasonally wet areas within the non-forest mosaic habitats across the north of the project area (Plates 50-52), with over 2,000 plants observed within the narrow survey period of less than two months, including one patch in closely grazed grassland supporting around 1,000 plants. Most other occurrences had far less plants (generally less than 100). It is likely to be present at additional locations in the same habitats.	This species is most likely to occur in seasonally wet areas on basalt, however some occurrences were recorded on alluvial deposits and dolerite. As the habitat niche for this species can occur within a myriad of non-forest vegetation types, potential habitat may occur within a 30 m buffer of marshlands, wetlands, and major streams in grassland (GPH), sedgy grassland (MGH) and agricultural land (FAG).
Myriophyllum integrifolium tiny watermilfoil	vulnerable/ -	-	*Myriophyllum integrifolium* occurs mostly in the northern Midlands, with isolated populations in the State's north, north-east and south. It grows at the margins of wetlands and in seasonally wet places, including depressions associated with small ephemeral lakes. It can occur in coastal heathland and in forest in the Midlands, where it is often associated with old muddy tracks. Was recorded at only one location within the project area, a shallow, seasonally wet area supporting an estimated 1,000 plants within the grassland of Wihareja (Plate 50). Only one other record is known within 5 km. Is likely to be more widespread within equivalent patches elsewhere within the non-forest habitats but is easily overlooked due to its tiny size and very brief annual life cycle.	Habitat for this species may occur within micro-topographical variations across the landscape and is difficult to map with any great certainty. As a conservative measure, potential habitat is likely to occur in grassland and sedgy grassland (GPH and MGH) habitats within 30 m of waterways and marshland and a 30 m radius of wetland vegetation communities (AHF, AHL).
Pterostylis pratensis Liawenee greenhood	vulnerable/ VULNERABLE	-	*Pterostylis pratensis* is restricted to the Central Highlands of Tasmania (Appendix E), growing at an elevation of 850-1100 m above sea level in subalpine *Poa labillardierei* tussock grassland that is very exposed, low and open, with patches of often stunted *Olearia algida* (alpine daisybush) and *Hakea microcarpa* (smallfruit needlebush) scrub on red–brown loamy to clay soils derived from basalt. Relatively common at a broad scale within the project area, with dozens of scattered plants within the grassland plains (Plates 53 and 54). Has a relatively short flowering period, meaning that our surveys are unlikely to have captured the full range of its occurrence within the project area, however this was captured in some areas by mapping predicted area extent with polygons for avoidance. Potential habitat for this species is widespread across the project area.	Habitat is defined as all areas of native grassland (GPH) on basalt or dolerite derived soils.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
Ranunculus pumilio var. *pumilio* ferny buttercup	rare/ -	-	*Ranunculus pumilio* var. *pumilio* occurs mostly in wet places (e.g., broad floodplains of permanent creeks, "wet pastures") from sea level to altitudes of 800-900 m above sea level. Prolific at a broad scale within the project area, with a minimum extent of occurrence of around 100 ha and with some locations supporting populations of thousands of plants scattered across the grassland plains, concentrated at a local scale within small patches of bare ground (Plate 55). Has a relatively short annual life cycle, meaning that our surveys are unlikely to have captured the full range of its occurrence within the project area – equally however, it is possible the similar and equally tiny *Ranunculus sessiliflorus* is present within the population and contributes to some of the abundance, noting with different moisture preferences the species may oscillate in dominance year to year.	The habitat requirements for this species are relatively broad and is present throughout the project area. Habitat may occur in a range of grassy vegetation types. As a conservative measure, habitat for this species has been defined as areas of grassland (GPH), grassy sedgeland (MGH), and agricultural land (FAG) within a 30 m buffer of mapped marshlands, wetlands, and major streams, and a 30 m buffer on wetland vegetation communities (AHF and AHL).
Rhodanthe anthemoides chamomile sunray	rare/ -	-	The distribution of *Rhodanthe anthemoides* includes montane grasslands, heath and heathy scrub in central and north-western Tasmania. A large, localised occurrence around the St. Patricks Plains trout dam (adjacent to Highland Lakes Road) was verified as still extant and healthy during our assessment (Plate 56) (with past estimates putting the population at over 10,000 plants). Outlying records such as on Ripple North and near the Shannon River on Allwrights were investigated but no plants were observed. It is considered a low likelihood that the species exists within the project area outside of the well documented occurrences proximal to the trout dam unless it has been heavily suppressed by grazing.	Given the distinctive nature of this species, additional occurrences are unlikely to have been overlooked in the project area. As such, the potential habitat for this species is defined as a radius of 100 m of all known records within grassland habitat (GPH).
Scleranthus fasciculatus spreading knawel	vulnerable/ -	-	*Scleranthus fasciculatus* is mostly known from a few locations in the Midlands and south-east. The vegetation at most of the sites is *Poa* grassland/grassy woodland. *Scleranthus fasciculatus* appears to need gaps between the tussock spaces for its survival and both fire and stock grazing maintain the openness it requires. Often found in areas protected from grazing such as fallen trees and branches. Found at only one location within the project area, a patch of dry sclerophyll forest on the northern boundary of Wihareja, where 5 plants were observed. Not previously reported from within 5 km.	Potential habitat in the project area may include areas of grassland and grassy woodlands that are protected from grazing. This species is scarcely known from the Central Highlands region[63]. Habitat may be more widespread, however given the limited extent recorded in the project area, it is likely to be highly localised. Potential habitat is defined as a 500 m buffer of known records within similar habitat (ie DPD forest, with a buffer of 100 m extending into GPH).
Senecio longipilus longhair fireweed	vulnerable/ -	-	Only 2 Tasmanian records prior to our surveys, one from 1837 and the other 1929, with the species considered to be locally extinct at both locations; the total time between Tasmanian observations of c. 90 years qualified the species for consideration as being presumed extinct – numerous occurrences were found within the project area, with a total estimate of around 30,700 (+/- 9,350) plants, concentrated within seven patches between 14 and 0.62 ha in size (Plates 57 and 58); these represent the only known plants in Tasmania. Was subsequently nominated for listing on the TSPA after discovery on site and accepted for listing as vulnerable.	Given that this species was not known at the site prior to our field surveys, it is likely to be more extensive than the current known range. The vast majority of records are in *Poa* dominated grassland on basalt, however a small number occur on the margins of dolerite outcrops and alluvial deposits. Some occurrences are with mapped agricultural land, however there is likely to be sufficient cover of *Poa* in these areas. The boundaries of the GPH and FAG communities can be somewhat 'fuzzy' and difficult to delineate a distinct boundary. It is difficult to ascertain the true extent of this species given it potential habitat is widespread across much of the Central Highland region[64]. Within the project area, potential habitat has been identified as all areas of *Poa* grassland (GPH) on basalt, as well a 200 m radius of known records within treeless vegetation types.

[63] Natural Values Atlas data – as at March 23 2023
[64] Threatened Species Section (2020)

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
Taraxacum aristum mountain dandelion	rare/ -	-	*Taraxacum aristum* occurs in subalpine grassland, grassy heath and grassy woodland in the Central Highlands. A total of four plants were observed during our surveys, with three on a rocky forested outcrop on the Ripple property (Plate 59) and the other within grassland habitat on Wihareja. Is likely to be more widespread in the project area, with relatively high numbers of plants known from the Steppes Reserve in similar habitats to those in the project area. The similar looking introduced *T. officinale* is widespread and abundant throughout the site.	This species may occur in a range of vegetation types; however it is typically known from grasslands and grassy woodlands. Potential habitat is therefore defined as all grasslands (GPH), as well as a 200 m radius on known records within similar habitat (DDE and DPD).
Trithuria submersa submerged watertuft	rare/ -	-	*Trithuria submersa* occurs in the Northern Midlands, near-coastal areas in the east and north-east, King Island, Flinders Island and Cape Barren Island, with an isolated record from the Central Highlands. Habitat includes areas subject to flooding, such as the margins of wetlands, small watercourses, shallow temporary depressions, and wet heathlands. Prolific at a localised scale within the project area (Plate 60), with some locations supporting populations of thousands of plants with densities of dozens of plants per square metre. Was observed within patches of seasonal mud in small depressions, shallow wet areas, and the margins of lagoons. Was mostly observed in the far north of the project area within the non-forest mosaic habitats but is likely to be more widespread than current records indicate.	Habitat for this species may occur within micro-topographical variations across the landscape and is difficult to map with any great certainty. As a conservative measure, potential habitat is likely to occur within 10 m of waterways, marshland and wetland (AHF, AHL) habitats.
Viola cunninghamii alpine violet	rare/ -	-	*Viola cunninghamii* occurs in short alpine herbfield, grassland and grassy heath in the higher parts of the eastern and central mountains where it is often associated with small patches of bare ground. Confirmed during our surveys around the Shannon River (Plate 61) but may be more widespread in the project area due to being relatively conspicuous and indistinct without flowers.	Observations of this species are typically associated with moist[65], riparian habitats[66], as such, potential habitat is defined as a 30 m buffer on all major waterways within grasslands and grassy sedgeland environments (GPH and MGH).
Previously reported from project area or within 500 m radius				
Asperula minima mossy woodruff	rare/ -	**<u>Previously</u> accepted records on site** *A. minima* very unlikely to be present based on our assessment	*Asperula minima* occurs in a range of vegetation types, the common factor being locally impeded drainage. Habitats include near-coastal swamp forests, *Melaleuca ericifolia* swamp forest, *Eucalyptus ovata* sedgy forest, "old pasture" regenerating to sedges and rushes, and firebreaks adjacent to clear-felled forest. Previous surveys have attributed records of this species to the project area but without supporting herbarium specimens to validate them. Although the project area may be viable for this species, our surveys of the locations purported to support *A. minima* established the presence of other non-threatened con-generics, particularly *A. pusilla* (Plate 62), *A. conferta* (Plate 63) and *A. gunnii* (Plate 64), but never *A. minima*. We concluded that *A. minima* is likely to be absent from the project area and that the previous records appear to be misidentifications. This was supported (and elaborated upon) by the independent assessment requested from ECOtas (Appendix D) and DPIPWE have marked the previous records on the NVA with a note saying they are likely to be *A.*	Our assessment has determined that this species is highly unlikely to be present in the project area. This result has been substantiated through external consultation (Appendix D). Potential habitat for this species has not been mapped.

[65] University of Tasmania (2019)
[66] Natural Values Atlas data – as at March 23 2023

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			pusilla – although we note that without specimens or photos from the previous surveys, we cannot be certain which of the *Asperula* that we recorded may have been attributed to *A. minima*.	
Epilobium willisii carpet willowherb	rare/ -	Considered to be **PRESENT**	*Epilobium willisii* occurs in wet montane herb fields around the central mountains and bare places around the eastern mountains. A single verified herbarium specimen is attributed to the St. Patricks Plains property within the project area. The species could not be relocated at this location (or within other suitable areas) during our assessment but given it can be very discrete and vary in seasonal detectability, it can be overlooked. In addition, to differentiate it from the very similar *E. tasmanicum* requires close examination of seeds, which are only present for a relatively short part of the survey period. Dozens of mat forming *Epilobium* were examined during our assessment, but none had characteristics that could be attributed to *E. willisii*.	Habitat for this species is difficult to define as it can occur in wet places throughout the project area. As a conservative measure, potential habitat is identified as a 30 m buffer on all watercourses and wetland habitats (AHF and AHL) within native grasslands and grassy sedgelands (GPH and MGH).
Hovea montana mountain purplepea	rare/ -	Very low	*Hovea montana* occurs in subalpine grasslands and grassy woodlands, occasionally extending to grassy/heathy subalpine forests dominated by *E. delegatensis, E. pauciflora, E. gunnii, E. coccifera* and *E. dalrympleana.* Habitat on site is suitable for this species, however it is extremely conspicuous when in flower, at which time we conducted searches of the most suitable habitats. Unlikely to have been overlooked. There is an NVA record for the species attributed to the northern boundary of the project area from NBES staff - this purely due to spatial inaccuracy of the record and the actual plants observed at that time were found on the other side of the road outside of the project area.	As this species is highly distinctive, it is unlikely to occur far beyond the current known extent. The potential habitat is therefore defined by a 200 m radius of known records within the same habitat, which in the case of this species is *Eucalyptus pauciflora* forest and woodland on dolerite (DPD).
Isoetes drummondii subsp. *drummondii* plain quillwort	rare/ -	Considered to be **PRESENT**	*Isoetes drummondii* subsp. *drummondii* is usually found in damp soils amongst dense grasses, such as the waterlogged pastures and waterways of the Midlands (with some outliers on the Forestier Peninsula and elsewhere). Habitats include woodland and forest dominated by *Eucalyptus rodwayi* and *E. amygdalina*, man-made ditches, muddy tracks and grassy "runs" through open forest. It also occurs on the seasonally inundated shores of man-made or natural waterbodies such as Camerons Lagoon, Wihareja Lagoon and Lake Leake. Verified herbarium collections have been made from the project area in the 70s and early 90s, including Wihareja Lagoon and an ephemeral wetland on St. Patricks Plains. The species could not be relocated at these locations (or within other suitable areas) during our assessment but given it can be very discrete and vary in seasonal detectability, it can be overlooked.	Habitat for this species may occur within micro-topographical variations across the landscape and is difficult to map with any great certainty. As a conservative measure, potential habitat is likely to occur within 10 m of waterways, marshland and wetland (AHF, AHL) habitats.
Pilularia novae-hollandiae Australian pillwort	rare/ -	Considered to be **PRESENT**	*Pilularia novae-hollandiae* occurs mainly in the central to northern parts of the State, in mud or silt of shallow rivers and on seasonally inundated margins of creeks and rivers. It is often hidden among grasses and sedges in damp mud, bogs and swamps. A vouchered specimen of this species was collected from Wihareja lagoon in 1991. The species could not be relocated at that location (or within other suitable areas) during our assessment but given it can be very discrete and vary in seasonal detectability, it can be overlooked.	H Habitat for this species may occur within micro-topographical variations across the landscape and is difficult to map with any great certainty. As a conservative measure, potential habitat is likely to occur in grassland and sedgy grassland (GPH and MGH) habitats within 10 m of waterways, marshland and wetland (AHF, AHL) habitats.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
Plantago glacialis small-star plantain	rare/ -	Nil	*Plantago glacialis* is found in short alpine herb fields, associated with snow patches in the central and western mountains. The nearest verified herbarium specimen is over 50 km away on Mount Rufus. The project area is not considered to contain viable habitat for this species. The record from 1995 in Cider Marsh within the Steppes Reserve (less than 500 m from the project area boundary) is thought to be a misidentification of *Plantago paradoxa*. *P. paradoxa* was found to be common on site, has basal tufts of golden-brown hairs and can in some cases have almost glabrous leaves (like *P. glacialis*).	No habitat present on site.
Prasophyllum crebriflorum crowded leek-orchid	endangered/ ENDANGERED	**Accepted records on site** may warrant re-attribution to *P. sphacelatum,* with taxonomic review	In north-western Tasmania (Appendix E), *Prasophyllum crebriflorum* occurs in montane tussock grassland dominated by *Poa labillardierei* (silver tussock grass), with scattered patches of the woody shrub *Hakea microcarpa* (smallfruit needlebush). On the Central Plateau, plants sometimes ascribed to *Prasophyllum crebriflorum* occur in highland native grassland dominated by *Poa gunnii* (Gunns snowgrass) and grassy woodland with a sparse overstorey of *Eucalyptus gunnii*. Previous surveys within the project area have attributed *Prasophyllum* plants of the subalpine green-brown type to this taxon. However, our conclusion from observations during the current assessment is that *Prasophyllum* plants of this type in the project area are better ascribed to the non-threatened *P. sphacelatum,* primarily due to flower size and the nature of the dorsal sepal (Plate 65). This is supported by the independent assessment undertaken at our request by ECOtas (Appendix D) and the presence of a verified herbarium specimen of *P. sphacelatum* from Allwrights (HO400905). Nonetheless, due to the complexities of the previously reported *Prasophyllum* on site being associated with an offset for another project, DPIPWE consider it more appropriate to continue to treat the plants on site as *P. crebriflorum* (and have lodged our observations of *Prasophyllum* from the current survey as *P. crebriflorum* on the NVA, but with a note saying they are probably *P. sphacelatum*) until taxonomic uncertainty is resolved with a revision of the genus. Similarly, as a precautionary approach, we have treated our observations of suspected *P. sphacelatum* as equal conservation significance to *P. crebriflorum* in the consideration of results of this assessment (Figure 5).	Our assessment has determined that this species is highly unlikely to be present in the project area. This result has been substantiated through external consultation (Appendix D). Potential habitat for this species has not been mapped.
Schoenoplectus tabernaemontani river clubsedge	rare/ -	Very low	No NVA observation records or herbarium specimens are known for this species from within 50 km, however Allwrights Lagoon is mentioned as containing an important population of the species on its threatened species note sheet[67], and the species is also mentioned as present (under the synonym *Schoenoplectus validus*) at Allwrights within the directory of important wetlands information sheet[68]. Given the reports of this species from Allwrights Lagoon are not substantiated by verified NVA or herbarium records, they may be erroneous misattributions. The only species we observed within lagoons on site that may be confused with *S. tabernaemontani* is *B. arthrophylla*, which has vaguely similar dropping panicles, has poly-tubular stems, and appears to be a broadly similar blue-green colour, particularly when observed from a distance, such as what may happen if observed from the margins of a lagoon. There is definitively no likelihood of *Schoenoplectus tabernaemontani* having been overlooked in our surveys. As such, if it was ever present in Allwrights Lagoon it is no longer there or	As the potential for occurrence is very low, and the species is highly distinctive and conspicuous and unlikely to have been overlooked, potential habitat for this species has not been modelled.

[67] Threatened Species Unit, DPIPWE (2012)
[68] Commonwealth of Australia (2020b): http://www.environment.gov.au/cgi-bin/wetlands/report.pl

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			may be in prolonged dormancy (not typical for the species in our experience).	
Uncinia elegans handsome hooksedge	rare/ -	Low	*Uncinia elegans* occurs in a wide range of forest types including wet sclerophyll forest, dry sclerophyll forest and open grassy woodlands. It is most often associated with damp grassy habitats and can occur on disturbed sites. It has been reported from adjacent to the project area near Arthurs Lake Road. Moderately suitable habitat occurs on site in moist woodland and forest areas, but the species has not been observed in these habitats and is unlikely to have been overlooked unless restricted in extent, very low in abundance, and/or suppressed by grazing during our assessment.	As the potential for occurrence is low, and the species is unlikely to have been overlooked unless restricted in extent, low in abundance, and/or suppressed by grazing, potential habitat for this species has not been modelled.
Previously reported from within 5 km radius				
Acacia siculiformis dagger wattle	rare/ -	Very low	*Acacia siculiformis* is found near watercourses (e.g., dense shrubby riparian scrubs along major rivers in the Midlands and surrounding uplands) and in dry sclerophyll forest. It is often associated with rocky dolerite sites. Care needs to be taken with outlier records not supported by herbarium specimens. Only two observation records within 5 km. Habitat is suitable in rocky and riparian areas, particularly in the south of the project area. Unlikely to be present within the development footprint, and if present in the project area at all can be expected to be in a relatively restricted area and/or not overly abundant.	As the potential for occurrence is very low, and the genus is highly distinctive and conspicuous and unlikely to have been overlooked, potential habitat for this species has not been modelled.
Agrostis australiensis southern bent	rare/ -	Very low	*Agrostis australiensis* has been recorded from alpine fjaeldmark, damp sclerophyll forests on moist well-drained soils and from intermittent wetlands in the Central Highlands. The distribution and habitats of native species of *Agrostis* are poorly understood because of recent taxonomic changes. Suitable habitat for this species occurs on site within areas of frost heave and seasonally inundated areas in the non-forest mosaic. Nothing fitting the characteristics of this species has been observed during our surveys and it is unlikely to be present unless restricted in extent, very low in abundance, and/or suppressed by grazing during our assessment.	As the potential for occurrence is very low, and the species is unlikely to have been overlooked unless restricted in extent, low in abundance, and/or suppressed by grazing, potential habitat for this species has not been modelled.
Agrostis diemenica flatleaf southern bent	rare/ -	Very low	*Agrostis diemenica* has been recorded from the edges of lakes, marshes and streams. The distribution and habitat requirements of native species of *Agrostis* is poorly understood because of many recent taxonomic changes. Suitable habitat for this species occurs on site within seasonally inundated areas in the non-forest mosaic. Nothing fitting the characteristics of this species has been observed during our surveys and it is unlikely to be present unless restricted in extent, very low in abundance, and/or suppressed by grazing during our assessment.	As the potential for occurrence is very low, and the species is unlikely to have been overlooked unless restricted in extent, low in abundance, and/or suppressed by grazing, potential habitat for this species has not been modelled.
Amphibromus neesii southern swampgrass	rare/ -	Very low	*Amphibromus neesii* is found in damp ground around marshes, lagoons, river flats, pools and streams. Suitable habitat for this species occurs on site within seasonally inundated areas in the non-forest mosaic. Nothing fitting the characteristics of this species has been observed during our surveys and it is unlikely to be present unless restricted in extent, very low in abundance, and/or suppressed by grazing during our assessment.	As the potential for occurrence is very low, and the species is unlikely to have been overlooked unless restricted in extent, low in abundance, and/or suppressed by grazing, potential habitat for this species has not been modelled.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
Brachyscome rigidula cutleaf daisy	vulnerable/ -	Very low	*Brachyscome rigidula* is found in the Midlands, East Coast and in parts of the eastern Central Highlands of Tasmania, where it occurs in rough pasture, grassland and grassy woodland on dry rocky hills and flats. This species has only been recorded twice within 5 km of the project area and has not been observed within that radius for 25 years. Seedlings of the species are highly palatable, and the likelihood of its presence is thus reduced by heavy grazing and browsing.	Grassland and grassy woodland vegetation may support this species in the project area, however given the lack of recent records from the broader region, and the low likelihood of detection if present, potential habitat has not been modelled.
Dianella amoena grassland flaxlily	rare/ ENDANGERED	Very low	*Dianella amoena* occurs mainly in the northern and southern Midlands, where it grows in native grasslands and grassy woodlands. The single record from within 5 km of the project area (Appendix E) is from 1984 and not supported by a herbarium specimen. The record may be erroneous as the nearest herbarium specimen is around 50 km away in the lowlands near Hamilton. Highly unlikely to be present on site.	Highly unlikely to be present on the site, as such, potential habitat has not been modelled.
Discaria pubescens spiky anchorplant	endangered/ -	Very low	*Discaria pubescens* is found sporadically in the Midlands and more abundantly in drier parts of the Central Highlands. It grows on sandy or gravelly soil, in basalt talus slopes and clefts amongst fractured dolerite rocks and flood channels. Many sites are in rough pasture, and it also grows on roadsides. Recent collections indicate the species is occasionally associated with sandstone outcrops. Habitat on site is suitable, however the species is highly distinctive and conspicuous, meaning it is unlikely to have been overlooked unless present in low numbers and/or with a very restricted extent.	As the potential for occurrence is very low, and the species is highly distinctive and conspicuous and unlikely to have been overlooked, potential habitat for this species has not been modelled.
Glossostigma elatinoides small mudmat	rare/ -	Low	*Glossostigma elatinoides* is an aquatic plant that occurs submerged in shallow water and on the banks of streams. Suitable habitat is present on site and the species is sufficiently indistinct (when not flowering) and inconspicuous to be overlooked if not abundant or widespread. If present it is unlikely to overlap with the development footprint due to the avoidance of major wetlands and riparian habitats.	If present on the site, it is considered not to be at risk of impacts. As a result of this conclusion, habitat for this species has not been modelled.
Pentachondra ericifolia fine frillyheath	rare/ -	Very low	*Pentachondra ericifolia* occurs in rocky sites in open alpine/dry sclerophyll woodland and heathland. Habitat on site is suitable, however the species is highly distinctive and conspicuous, meaning it is unlikely to have been overlooked unless present in low numbers and/or with a very restricted extent.	As the potential for occurrence is very low, and the species is highly distinctive and conspicuous and unlikely to have been overlooked, potential habitat for this species has not been modelled.
Phyllangium divergens wiry mitrewort	vulnerable/ -	Very low	*Phyllangium divergens* occurs in a wide variety of near-coastal habitats on a range of substrates, a common feature usually being bare ground (e.g. tracks) and rock exposures (e.g. outcrops, coastal cliffs, etc.). Although suitable habitat is present on site, the highland location would be atypical for the species to occur. The single record from within 5 km of the project area is from 1995 and not supported by a herbarium specimen. The record may be erroneous as the nearest herbarium specimen is over 50 km away in the lowlands near Launceston. Highly unlikely to be present on site.	Highly unlikely to be present on the site, as such, potential habitat has not been modelled.
Pterostylis wapstrarum fleshy greenhood	endangered/ CRITICALLY	Very low	*Pterostylis wapstrarum* records are largely restricted to the Midlands and south-east of Tasmania where it occurs in native grassland and possibly grassy woodland. It has been	Highly unlikely to be present on the site, as such, potential habitat has not been modelled.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
	ENDANGERED		reported from basalt soils. Records from the eastern Central Plateau (Appendix E) are historical (1929 the most recent) and the species is probably extinct in the region, or the specimens may warrant re-detting to *P. pratensis*.	
Predicted by habitat mapping only				
Acacia axillaris Midlands wattle	vulnerable/ VULNERABLE	Very low	*Acacia axillaris* is mainly confined to riparian habitats such as dense riparian scrub and associated floodplains but also extends to paddocks and open grassy forests in frost hollows and areas of poor drainage, but also occasionally occurs on rocky slopes (there is a somewhat anomalous population on the midslopes of Mt Barrow in the north-east). All populations are strongly associated with dolerite. Records outside the core of the range (e.g. Prosser River, Broad River, River Clyde) need to be treated carefully as they may represent the more recently described *Acacia derwentiana*. Habitat on site is suitable, and the location is marginally plausible, however the species is highly distinctive and conspicuous, meaning it is unlikely to have been overlooked unless present in low numbers and/or with a very restricted extent. Not known within 10 km (Appendix E).	As the potential for occurrence is very low, and the species is highly distinctive and conspicuous and unlikely to have been overlooked, potential habitat for this species has not been modelled.
Caladenia anthracina blacktip spider-orchid	endangered/ CRITICALLY ENDANGERED	Nil	*Caladenia anthracina* has a restricted distribution in the Campbelltown/Ross area, occurring in grassy woodland with *Acacia dealbata* (silver wattle) and bracken on well-drained sandy soil. Two historical sites from the Derwent Valley are presumed extinct. No suitable habitat within the project area and well beyond (> 50 km) known range (Appendix E).	No habitat present on site.
Lepidium hyssopifolium soft peppercress	endangered/ ENDANGERED	Nil	The native habitat of *Lepidium hyssopifolium* is the growth suppression zone beneath large trees in grassy woodlands and grasslands (e.g., over-mature black wattles and isolated eucalypts in rough pasture). *Lepidium hyssopifolium* is now found primarily under large exotic trees on roadsides and home yards on farms. It occurs in the eastern part of Tasmania between sea-level to 500 metres above sea level in dry, warm and fertile areas on flat ground on weakly acid to alkaline soils derived from a range of rock types. It can also occur on frequently slashed grassy/weedy roadside verges where shade trees are absent. No suitable habitat within the project area, incompatible management regime (heavy grazing and browsing), and well beyond (> 10 km) extant range (Appendix E).	No habitat present on site.
Pterostylis commutata Midlands greenhood	endangered/ CRITICALLY ENDANGERED	Nil	*Pterostylis commutata* is restricted to Tasmania's Midlands, where it occurs in native grassland and *Eucalyptus pauciflora* grassy woodland on well-drained sandy soils and basalt loams. Habitat is suitable within the project area but well beyond (> 50 km) known range (Appendix E).	No habitat present on site.
Pterostylis ziegeleri grassland greenhood	vulnerable/ VULNERABLE	Nil	*Pterostylis ziegeleri* is restricted to the east and north of Tasmania. In coastal areas, the species occurs on the slopes of low stabilised sand dunes and in grassy dune swales, while in the Midlands it grows in native grassland or grassy woodland on well-drained clay loams derived from basalt. Habitat is suitable within the project area but well beyond (> 50 km) known range (Appendix E), which under the current description is restricted to lowlands. A revision of	No habitat present on site.

Species	Status[60] TSPA / EPBCA	Potential to occur on site	Observations and preferred habitat[61]	Modelled habitat within the project area[62]
			the taxonomy may see this taxon merged with *P. pratensis*.	
Xerochrysum palustre swamp everlasting	vulnerable/ VULNERABLE	Very low	*Xerochrysum palustre* has a scattered distribution with populations in the north-east, east coast, Central Highlands and Midlands (Appendix E). It occurs mostly in wetlands and grassy to sedgy wet heathlands but extends to associated heathy *Eucalyptus ovata* woodlands and has been found in the highlands on Basalt outcrops. Sites are usually inundated for part of the year. Habitat is suitable on site, along outcrops of the Shannon River in particular, however only *Xerochrysum subundulatum* has been observed in the project area and this is sufficiently uncommon to suggest there is very limited likelihood that plants of *X. palustre* remain undetected unless they occur within a very restricted extent, are low in abundance, and/or have been suppressed by grazing (which does not generally happen with this species).	As the potential for occurrence is very low, and no occurrences were located during surveys of the likely habitat, potential habitat for this species has not been modelled.

A further two species have accepted records from the project area, but our observations (and an independent assessment – Appendix D) indicate these may have been misidentifications of closely related non-threatened species.

- *Asperula minima* (TSPA rare) – suspected misidentification of *A. pusilla*, *A. conferta* and/or *A. gunnii*
- *Prasophyllum crebriflorum* (TSPA and EPBCA endangered) – suspected misidentification of *P. sphacelatum*

Table 2 lists threatened species with observation records attributed to within a 5 km radius of the project area and discusses the potential for each species to occur on site based on habitat and the context of known records.

Given the size of the project area and the diversity of niches, it is possible that the project area supports additional species of threatened flora; however, the likelihood from the perspective of individual species being discovered on site is low to very low, given low habitat suitability for the potential species and/or the fact they are highly conspicuous species unlikely to have been overlooked. The main exceptions to this are species with the potential to have been suppressed by heavy grazing.

Plate 36: *Asperula scoparia* ssp. *scoparia* coming into flower within the north of the project area

Plate 37: *Asperula subsimplex* aquatic habit within seasonal shallowly inundated area

Plate 38: *Asperula subsimplex* habit during seasonal desiccation of the same shallow wet area pictured in Plate 37

Plate 39: *Barbarea australis* observed on the Shannon River, with inset showing winged seed under magnification

Plate 40: Dense *Calocephalus lacteus* within shallow, seasonally moist grassland area

Plate 41: *Carex capillacea* on the margin of the Shannon River

Plate 42: *Colobanthus apetalus* collected from purported site of *C. curtisiae*

Plate 43: *Cryptandra amara* on the banks of the Shannon River on Christians Marsh

Plate 44: *Glycine latrobeana* within forest remnant on Christians Marsh

Plate 45: *Hovea tasmanica* in dense flower on Christians Marsh

Plate 46: *Hovea tasmanica* shrubs on the banks of the Shannon River on Christians Marsh

Plate 47: *Isoetes humilior* growing in the Shannon River on the boundary of St. Patricks Plains and Allwrights – inset material on the ruler shows the diagnostic velum covering the sporangium

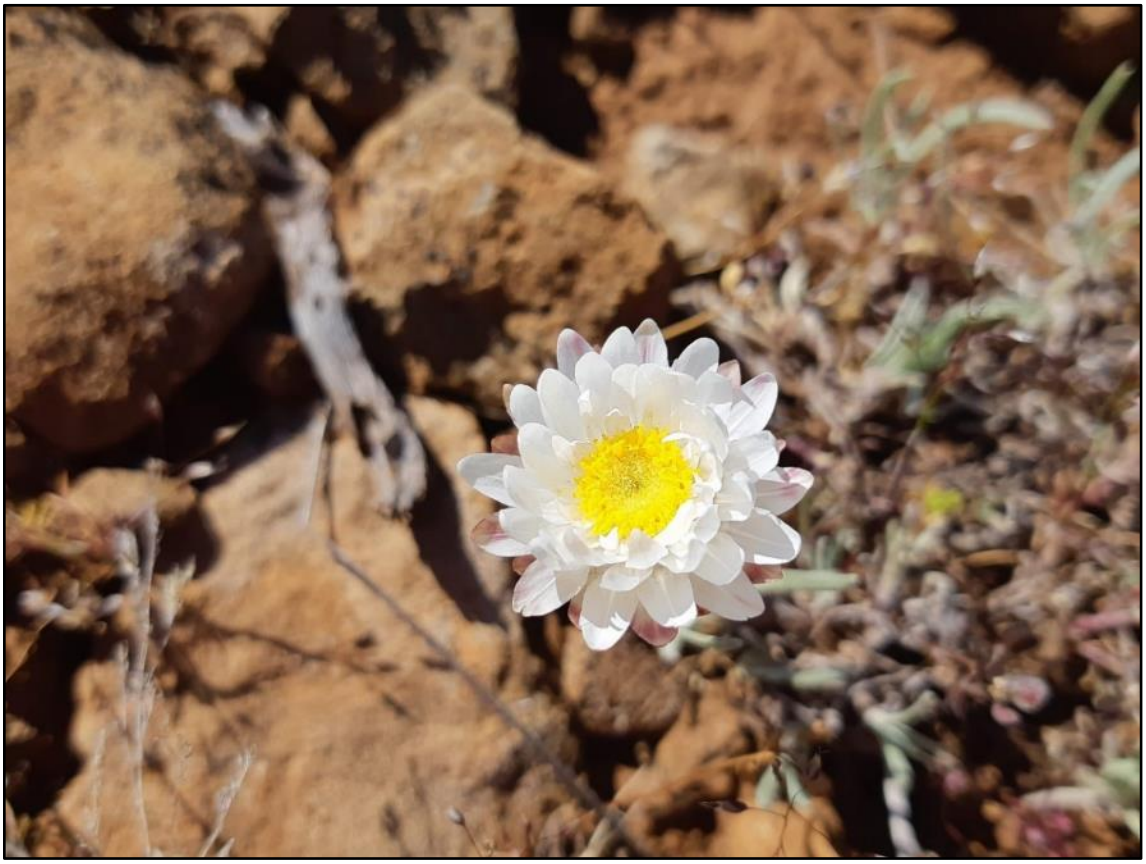


Plate 48: *Leucochrysum albicans* on basalt outcrop on St. Patricks Plains

Plate 49: *Muehlenbeckia axillaris* on basalt outcrop pm Allwrights near the Shannon River

Plate 50: Ephemeral wet area containing *Myosurus australis* (green arrow) and *Myriophyllum integrifolium* (blue arrow)

Plate 51: Single *Myosurus australis* plant on the edge of a seasonal wet area

Plate 52: Cluster of *Myosurus australis* on the edge of a seasonal wet area

Plate 53: Single *Pterostylis pratensis* within grassland habitat

Plate 54: Cluster of three *Pterostylis pratensis* within grassland habitat

Plate 55: Typical density of *Ranunculus pumilio* var. *pumilio* within grassland habitat

Plate 56: *Rhodanthe anthemoides* within grassland habitat near St Patricks Plains trout dam

Plate 57: *Senecio longipilus* within grassland habitat in the north of the project area, with inset showing characteristic striated achenes

Plate 58: *Senecio longipilus* within grassland habitat in the north of the project area

Plate 59: *Taraxacum aristum* within rocky forest habitat in the northwest of the project area

Plate 60: Typical density of *Trithuria submersa* where it occurred within seasonal mud patches within the non-forest mosaic area

Plate 61: *Viola cunninghamii* on rocky edge of Shannon River

Plate 62: *Asperula pusilla* typical of the project area, mostly found in forested areas and basalt outcrops in the non-forest areas

Plate 63: *Asperula conferta* was frequent within grassland habitats in the project area

Plate 64: *Asperula gunnii* was frequent within grassland habitats in the project area

Plate 65: Typical *Prasophyllum* from within grassland habitat in north of project area – which we have determined should be treated as *Prasophyllum sphacelatum* – note the large flowers and the lack of reflex and twist in the dorsal sepal

3.2.2 Conservation significant flora

In addition to threatened species, our surveys recorded 4 other vascular flora in the project area (Figure 5) that we consider to be conservation significant on the basis of few known records within Tasmania (using Natural Values Atlas data and herbarium records) – one of which has since been listed as threatened under the TSPA:

- *Carex* sp. – 2 locations in project area with a total extent of occurrence of < 10 m^2 (Plate 66, Figure 5) – examples of this form of Carex are being investigated as a possible new taxa in Tasmania, or potentially a stemless form of a widespread non-threatened species (which may not warrant conservation significance in that case).
- *Cardamine tryssa* (thought to be extinct until rediscovered in 2017 – still only around 100 records statewide) – 3 locations supporting 5 plants observed within the project area (Plate 67, Figure 5) not at risk of impacts.
- *Cystopteris tasmanica* (less than 35 records statewide) – observed at one location within the project area (Plate 68, Figure 5), with at least 5 plants present, but is probably more abundant in that localised area (not at risk of impacts).

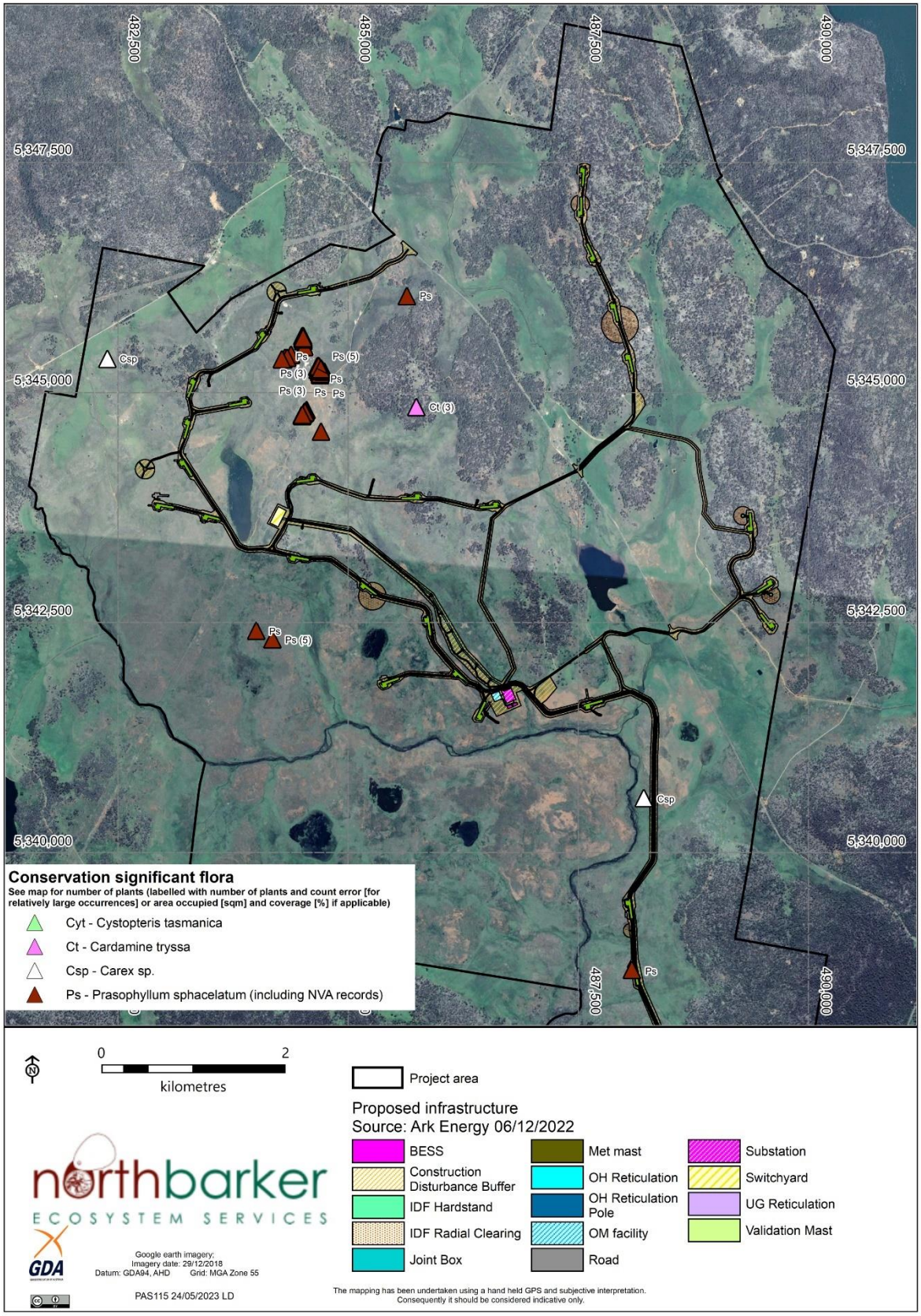


Figure 5a: Distribution of conservation significant flora within north of project area

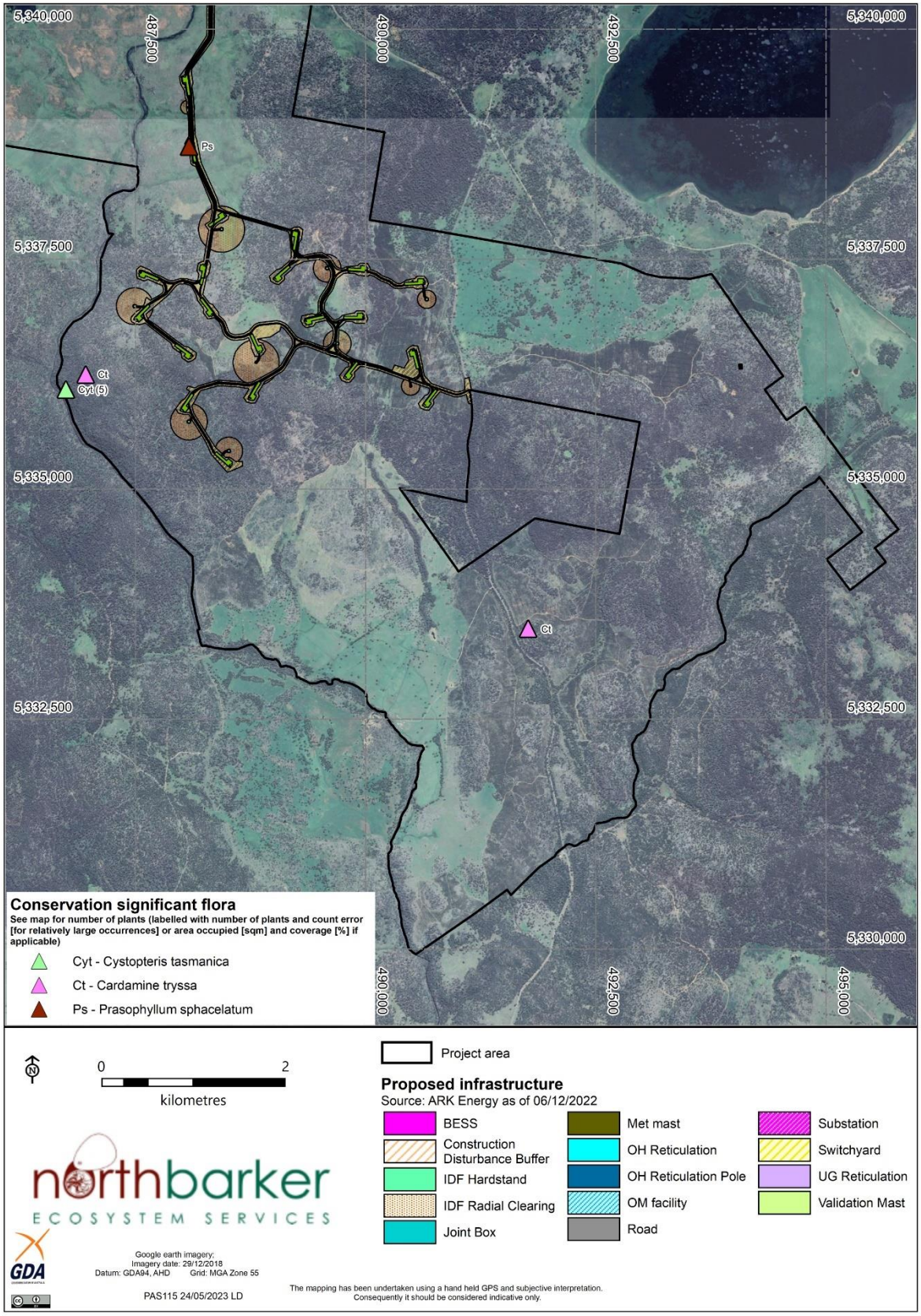


Figure 5b: Distribution of conservation significant flora within south of project area

Plate 66: Stemless *Carex* sp. from within grassland habitat in north of project area

Plate 67: *Cardamine tryssa* collected from a forest remnant in the north of project area

Plate 68: *Cystopteris tasmanica* from rocky slopes above the Shannon River in the south of project area

3.3 Introduced Plants and Plant Pathogens

3.3.1 Weeds

The study area has been found to support several introduced species, with around 70 recorded from the 2019/22 surveys, including 8 species of weeds declared under the *Tasmanian Weed Management Act 1999*.

The declared weeds observed in the project area are (Figure 6):

- Californian thistle *Cirsium arvense* (Plate 69)
- slender thistle *Carduus pycnocephalus*
- gorse *Ulex europaeus* (Plate 70)
- orange hawkweed *Pilosella aurantiaca* ssp. *aurantiaca* (Plate 71)
- ragwort *Senecio jacobaea* (Plate 72)
- canary broom *Genista monspessulana*
- English broom *Cytisus scoparius*
- crack willow *Salix x fragilis nothovar fragilis*

Declared weeds (as well as woody environmental weeds) are relatively uncommon across the project area, with ragwort (> 100), gorse (> 500), slender thistle (> 600), and Californian thistle (> 1,500) the only species observed to have more than 10 individuals within the entire project area. Ostensibly the low numbers of declared weeds are related to the high levels of grazing and browsing (Plate 72), in conjunction with some targeted control by landowners along high-risk areas such as Highland Lakes Road – as an example of the latter, the orange hawkweed recorded during our survey was reported to the nearest landowner on the day and subsequently eradicated that afternoon. In contrast, non-declared herbaceous weeds are ubiquitous throughout even the most high-quality natural habitats in the project area, with species such as *Taraxacum officinale* and *Agrostis capillaris* extremely abundant but appearing to have little detrimental impact on native values.

Plate 69: Californian thistle within a heavily grazed rut in grassland habitat in the north of the project area on Allwrights

Plate 70: Gorse on an interface between pasture and woodland in the south of the project area on the Shannon River

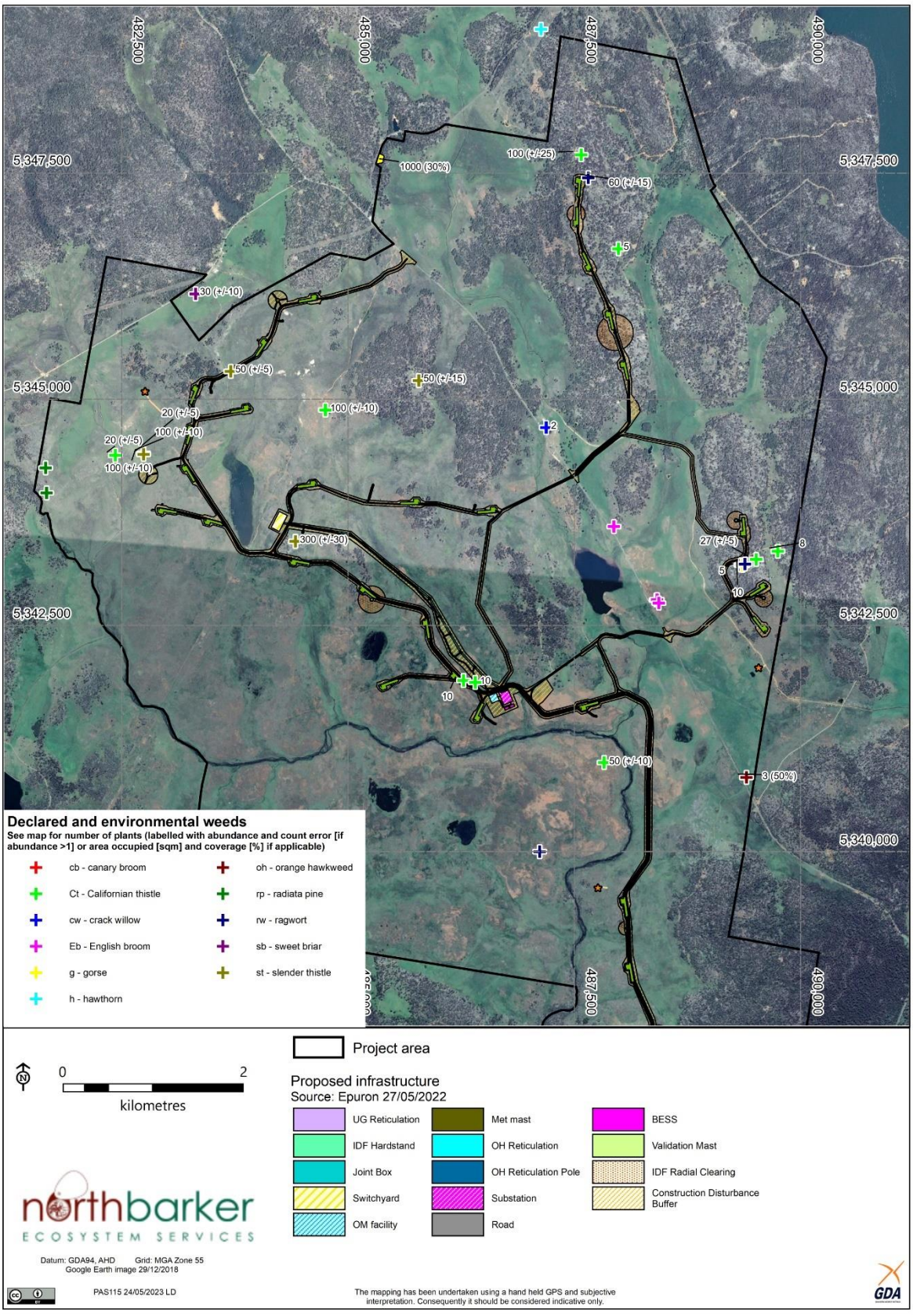


Figure 6a: Distribution of weeds within north of project area

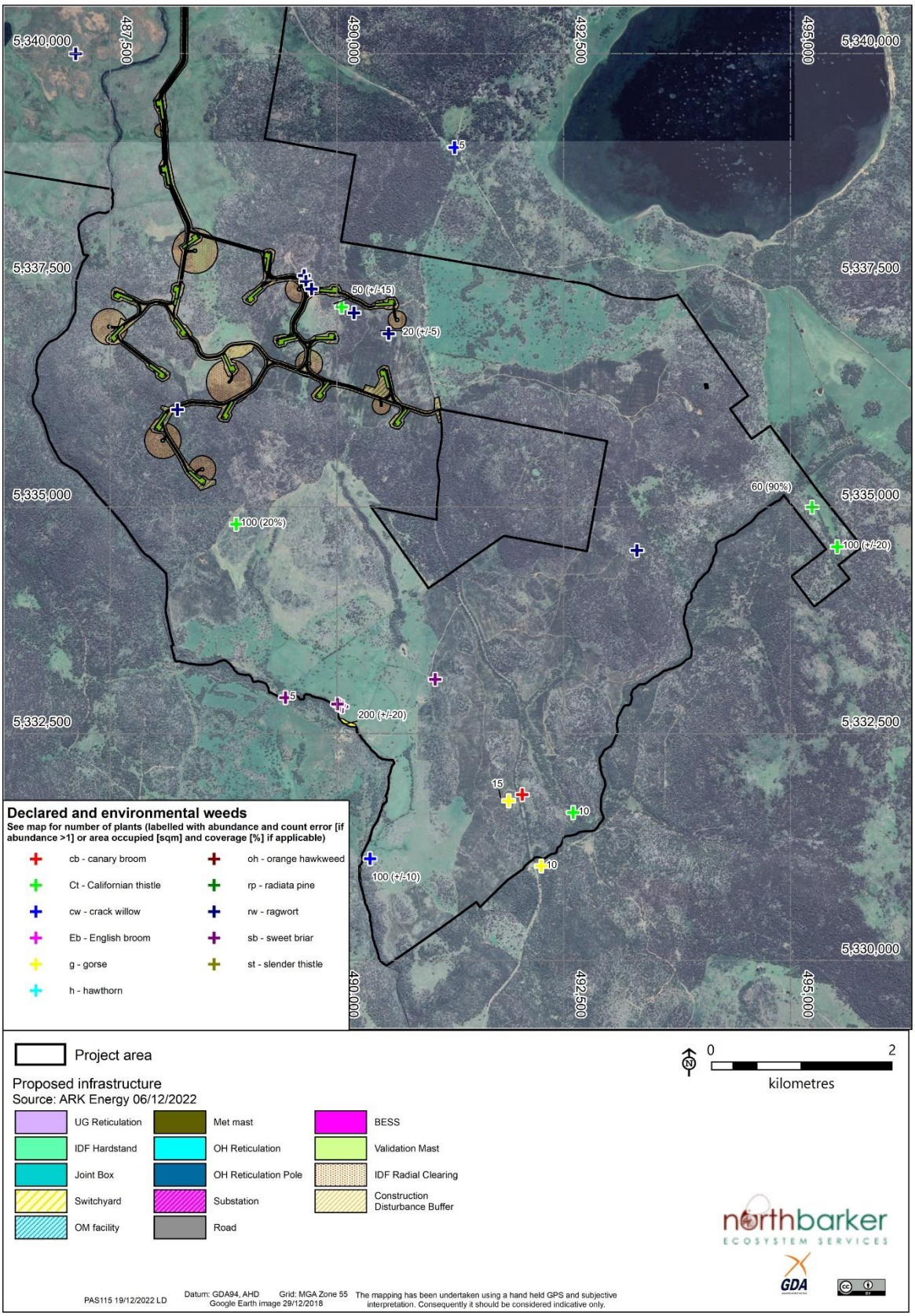


Figure 6b: Distribution of weeds within south of project area

Plate 71: Orange hawkweed discovered on Highland Lakes Road during our surveys and eradicated on the day by an adjacent landowner

Plate 72: Ragwort on the edge of a forestry road within the project area

Plate 73: Heavily browsed gorse

3.3.2 Cinnamon root-rot fungus (*Phytophthora cinnamomi*)

Commonly referred to as dieback or root rot fungus, *Phytophthora cinnamomi* (PC) is a soil-borne fungus exotic to Tasmania. The fungus is pathogenic, requiring plant tissue as a food source. High degrees of susceptibility to PC are known to occur within members of the Epacridaceae and Proteaceae[69]. When infected, susceptible species display a characteristic progression of morphological traits, beginning with leaf yellowing, progressing to substantive dieback (browning), and ending in death. Other potentially fatal processes, such as drought, can cause similar visual symptoms to PC, but the impact of drought at a given location tends to vary less within and between species. Thus, a mosaic of symptomatic and healthy plants can be a good indicator of the presence of PC, in particular if symptoms are concentrated in susceptible species and in moist locations.

No signs of *Phytophthora* have been observed during our field surveys. The project area is mostly above the 700 m a.s.l. altitudinal limit which inhibits PC activity due to insufficient soil warmth. It would thus be atypical (but not unheard of) for PC to be present in such an environment; in addition, cases of PC infection at high altitude tend to be limited to seasonal activity in association with summer soil temperatures and thus may not be as virulent nor spread as rapidly as lowland infections.

[69] Podger and Brown (1989); Barker and Wardlaw (1995)

3.4 Fauna of Conservation Significance

3.4.1 Survey observations and habitat assessment

The 2019/20 surveys recorded five threatened fauna species from within the project area (Figures 7-9) (those marked with asterisks were already known from within or very close to the project area from NVA records):

- Tasmanian devil *
- Spotted-tailed quoll *
- Eastern quoll

- Tasmanian devils were confirmed at several locations in the project area, in the form of bones (1 location with a scull), (suspected) scats (8 locations), a carcass (1 road-killed individual on Highland Lakes Road), an audible individual within a den (1 location, Plate 74), and camera sightings (5 locations), with the latter including multiple nights of den occupation at 2 locations (Plate 75), but no definitive evidence of natal activity (although genital dragging was observed and a sub-adult devil was effectively resident in one den during monitoring over several weeks). Landowners and/or residents within the project area also informally noted the presence of devils on their properties, including captures on trail camera footage (pers. comm. Paul and Shauna Ellis [St. Patricks Plains], and Leanne Riley [Ripple]). Based on the amount of evidence of devil presence on the site (including past records), it is likely they are widespread across the project area, but unlikely to be very abundant.
- Observations of the spotted-tailed quoll were limited to a single road-killed individual on Highland Lakes Road. However, landowners and/or residents within the project area also informally described sightings of animals fitting the description of spotted-tailed quolls, including captures on trail camera footage (pers. comm. Paul and Shauna Ellis [St. Patricks Plains], and Leanne Riley [Ripple]). It is possible the species is widespread across the project area, but it is unlikely to be very abundant.
- Observations of the eastern quoll were limited to trail camera footage (multiple nights of what is suspected to be the same individual, Plate 76) at a single location near Arthurs Lake Road (Figure 7). Based on habitat and environmental suitability, it can be expected that the species is widespread across the project area, and it may be locally abundant in some locations.
- Potential denning opportunities for each of these species is unlikely to be a limiting factor on local populations, with widespread observations of wombat burrows (114 burrows recorded, including 3 with confirmed devil occupation) (Figure 7 and Figure 8), in addition to extensive amounts of rocky habitat with the potential to provide and/or conceal den sites. In addition, the heterogeneity of the habitats within the project area is such that very few areas could be considered to be sufficiently separated from native habitat to confidently eliminate the likelihood of supporting a location that could viably be used for natal denning purposes. Similarly, even wetland habitats appear to be prone to seasonal desiccation, allowing seasonal use of potential denning locations that may otherwise be deemed unsuitable if inundated on a more permanent basis. Consistent with this, our denning stratification modelling shows that almost the entire project area (other than permanently inundated locations) constitutes potential denning habitat, with a large amount (> 65 %) qualifying as optimal (Figure 8).
- Within 50 m of proposed direct impacts, a total of 11 burrows were recorded.
- Extrapolating from known burrow density, a further 52 burrows are predicted to have been undetected within the potential impact footprint (including a buffer of 50 m).

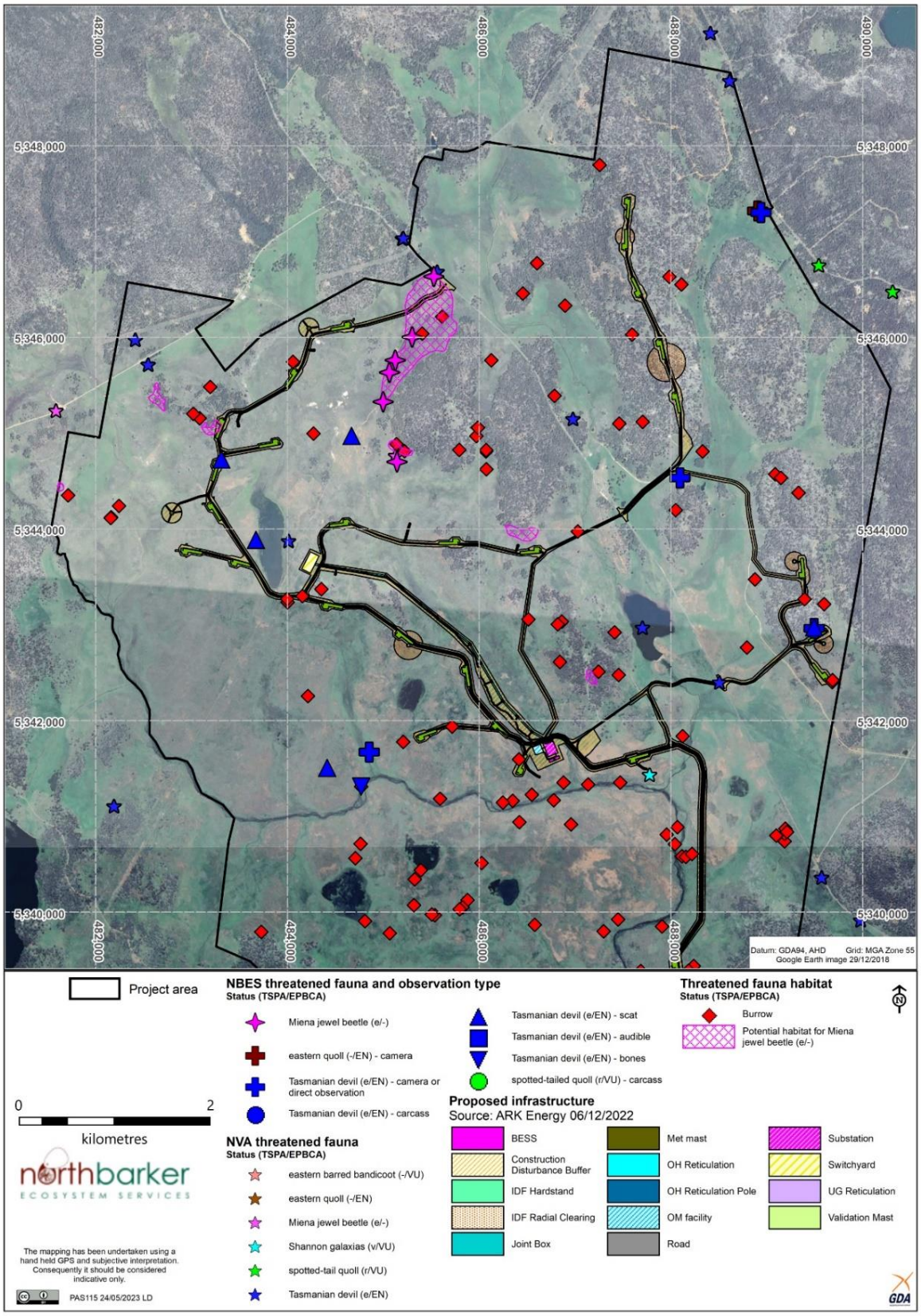


Figure 7a: Distribution of threatened fauna habitat and observations (excluding the ptunarra brown butterfly) in the north of the project area

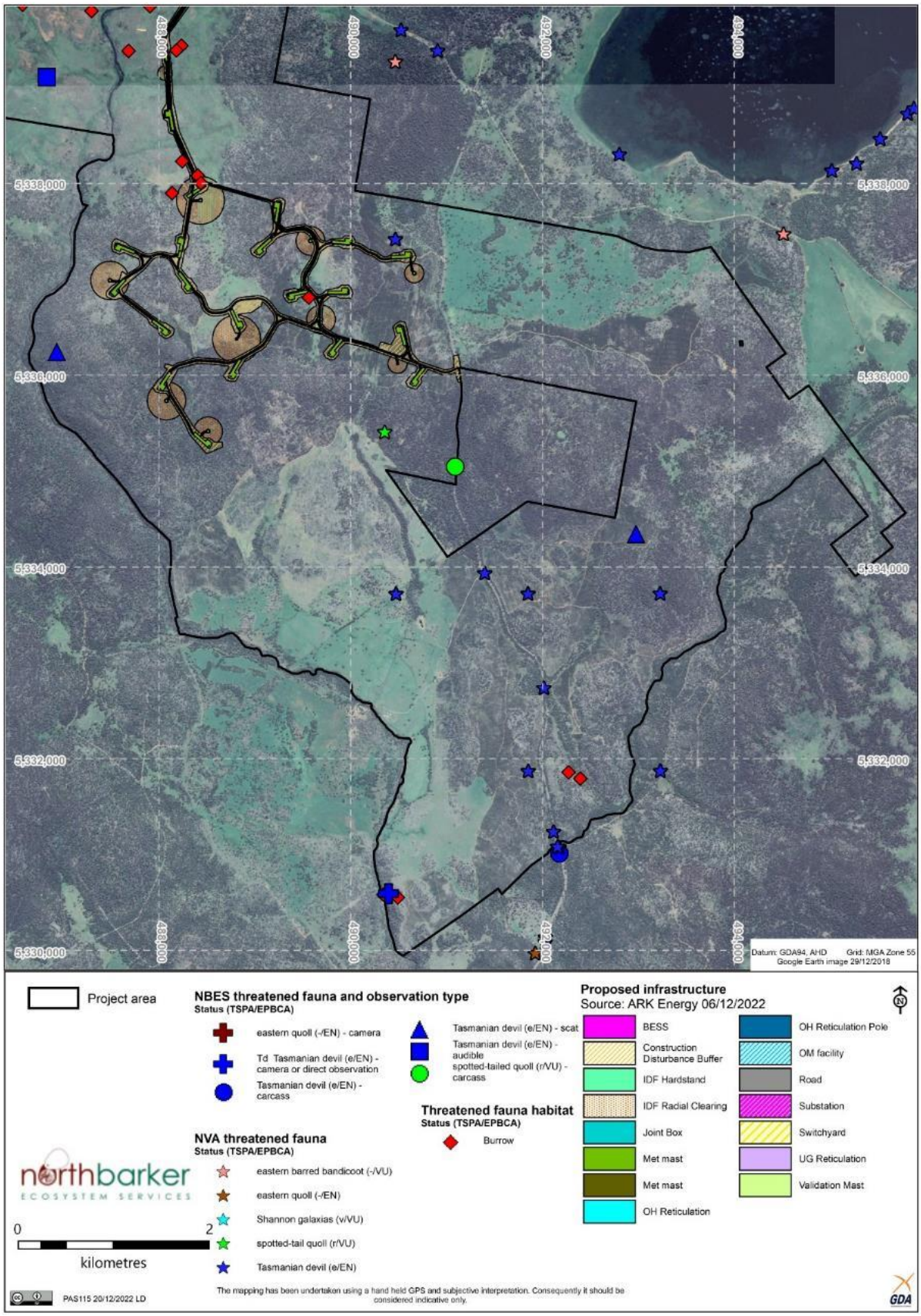


Figure 7b: Distribution of threatened fauna habitat and observations (excluding the ptunarra brown butterfly) in the south of the project area

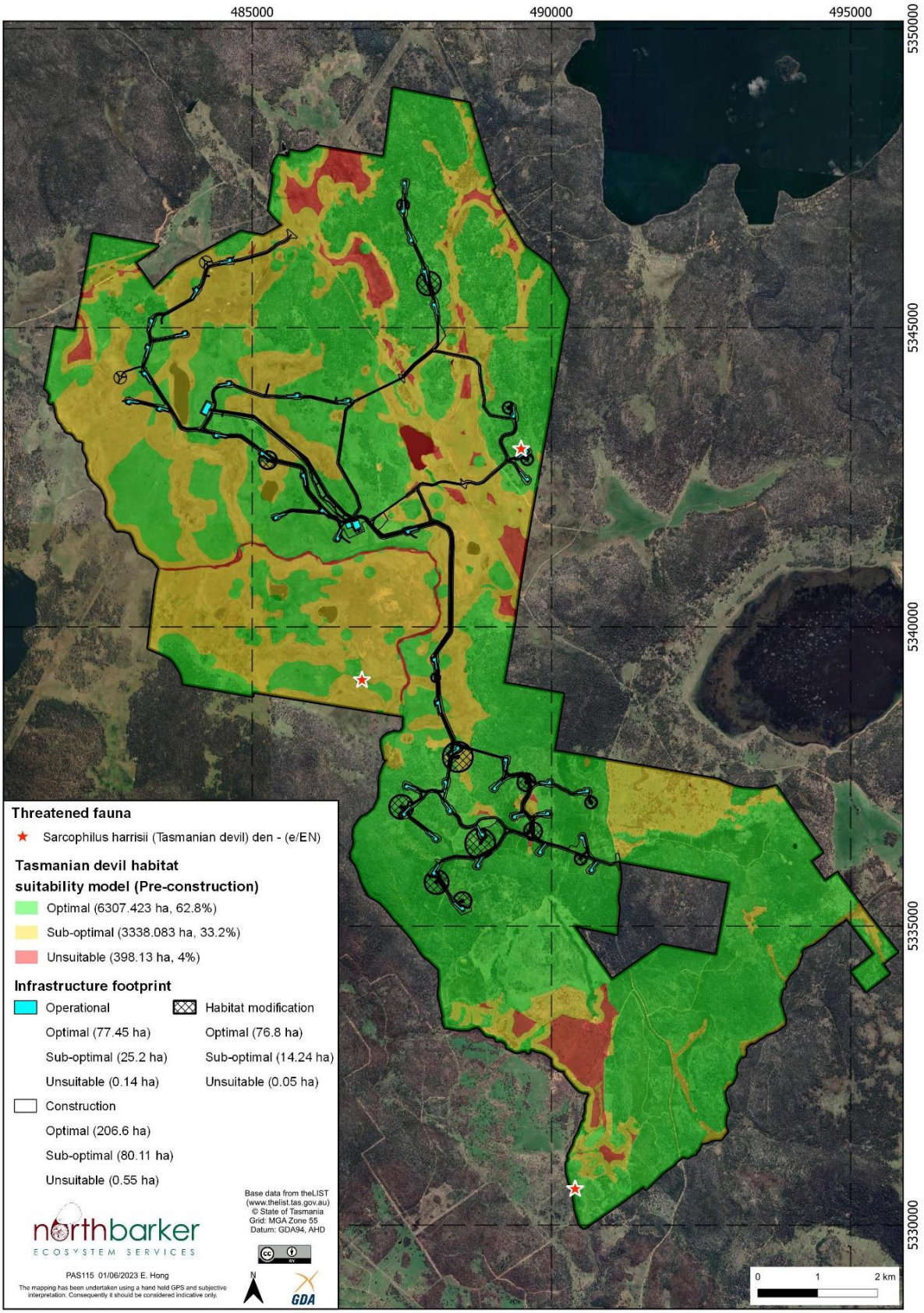


Figure 8: Stratification of denning habitat suitability across project area and in relation to impact footprint (prior to disturbance/works)

Plate 74: Den in which a devil could be heard (snoring) during the day (March 2020)

Plate 75: Young devil napping during the day outside a den in active use

Plate 76: Eastern quoll captured on camera trap near Arthurs Lake Road

- Miena jewel beetle *
    - A roadside NVA record (from Waddamana) prior to our surveys suggested this species could occur in the north of the project area. Around 56 ha of potential habitat for the species was mapped within the project area (Figure 7, Plate 77). A brief search of some of this habitat in 2020 (Figure 2) resulted in observations of 6 emergence holes likely to support larvae of the species (Plate 78). Adult occupation of the habitat was confirmed within the 2021 flowering season. It is possible that minor amounts of the primary food plant *O. hookeri* may be present outside of the mapped habitat patches, but it is unlikely to have been overlooked in any meaningful abundance. Conversely, some habitat patches may contain varying amounts of non-habitat plant species (at least for larval bores) which are closely related to *O. hookeri* and look similar on aerial images and in cases of remote mapping.

Plate 77: Patch of habitat (foreground) searched for Miena jewel beetle bore holes

Plate 78: Miena jewel beetle bore hole found within the north of the project area (by Richards and Spencer)

- Ptunarra brown butterfly *

  - Targeted field surveys confirmed the presence of the ptunarra brown butterfly on site (Plates 79 and 80), with over 2,000 individuals recorded during the transect surveys (and in excess of 80 individuals recorded as incidental sightings outside of the targeted searches, Figure 9). The analysis of survey results confirmed that relative abundance varies between habitat types, with sedgy grassland supporting the highest density of individuals, very short grassland supporting the lowest, and with intermediate densities within short native grassland with shrubs and tall inundation prone tussock grassland. The maximum number of individuals observed within a 2-minute survey was 54, within sedgy habitat near Allwrights Lagoon. Of the 42 surveys in which 10 or more individuals were observed, 28 of these were within sedgy habitat, with the other 14 being within short native grassland with shrubs. Almost 90 % of surveys within very short grassland failed to yield any observations, while the same occurred in less than 50 % of surveys in any other habitat type. Based on these results and the distribution of habitat types known from vegetation mapping, areas of high, medium and low population density/ habitat quality (in other words habitat quality classes are a direct reflection of the association between habitat types and the recorded density of butterflies) have been mapped across the project area, all of which are heavily concentrated in the north, particularly the northwest for high and medium quality habitat. A total of 1,209 ha of high-quality habitat has been mapped, with 2,135 ha of medium quality, and 443 ha of low quality. Based on average number of individuals recorded per survey (limited to data from one survey day only, to avoid the influence of seasonal variation) and the average distance surveyed per 2 minute interval (1,000 m^2: 100 m meandering and average visibility buffer of 5 m), the site may support a total population in the order of 200,000 individuals. The population might be slightly higher if individuals are also found in adjacent woodlands not targeted during our assessment.

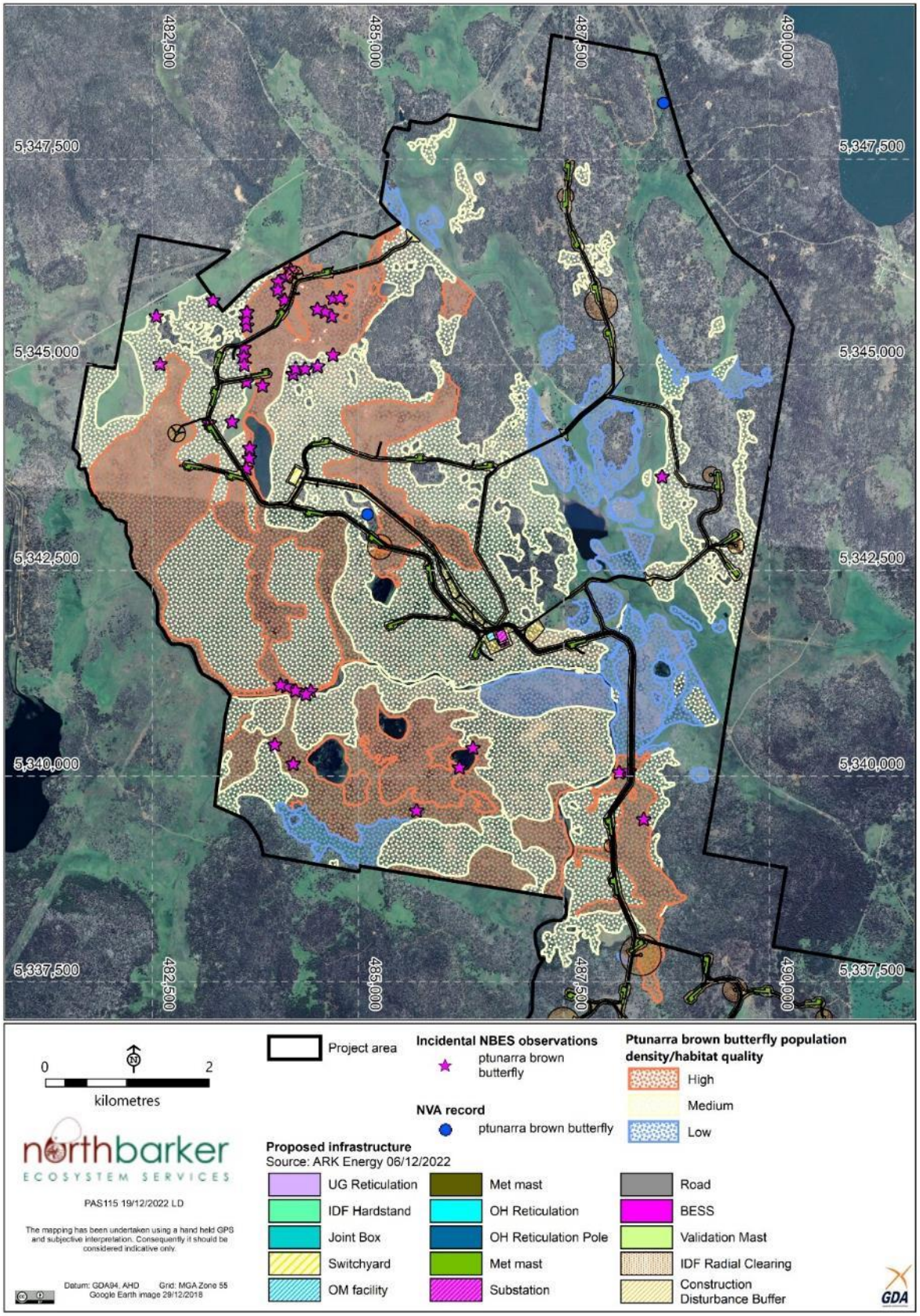


Figure 9: Distribution of ptunarra brown butterfly habitat and incidental observations in the project area

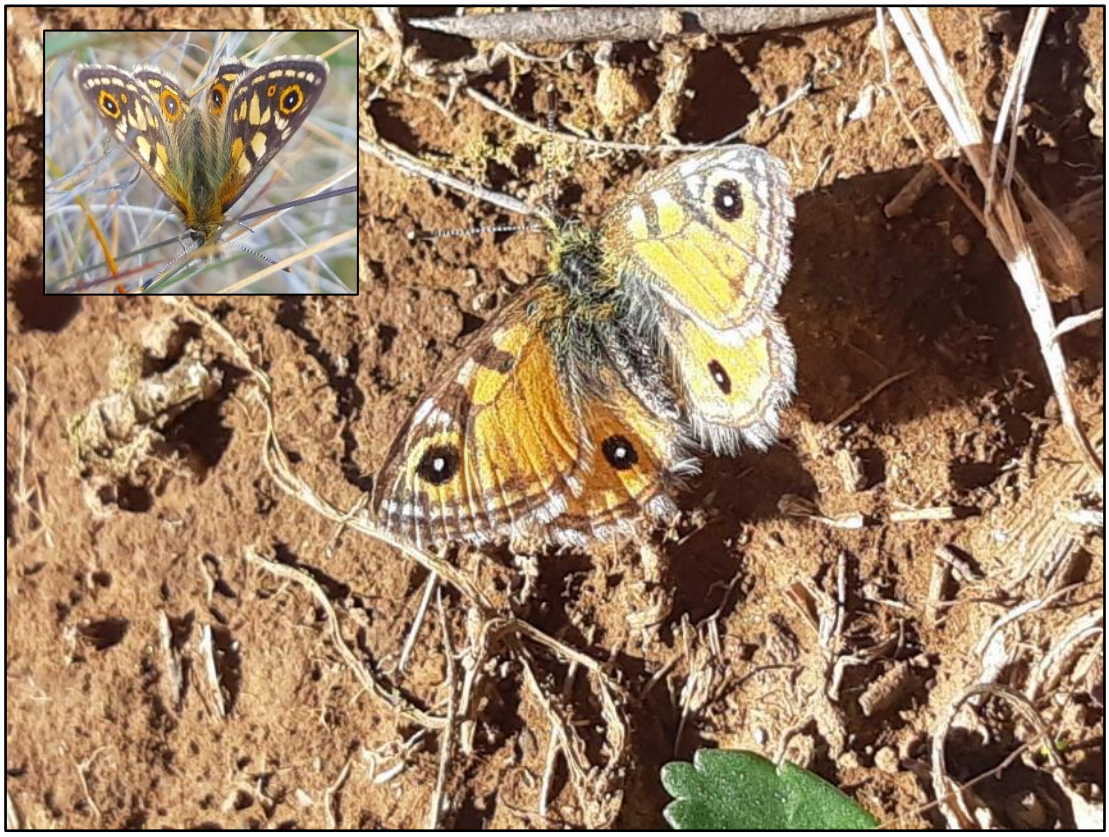


Plate 79: Ptunarra brown butterflies (female main image, male inset) within the north of the project area

Plate 80: Ptunarra brown butterfly male within the north of the project area

- Other fauna
  - Observations from the project area of all vertebrate fauna (excluding birds) detected on camera traps, through incidental observations, and/or through indirect presence indications (e.g. tracks and scats) are provided in Appendix F.
  - Several other threatened and/or migratory fauna are identified as having the potential to occur in the study area based on broad scale habitat mapping presented within the EPBC Protected Matters database or have verified observations within 5 km according to the Tasmanian *Natural Values Atlas*. Table 3 provides a description of the preferred habitat of these species and an assessment of the likelihood of their occurrence[70].

Table 3: Fauna species of conservation significance known within a 5 km radius of the survey area, or with the potential to occur based on EPBC habitat mapping[71]

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
AMPHIBIANS			
green and gold frog *Litoria raniformis*	Vulnerable/ VULNERABLE	Nil	In Tasmania, the species occurs in lowland areas in the south-east (where it is very rare) and north, breeding in permanent freshwater or slightly brackish habitats, generally with emergent vegetation. It has declined significantly (over 20 %) in range and abundance over the last 20 years, having disappeared from the Midlands, Derwent Valley, much of the Hobart region and parts of the north-west coast (although historical records are also less common in that region) (Appendix G). No likelihood of occurring on site based on the location.
INVERTEBRATES			
hydrobiid snail (Great Lake) *Beddomeia tumida*	Endangered/ -	Very low	Found only in six areas within the freshwaters of the Great Lake in northern central Tasmania, this species has a very restricted range. It is threatened by agricultural clearing and forestry, impoundment management and likely displacement and competition from the non-native *Potamopyrgus antipodarum*.

[70] Note, in addition to excluding most birds from this analysis (as they are covered by another investigation, obligate marine species are also excluded, as the proposal will have no conceivable impacts on such species.

[71] Natural Values Report # 1_03-Jun-2020, DPIPWE, 2020a; EPBCA Protected Matters report PMST_I63KLI

[72] Tasmanian *Threatened Species Protection Act 1995,* Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

[73] Threatened Species Section (2020)

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
			Unlikely to occur within the project area based on the habitat and location.
Great Lake glacidorbid snail *Benthodorbis pawpela*	Rare/ -	Very low	This species is endemic and restricted to the Great Lake in north-central Tasmania. Unlikely to occur within the project area based on the habitat and location.
Miena jewel beetle *Castiarina insculpta*	Endangered/ -	**PRESENT**	Endemic to Tasmania, the species is only reportedly found in the Great Lake/Lake Augusta area of Tasmania's Central Plateau. Found in open heath and subalpine woodland above 900 m, this species feeds primarily on *Ozothamnus hookeri*. Threats to this species include climate change, habitat loss and illegal collection. Characteristic emergence holes recorded during our 2020 surveys, with the presence of adults confirmed in 2021.
caddis fly (Great Lakes) *Costora iena*	Extinct/ -	Nil	Once found in the Great Lake area, this species is now extinct.
isopod (Great Lake) *Mesacanthotelson setosus*	Rare/ -	Very low	Endemic to Tasmania, this species is widespread throughout the Great Lake and in isolated populations within the Shannon Lagoon. Unlikely to occur within the project area based on the habitat and location.
isopod (Great Lake) *Mesacanthotelson tasmaniae*	Rare/ -	Very low	Endemic to Tasmania in isolated populations within the Great Lake in central Tasmania. This species has only been recorded in the southern end of the Great Lake at Becketts Bay. Unlikely to occur within the project area based on the habitat and location.
isopod (Great Lake & Shannon lagoon *Onchotelson brevicaudatus*	Rare/ -	Very low	Endemic to Tasmania, this species is widespread throughout the Great Lake and in isolated populations within the Shannon Lagoon. Unlikely to occur within the project area based on the habitat and location.
isopod (Great Lake) *Onchotelson*	Endangered/ -	Very low	Endemic to Tasmania in isolated populations within the Great Lake in central Tasmania. This species is restricted to central eastern side of

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
spatulatus			the Great Lake in Elizabeth Bay. Unlikely to occur within the project area based on the habitat and location.
ptunarra brown butterfly *Oreixenica ptunarra*	Endangered/ ENDANGERED	**PRESENT**	Found within *Poa* tussock grassland, woodland and grassy shrubland, this species is found in small populations above 400 m in the Central Plateau, the Steppes, eastern highlands, southern midlands and north-west plains (Appendix G). *Poa* grass is considered crucial for this species as the food plant for its caterpillar stage. Confirmed on site with targeted surveys.
amphipod (Great Lake) *Tasniphargus tyleri*	Rare/ -	Very low	Endemic to Tasmania, this species is widespread throughout the Great Lake and is associated with charophyte algal beds. Unlikely to occur within the project area based on the habitat and location.
isopod (Great Lake) *Uramphisopus pearsoni*	Rare/ -	Very low	Endemic to Tasmania in isolated populations within the Great Lake in central Tasmania. This species is confined to soft sediments in deep water habitats in Brandum Bay basin, the northern section of the Great Lake. Unlikely to occur within the project area based on the habitat and location.
FISH			
swan galaxias *Galaxias fontanus*	Endangered/ ENDANGERED	Nil	This species is restricted to a few small natural populations of freshwater headwater streams and catchments such as the Swan and Macquarie River catchments and between Rocka Rivulet in the south and St Pauls River in the north (Appendix G). This species has also been translocated to Cygnet, Lost Falls, South Esk and Little Swanport catchments. The introduction of larger fish such as trout are the greatest threat to this species. They are also threatened by changes in water quality and flow. Unlikely to occur within the project area based on the location.
saddled galaxias *Galaxias tanycephalus*	Vulnerable/ VULNERABLE	Very low	This species is abundant in Woods Lake in the Central Highlands with small populations in nearby Arthurs Lake (Appendix G). Whilst this species is predated on by brown trout, under current natural recruitment levels are not

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
			considered threatened by the trout. Instead, they are threatened by hydro-electric power generation and irrigation supplies which lower the water levels exposing important habitats for this species such as macrophyte beds and rocky shoreline. Unlikely to occur within the project area based on the habitat and location.
Shannon galaxias *Paragalaxias dissimilis*	Vulnerable/ VULNERABLE	May be **PRESENT**	This species lives around rocky or vegetated areas within the margins of the Great Lake, Shannon Lagoon and Penstock Lagoon, in Tasmania's Central Plateau (Appendix G)[74]. Shannon and Penstock lagoons are artificial impoundments downstream from Great Lake, and their populations are likely to be derived from Great Lake[75]. An NVA record is attributed to the project area (approximately on the Shannon River) within St Patricks Plains (Figure 7). It is possible the Shannon River may have derived some individuals from an environmental flow release from Great Lake, but it is uncertain if the river could sustain a permanent population. Given the river will not be a part of the footprint for this project, there are no expected impacts to the suitability of potential habitat within the river.
Great Lake galaxias *Paragalaxias eleotroides*	Vulnerable/ VULNERABLE	Very low	Small populations exist within the Great Lake and Shannon Lagoon in Tasmania's Central highlands[76]. It inhabits shallow rocky areas and macrophyte beds around the margins of the lake. Unlikely to occur within the project area based on the habitat and location.
Arthurs galaxias *Paragalaxias mesotes*	Endangered/ ENDANGERED	Very low	Found only around the shallow margins of Arthurs Lake, Woods Lake and River Lake in Tasmania's Central Highlands.[77] This species inhabits rocky and vegetated areas within pools and outlet streams. Unlikely to occur within the project area

[74] https://www.fishbase.se/summary/14287
[75] Threatened Species Section (2006)
[76] https://fishesofaustralia.net.au/home/species/3684#moreinfo
[77] https://fishesofaustralia.net.au/home/species/3917#moreinfo

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
			based on the habitat and location.
MAMMALS			
spotted-tailed quoll *Dasyurus maculatus* subsp. *maculatus*	Rare/ VULNERABLE	**PRESENT**	Occurs widely in Tasmania, including the northwest (Appendix G). Primary habitats are wet forest and rainforest. Several observations (< 10) on the NVA are attributed to within 500 m of the proposal and the species was confirmed as present during our investigation. Based on the availability of habitat it is expected to be widespread but not abundant within the project area. The project area is not located within the range of an important population (Appendix H).
eastern quoll *Dasyurus viverrinus*	-/ ENDANGERED	**PRESENT**	The eastern quoll is widespread in Tasmania and was previously widespread in mainland south-eastern Australia but has been effectively extinct there since 1963 (some reintroductions have occurred). Not currently listed as a threatened species within Tasmania under the TSPA. Records from the NVA indicate that the eastern quoll occurs in most parts of Tasmania but is recorded infrequently in the wetter western third of the state (Appendix G). The species' distribution is associated with areas of low rainfall and cold winter minimum temperatures. It is found in a range of vegetation types including open grassland (including farmland), tussock grassland, grassy woodland, dry eucalypt forest, coastal scrub and alpine heathland, but is typically absent from large tracts of wet eucalypt forest and rainforest. Confirmed as present in the project area during our investigations. Based on the availability of habitat it is expected to be widespread within the project area and may have areas with relatively high local abundance.
eastern-barred bandicoot *Perameles gunnii gunnii*	-/ VULNERABLE	Very low	This species originally occurred in native grasslands and grassy woodlands in Tasmania's Midlands. However, it is now rare in the Midlands where most of its habitat has been cleared (Appendix G). Since European

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
			settlement the eastern barred bandicoot has spread into (originally heavily forested) agricultural areas in the state's southeast, northeast and northwest. It favours a mosaic of open grassy areas for foraging and thick vegetation cover for shelter and nesting. Removal of plant cover in agricultural areas is seen as one of the main threats to the species. The species is relatively uncommon in the highlands. Although it has previously been reported from within the project area, it has not been reported from within 500 m of the site since 1976. The project area is beyond the core range of the species and it is unlikely to be widespread or abundant on site if a permanent population is present, which is unlikely.
Tasmanian devil *Sarcophilus harrisii*	Endangered/ ENDANGERED	**PRESENT**	The Tasmanian devil lives in a wide range of habitats across Tasmania (Appendix G), especially in landscapes with a mosaic of pasture and woodland. Populations have declined substantially since the first observations of the infectious cancer Devil Facial Tumour Disease (DFTD). DFTD has now spread across much of Tasmania. The reduced population is also likely to be more sensitive to additional threats such as death by roadkill, competition with cats and foxes, and loss or disturbance of areas surrounding traditional dens where young are raised. The protection of breeding opportunities is particularly important for the species due to the mortalities from demographic pressures. Confirmed to occur within the project area through various detection methods. Based on the amount of evidence of devil presence on the site (including past records), it is likely they are widespread across the project area, but unlikely to be very abundant.
REPTILES			
tussock skink *Pseudemoia pagenstecheri*	Vulnerable/ -	Low	Occurs in *Poa* tussock grassland and *Themeda* grassland without trees. The closest known record is around 50 km away. Several skinks of the *Pseudemoia* genus were observed on site with prominent lateral striping, including some males with red-orange bands. Only female individuals could

Species	Status[72] TSPA / EPBCA	Potential to occur	Observations and preferred habitat[73]
			however be examined closely and photographed in detail (Plates 81 and 82). Photographs sent to various people experienced with field identification of *Pseudemoia* species returned a variety of opinions, including positive identification as *P. pagenstecheri*. However, having considered all the opinions, in association with consideration of the location and our field observations, the *Pseudemoia* observed on site have tentatively been attributed to the non-threatened *P. entrecasteauxii*.

Plate 81: Female *Pseudemoia* observed within the project area, suspected to be *P. entrecasteauxii*

Plate 82: Female *Pseudemoia* observed within the project area, suspected to be *P. entrecasteauxii*

4 POTENTIAL IMPACTS AND MITIGATION

4.1 Mitigation and Avoidance Through Planning and Design

The proponent in the very early stages of planning used existing natural values data (primarily TASVEG and NVA records) to facilitate avoidance of known conservation significant values with the preliminary proposed layout, including designated exclusion areas based on the presence of natural values (Figure 1). It was acknowledged however that this process would be limited in utility due the unreliability of existing natural values mapping (particularly errors within the TASVEG database). Avoidance was subsequently limited at that stage to definitive natural values, such as wetlands and the past reported locations of threatened flora.

Following the conclusion of our field investigations, the proponent was supplied with our spatial data and recommendations for further prioritising the avoidance of natural values based. This has aided the minimisation of impacts prior to finalising the layout of the project infrastructure (and thus the distribution of the eventual impact footprint).

Additional mitigation measures can be applied during further redesign, construction and operation phases in order to result in non-significant levels of residual impact and to ensure avoidance of significant impacts to Matters of National Environmental Significance (details of significant impact consideration are within Appendix I, with a copy of the protected matters report in Appendix J). For instance, micro-siting surveys in the lead up to construction can assist in minimising impacts on values that have fine scale heterogeneity (*i.e.* where changes in composition or condition at a local scale may create the opportunity for reducing impacts), are strongly seasonal (creating the potential for being overlooked or underestimated in surveys), and/or are difficult to accurately survey at the scale of a c. 10,000 ha project area.

4.2 Impact Footprint

The current proposed works have a potential impact footprint of 481.13 ha – this includes impacts that will be direct (193.88 ha), as well as indirect (a proportion of which may only be temporary and subject to rehabilitation) (287.25 ha). In addition, within the direct impacts, there is a subset of components that only require vegetation management (removal of tall woody vegetation) – these are listed with direct impacts on the basis of operational requirements meaning they are changes for the lifetime of the project (not just construction phase), however it is noted as an important distinction that they are not expected to be complete habitat loss/clearance, but rather a change in vegetation community, which in some cases will mean the habitat is still suitable for conservation significant values – indeed in native non-forest units, the vegetation management will be inconsequential. These changes within the vegetation management subset of direct impacts are summarised in Table 4, with those units that are already non-forest expected to be able to maintain the extant vegetation type through the vegetation management, as they are not defined by/already lack the tall woody vegetation to be removed for management of overhead obstructions.

Within the permanent losses expected from the direct impact areas (102.79 ha), 18.86 ha are located within non-native vegetation that already constitutes modified land (Table 5), with 7.15 ha of this being silvicultural forest and the balance (11.71 ha) being agricultural land and associated miscellaneous human modified land. Permanent loss of native vegetation therefore is only 83.83 ha, representing 17.44 % of the total potential impact footprint and less than 1 % of the project area (Table 5). Even with non-native vegetation included, the expected permanent losses from direct impacts constitute only 1.02 % of the project area (Table 5).

Potential indirect impacts from the proposal are likely to be contingent upon the adequacy of management prescriptions and mitigation. They also vary with natural values. For instance, a change in land management associated with the footprint (e.g., fencing off some infrastructure) could have different indirect impacts for weeds (prevention of access for control by herbivores or land managers), fauna (potential for fragmentation and/or interruption of dispersal), and threatened flora (potential for habitat alteration from changes in grazing intensity). It is also noted that a variable amount of indirect impact/s associated with different components of the footprint will only be temporary impacts required to complete the construction but should be able to regenerate and/or be revegetated.

Subsequently, the disturbance footprint used in impact calculations for this assessment includes the potential for indirect impacts as a buffer around footprint components. This also allows for some construction space during works (as it is inevitable that workers and plant will cause some impacts beyond the direct impact area during construction), as well as factoring in the potential for habitat change from indirect impacts following works and during operations (e.g. vegetation change caused by hard surface runoff). Based on this, the potential indirect impact footprint of the project is 287.25 ha.

In discussion of impacts below, values thus refer to the sum total of the direct and indirect impact areas (collectively "the impact"). Distinctions between direct and indirect impacts are discussed where relevant within discussion and consideration of different natural values, as is the distinction between permanent vegetation loss and vegetation modification, noting in all cases a conservative 'worst case scenario' is taken where there is any doubt as to the potential nature of impacts.

Direct/Operational Impacts – 193.88 ha

Permanent loss – 102.79 ha

- BESS – 0.30 ha
- Hardstands – 43.26 ha
- IDF (IdentiFlight) hardstand – 0.89 ha
- Joint box - 0.01 ha
- Met mast – 0.76 ha
- Overhead reticulation pole – 0.52 ha
- OM facility – 0.81 ha
- Road – 40.85 ha
- Substation – 1.62 ha
- Switchyard – 2.00 ha
- Underground reticulation – 11.77 ha

Vegetation management – modification/potential change of vegetation community – 91.09 ha

- IDF (IdentiFlight) radial clearing sectors (vegetation management) – 87.15 ha
- Overhead reticulation (vegetation management) – 3.94 ha

Indirect Impacts/Buffer Area – 287.25 ha

- Construction disturbance buffer – 287.25 ha

Table 4: Different vegetation responses within the management subset of direct impacts (ha)

	Original community likely to change from management		Original community likely to persist through management		Total
	Native forest	Silvicultural forest	Native grassland/sedgeland	Modified land	
IDF radial clearing sectors	52.28	7.10	13.39	14.38	**87.15**
Overhead reticulation	-	-	3.94	-	**3.94**
Total	52.28	7.10	17.33	14.38	**91.09**

Table 5: Summary of impacts in relation to vegetation type

	Impact areas				Avoidance areas	
	Direct and permanent impact – operational infrastructure (% of total in project area)	**Habitat modification for operations – but not permanent loss (% of total in project area)**	**Construction disturbance buffer – potential temporary impacts (% of total in project area)**	**Impacts total (% of total in project area)**	**Retention (% of total in project area)**	**Total within project area**
Dry eucalypt forest and woodland	29.79 (0.78 %)	52.28 (1.38 %)	72.33 (1.91 %)	154.40 (4.07 %)	3,638.90 (95.93 %)	**3,793.30**
Non-eucalypt forest	0.19 (2.84 %)	0.00 (0 %)	0.91 (13.60 %)	1.10 (16.44 %)	5.59 (83.56 %)	**6.69**
Native non-forest (grassland and sedgeland)	53.95 (1.42 %)	17.33 (0.46 %)	158.13 (4.17 %)	229.40 (6.05 %)	3,563.61 (93.95 %)	**3,793.01**
Aquatic habitats	-	-	-	-	72.29 (100 %)	**72.29**
Silvicultural forest	7.15 (1.19 %)	7.10 (1.18 %)	20.07 (3.33 %)	34.32 (5.70 %)	567.83 (94.30 %)	**602.15**
Modified land	11.71 (0.68 %)	14.38 (0.84 %)	35.81 (2.09 %)	61.90 (3.61 %)	1,652.09 (96.39 %)	**1,713.99**
Water	-	-	-	-	61.90 (100 %)	**61.90**
Total	**102.79 (1.02 %)**	**91.09 (0.91 %)**	**287.25 (2.86 %)**	**481.13 (4.79 %)**	**9,562.20 (95.21 %)**	**10,043.33**

4.3 Native Vegetation Communities

4.3.1 Conservation significant vegetation

- The footprint will not impact any EPBCA listed ecological communities nor the nationally important wetland of Allwrights Lagoon.
- The impact area does contain TASVEG units GPH and MGH, which are listed as threatened under the Tasmanian NCA, but the vast majority of each have been excluded from the footprint (Tables 5 and 6).
- The impact footprint also includes very minor impacts to DRO and NLE (both RFA priorities within the region).
- The remaining communities within the footprint are well reserved at the State and regional level (and not threatened).
- It is noted that the footprint does not intersect (or conceivably compromise) any wildlife habitat strips designated under the *Forest Practices Code 2015,* noting these are restricted to public land and the entire footprint is within private tenure – the nearest informal reserves (which include wildlife habitat strips) are shown in Figure 10.

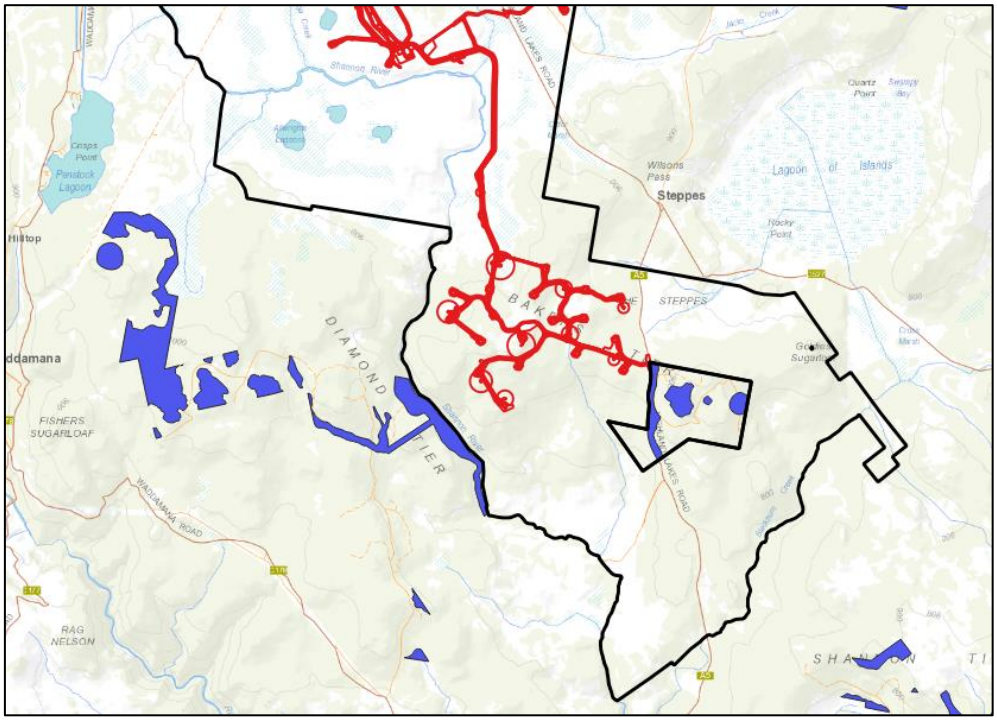


Figure 10: Distribution of informal reserves (which contain wildlife habitat strips) around project footprint, noting none of the reserved areas are intersected by the footprint

4.3.2 Extent of impact

- Overall, the impact footprint has the potential to affect a total of 7 native vegetation units (Table 6).
- The potential extent of impact on this native vegetation is 384.9 ha, which constitutes 5.02 % of the native vegetation within the project area.
- Proportional potential impacts and losses to individual units are very low, noting for each native unit with potential impacts, construction disturbance (rather than direct impact) contributes a minimum of 40 % of total impacts, with the contribution of direct impacts being as low as 17.27 % and 27.87 % for NLE and GPH respectively.
- In total, only 153.53 ha of the proposed impact to native vegetation is expected to be direct impacts, with the balance of 231.37 ha of proposed native vegetation impacts attributable to indirect impacts (construction disturbance buffer).
- It is expected that some of the 231.37 ha of indirect disturbance will be able to regenerate, or be revegetated/restored/managed, in a way that maintains native vegetation after works are completed.
- Furthermore, 69.61 ha of the direct impact area within native vegetation will be limited to the removal of obstructive woody vegetation within the IDF clearing sectors and under the overhead reticulation, but will be able to maintain low native vegetation (*i.e.,* will constitute vegetation modification rather than permanent loss and may still meet the definition of native vegetation units after modification, particular with native grassland/sedgeland, in which the change could be inconsequential).
- The balance of 96.22 ha of impact (or 19.99 % of the total impact area) is confined to units not constituting native vegetation communities (FAC, FAG, FPH, FRG and FUM).

4.3.3 Potential for further mitigation

Although the potential losses of native vegetation communities are not considered to be highly significant with respect to conservation status and the likelihood of persistence of vegetation communities at a local level and higher (Table 6), the impacts can be further reduced with mitigation commitments.

Direct and irreversible clearance should be concentrated within the areas of cleared land and non-threatened vegetation as much as possible. Where threatened and/or native vegetation is unavoidable, micro-siting at a local scale may be able to direct impacts into localised areas with less contribution to the overall value (e.g., a rocky area containing minimal vegetation, or a localised area with lower quality vegetation than the surrounds). As well as representative examples of all communities, the project should aim to protect localised variations within units (e.g. maintaining the distribution of the different facies of GPH).

Where disturbance but not complete clearance of native vegetation is required, such as slashing firebreaks or easements, micro-siting may be useful for selecting those areas that will be the least impacted (or may even benefit) from this modification.

To further minimise net losses, revegetation could be considered as a minor form of mitigation in areas where clearance of native vegetation is not required to be a permanent loss (e.g. borrow pits [if required], temporary access routes and temporary construction disturbance footprints). Suitable species for revegetation should be sourced from the local environment (see species lists in Appendices A and C). A list of potentially suitable species is provided in Appendix K. Revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc*., are best outlined in a revegetation plan once specific project details, timing, locations, *etc*., are finalised, and may be included as a requirement in a post-construction management plan.

If further clearance is required due to redesign, to minimise vegetation losses, the proposal should clearly define the extent of clearance required and concentrate the design footprint within areas of already cleared land where possible, as well as avoid impacts to threatened communities (as well as habitat for threatened fauna, or locations of threatened flora).

Prior to the commencement of works, the impact area should be marked (either *in situ* and/or clearly on construction plans) and all contractor agreements should specify that works, vehicles and materials must be confined within the designated impact areas. Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.

4.3.4 Summary of recommendations for native vegetation

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation – the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g. lower condition areas), as well as maintaining variation within a community across the project area (e.g. protecting different facies within a community where fine scale variation is present).
- Where disturbance but not complete clearance of native vegetation is required, such as slashing firebreaks or easements, micro-siting may be useful for selecting those areas that will be the least impacted (or may even benefit) from this modification.

- Similarly, where modification areas required for IDF clearance and overhead reticulation occur within native vegetation, the requisite removal of vegetation should be done as selectively as possible to maintain the vegetation in a manner that as closely approximates the original native TASVEG unit as possible and/or maintains any key habitat values – this is likely to require a targeted vegetation management plan for these sectors, which could be a condition of approval to have completed prior to works.
- In cases of redesign, maximise to the extent possible the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact areas.
- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g., borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation (sourced from the local environment, with example species in Appendix K), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc*.

4.3.5 Offset opportunities and priorities for native vegetation

- After avoidance and mitigation, if residual impacts to threatened native vegetation are sufficient to require offsets, offset priorities should be the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve condition of these units could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing landuse for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.

4.4 Threatened and Conservation Significant Flora

4.4.1 Potential impacts and context

The impact footprint (including direct impacts and indirect construction disturbance buffer) intersects with 8 threatened flora locations, either in terms of past NVA records or observations from the current study (Table 7) – potential habitat for threatened flora is widespread within the project area (Table 7).

In terms of EPBCA threatened flora:

- *Colobanthus curtisiae*
    - Noting there is a strong likelihood that many past reports of this species from the site are erroneous, the direct impact footprint intersects with the locations of 10 previously reported plants, with a further 18 reported from with the construction disturbance buffer. NBES did not record any *Colobanthus curtisiae* at these locations and consider the species to be restricted to rocky outcrops within forested area, none of which surveyed within the footprint have been found to support the species.
    - The locations of 605 previously reported plants will be retained beyond the footprint (95.37 % of all reported locations – noting the observation notes of many of these records suggest the species is widespread across the plateau).
- *Pterostylis pratensis*
    - The occurrences on site are noted as representing an important population referenced within the respective NRE listing statement (referred to as St. Patricks Plains), noting the listing statement is relatively out of date and the data collected for the current study are likely to be the most detailed assessment of the population to date (and have subsequently established greater population abundance and extent than referenced within the listing statement).
    - The impact footprint overlaps with 60 reported plants of this species (either from NVA records [42] or NBES observations [18]). Only 10 of these plants are found within the direct impact area, with the remaining 50 within the construction disturbance buffer.
    - A minimum of 595 previously observed plants (NBES and NVA records) will be retained outside of the footprint, in addition to a 7.62 ha area in which at least 87 plants were recorded but which was mapped as polygon area on the expectation additional plants would be present – this brings the minimum total plants to be retained beyond the footprint to 682.
    - The proportional loss of plants to direct impact is therefore 1.34 % of the total recorded, while the proportion at risk within the construction disturbance area is 6.74 % of the total. Therefore, the total percentage of observed plants at risk from the footprint is 8.09 % (60 out of 742 plants).
    - The greatest scope for avoidance is thus to selectively protect the species within the construction disturbance buffer with small exclusion zones, noting the species would conceivably only require a buffer of 2 m to prevent impacts (given its tiny size). We recommend application of the exclusion zones as shown in Figure 11 – with these targeted exclusion zones in place, the proportional impacts to the population of *P. pratensis* can be reduced to below 5 %, with only 28 of the 742 known plants at risk (3.77 %) (Table 8).
    - With or without this measure, the proportional potential impacts on total available habitat are around 6 % (Table 8), noting over 3,000 ha of potential habitat is present within the project area. This 6 % potential impact is worst case scenario, in that it does not include consideration that 5.33 ha of the potential habitat is within the vegetation management areas for IDF obstructions and overhead reticulation, in which areas there will be ample scope to manage these areas in the required fashion while not impacting the habitat value (nor even individual occurrences of this species). This however is

a relatively minor gain and still puts proportional losses of total available habitat at around 6 %.

- The additional EPBCA listed species *Barbarea australis, Eucalyptus gunnii* subsp. *divaricata, Leucochrysum albicans* var. *tricolor,* and *Glycine latrobeana*, are not considered to be at risk of impact as no extant locations are within the footprint.
    - In terms of the *L. albicans* ssp. *tricolor*, previous NVA records (from NBES surveys) were verified as still supporting the species during the present field surveys. These plants occur ~200 m to the north of a proposed access road for the proposal (see inset map 1 of Figure 4c), near a dam on Ripple Creek – this location will not be directly or indirectly impacted by the proposed works.
    - In terms of *Eucalyptus gunnii* subsp. *divaricata*, three past NVA records occur on the outer edge of the proposed disturbance footprint – however, analysis of a series of aerial photographs and field verification have confirmed that these trees are no longer present at this location (having died/fallen/been removed). Figure 12 shows detail of this location and the separation between other locations of the species and the footprint. It is also noted that all mapped areas (21.71 ha) of *Eucalyptus gunnii* woodland (TASVEG - DGW) (which have been heavily impacted by dieback) have been excluded from the footprint (Figure 4).
- The purported locations of *Prasophyllum crebriflorum/P. sphacelatum* were intersected by a previous design but have been avoided with the current footprint – noting the attribution to *P. crebriflorum* is considered to be potentially incorrect.

In terms of TSPA rare and threatened flora:

- *Asperula scoparia*
    - 16 locations previously reported from the project area (NVA and NBES records).
    - One of these locations (supporting a single plant) is located within the direct impact area.
- *Calocephalus lacteus*
    - A total of 2,794 plants have variously been recorded within the project area, with 290 from NVA records, 1003 from NBES points, and an additional 1501 plants mapped as polygon areas in our survey.
    - The impact footprint intersects with locations supporting 24 plants, representing a total potential impact of less than 1 percent of the total (0.86 %). In addition, only 2 of the 24 plants are within the direct impact area, with the balance of 22 plants at risk within the construction disturbance buffer.
    - The two plants within the direct impact area represent 0.072 % of the reported plants from the site.
- *Muehlenbeckia axillaris*
    - Project area contains a minimum of 241 isolated plants that have been mapped as single points (NVA and NBES records), in addition to 16.81 ha of area of occupation with matted plants to dense to make accurate abundance estimates.

- Only 4 of the 241 isolated plants (1.66 %) are within the potential impact footprint, with 2 of these within the direct impact area and the other 2 in the construction disturbance buffer.
- Within the polygon areas, 0.48 ha of the 16.81 ha total is intersected by the footprint, representing a total proportional impact of 2.86 %. Only 0.09 ha of this 0.48 ha is within the direct impact area, with the balance in the construction disturbance footprint.

- *Ranunculus pumilio* var. *pumilio*
  - An estimated total of > 112,000 plants are present in the project area, with a combination of past NVA records, NBES point observations, and areas NBES have mapped as extent of occurrence polygons.
  - A total of 115 isolated plants are at risk of impacts, however 100 of these are within the construction disturbance buffer, and a further 15 in the IDF clearance areas, noting that a ground hugging annual is unlikely to be impacted by the requisite clearance of IDF sectors.
  - In addition, a 0.15 ha area of occurrence (estimated to support 991 plants) is intersected by the footprint, but with only 0.01 ha (66 plants) in the direct impact area and the balance in the construction disturbance buffer.
  - In total, the 1,106 plants within the impact area represent only 0.98 % of the total population observed, noting that only 6 % of these plants are expected to be lost to direct impacts and the species as a whole is likely to persist within the construction disturbance buffer and IDF clearance areas due to its small size and disturbance ecology.
- *Senecio longipilus*
  - An estimated population in the order of 30,000 plants, with 9,374 mapped in individual locations, and a further 43.01 ha estimated to support 20,700 plants (Tables 7 and 8).
  - 1,945 individual locations are intersected by the footprint, with only 2 plants of these within the direct impact area (0.1 %) and the balance (99.9 %) in the construction disturbance footprint.
  - An additional 2.45 ha mapped as a polygon extent of occurrence (equivalent to 1,680 plants and representing 5.69 % of the total mapped area of occupancy) is intersected by the footprint, however only 0.5 ha of this is within the direct impact area (equivalent to 362 plants and representing 1.17 % of the mapped area of occupancy), with the balance in the construction disturbance footprint.
  - In total, the 3,625 plants at risk of impacts represents 12.05 % of the estimated total population, noting only 364 of these are at risk of direct impacts (around 1 % of the total population estimate), with 89.96 % of the impact attributable to the construction disturbance buffer (equivalent to 3,261 plants or 10.87 % of the total population estimate).
  - Potential losses from direct impacts are thus not considered to represent a significant proportion of the population.
  - Given that the overwhelming majority of potential impacts are within the indirect impact zone of the construction disturbance buffer, and the fact that plants have relatively clustered nodes of occurrence, the potential for total

impacts could be reduced by selectively narrowing the construction disturbance buffer in areas where the species is concentrated (Figure 4) – these areas could be treated as exclusion zones and, given the species is highly concentrated within a small number of locations, may not present a major impediment to works. We recommend application of the exclusion zones as shown in Figure 11 – with these targeted exclusion zones in place, the proportional impacts to the population of *S. longipilus* can be reduced to around 10 % (Table 8).

  - Even in the absence of annexing additional areas of occurrence from the construction disturbance buffer, the fact that the footprint in no area will fully remove any single patch of occurrence, combined with the ecology of the species as a highly fecund, bulk seed producing disturbance coloniser (consistent with the typical ecology of *Senecio* species), means that the balance of plants within the undeveloped areas of occurrence will be a significant source of propagules for the adjacent construction disturbance buffer, in which this species can be expected to be one of the dominant pioneering species post-works. Rather than rely on this means of self-establishment, albeit highly probable, this can be supported by the collection of seeds in the season prior to works commencing, to then be used as a targeted source of rehabilitation post works in proximity to remaining occurrences and within areas in which plants were impacted. In this scenario, the balance of plants post-works could be comparable to the population size prior to development. For added measure, a collection of seeds should be lodged with the Tasmanian Seed Conservation Centre.
  - With either or both of these measures applied, the total losses to the species can be reduced (ideally to a level of less than 5 % of the estimated population).
  - If the option to avoid by selectively narrowing the construction disturbance buffer is not viable, and the natural recolonisation of the species is relied on (with or without the supplementary addition of seeds), it is possible to require monitoring of the re-establishment of the species as a condition of approval, and if the species doesn't re-establish to a reasonable proportion of the existing population (say 95 % of the current estimate) within a certain number of years, the need for an offset in the form of supplementary planting could be triggered.

- Observed locations of *Carex capillacea* and *Trithuria submersa* were intersected by a previous design but have been avoided with the current footprint.
- No additional TSPA flora have been recorded within the potential impact area.

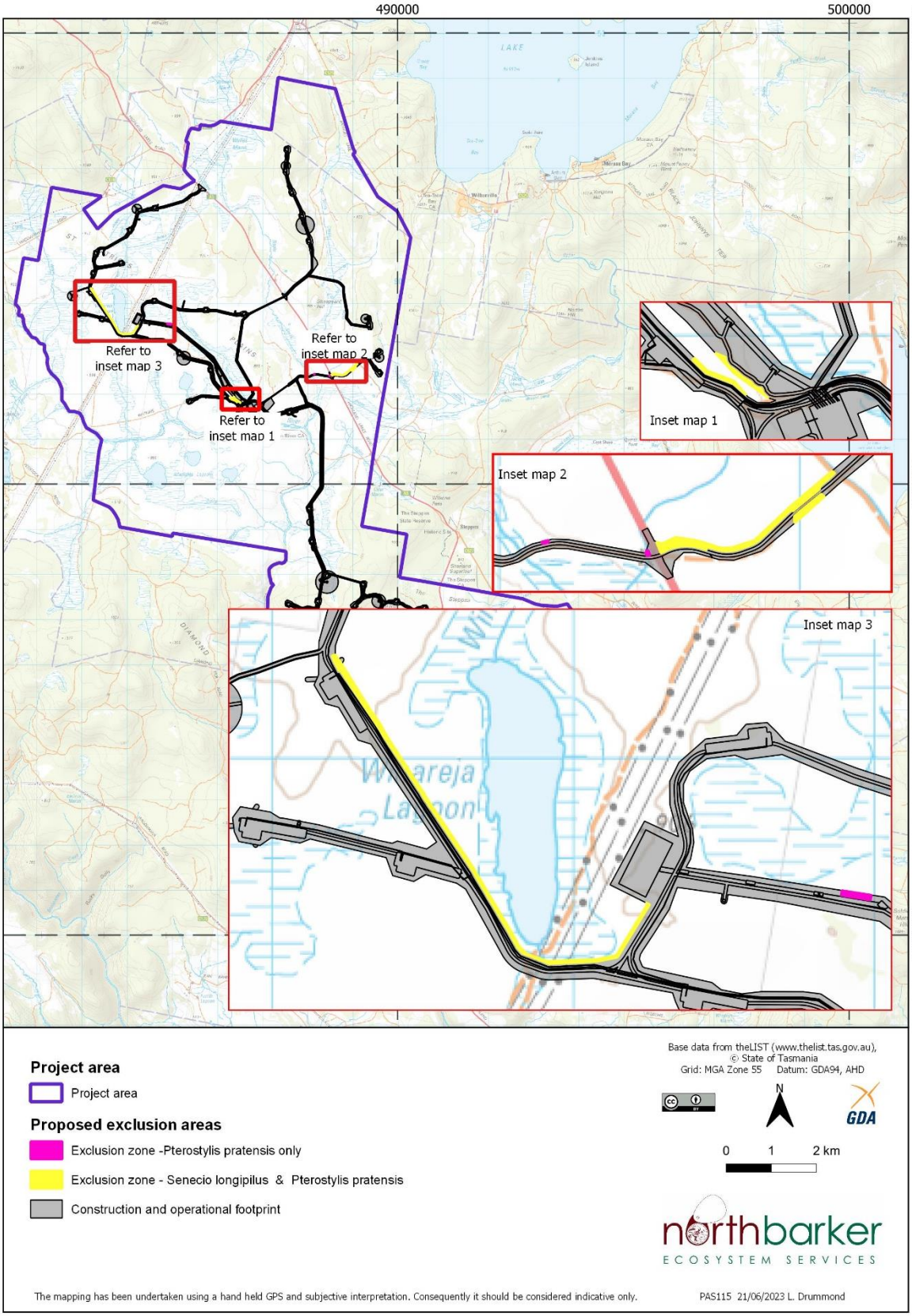


Figure 11: Recommended exclusion zones within the construction disturbance buffer for the purpose of reducing impacts to *P. pratensis* and *S. longipilus*

Table 6: Proportional and quantitative native vegetation impacts from the footprint (with construction disturbance buffer). All area units are in hectares[78]

Community/ unit (Bold denotes units with expected impacts)	Extent in project area	Total impact area Direct impact *Indirect disturbance*	Total impact % of extent in project area	Minimum extent to remain in project area with no impacts or modification	Extent in State (Total impact % of extent)	Extent in council area (Total impact % of extent in council area)	Extent in bioregion (Total impact % of extent in bioregion)	Extent in permanent native forest estate[79] (Total impact % of extent in permanent native forest estate)
(AHF) Fresh water aquatic herbland	70.15	0.00	0.00	70.15	7,700 (0 %)	5,300 (0 %)	5,100 (0 %)	-
(AHL) Lacustrine herbland	2.13	0.00	0.00	2.13	3,200 (0 %)	1,000 (0 %)	800 (0 %)	-
(DAD) *Eucalyptus amygdalina* forest and woodland on dolerite	345.22	0.00	0.00	345.22	156,100 (0 %)	7,100 (0 %)	2,200 (0 %)	5,986 (0 %)
(DDE) *Eucalyptus delegatensis* dry forest and woodland	1,072.06	63.73 37.08 *26.65*	5.94	1,008.33	256,300 (0.02 %)	119,800 (0.04 %)	99,500 (0.05 %)	165,758 (0.03 %)
(DDP) *Eucalyptus dalrympleana* - *Eucalyptus pauciflora* forest and woodland	531.34	46.91 24.77 *22.14*	8.83	484.44	9,500 (0.38 %)	8,200 (0.44 %)	2,600 (1.37 %)	13,026 (0.27 %)
(DGW) *Eucalyptus gunnii* woodland	21.71	0.00	0.00	21.71	2,200 (0 %)	1,100 (0 %)	2,000 (0 %)	-
(DPD) *Eucalyptus pauciflora* forest and woodland on dolerite	1,688.57	42.92 19.94 *22.98*	2.54	1,645.65	29,800 (0.12 %)	26,300 (0.137 %)	18,100 (0.20 %)	17,079 (0.21 %)
(DRO) *Eucalyptus rodwayi* forest and woodland	134.40	0.85 0.28 *0.57*	0.63	133.56	14,300 (0.01 %)	8,200 (0.01 %)	5,500 (0.02 %)	6,272 (0.01 %)
(GPH) Highland *Poa* grassland	2,706.09	181.58 50.52 *131.06*	6.71	2,524.50	24,000 (0.76 %)	17,200 (1.06 %)	17,600 (1.04 %)	-
(MGH) Highland grassy sedgeland	1,083.63	47.82 20.75 *27.07*	4.41	1,035.81	20,500 (0.21 %)	16,000 (0.26 %)	18,100 (0.24 %)	-
(MRR) Restionaceae rushland	3.29	0.00	0.00	3.29	10,300 (0 %)	2,100 (0 %)	1,800 (0 %)	-
(NLE) *Leptospermum* forest	6.69	1.10 0.19 *0.91*	16.50	5.59	52,800 (0.002 %)	900 (0.12 %)	6,400 (0.02 %)	388 (0.28 %)

[78] DPIPWE (2020c) – noting that the accuracy of the proportional calculations is subject to the mapping limitations of the base data in DPIPWE 2020c

[79] As of 30/06/22

Table 7: Summary of potential impacts to threatened flora species with the context of total amounts recorded in project area – total available habitat is presented as per the habitat definitions in Table 2

Species ***(Bold denotes species with observations in potential impact area)***	**NVA Records – excluding NBES submissions from this study (treated separately):** **(Units are plant abundance, noting where individual NVA records lack abundance data the value is taken as 1)** ***Denotes NVA records considered to be potentially wholly or largely unreliable identifications**			**Plants directly counted/estimated:** **Abundance**			**Plants measured/estimated by area of occupation:** **Area (ha)** **[Abundance given where estimated within area, or calculated based on density]**			**Total available habitat** **(potential extent of occurrence)*** **Area (ha)** *** Potential extent of occurrence^ is a broad level estimate of areas that may contain habitat niches that may provide areas of occupancy# for threatened flora species – it cannot be assumed that species will have complete occupation of their potential extent of occurrence, nor that potential for occurrence within the modelled overall extent will be uniformly suitable at a finer scale – e.g. plants can be expected to have finer niches within the overall mapped potential extent of occurrence.**		
	Total recorded in project area	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**
*Asperula minima**	25	25	0	0	0	0	-	-	-	-	-	-
Asperula scoparia	7	7	0	9	8	**1** (Direct impact)	-	-	-	1,698.99	1,546.17	152.83
Asperula subsimplex	11	11	0	1,056	1,056	0	3.21	3.21	0	1,453.26	1,408.16	45.10
Barbarea australis	0	0	0	21	21	0	-	-	-	30.03	30.03	-
Calocephalus lacteus	290	268	**22** (2 direct impact – 20 in construction disturbance buffer)	1,003	1,002	**1** (Construction disturbance buffer)	0.45 [1,501]	0.45 [1,500]	**0.0001** (construction disturbance buffer only) [**1 plant**]	2,938.74	2,748.31	190.43
Carex capillacea	1	1	0	1	1	0	36.52 [100,000]	36.52 [100,000]	0	57.08	57.08	-
Colobanthus curtisiae*	633	605	**28** (10 direct impact – 18 in construction disturbance buffer)	0	0	0	-	-	-	53.49	53.22	0.22
Cryptandra amara	0	0	0	10	10	0	-	-	-	16.30	16.30	-

Species ***(Bold denotes species with observations in potential impact area)***	**NVA Records – excluding NBES submissions from this study (treated separately):** **(Units are plant abundance, noting where individual NVA records lack abundance data the value is taken as 1)** ***Denotes NVA records considered to be potentially wholly or largely unreliable identifications**			**Plants directly counted/estimated:** **Abundance**			**Plants measured/estimated by area of occupation:** **Area (ha)** **[Abundance given where estimated within area, or calculated based on density]**			**Total available habitat** **(potential extent of occurrence)*** **Area (ha)** *** Potential extent of occurrence^ is a broad level estimate of areas that may contain habitat niches that may provide areas of occupancy# for threatened flora species – it cannot be assumed that species will have complete occupation of their potential extent of occurrence, nor that potential for occurrence within the modelled overall extent will be uniformly suitable at a finer scale – e.g. plants can be expected to have finer niches within the overall mapped potential extent of occurrence.**		
	Total recorded in project area	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**
Epilobium willisii	1	1	0	0	0	0	0	0	0	1,306.64	1,247.70	58.95
Eucalyptus gunnii* subsp. *divaricata	27	24	**3** (Locations only, with plants no longer present)	0	0	0	-	-	-	21.71	21.71	-
Glycine latrobeana	1	1	0	32	32	0	-	-	-	76.12	76.12	-
Hovea montana	1	1	0	0	0	0	-	-	-	4.58	4.58	-
Hovea tasmanica	100	100	0	657	657	0	-	-	-	14.82	14.82	-
Isoetes drummondii subsp. *drummondii*	3	3	0	0	0	0	-	-	-	1,610.00	1,562.09	47.90
Isoetes humilior	2	2	0	0	0	0	0.0005	0.0005	0	105.90	105.90	-
Leucochrysum albicans subsp. *tricolor*	1,734	1,734	0	3	3	0	0.003	0.003	0	3.59	3.59	-
Muehlenbeckia axillaris	82	78	**4** (2 direct impact, 2 in construction disturbance buffer)	159	159	0	16.81	16.33	**0.48** (0.09 ha direct impact, balance in construction disturbance buffer)	439.38	422.65	16.73
Myosurus australis	0	0	0	2,148	2,148	0	-	-	-	1,713.78	1,649.38	64.40

Species ***(Bold denotes species with observations in potential impact area)***	**NVA Records – excluding NBES submissions from this study (treated separately):** **(Units are plant abundance, noting where individual NVA records lack abundance data the value is taken as 1)** ***Denotes NVA records considered to be potentially wholly or largely unreliable identifications**			**Plants directly counted/estimated:** **Abundance**			**Plants measured/estimated by area of occupation:** **Area (ha)** **[Abundance given where estimated within area, or calculated based on density]**			**Total available habitat** **(potential extent of occurrence)*** **Area (ha)** *** Potential extent of occurrence^ is a broad level estimate of areas that may contain habitat niches that may provide areas of occupancy# for threatened flora species – it cannot be assumed that species will have complete occupation of their potential extent of occurrence, nor that potential for occurrence within the modelled overall extent will be uniformly suitable at a finer scale – e.g. plants can be expected to have finer niches within the overall mapped potential extent of occurrence.**		
	Total recorded in project area	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**
Myriophyllum integrifolium	0	0	0	1,000	1,000	0	0.005	0.005	0	1,377.59	1,318.65	58.95
Pilularia novae-hollandiae	1	1	0	0	0	0	-	-	-	1,020.15	977.98	42.17
*Prasophyllum crebriflorum**	172	172	0	0	0	0	-	-	-	-	-	-
Pterostylis pratensis	470	428	**42** (10 direct impact, 32 in construction disturbance buffer)	185	167	**18** (All in construction disturbance buffer)	7.62 [87]	7.62 [87]	0 [0]	3,227.44	3,024.03	203. 41
Ranunculus pumilio* var. *pumilio	22	22	0	533	418	**115** (100 in construction disturbance buffer, 15 in IDF clearance which may not require their clearance)	98.20 [112,240]	98.05 [111,249]	**0.15** **[991 plants]** (925 plants/ 0.14 ha in construction disturbance buffer only – balance are direct impacts)	1,665.96	1,610.26	55.70
Rhodanthe anthemoides	25,087	25,087	0	14	14	0	1.17 [18,000]	1.17 [18,000]	0 [0]	16.28	15.94	0.34
Scleranthus fasciculatus	0	0	0	6	6	0	-	-	-	16.11	16.11	-
Senecio longipilus	0	0	0	9,374	7,429	**1,945**	43.01	40.56	**2.45**	1,726.28	1,611.29	114.99

Species ***(Bold denotes species with observations in potential impact area)***	**NVA Records – excluding NBES submissions from this study (treated separately):** **(Units are plant abundance, noting where individual NVA records lack abundance data the value is taken as 1)** ***Denotes NVA records considered to be potentially wholly or largely unreliable identifications**			**Plants directly counted/estimated:** **Abundance**			**Plants measured/estimated by area of occupation:** **Area (ha)** **[Abundance given where estimated within area, or calculated based on density]**			**Total available habitat** **(potential extent of occurrence)*** **Area (ha)** *** Potential extent of occurrence^ is a broad level estimate of areas that may contain habitat niches that may provide areas of occupancy# for threatened flora species – it cannot be assumed that species will have complete occupation of their potential extent of occurrence, nor that potential for occurrence within the modelled overall extent will be uniformly suitable at a finer scale – e.g. plants can be expected to have finer niches within the overall mapped potential extent of occurrence.**		
	Total recorded in project area	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**	**Total recorded in project area**	**Retained total without further mitigation**	**Impacted total without further mitigation**
						(2 in direct impact area, remainder in disturbance buffer)	[20,700]	[19,020]	[**1,680**] (1,318 plants/ 1.95 ha in construction disturbance buffer only – balance are direct impacts)			
Taraxacum aristum	50	50	0	4	4	0	-	-	-	12.84	12.84	-
Trithuria submersa	1	1	0	37,564	37,564	0	0.025	0.025	0	1,610.00	1,562.09	47.90
Viola cunninghamii	1	1	0	2	2	0	-	-	-	106.05	103.46	2.59

^ Extent of occurrence [EOO] is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat)… Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence)[80].

 # Area of occupancy [AOO] is defined as the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases (e.g. irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured[81].

[80] IUCN (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp. http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf
[81] IUCN (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp. http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf

Table 8: Key threatened species with increased retention (proportionally lower losses of individuals and available habitat) with the application of recommended mitigation (targeted exclusion zones)

Note: percentage values indicate percentage of total within project area

Species	Abundance from NVA and NBES points, and NBES polygon areas of occupation					Total available habitat				
	Total recorded in project area	Without mitigation		With mitigation		Total recorded in project area	Without mitigation		With mitigation	
		Retention [% of total]	Potential impact [% of total]	Retention [% of total]	Potential impact [% of total]		Retention [% of total]	Potential impact [% of total]	Retention [% of total]	Potential impact [% of total]
Pterostylis pratensis	742	682 [91.91 %]	60 [8.09 %]	714 [96.23 %]	**28 [3.77 %]**	3,227.44	3,024.03 [93.70 %]	203.41 [6.30 %]	3,027.26 [93.80 %]	**200.18 [6.20 %]**
Senecio longipilus	30,074	26,449 [87.95 %]	3,625* [12.05 %]	27,003 [89.79 %]	**3,071* [10.21 %]**	1,726.28	1,611.29 [93.34 %]	114.99 [6.66 %]	1,613,99 [93.50 %]	**112.29 [6.50 %]**

*** Note that only 2 of these plants occurs in the direct impact footprint (0.02 % of the total number of recorded plants), the remainder occur within the construction buffer footprint.**

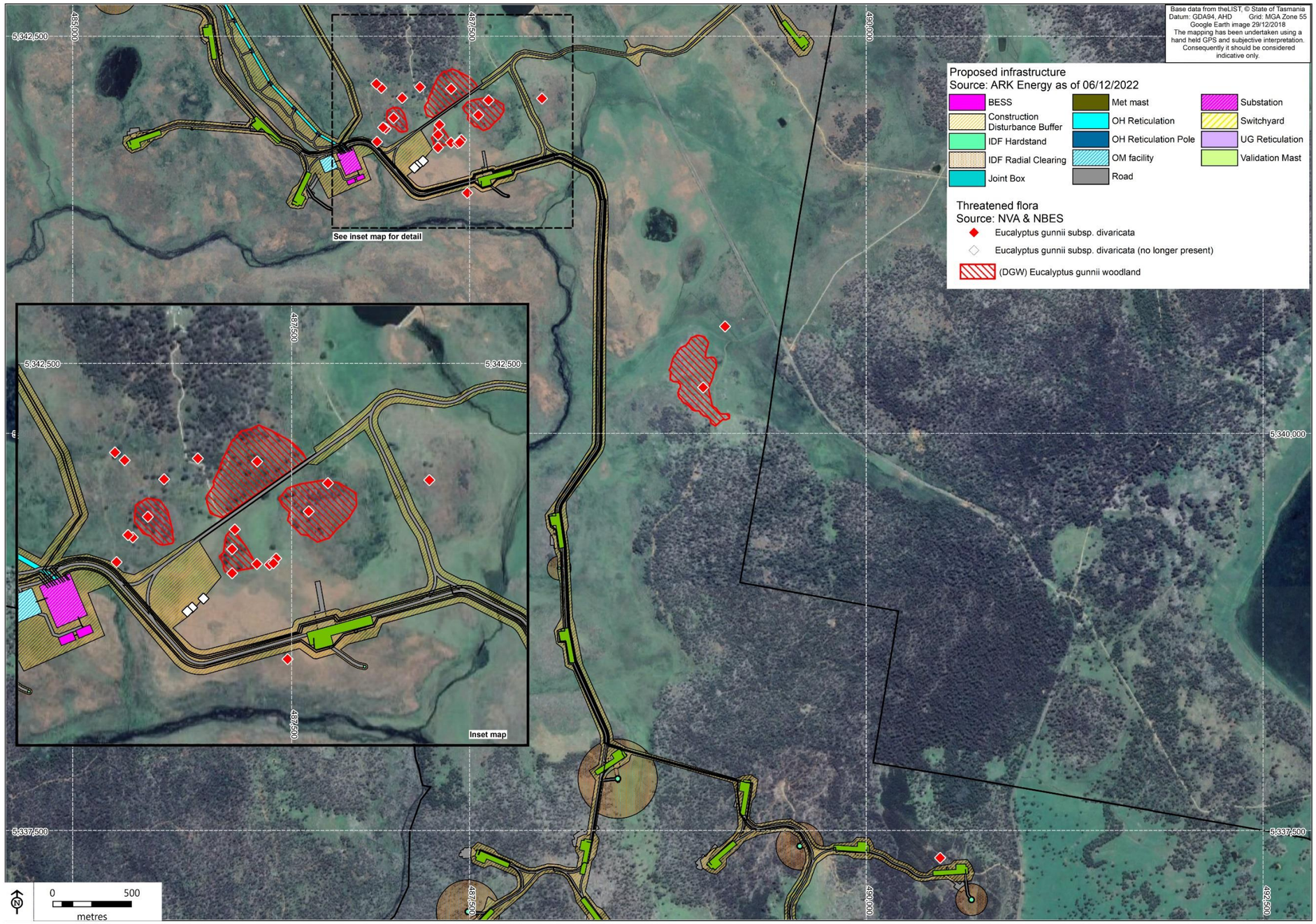


Figure 12: Distribution of *Eucalyptus gunnii* subsp. *divaricata* in relation to proposed impact areas

4.4.2 Potential for further mitigation

Because of the nature of the plants involved and the scale of the surveys, there can be expected to be more individuals of threatened and conservation significant flora at risk from the footprint and within the project area as a whole – largely this applies to very small and discrete species such as *Asperula scoparia* and *Pterostylis pratensis*, and annual species such as *Myosurus australis* and *Ranunculus pumilio*. Equally however, for short lived species with interannual variation, there could be fewer plants at risk at the point of construction if conditions are different to the survey years. Current survey coverage is nonetheless considered to be very good as a basis for considering the scale of impacts and, based on the broad scale sampling undertaken in the various surveys, it appears unlikely substantial populations of other species of threatened flora will be recorded on site in the future (Table 2). Furthermore, given that the footprint impacts only a small proportion of viable habitat within the project area, a likely outcome of further surveys would be a decreased proportional loss of threatened and conservation significant flora due to increased population estimates for the broader area. As it stands, the proportional losses are already very small for respective species with regard to overall populations. As such, it appears highly unlikely that the proposal will put at risk the long-term persistence of any threatened or conservation significant flora within the project area, let alone at a level beyond the project area (e.g., regional or state-wide – although it is acknowledged that in some cases the populations within the project area may well constitute the entire state-wide populations).

Nonetheless, to continue to minimise the direct loss of threatened flora, it is recommended to exclude as many of the known locations as possible from the impact footprint during the final design phases, including application of the recommended targeted exclusion zones for *P. pratensis* and *S. longipilus*.

Micro-siting surveys (with scope for repositioning components of the footprint and thus avoiding threatened flora), undertaken within the appropriate seasons will be the most effective way of mitigating impacts that may occur to currently undocumented occurrences of threatened and conservation significant flora, and precisely quantifying the final unavoidable impacts. Micro-siting should be applied to any aspect of the final footprint and a buffer of 20 m.

Selective/informed clearance of the IDF visibility sectors can also be used to preserve conservation significant values within the sectors at a height that does not obstruct the IDF, noting that many of the threatened flora on site are very small and could viably persist within an IDF clearance sector following removal of obstructive woody vegetation.

In addition to avoiding the direct loss of sites, the general areas around threatened and conservation significant flora locations should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 20 m of proposed works – exclusion zones must be specified within the construction contracts and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements. There is also considerable scope for selective avoidance within the construction disturbance buffer, as the proportional impacts can be lessened in this buffer with targeted surveys and exclusion areas within the overall buffer.

The margin of the final footprint should be surveyed for *Eucalyptus gunnii* ssp. *divaricata* to a radius of 15 m (the maximum tree protection zone under Australian Standard for the Protection of Trees on Development Sites (AS 4970-2009) – any individuals of the species

found within the buffer (and alive) should be protected with a radial exclusion zone proportional to 12 x diameter at breast height (as per AS 4970-2009).

In addition, a designated construction exclusion zone should be implemented around the location of *Leucochrysum albicans* var. *tricolor*, which is approximately 200 m from the footprint but as a significant population warrants additional protection.

4.4.3 Offset opportunities and priorities for threatened flora

- After avoidance and mitigation, if residual impacts to threatened native flora are sufficient to require offsets, the site has significant scope to contribute to an improved reservation status of several species.
- There is also significant scope on site for applying management agreements designed to maintain or improve habitat for threatened flora, including through grazing prescriptions, control of woody plants (within non-forest environments), and ecological burning.
- Based on current impacts however the need for offsets is unlikely, particularly with the option to implement targeted exclusion zones for *Senecio longipilus* and *Pterostylis pratensis*. Specific to these species however, additional consideration of offsets may be warranted if proportional impacts to the overall population estimates cannot be reduced (such as if the recommended exclusion zones aren't applied).
    - For the *Senecio longipilus* the species is considered to be highly suited to seed collection and propagation of replacement plants, noting the construction disturbance buffer post-works would be a highly suitable location for establishing an offset planting, which could be self-sustaining along the new habitat edges where they occur adjacent to native grasslands on basalt outcrops in particular.
    - For *Pterostylis pratensis* the most effective offset outcome would be to place a conservation covenant (or similar reservation mechanism) around a concentration of plants, noting the species is poorly reserved as per the NRE listing statement.
- The project has already contributed some valuable information to conservation due to the rediscoveries of *Myosurus australis* and *Senecio longipilus* (as well as the large number of new threatened species observations in general). Observations of both species were shared with the seed bank at the Royal Botanic Gardens of Tasmania to facilitate the collection of seeds, of which the seed bank had no collections of either prior to this study. Photos of *M. australis* were also submitted to NRE for use within the relevant threatened species note sheet and species information page on the Threatened Species Link, neither of which had an example of the species photographed in the wild before our photos were supplied.

4.5 Threatened Fauna

Based on the survey results and habitat quality assessment, the design process was guided with the intention of minimising impacts to threatened fauna (amongst other things) (Table 9). The design process resulted in the avoidance of:

- 96 % of high-quality habitat for the ptunarra brown butterfly (1,158 of 1,208 ha), 93 % of moderate quality habitat (1,978 of 2,135 ha), and 95 % of low-quality habitat (421 of 444 ha).
- All emergence hole and adult observation locations, and 94 % of mapped potential habitat for the Miena jewel beetle; and
- All known dens with confirmed devil activity[82], and 96 % of all mapped burrows.

Direct avoidance has thus reduced the potential for significant impacts on threatened fauna considerably, particularly the ptunarra brown butterfly. We detail below some mitigation measures (such as pre-clearance surveys) that should be applied to ensure residual impacts are not significant and prevent the proposal from having an unacceptable impact on the potential persistence or occurrence of threatened fauna in the area.

Table 9: Summary of threatened and conservation significant fauna habitat impacts

		Area (ha) (other than burrows, which are a direct count)		
		Total	**Retained (% total)**	**Impacted (% total)**
Ptunarra brown butterfly *habitat quality*	**High**	1,208	1,158 (96 %)	50 (4 %)
	Moderate	2,135	1,978 (93 %)	157 (7 %)
	Low	444	421 (95 %)	23 (5 %)
	Total	3,787	3,557 (94 %)	230 (6 %)
Miena jewel beetle *habitat*		56.2	53 (94 %)	3.2 (6 %)
Tasmanian devil and quolls *general habitat (foraging)*		10,043	9,562 (95 %)	481 (5 %)
Burrows *(potential denning sites)*		114	109 (96 %, including all confirmed occupied at time of survey)	5 (4 %)

4.5.1 Tasmanian devil, spotted-tailed quoll, and eastern quoll

4.5.1.1 Context

These species are wide-ranging carnivores, with foraging locations largely driven by prey occurrences rather than habitat types or conditions (more so for the devil than the quolls which can display some stratification of habitat use but nonetheless where present cannot reliably be excluded from using any particular habitat type). On this basis, the entire site is potentially suitable habitat (with all three species known to be present). Due to the more

[82] Two of the three recorded occupied burrows/dens are avoided by the footprint by more than 1 km (up to 4.9 km away in one case – the other, which had a single visit from a devil during the extended camera surveillance, is 30 m from the disturbance footprint and 60 m from the direct impact boundary

specific and critical nature of breeding sites (natal dens), these are treated with priority in impact assessments and mitigation measures – although if breeding sites are not directly impacted, it can be possible for them to remain viable quite close to development and disturbance[83].

4.5.1.2 Site specifics/ existing conditions

Each of the species have been confirmed to be present within the project area and are expected to be widespread across the site. Effectively the entire project area (96 %) (other than permanently inundated locations) is considered potential denning habitat for devils and quolls (Table 10, Figure 8). The largest areas of modified land (e.g., pasture) can be expected to be the least likely to support natal dens, but, based on our observations and supported by evidence (see definitions in Table 1), these areas cannot with complete confidence be excluded from consideration of supporting such dens due to high local levels of habitat heterogeneity and the potential for large, modified areas to support small niches with denning suitability. Devil use of burrows/dens has been confirmed at three locations within the project area. Annual natal activity for each of the species is likely somewhere within the project area given its size and the availability of habitat. The entire project area is also identified as potential foraging habitat for devils and quolls.

Table 10: Summary of distribution of denning habitat classes in relation to proposed footprint

		Impact Areas (% of total in project area)				**Avoidance area**	
		Direct and permanent impact – operational infrastructure	**Habitat modification for operations – but not permanent loss**	**Construction disturbance buffer - potential temporary impacts**	**Total extent of potential impacts and modifications**	**Retained (% of total)**	**Total in project area** (% of total)
Denning habitat suitability – devils and quolls **(all classes contain viable foraging habitat)**	**Optimal**	77.45 (1.23 %)	76.80 (1.22 %)	206.60 (3.28 %)	360.84 (5.72 %)	5,946.59 (94.28 %)	6,307.43 (62.8 %)
	Suboptimal	25.20 (0.75 %)	14.24 (0.43 %)	80.10 (2.40 %)	119.56 (3.58 %)	3,218.53 (96.42 %)	3,338.08 (33.2 %)
	Unsuitable	0.14 (0.04 %)	0.05 (0.01 %)	0.55 (0.14 %)	0.74 (0.19 %)	397.39 (99.81 %)	398.13 (4 %)
	Total	102.79 (1.02 %)	91.09 (0.91 %)	287.25 (2.86 %)	481.13 (4.79 %)	9,562.51 (95.21 %)	10,043.64

4.5.1.3 Potential impacts and mitigation

Denning opportunities

The majority of denning habitat within the project area (95 % of the total habitat) and the majority of known denning opportunities (burrows – 96 % retention) will be retained (Tables 9

[83] Natural and Cultural Heritage Division (2015)

and 10) and, even with operational disturbance, denning opportunities close to the footprint can be expected to remain viable into the future[84], perhaps with den specific mitigation measures should active dens be found very close to the footprint.

Construction of the project is nonetheless likely to require the permanent destruction of some burrows/potential denning locations. Even if the locations of all known burrows were avoided, more will be discovered during pre-clearance surveys and/or construction (see probability figures in Section 3.4.1) and complete avoidance may be infeasible.

It is expected that the project area supports natal denning sites for each of these species, although given the relatively small scale of the footprint compared to the overall area, the probability of them occurring within the footprint is reduced. The standard process for mitigating impacts from the destruction of potential dens is to implement pre-clearance surveys in association with approved den monitoring and management protocols. A project specific den monitoring and management protocol has been developed and is in Appendix L. Given that the habitat includes extensive areas of complex rocky escarpments and embankments that could conceal multiple potential den sites (Plates 83 and 84), as well as areas where impenetrable shrubs conceal potential denning activity (Plate 85), it can be expected that there will be an imperfect detection probability of potential dens with any targeted survey of the footprint. This limitation is mitigated in the preclearance protocol with an unanticipated discovery clause and contingencies for inadequate detection probability.

Should this level of detailed den detection not be viable (or not considered necessary by regulators), other alternative/supplementary measures may be considered, such as mapping the potential impact footprint for den detection difficulty and proposing supplementary search techniques and/or variations to standard den management protocols within areas of very low den detection probability. For instance, surveys could include multiple searches of difficult areas, or supplementary searching with the aid of a den detection dog. Variations on the standard management protocol could include a greater reliance on an unanticipated discovery protocol, or habitat-specific variations (such as clearing dense shrubbery [with approval] prior to a den survey).

Following either scenario (*i.e.,* with or without a tagging and tracking exercise for the purposes of detailed den detection) it is then recommended that pre-clearance surveys and den management protocols are applied to the eventual footprint in the lead up to construction to give confidence no other natal sites have been missed and prevent unnecessary mortalities to animals trapped in burrows.

Roadkill

In addition to potential impacts to natal sites, the project may result in increased demographic pressure from roadkill of these species, particularly during the construction phase. The area already includes roads used for various purposes (e.g., public and private roads), which can, to varying degrees, be expected to be used more during project construction and operation, as well as the additional risk associated with constructing new roads. To mitigate the potential for increased likelihood of road mortalities:

- Internal road use should be limited to daytime hours to the maximum extent possible within the requirements of the project.
- Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.

[84] Natural and Cultural Heritage Division (2015)

- For materials that will be transported to the site using roads, this should primarily occur during daytime hours – any transport required outside daytime hours should be subject to a roadkill risk assessment with mitigation if required.
- During the construction phase, all internal roads within the works area should be monitored (with documentation) for roadkill whenever the roads are being used, with mortalities removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation (as indicated in a traffic assessment report).
- During operations, a monitoring program (with documentation) should be established on internal roads for roadkill – with the frequency of monitoring to be established with understanding of how frequent staff will be on site once the site is operational. As part of the program, mortalities would be removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation.

General habitat change and loss

The 481.13 ha impact footprint will not result in an equivalent loss of potential habitat for these species due to their broad ecological niche and minimal habitat selection within a local area. In other words, following construction, much of the habitat within the footprint will still be viable for general use such as dispersal and foraging movements, but may simply be different habitat to what was present prior to development, without this necessarily being a detrimental change. This will apply to areas converted to roads (which may subsequently improve as dispersal corridors), areas in which vegetation is partially or fully cleared but not physically excluded from the surrounding area, and areas where the development is overhead or underground.

Where forested vegetation is required to be partially cleared/modified (*i.e.* for IDF radial clearing and overhead reticulation) and managed during operation, it is anticipated that the forest vegetation will be managed as (or revert to) something equivalent to a disturbance induced grassland (TASVEG - GCL) or a regenerating scrub/heathland derived from existing species most compatible with that kind of management (e.g. TASVEG - SHS). Native non-forest vegetation will effectively remain the same. This management of vegetation by definition (Table 1) will not necessarily render the habitat unsuitable for denning (nor foraging) and for much of the impact area (outside of permanent footprint losses), habitat can be expected to remain as viable foraging and denning habitat, which we have explored by running the denning stratification model with post-clearance parameters to factor in change in vegetation structure and distribution (Table 11).

Permanent loss of habitat (for both foraging and denning) will be limited to areas of solid obstructions (e.g. turbines themselves, substations, roads etc.). These elements of permanent footprint infrastructure constitute an area of 102.79 ha of the overall footprint, representing a loss of 1.02 % of the current available habitat within the project area. In addition, more habitat may effectively be lost in terms of denning potential due to changed suitability (Table 11) (but will still be viable for foraging). Accordingly, outside of the permanent impact footprint, an additional 97.40 ha of optimal denning habitat will be converted to either suboptimal or unsuitable for denning, with an associated increase in the availability of habitat suboptimal for denning (with losses to unsuitable habitat and gains from changes in optimal habitat). The overall net change within these areas of disturbance and modification results in the additional loss of 0.20 ha of viable denning habitat (and reduced suitability of a further 97.20 ha) (Table 11 and Figure 13). These changes from optimal to suboptimal are primarily due to the

conversion of forested vegetation to treeless vegetation, which increases exposure, and thus reduces the suitability for devils beyond the immediate margins of remaining forest (Table 1). Given that suboptimal is still viable for denning, the overall additional loss in denning suitability from vegetation change (0.20 ha) is not considered to be significant.

Table 11: Summary of impacts to denning habitat availability for devils and quolls post disturbance (losses from permanent footprint and from changed denning suitability)

		Losses to direct and permanent impact footprint – operational infrastructure	**Additional net change within vegetation management areas and construction disturbance buffer**	**Conversion Type**
Denning habitat suitability – devils and quolls	**Optimal**	- 77.45	- 97.40	Optimal to suboptimal – 97.28 ha Optimal to unsuitable – 0.12 ha No change – 186.10 ha
	Suboptimal	- 25.20	97.20	Suboptimal to optimal – 0 ha Suboptimal to unsuitable – 0.08 ha No change – 94.28 ha
	Unsuitable	- 0.14	0.20	Unsuitable to optimal – 0 ha Unsuitable to suboptimal – 0 ha No change - 398.13 ha
	Total	**102.79**	**Net additional loss of 0.20 of suitable denning habitat (and reduced suitability of 97.20)**	

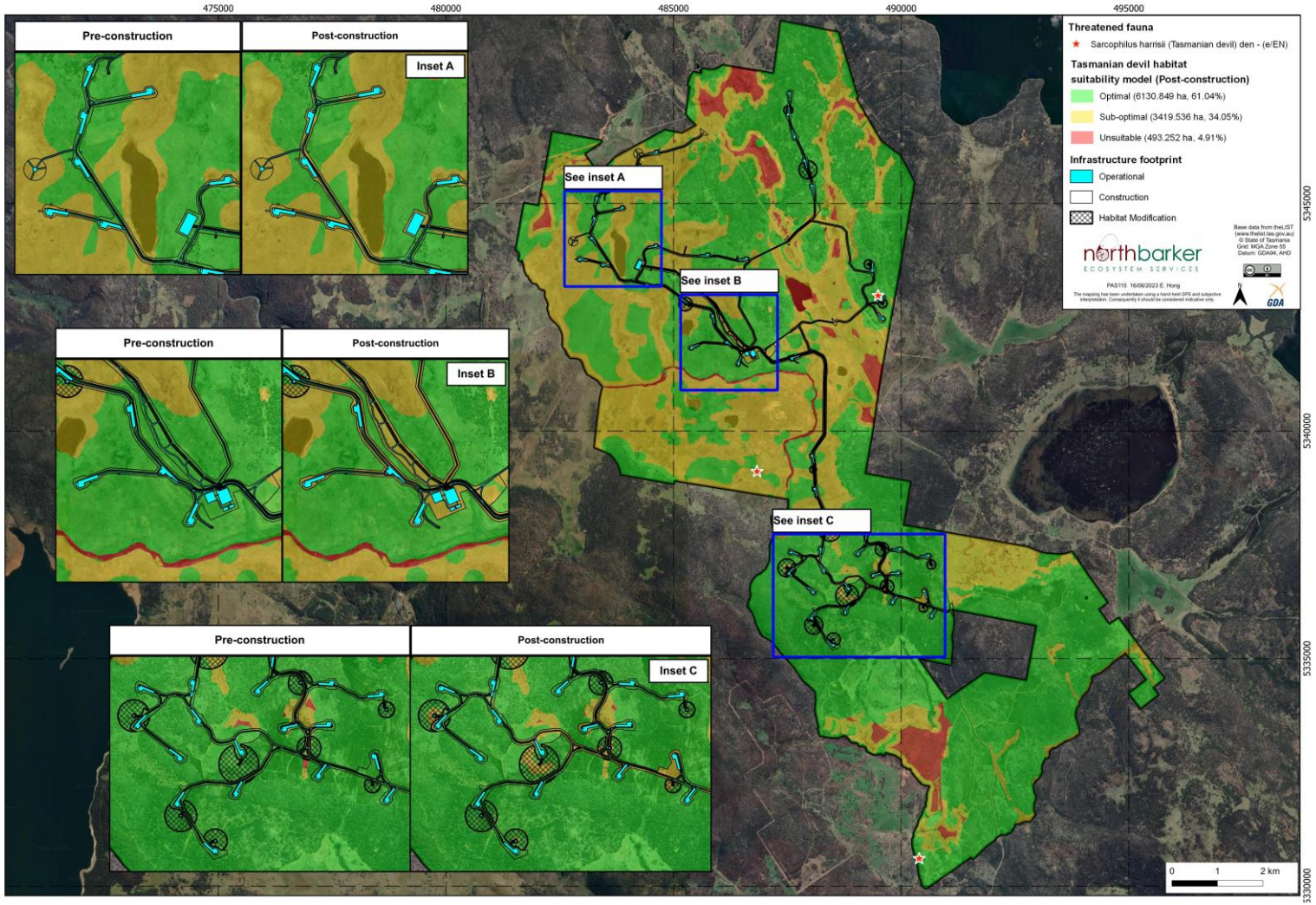


Figure 13: Stratification of denning habitat suitability across project area and in relation to impact footprint post disturbance

4.5.1.4 Summary of avoidance and mitigation recommendations for devils and quolls

- Avoid impacts to dens/burrows confirmed to support devils based on the current survey results. It is noted however, that if this is not achievable, it may be possible to reassess the status of the dens/burrows closer to works (*i.e.,* the locations may no longer be occupied at that time).
- Implement the recommended den management protocols within the final impact footprint (direct and indirect) to a buffer of 50 m[85] in the lead up to clearance/disturbance.
- Implement roadkill mitigation measures as follows:
  - Internal road use should be limited to daytime hours.
  - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
  - For materials that will be transported to the site using roads, this should primarily occur during daytime hours – any transport required outside daytime hours should be subject to a roadkill risk assessment with mitigation if required.
  - During the construction phase, all internal roads within the works area should be monitored (with documentation) daily for roadkill, with mortalities removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation (as indicated in a traffic assessment report).
  - During operations, a monitoring program (with documentation) should be established on internal roads for roadkill – with the frequency of monitoring to be established with understanding of how frequent staff will be on site once the site is operational. As part of the program, mortalities would be removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation.

[85] As per the DPIPWE devil survey guidelines

Plate 83: Complex rock outcrops within the project area have the potential to conceal den sites

Plate 84: Complex rocky banks within the project area have the potential to conceal den sites

Plate 85: Impenetrable shrubs within the project area have the potential to conceal den sites

4.5.2 Ptunarra brown butterfly

4.5.2.1 Context

Found within *Poa* tussock grassland, woodland and grassy shrubland, in small populations above 400 m on the Central Plateau and other parts of Tasmania. *Poa* grasses are crucial for this species as the food plant for its caterpillar stage. Threats included habitat clearance and conversion, over-grazing, inappropriate burning regimes, and predation and competition from the European wasp.

4.5.2.2 Site specifics/ existing conditions

Our surveys established that a large population of around 200,000 individuals is supported by around 4,000 ha of habitat within the project area. Given that the 2008 Recovery Plan estimated that the Central Highlands region only contained around 4,300 ha of habitat and a population of 115,000 (+/- 98,000) individuals[86], the results from our survey indicate that the sites population is significant in size and extent. It may represent the single most important population/ contiguous area of habitat for the species throughout its range.

[86] Bell, P.J. (1998), Threatened Species Unit (1998) – noting that the estimates in these sources likely did not factor into the Central Highlands estimates the true extent of habitat within the project area due to mapping inadequacies, which would have subsequently impacted their population estimate for the region

4.5.2.3 Potential impacts and mitigation

Complete avoidance of habitat supporting this species may be seen as infeasible for the proponent, given that the habitat is so extensive throughout the north of the project area. Subsequently, if complete avoidance is unachievable, avoidance should be prioritised on the basis of our habitat quality stratification results from high to low. The avoidance of high-quality habitat may actually be aided by its relatively low position in the landscape and the preference to place WTGs disproportionately on relative high points in the landscape, such as outcrops, knolls and ridges. Because of this non-random placement, the towers can be expected to have a disproportionate potential impact on the moderate quality habitat class, which typically occurs on relative high points on the non-forest areas of the plateau. Associated tower infrastructure however, such as roads can be expected to have a high likelihood of intersecting high-quality habitat in order to join various components of the project footprint. Such avoidance has been achieved to a high degree in the various iterations of the planning phase, with high levels of habitat retention proposed across of the habitat quality classes (Table 9).

The proposed disturbance of habitat is likely to lead to increased European wasp numbers within the development footprint, increasing the risk of their predation and competition. It is recommended that European wasp numbers are monitored (concurrently with ptunarra brown butterfly numbers) during and following construction, including, if necessary, control of European wasps to protect butterflies from predation – a proposed wasp (and ptunarra brown butterfly) monitoring strategy is provided (Appendix M).

4.5.3 Miena jewel beetle

4.5.3.1 Context

Found in open heath and subalpine woodland above 900 m on Tasmania's Central Plateau. Feeds primarily on *Ozothamnus hookeri*, which is the exclusive host of boring larvae. Threats to the species include loss of habitat through conversion, over-grazing or fire.

4.5.3.2 Site specifics/ existing conditions

Characteristic emergence holes have been confirmed within the project area, with around 56 ha of potential habitat known to be present (noting the density of the host plant may vary within mapped habitat patches, as can the occupation rate within areas of the host species). Definitive evidence of occupation was made in 2021 with varying density of occurrence throughout the habitat (noting this variation is not necessarily consistent year to year – or every second year in this case as the species has a two-year larval period, with adults being scarce in alternate years, which are those with even year dates. It is possible minor amounts of the primary food plant *O. hookeri* may be present outside of the mapped habitat patches.

4.5.3.3 Potential impacts and mitigation

Given the ecology of this species and the nature of the proposal, habitat loss is seen as the primary potential impact to this species. The following are recommended:

- All known potential habitat patches should be excluded from the footprint of the development.
- In addition to avoiding known habitat patches, the host plant *Ozothamnus hookeri* must be considered during micro-siting surveys of the final footprint within the northern half of the project area, to ensure that no potential habitat has currently been overlooked due to the scale of the surveys.
- If all habitats cannot be avoided, an estimate of individuals to be impacted will be required to inform a permit to take under the TSPA (Section 5), with an estimate of

individuals likely to require a targeted survey of food plants within the flowering season.

However, given that avoidance of the remaining 3.3 ha of potential habitat within the footprint (5.9 % of the total area of habitat recorded) is not feasible with the functional requirements of the development, and that potential variation in beetle density could mean that the 3.3 ha of habitat at risk could be proportionally more or less important to the overall persistence of the population, depending on how many beetles it supports, an alternative approach may be warranted as follows:

- Conduct an additional survey comparing the density of beetles within the unavoidable impact area to the remaining habitat patches – given that beetle density may fluctuate between years and that the upcoming summer of 2024 will be an alternate year in the species 2-year larval life-cycle, we propose that in lieu of counting beetles, a count of larval bore holes is undertaken instead over the coming winter (2023) – this may in fact be a more reliable measure of the value of the habitat within the impact area, as comparing counts of adult beetles in a given area may be obfuscated by the fact the adults could have moved around to different locations and/or plants once they have emerged from their bore holes and larval stages (notwithstanding that the flowering plants used by the adults represent an important part of the lifecycle too).
- To support the count of larval bore holes, a count (or relative measure of abundance) of *O. hookeri* plants should be collected (concurrently with the bore hole count) within the impact area and patches of habitat outside of the footprint – this will provide a more robust measure of foraging habitat loss/retention than the current habitat patches, which do not account for variable density of the host and foraging plants within each patch.

If the area of habitat to be lost to the footprint is not found to be disproportionately important for bore hole locations (relative measure of abundance for number of beetles) nor for the abundance of food plants (direct measure of habitat availability for adults), the proposed extent of clearance may not be considered a significant loss by the regulator.

Further mitigation is available at the pre-clearance phase to limit the risk of direct impacts to individuals (and thus reduce the overall effect of the habitat loss by not removing these individuals from the breeding population) as follows:

- In the winter of the last even-dated year prior to works commencing (within, or in the immediate vicinity of the known habitat patches, as works beyond this area are irrelevant), all plants found to support larval bore holes of this species should be cut at ground level and translocated to a habitat patch beyond the impact footprint.
- Any larvae within the bore holes can be expected to be able to survive on the wood of the translocated plant until emergence the following summer (Karen Richards pers. comm.) – note this is why the harvesting of the plants must be undertaken in the winter of an even-dated year, as if it was undertaken in the winter of an odd year the larvae could not survive for 18 months on the dead plant and thus would not make it to adulthood.
- Translocation of the habitat plants containing larval bore holes (and presumably larvae within) will require a permit to take threatened wildlife under the TSPA/NCA.

4.5.4 Eastern barred bandicoot

4.5.4.1 Context

The species is relatively uncommon in the highlands. It has previously been reported from within the project area but has not been reported from within 500 m of the site since 1976 (noting it was not detected on trail cameras during our investigation, nor by any other means).

4.5.4.2 Site specifics/ existing conditions

The project area is beyond the core range of the species, and it is unlikely to be widespread or abundant on site if a permanent population is present, which is unlikely.

4.5.4.3 Potential impacts and mitigation

Based on the survey results and the habitat quality, no specific mitigation measures are warranted for this species.

4.5.5 Shannon galaxias

4.5.5.1 Context

This species occurs in Great Lake, Shannon Lagoon and Penstock Lagoon, with populations in the latter two likely derived from the Great Lake.

4.5.5.2 Site specifics/ existing conditions

It is possible that in the past the Shannon River may have received some individuals from an environmental flow release from Great Lake, but it is uncertain if the river could sustain a permanent population.

4.5.5.3 Potential impacts and mitigation

Given the river will not be a part of the footprint for this project, there are no expected impacts to the suitability of potential habitat within the river. If there is any potential for the river to be impacted (including via extraction), it is recommended to further investigate the potential for a population of the Shannon galaxias to be present within the project area – noting there would be an approvals process and environmental study were this to occur. Beyond this, no mitigation is considered to be necessary for this species.

4.5.6 Offset opportunities and priorities for threatened fauna

Species that have significant residual impacts are likely to require offsetting (100 % of the residual impacts), with offsets for State-listed species to adhere to the general principles within the Guidelines for Natural Values Surveys – Terrestrial Development Proposals[87] and offsets for MNES required to meet the requirements of the EPBCA Environmental Offsets Policy[88], noting that for the latter direct offsets should contribute at least 90 %, but in most cases proponents are expected to meet 100 % of the requirement through direct offsets where available. Any usage of indirect impacts as part of an offset contributing to EPBCA requirements will require discussion with DCCEEW and support as to whether the indirect offsets are viable. Potential indirect offset contributions are provided below:

- The prevention of impacts to potential den sites is considered to be adequate for maintaining the potential population persistence of devils and quoll species in the

[87] DPIPWE (2015a)

[88] Commonwealth of Australia (2012)

area. If at some point during construction or mitigation, natal den locations are found and are required to be decommissioned, these should result in an offset – replacement dens from artificial structures are not seen as useful in an environment with so many natural alternatives, so a more beneficial offset may involve a monetary contribution to research and/or species conservation.

- Similarly, roadkill mortalities to threatened fauna, if they are considered to constitute significant residual impacts, may best be offset with a monetary contribution to research and/or species conservation, particularly if it can be linked to roadkill mitigation priorities.
- In terms of the overall loss of potential habitat for devils and quolls, the permanent loss of only 102.79 ha, plus the additional loss of denning suitability within 0.20 ha (but remaining suitable for foraging) is not considered to constitute a significant residual impact (as per the assessments in Section 5.1). If there is a requirement to offset this loss of habitat however, there is limited value to these species in the offset being a covenant of additional land, as this is not considered likely represent a net gain for the species, considering available land is not limiting their populations, and tenure and reservation status have little relationship to devil density[89]. In equivalent scenarios a monetary offset has been accepted as the most beneficial mechanism for loss of habitat, and if required in this scenario could be scaled according to the measured habitat quality and supported density of devils (from available local data).
- After avoidance and mitigation, if residual impacts to ptunarra brown butterfly habitat are sufficient to require offsets, offset priorities should be the highest quality butterfly habitat and, more broadly, the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve habitat for the butterfly could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing land use for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.
- If the proportional loss of Miena jewel beetle habitat (or number of individuals) is considered significant following the recommended additional survey work, there is ample scope to undertake replacement planting of the key habitat plant within or supplementary to equivalent habitat patches.

4.6 Weeds

Earthworks associated with clearance and infrastructure construction present a risk of spreading and introducing weeds, both onsite and offsite. Development activities for this proposal may result in the spread of several declared or environmental weeds, including those with the capacity to negatively impact environmental and pastoral values. To limit the

[89] DPIPWE (2010); Cunningham *et al.* (2021)

potential for weed introduction and dispersal, the following are recommended to comply with NREs *Weed and Disease Planning and Hygiene Guidelines*:

- Undertake surveys of the precise works footprint when it is finalised.
- Following the above surveys, prepare and implement a project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environment Management Plan or similar), which amongst other things must adhere to the principles of containment requirements and prescriptions for:
  - Weed removal and treatment prior to, during, and after civil works.
  - Requirements for wash-down and inspections of all site plant, including earth-moving machinery[90].

[90] DPIPWE (2015b); Allen and Gartenstein (2010)

5 LEGISLATIVE IMPLICATIONS AND ASSESSMENT

5.1 Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBCA)

The project has been determined as a controlled action under the EPBCA (EPBC 2019/8497) and will require assessment and approval under the Act. The Environment Protection Authority Tasmania (EPA) will oversee the assessment in accordance with a bilateral agreement between the State and the Commonwealth under section 45 of the Act.

The Project Specific Guidelines (PSGs) for Preparing an Environment Impact Statement issued by the EPA explicitly requests information on the following MNES (excluding bird species not covered by our scope):

- Tasmanian devils *Sarcophilus harrisii* – EN
- Spotted tailed quoll *Dasyurus maculatus* – VU
- Ptunarra brown butterfly *Oreixenica ptunarra* – EN

In addition, other values referenced in the PSGs that can include or be related to MNES include:

- Threatened flora and ecological communities
- Wombat burrows (which can potentially provide denning habitat for devils and quolls)

These MNES (and others) have been considered in the context of our survey results and the proposal. MNES known to be present (or with a high likelihood of occurrence in the area, based on habitat and other factors), have been considered in more detail below in relation to EPBCA significant impact criteria. It is our conclusion that the risk of significant residual impacts from the proposal is relatively low with the above specified mitigation measures in place (Section 4). The limited residual impacts following mitigation, mean there is a very low likelihood of triggering individual significant impact criteria and overall impacts meeting/ surpassing the general test of significance.

5.1.1 Tasmanian devil

5.1.1.1 Significant Impact Assessment

Regarding species listed under the EPBCA as Endangered, such as the Tasmanian devil, an action is considered likely to have a significant impact if there is a real chance or possibility that it will:

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

Each of the nine criteria is considered separately. Impacts that need to be considered not only include the direct impacts of the action but also indirect and offsite impacts, including facilitated impacts. Each of the nine criteria is discussed below in the context of proposed

development and the likelihood of a significant impact upon the Tasmanian devil. The takeaway conclusion for each criterion is italicised at the bottom of each section.

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

A 'population of a species' is defined under the EPBCA as an occurrence of the species in a particular area, including 'a geographically distinct regional population' or 'a population, or collection of local populations, that occurs within a particular bioregion'. The Species Profile and Threats Database (SPRAT) profile for devils divides them into two genetically distinct populations:

1) north-western; and
2) eastern/south-western[91]

With the project area falling within the range of the eastern/south-western population, the only conceivable way that the proposal could lead to a long-term decrease in the size of the Tasmanian devil population across that entire region would be if the proposal led to major changes in habitat availability or substantially increased demographic pressures on the species at the regional level. The eastern/south-western population ranges across 50,630 sq km[91]. Thus, the total project impact area itself of 481.13 ha is only 0.009% of the range of the population, and the total permanent loss of habitat of 102.79 is only 0.002% of the range (with the 0.2 ha of additional loss of denning suitability only making a negligible difference). The proposal is therefore extremely unlikely to substantially impact the size of this devil population as the area within which impacts are contained is simply too small in proportion to the size and extent of the overall population.

The potential impact from the proposal applies to a greater extent to local individuals. At the scale of an individual, the proposal's total area of potential impact is less than half the area of an individual devil's home range[92]. Devil density in the area is approximately 1 devil per sq km (100 ha)[93], so the project is expected to directly impact part of the equivalent range of a maximum of 5 devils – with the permanent losses being much smaller than overall impact area, the loss of habitat of 102.79 ha plus the loss of denning suitability within 0.2 ha is equivalent to the potential loss of carrying capacity equivalent to 1.03 devils. For a population covering over 50,000 sq km and conceivably (based on density modelling[94]) supporting in the order of 50,000 individuals, this is not considered to be a significant loss.

Based on the small footprint of impact within a vast population area, this action will not lead to a long-term decrease in the size of a population.

2) Reduce the area of occupancy of the species

Area of occupancy is defined by the IUCN[95] as "the area within the 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy."

While the total impact footprint of the project is 481.13 ha, most of these impacts will be temporary or indirect from construction operations. The direct impacts from infrastructure construction cover only 193.88 ha. Of this, 91.09 ha will be clearing sectors and overhead reticulation which will still contain vegetation, and 40.85 ha will be roads, which devils use for

[91] Commonwealth of Australia (2020)
[92] Andersen *et al.* (2020)
[93] DPIPWE (2010); Cunningham *et al.* (2021)
[94] DPIPWE (2010); Cunningham *et al.* (2021)
[95] IUCN (2012)

ease of travel[96], 43.26 ha will be concrete hardstands, involving complete removal of habitat, though devils can still move across these areas as they do roads. Nearly all of the project's impact footprint, therefore, involves a change in habitat rather than removal, and these changes in habitat may not be detrimental to devils.

Devils are habitat generalists and can persist in human-modified landscapes, even taking advantage of habitat fragmentation features for travel and foraging[97]. As a network of forest patches will persist even after project operations, devils will probably continue to use the area much as before, so their area of occupancy is unlikely to decline. Additionally, the landscape of the project is already fragmented, containing a patchwork of pasture and forest (plantation and native), so further fragmentation will not cause major changes to the general landscape composition.

Thus, this action will not reduce the area of occupancy of this species.

3) Fragment an existing population into two or more populations

Devils are resilient to habitat fragmentation[98]. To fragment a population into two or more populations, this project would have to create a barrier that devils could not/would not cross, for example, the 2 km wide body of water separating Bruny Island from mainland Tasmania (devils have never occurred on Bruny Island). The proposal instead involves clearing patches of vegetation and connecting them by roads, with patches of remaining forest habitat among them. Devils readily move through human-modified landscapes and will even select roads for movement and foraging[99], so it is highly unlikely that this proposal will prevent ongoing interaction among devils in the population nor impact the ability of devils to disperse through the surrounding already fragmented landscape.

Thus, this action will not fragment an existing population into two or more populations.

4) Adversely affect habitat critical to the survival of the species

The Draft Tasmanian Devil Recovery Plan[100] states that critical devil habitat includes 'all disease-free areas within mainland Tasmania with suitable devil habitat', 'all areas of pre-disease core habitat', and 'areas that may be required under the recovery program for the future introduction of Tasmanian devils'. 'Disease' refers to Devil Facial Tumour Disease (DFTD), the most significant threat to devils. The proposal area has been diseased for ~20 years[101]. It is however within pre-disease core habitat that once contained relatively high devil densities (~3 devils per km^2), which is consistent with it currently maintaining some of the highest devil densities within post-DFTD landscapes[102]. The sites habitat currently contains a patchwork of forest and pasture, which is good devil habitat[103], and we observed a high number of burrows during surveys which could provide denning sites – coupled with apparent prey availability (evidenced by the raptor population on site) it is apparent the site is still high quality habitat – in a hypothetical scenario where the eradication/suppression of DFTD from the area was possible (e.g. due to a successful vaccine), it is expected the area could support

[96] Andersen *et al.* (2017)
[97] Andersen *et al.* (2017)
[98] Andersen *et al.* (2017)
[99] Andersen *et al.* (2017)
[100] DPIPWE (2010)
[101] Cunningham *et al.* (2021)
[102] DPIPWE (2010); Cunningham *et al.* (2021)
[103] Andersen *et al.* (2017)

similarly high numbers of devils once more (such as in the pre-DFTD era) and could return to supporting some of the highest densities of devils in the State.

However, pre-disease core habitat areas, as defined by the Recovery Plan, stretch across most of central, eastern and northern Tasmania, covering ~50% of Tasmania[104], and are thus a very coarsely defined area. The relatively small scale of the proposal by comparison to this coarse area renders it likely to have a non-significant impact on total devil core habitat, especially as most of the habitat in the project's impact footprint will be changed rather than removed (as outlined above). Furthermore, since devils can favour some features of fragmented habitat[105], and the project area is already fragmented, the proposal may not significantly adversely affect devil habitat or change devil use of the local landscape.

Thus, this action will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of a population

The most significant risk to devil breeding cycles from the proposal is destruction of den sites. Devils typically den underground, such as in wombat burrows, or in rock/log piles[106]. Habitat clearance could reduce the number of den sites available to devils, and even injure or kill devils trapped inside dens during operations. This is a particular risk to maternal dens, where young devils may be left in dens and unable to escape.

To mitigate this risk, standard den management protocols will be implemented within the final impact footprint (direct and indirect with a buffer of 50 m) prior to clearance of habitat. This involves surveying the area on foot for potential den sites and monitoring located potential dens with remote cameras to identify use by devils. If the den is found to be a maternal den (i.e., containing devil joeys or used by a devil with pouch young), a 50 m exclusion zone will be placed around the den and cameras will be kept in place until the mother and young have discontinued use of the den. Regularly used dens (i.e., devils returning almost every night) will have the same exclusions and monitoring applied as maternal dens until the den is confirmed vacant. Once confirmed vacant, maternal dens and regularly used dens will be decommissioned. Dens used only occasionally will be monitored with cameras for the night immediately prior to inspection, and if occupied by a devil, monitoring will continue (with or without the aid of a one-way gate to aid eviction) until the den is conclusively vacant and can be decommissioned. A den monitoring and management protocol is provided in Appendix L.

Thus, this action will not disrupt the breeding cycle of a population.

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

As stated above, while the total impact footprint of the project is 481.13 ha, most of these impacts will be temporary or indirect from construction operations. The direct impacts from infrastructure construction cover only 193.88 ha. Of this, 91.09 ha will be clearing sectors which will still contain vegetation, and 40.85 ha will be roads, which devils use for ease of travel[107]. 43.26 ha will be concrete hardstands, involving complete removal of habitat, though devils can still move across these areas as they do roads. Nearly all of the projects impact

[104] DPIPWE (2010)
[105] Andersen *et al.* (2017)
[106] Smith (2012)
[107] Andersen *et al.* (2017)

footprint, therefore, involves a change in habitat rather than removal, and these changes in habitat may not even be detrimental to devils.

Devils are habitat generalists and can persist in fragmented habitat, even favouring some features of fragmentation for foraging opportunities and rapid travel[108]. As the proposal will only clear patches of vegetation within an already fragmented landscape, this may not decrease habitat quality for devils and even local devil populations are unlikely to significantly decline. This, combined with the very small scale of the project compared to the species' range, means it is extremely unlikely that clearing habitat for the project will result in devil species decline.

Thus, this action will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7) Result in invasive species that are harmful to the species becoming established in the species' habitat

As devils are top predators, invasive species are not a major threat to them. Devils outcompete invasive predators such as feral cats, even suppressing their numbers[109]. Foxes, though briefly introduced to Tasmania, have now most likely been extirpated from the state[110], and there is no reason to believe this project will introduce them to the area. Invasive prey such as rabbits and rodents cannot harm devils and may even provide an extra food source.

Weeds are present in the project area and project operations could spread these weeds, potentially causing small-scale changes to vegetation composition. Implementation of a project specific Weed Management Plan is recommended to mitigate this risk, with provisions including weed removal and requirements for wash-down of machinery. Regardless, any changes in vegetation composition are highly unlikely to impact devils as even at large scales devils are habitat generalists[111].

Therefore, this action is unlikely to result in invasive species that are harmful to the species becoming established in the species' habitat.

8) Introduce disease that may cause the species to decline

The major threat to devils, DFTD, has been present in the proposal area for ~20 years[112]. The disease emerged as a random mutation in a single devil and spreads through direct contact between individuals, particularly during the mating season[113]. There is no evidence that any human activity caused the emergence of DFTD, can exacerbate its spread, nor increase its virulence. The creation of roads could increase ease of movement for devils through the landscape[114], potentially increasing contact rates among devils, and it is unknown if this could increase disease transmission. However, as the area has been diseased and DFTD is extremely prevalent in the area already, it is highly unlikely that any increases in devil contact rates from roads in the project would result in significant changes in disease transmission. No other disease is recognised as a major threat to the devil, nor is one likely to be found on site, or be introduced in association with the proposal.

[108] Andersen *et al.* (2017); Jones & Barmuta (2000)
[109] Cunningham *et al.* (2021)
[110] Caley *et al.* (2015)
[111] Andersen *et al.* (2017)
[112] Cunningham *et al.* (2021)
[113] Hamede *et al.* (2013)
[114] Smith (2012)

Thus, this action will not introduce or further spread disease which may cause the species to decline.

9) Interfere substantially with the recovery of the species

Given that the main threat to the Tasmanian devil is DFTD, the recovery of the species is contingent on work to manage this disease and cultivate safeguards against the loss of all wild individuals. Currently the recovery of the Tasmanian devil is based around the work being undertaken by the 'Save the Tasmanian Devil Program'. The Draft Tasmanian Devil Recovery Plan[115] identifies the following actions:

1) Maintain and manage insurance populations
2) Manage DFTD in the wild
3) Monitor Tasmanian devils
4) Conduct disease investigations
5) Manage other threats in the wild
6) Research and measure habitat variables
7) Coordinate recovery program
8) Communicate with the community and stakeholders

'Other threats' in Action 5 include the threat of foxes in Tasmania, collisions with vehicles, habitat loss and illegal culling. As outlined above, the proposal is unlikely to cause significant habitat loss for devils.

Collision with vehicles is a concern with this proposal due to increased use of existing roads and the creation of new roads. Roadkill is a major source of devil mortality and can even lead to local extinctions[116]. However, the roads in this proposal will be low use once operations are complete, so the long-term increase in risk to devils is likely to be non-significant. In the short term, during construction, roadkill mitigation measures will be put in place to reduce this risk. These measures include limiting road use outside of daylight hours (since devils are nocturnal[117]), implementing speed limits ≤ 40 km/h, and roadkill monitoring programs. These measures should minimise risks to local devil populations from the creation and use of roads for the proposal.

Thus, with mitigation measures in place, this action will not interfere with the recovery of this species.

5.1.1.2 Conclusion

Mitigation measures have been proposed for pre-clearance den surveys and for limiting roadkill in relation to the proposal. Following these measures will reduce the likelihood of any impacts to breeding success from the proposal, which may be the most likely way the project could result in a significant impact to the species. The species is likely to continue to utilise the site following works and there is no likelihood of the proposal limiting dispersal or connectivity. As such the proposal has:

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of a

[115] DPIPWE (2010)
[116] Jones & Barmuta (2000)
[117] Andersen *et al.* (2020)

population, no potential to lead to a long-term decrease in the size of a population and no impacts to habitat to the extent that the species is likely to decline.

- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.
- No meaningful reduction in the area of occupancy of the species, given that permanent habitat losses are only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to the Tasmanian devil with den management and roadkill mitigation in place.

5.1.2 Spotted-tailed quoll

Present within the project area but the project area is not located within the range of what are considered to constitute important populations. Mitigation measures have been proposed for pre-clearance den surveys and for limiting roadkill in relation to the proposal. Following these measures will reduce the likelihood of any impacts to breeding success from the proposal. The species is likely to continue to utilise the site following works and there is no likelihood of the proposal limiting dispersal or connectivity. As such the proposal has:

- No potential for adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of an important population, no potential to lead to a long-term decrease in the size of an important population and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.
- No meaningful reduction in the area of occupancy of the species, given that permanent habitat losses are only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to the spotted-tailed quoll.

5.1.3 Eastern quoll

Mitigation measures have been proposed for pre-clearance den surveys and for limiting roadkill in relation to the proposal. Following these measures will reduce the likelihood of any impacts to breeding success from the proposal, which may be the most likely way the project could result in a significant impact to the species. The species is likely to continue to utilise the site following works and there is no likelihood of the proposal limiting dispersal or connectivity. As such the proposal has:

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of a population, no potential to lead to a long-term decrease in the size of a population and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.

- No meaningful reduction in the area of occupancy of the species, given that permanent habitat losses are only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to the eastern quoll with den management and roadkill mitigation in place.

5.1.4 Ptunarra brown butterfly

5.1.4.1 Significant Impact Assessment

Each of the nine criteria is discussed below in the context of proposed development and the likelihood of a significant impact upon the ptunarra brown butterfly. The takeaway conclusion for each criterion is italicised at the bottom of each section.

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

The State recovery plan lists the Central Plateau, Steppes, Southern Midlands and East Coast and Tiers as having about 120 populations. The distance of genetic transfer between *O. ptunarra* has not been studied to any great detail, however given the fragmentation between many populations due to anthropogenic influences, it is likely many populations are no longer able to mix (which could lead to more localised definitions of populations or sub-populations). Indeed, given ptunarra brown butterflies are weak flyers, populations can be quite restricted[118]. In the case of the current site, the level of connectivity is likely to be sufficient that the site only supports a single population rather than several discrete colonies. In terms of extending beyond the project area, it is possible some additional habitat is present north of the project area, however, in the absence of additional habitat mapping and survey data it is conservative to assume the extent of habitat within the project area represents the extent of a single population.

Our surveys established that the population consists of around 200,000 individuals across around 4,000 ha of habitat, which may represent the single most important population/ contiguous area of habitat for the species throughout its range.

The footprint of the development has avoided 96 % of high-quality habitat for the ptunarra brown butterfly, 93 % of moderate quality habitat, and 95 % of low-quality habitat, with the impacts dispersed across the population extent (*i.e.,* not concentrated in particular areas). Based on the extent of habitat avoidance and retention, habitat loss from the proposal is not considered to be sufficient to be responsible for a potential long-term decrease in the entire population.

As a demographic pressure, the increased occurrence of European wasps through the population areas impacted by the footprint could decrease the population in a significant manner, however this is considered to be feasible to manage with the recommended method in Appendix M.

Based on the high level of habitat avoidance and retention, and the recommendation to monitor and control European wasps, the impacts long-term on the overall size of the population are not considered likely to be significant.

2) Reduce the area of occupancy of the species

[118] Bell, 1999

Area of occupancy is defined by the IUCN as "the area within the 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy."

The approved conservation advice outlines the extent of occurrence within Tasmania is estimated at 10,200 km^2 and area of occupancy is 139 $km^{2.}$. Area of occupancy on the Central Plateau was estimated in the recovery plan at 600 ha, although the accurate mapping and surveying of the current site has clearly increased that.

The footprint of the development has avoided 96 % of high-quality habitat for the ptunarra brown butterfly, 93 % of moderate quality habitat, and 94 % of low-quality habitat, with the impacts dispersed across the population extent (*i.e.,* not concentrated in particular areas creating 'holes' in occupancy).

Based on this level of retention and the small extent of habitat to be lost compared to the 139 km^2 area of occupancy state-wide, the proposal is not considered to be a meaningful risk of reducing the area of occupancy of the species at the species level.

3) Fragment an existing population into two or more populations

As shown in Figure 8, the impact area will be enveloped by the population habitat patches in a way that is not ostensibly at greater risk of fragmentation then the current distribution of habitat patches, which includes some discontinuous patches and gaps equivalent or greater than the gaps that will be created by the footprint.

Based on this, the project is not considered likely to have a significant impact on the population by fragmenting it.

4) Adversely affect habitat critical to the survival of the species

There are no sites listed as critical to survival of the species in conservation advice. However, our surveys established that the population consists of around 200,000 individuals across around 4,000 ha of habitat, which may represent the single most important population/ contiguous area of habitat for the species throughout its range. Nonetheless, with the main potential impacts of habitat loss and wasp invasion avoided and possible to mitigate with management, the aspects critical to the survival of the population will be preserved; at the species level this change in habitat is not considered to be significant.

The proposal is thus not considered likely to breach this significant impact criterion.

5) Disrupt the breeding cycle of a population

Adults are known to fly in fine weather between March and early April but are only on the wing for around two-four weeks at any one locality. During this time, they feed from the nectar of flowers (including introduced species) and females deposit their eggs within tussocks of various species of *Poa* [119]. The eggs hatch six weeks later and the larvae then over-winter, feeding at night on the tips of the tussocks. Pupation occurs annually around February, taking about one month[120].

Disruption of ptunarra brown butterfly could occur through habitat loss, reduced area of occurrence/occupancy, and/or fragmentation, however we have concluded these are not likely

[119] Bell, 1999

[120] Bell, 1999

to have significant impacts at the population and/or species level. At the level of individuals there will be the potential for varied levels of predation with relation to European wasps, for which a monitoring and control method has been devised to limit the potential for impacts. Overall, at the species and population level the vast majority of individuals are not likely to have any measurable interruption to breeding activities as a result of the proposal.

The proposal is thus not considered likely to breach this significant impact criterion.

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

As stated above, the large majority of habitat on site will be avoided/retained, such that although a minority of habitat will be modified, destroyed and removed (with isolation not anticipated), the small amount of loss/change is not considered to result in population level impacts. At a higher level still, it is thus implausible that the proposal will result in significant impacts at a level that a measurable decline in the species overall would be plausible.

The proposal is thus not considered likely to breach this significant impact criterion.

7) Result in invasive species that are harmful to the species becoming established in the species' habitat

Without mitigation, the construction and operations of the proposal could lead to the proliferation and establishment of weeds in the years following the completion of works. Numerous weeds are already present within the landscape but not a degree that has displaced ptunarra brown butterflies. The recommended Weed and Hygiene Management Plan should be sufficient for ensuring that weed species do not increase to a degree that would result in a significant impact on the population of butterflies.

European wasps are present sparsely on site and it is acknowledged they will be prone to increasing with edge effects from clearance. A monitoring method has however been proposed and includes control measures for wasp removal when unsatisfactory increases are detected.

Thus, with this mitigation in place, the proposal can prevent breaching this significant impact criterion.

8) Introduce disease that may cause the species to decline

There are no documented diseases that impact on the viability of *O. ptunarra* and no diseases known that might be expected to be introduced by a proposal of this nature in this area.

The proposal is thus not considered likely to breach this significant impact criterion.

9) Interfere substantially with the recovery of the species

There is no national recovery plan for this species, with the conservation advice stating a recovery plan is not required, with the approved conservation advice for the species providing sufficient direction to implement priority actions and mitigate against key threats. The State recovery plan lists the following priority actions.

- Habitat loss, disturbance and modification
- Animal predation
- Fire
- Conservation information
- Enable recovery of additional sites and/or populations

The potential impacts of habitat loss, disturbance and modification have been rationalised above within the context of the extent of habitat to remain unimpacted.

No changes to fire regimes are proposed nor anticipated because of the proposal.

The available conservation information on this species could be seen to have improved with the level of surveying and mapping of this population derived from the impact assessment; in addition, the proposed monitoring and mitigation with respect to potential increase in European wasps will be a valuable test case as to the efficacy of the control measures in limiting residual impacts.

The proposal is not seen to be limiting the recovery of additional sites or populations and there is no evidence the population on site is in decline.

The proposal is thus not considered likely to breach this significant impact criterion.

5.1.5 Eastern barred bandicoot

The species is unlikely to be present within the project area and the area is unlikely to support part of an important population. As the proposal will not impact a meaningful amount of potential habitat for the species, the project has:

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of an important population, no potential to lead to a long-term decrease in the size of an important population and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.
- No meaningful reduction in the area of occupancy of the species, given the habitat on site is only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to the eastern barred bandicoot.

5.1.6 Shannon galaxias

The species is unlikely to be present within the project area and the area is unlikely to support part of an important population. As the proposal will not impact a meaningful amount of potential habitat for the species, the project has:

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of an important population, no potential to lead to a long-term decrease in the size of an important population and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.

- No meaningful reduction in the area of occupancy of the species, given the habitat on site is only likely to constitute a very minor and occasional potential foraging resource.

Thus, the proposal has no potential for significant impacts to the Shannon galaxias.

5.1.7 *Pterostylis pratensis*

5.1.7.1 Distribution and Habitat

This species is endemic to Tasmania and is found only in the Central Highlands region between altitudes of 850 m and 1,100 m above sea level. The known range of this species extends across ~150,000 ha, and contains at least 11 known extant populations, the largest of which occur at Lake Echo (Cattle Hill), Liawenee Moor, and St Patrick's Plains.

The St Patricks Plains subpopulation contains at least 742 plants from NVA records (some of which are likely to contain multiple plants but do not provide abundance) and observations by NBES within the project area – based on habitat suitability and the distribution of records, the population extends over a large area ~3,200 ha, which could contain in the order of several thousand plants. The species is thought to have a state-wide population >10,000 plants.

Pterostylis pratensis typically grows in subalpine *Poa labillardierei* grasslands with emergent *Olearia algida* and *Hakea microcarpa* shrubs on red-brown loamy to clay soils derived from basalt. These areas tend to contain very low vegetation and are often quite exposed. The project area contains 3,227 ha of grassland habitat broadly suitable for the species (Table 7).

5.1.7.2 Proposed Impact

In terms of known plants and reported locations, the total percentage of observed plants at risk from the footprint is 8.09 % of what is known from the project area (60 out of 742 plants). Noting that only 10 plants (1.34 % of the total recorded) are within the direct impact area and the balance of 50 plants (6.74 % of the total) within the construction impact buffer may be possible to protect with internal exclusion zones aided by pre-works surveys. Locations of impacted occurrences are shown in Figure 14.

5.1.7.3 Significant Impact Assessment

Regarding species listed under the EPBCA as Vulnerable, such as *Pterostylis pratensis*, an action is considered likely to have a significant impact if there is a real chance or possibility that it will:

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

Each of the nine criteria is considered separately. Impacts that need to be considered not only include the direct impacts of the action but also indirect and offsite impacts, which in this case include facilitated impacts. Each of the nine criteria is discussed below in the context of

proposed development and the likelihood of a significant impact upon *P. pratensis*. The takeaway conclusion for each criterion is italicised at the bottom of each section.

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

An 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

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

The St. Patricks Plains population is considered important on the basis of size and abundance.

However, given the direct impact to known individuals within this population is only 1.34 % of the total recorded, with a further 6.74 % at risk from indirect construction disturbance (but with scope to protect these individuals), and the high likelihood that the population overall supports many hundreds more individuals (extrapolating from availability of suitable habitat), the overall potential impact on this population is considered to be minor.

Based on the impact to a species that is locally abundant across the project area and potentially more abundant in the extent of the population overall, this action will not lead to a meaningful long-term decrease in the size of an important population.

2) Reduce the area of occupancy of an important population

Area of occupancy is defined by the IUCN[121] as "the area within the 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy."

According to the Threatened Tasmanian Orchids Recovery Plan 2017, the current known extent of this species is ~150,000 ha, spread across a linear range of ~123 km (Appendix E). The St. Patricks Plains population extends over a large area ~3,200 ha. Given that the proposed development will impact upon only 10 to 60 plants, and there is a proposed impact of 203.41 ha (6.72 % of the extent in the project area) of suitable habitat in GPH, the impact to the overall area of occupancy is not significant (< 0.2 % of the area of occupancy at state-wide level and 5.2 % of the local population).

Thus, this action will not meaningfully reduce the area of occupancy of this population.

3) Fragment an existing important population into two or more populations

The St Patricks Plains subpopulation of this species extends over a large area (~3,200 ha). The impact to 10 to 60 plants at 3 locations will not fragment the broader population at this site given the development components will not represent impassable barriers to seeds or pollinators (both of which are capable of wind dispersal) and that the site already includes equivalent infrastructure (e.g., roads and dams) that is not considered to have fragmented the existing population.

Thus, this action will not fragment an existing important population into two or more populations.

4) Adversely affect habitat critical to the survival of the species

Given that *P. pratensis* is locally abundant at the St Patricks Plains site, the impact to 203.41 ha of potential habitat is considered to be minor in context of the broader landscape. High

[121] IUCN (2012)

quality habitat for this species will remain extant within the project area and will not be impacted by the proposed development. There is nothing critically important about the locations proposed to be impacted to suggest the loss will impact the population as a whole.

Thus, this action will not adversely affect habitat critical to the survival of the species.

5) Disrupt the breeding cycle of an important population

Pterostylis pratensis is pollinated by insects, by trapping insects in a trigger mechanism. The means of removal of a small number of plants and a minor amount of potential habitat will not impact upon the ability of the remaining population to pollinate remaining plants. As such, the proposal will have no meaningful impact on the breeding cycle of this population.

Thus, this action will not disrupt the breeding cycle of an important population.

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

The preferred habitat for *P. pratensis* is in subalpine grassland dominated by *Poa labillardierei*, with scattered shrubs of *Olearia algida* and *Hakea macrocarpa*. The proposed development will impact on 182 ha of GPH, which accounts for 6.72 % of the extent of this community within the project area. Given the availability of habitat across the broader project area (and beyond), the impact to habitat for this species is not significant.

In addition, there is scope for rehabilitation and avoidance of areas of GPH that may be temporarily disturbed within the construction disturbance buffer, further reducing proportional impacts.

Thus, this action will not modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7) Result in invasive species that are harmful to the species becoming established in the species' habitat

Without mitigation, construction works, and disturbance can lead to the establishment of weeds following the completion of works. This species typically occurs in rocky areas that have been free from slashing and cultivation, however it is tolerant of grazing pressures. Grazing may help in maintaining grassy habitat for this species, however, may present a risk of introducing weeds.

By adhering to the recommendations surrounding weed management (detailed in Section 4.5), the risk of introducing weeds to areas of viable habitat can be reduced. Follow up weed surveys will aid in maintaining the quality of habitat in the vicinity of areas of impact.

Therefore, this action is unlikely to result in invasive species that are harmful to the species becoming established in the species' habitat.

8) Introduce disease that may cause the species to decline

There are no documented diseases that may impact on the viability of this species in the broader area due to proposed works. Adhering to the NRE Weed and Disease Planning and Hygiene Guidelines[122] will further mitigate this risk.

Thus, this action will not introduce disease which may cause the species to decline.

9) Interfere substantially with the recovery of the species

[122] DPIPWE (2015b)

Under subsection 269A (7) of the EPBCA, listed species adopt the Threatened Tasmanian Orchids Recovery Plan[123] as the approved recovery plan.

Under this recovery plan, the performance criteria relevant to *P. pratensis* and the proposed development are as follows:

Recovery Objective	**General Performance Criteria**
To maintain and/or increase the number of known subpopulations of each species.	For species with more than 10 extant subpopulations, the number of known subpopulations has been maintained.
To maintain and/or increase the number of individuals within subpopulations of each species.	An increase in the number of individuals within all priority subpopulations through presence/absence and extension surveys, and critical management actions as identified in Appendix 2 (of the recovery plan).

According to Appendix 2 of the recovery plan[124], the St Patricks Plains property is listed as a priority population. The proposal however is not considered likely to interfere with the recovery of the population on account of the relatively small number of plants at risk (10 to 60 plants) and the broad extent of habitat to be retained (> 90 %).

Thus, this action will not interfere with the recovery of this species.

5.1.7.4 Conclusion

The impact to between 10 and 60 plants of *Pterostylis pratensis* due to the proposed development at St Patrick's Plains will not have a significant impact on this species due to its localized abundance and the retention of the majority of known plants and available habitat, which total around 742 known occurrences and ~3,200 ha of potential habitat within the project area.

5.1.8 Other threatened flora

As the proposal will not impact a meaningful amount of habitat or number of occurrences for any additional EPBCA listed flora, the project has:

- No likelihood of breeding disturbance and therefore no adverse impacts on habitat critical to the survival of the species, no potential to disrupt the breeding cycle of a population (important or otherwise), no potential to lead to a long-term decrease in the size of a population (important or otherwise) and no impacts to habitat to the extent that the species is likely to decline.
- No possible fragmentation effects.
- No likelihood of introduction of disease or harmful invasive species.
- No potential for interference with the recovery of the species.
- No meaningful reduction in the area of occupancy of the species.

Thus, the proposal has no potential for significant impacts to additional threatened flora with the recommended mitigation and avoidance in place.

[123] Threatened Species Section (2017)
[124] Threatened Species Section (2017)

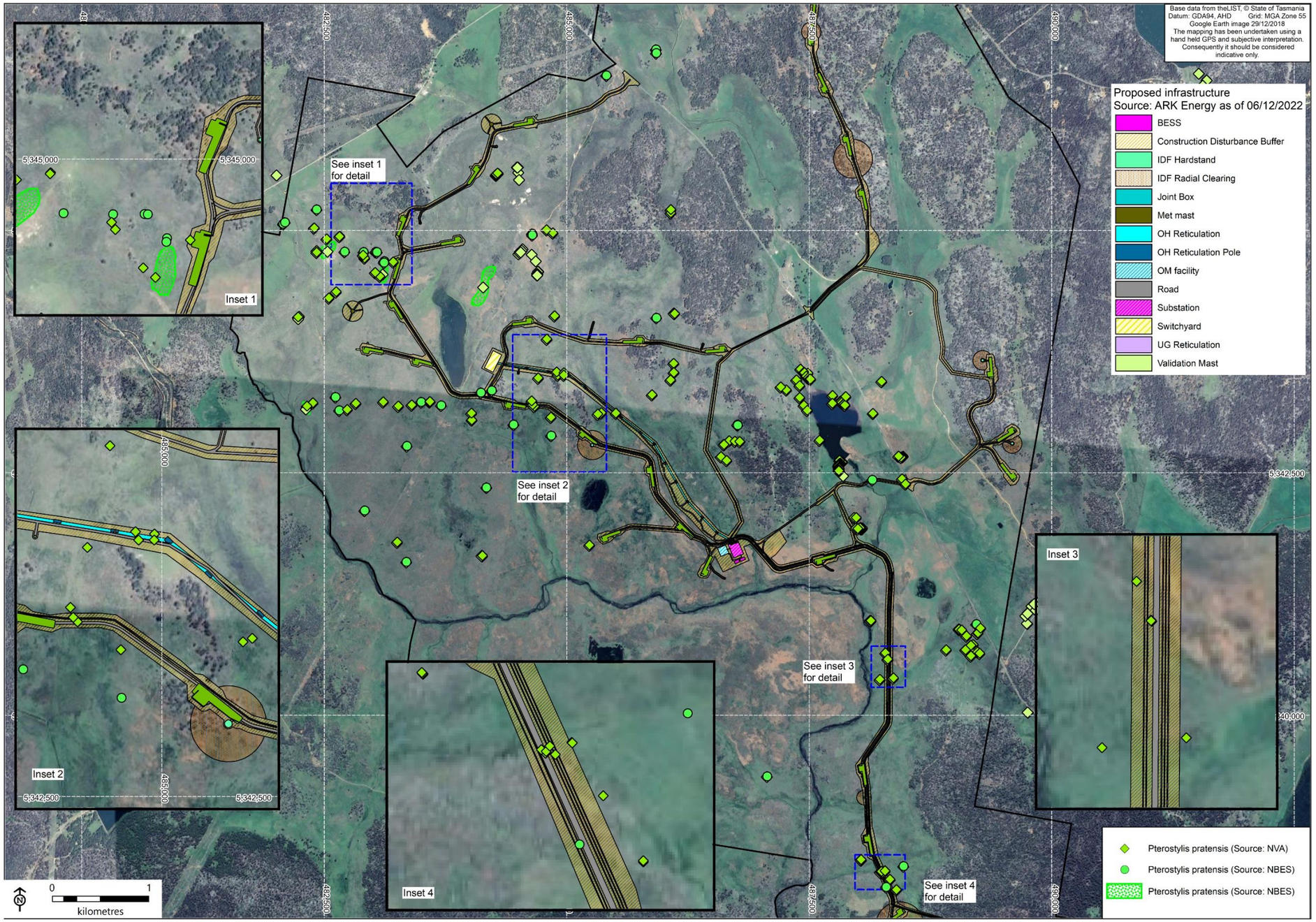


Figure 14: Distribution of *Pterostylis pratensis* in relation to proposed impact areas

5.2 Tasmanian Threatened Species Protection Act 1995 (TSPA)

Under the TSPA, a person cannot knowingly, without a permit, 'take' a listed species. With the definition of 'take' encompassing actions that kill, injure, catch, damage, destroy and/or collect threatened species or vegetation elements that support threatened species, e.g., nests and dens.

A permit to take threatened species will be required for where the project cannot directly avoid occurrences of threatened flora listed under the TSPA, and/or is likely to impact individuals of threatened fauna (including the Miena jewel beetle). Given the high degree of seasonality and interannual variation in the populations of the threatened flora present in the project area, the approval of such a permit may be contingent upon precise up to date surveys of the final footprint close to construction.

5.3 Tasmanian Nature Conservation Act 2002 (NCA)

A permit to take products of wildlife will be required for this project if any dens or burrows need to be decommissioned/destroyed.

5.4 Tasmanian Weed Management Act 1999

Eight species of declared weeds have been observed in the survey area. The relevant statutory weed management plans define the Central Highlands Council as a Zone A locality for orange hawkweed (*Pilosella aurantiaca* ssp. *aurantiaca)*, and a Zone B municipality for the remaining declared weeds known from the project area:

- Californian thistle *Cirsium arvense*
- slender thistle *Carduus pycnocephalus*
- gorse *Ulex europaeus*
- ragwort *Senecio jacobaea*
- canary broom *Genista monspessulana*
- English broom *Cytisus scoparius*
- crack willow *Salix x fragilis nothovar fragilis*

According to the provisions of the *Weed Management Act 1999*, Zone B municipalities are those which host moderate or large infestations of the declared weed that are not deemed eradicable because the feasibility of effective management is low at this time. Therefore, the objective is containment of infestations. This includes preventing spread of the declared weed from the municipality or into properties currently free of the weed or which have developed or are implementing a locally integrated weed management plan for that species. As well there is a requirement to prevent spread of the weeds to properties containing sites with significant flora, fauna, and vegetation communities.

Zone A localities are areas in which eradication is deemed feasible and is the responsibility of the land manager (or the lease holder).

5.5 Tasmanian Forest Practices Act 1985

Under the *Forest Practices Act 1995*, a Forest Practices Plan is not required for clearing of land in particular circumstances. The prescribed circumstances are defined in the *Forest Practices Regulations 2017*.

Section 4 of the Regulations states under what circumstances a Forest Practices Plan is not required. These circumstances include the harvesting of timber or the clearing of trees on any land, or the clearance and conversion of a threatened native vegetation community on any land, to enable the construction and maintenance of electricity infrastructure, if –

(i) there is an easement on the land that enables the electricity infrastructure to be constructed or used, or, if there is no such easement, if the owner of the land consents to the construction or maintenance of the electricity infrastructure on the land; and

(ii) the clearance and conversion are undertaken in accordance with an environmental management system endorsed by the Forest Practices Authority.

As the proposed development meets these definitions, a Forest Practices Plan is not required. It is also exempt under the proviso of requiring development approval via the *Land Use Planning and Approvals Act 1993* and the local planning scheme.

5.6 Tasmanian Land Use Planning and Approvals Act 1993 (LUPAA)

LUPAA states that 'in determining an application for a permit, a planning authority must (amongst other things) seek out the objectives set out in Schedule 1[125].

Schedule 1 includes 'The objectives of the Resource Management and Planning System of Tasmania' which are (amongst other things):

'To promote sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity'.

Sustainable development includes 'avoiding, remedying or mitigating any adverse effects of activities on the environment'[126].

The intent of LUPAA will be met through the assessment by the EPA and this study suggests these provisions can be achieved.

6 CONCLUSION AND RECOMMENDATIONS

The project has been determined as a controlled action under the EPBCA (EPBC 2019/8497) and will require assessment and approval under the Act. The Environment Protection Authority Tasmania (EPA) will oversee the assessment in accordance with a bilateral agreement between the State and the Commonwealth under section 45 of the Act.

The Project Specific Guidelines (PSGs) for Preparing an Environment Impact Statement issued by the EPA explicitly requests information on the following MNES (excluding bird species not covered by our scope):

- Tasmanian devils *Sarcophilus harrisii* – EN
- Spotted tailed quoll *Dasyurus maculatus* – VU
- Ptunarra brown butterfly *Oreixenica ptunarra* – EN

In addition, other values referenced in the PSGs that can include or be related to MNES include:

- Threatened flora and ecological communities

[125] Section 51(2)(b) – Part 4 Enforcement of Planning Control – Division 2 Development Control (*LUPPA 1993*)

[126] page 56 – *LUPAA 1993*

- Wombat burrows (which can potentially provide denning habitat for devils and quolls)

Our results and analyses have established that the proposal can proceed without resulting in a significant impact to these or other MNES. Largely this is due to avoidance of key habitats during the design phase and the capacity to apply mitigation measures required to ensure residual impacts are non-significant.

No impacts are anticipated to ecological communities listed under the Commonwealth EPBCA. Very limited impacts are possible to threatened vegetation communities listed under the Tasmanian NCA. A very large number of threatened flora are present within the project area, but only a small proportion at risk from the footprint. It may be possible with design changes and mitigation to entirely avoid threatened vegetation communities and flora.

Direct avoidance and a small footprint have significantly reduced the potential for impacts to threatened fauna, but residual impacts can be further reduced by applying the micro-siting and mitigation measures prescribed.

The following recommendations are made regarding general management of the proposal area and to ensure minimal impacts to conservation significant values.

6.1 Native Vegetation

- Concentrate direct and irreversible clearance within areas of non-native vegetation (cleared land) and non-threatened vegetation as much as possible.
- Apply micro-siting approach (with the aid of an ecologist) to areas of the final footprint within native vegetation – the micro-siting should aim to make minor adjustments to the footprint on the ground by selecting localised areas with relatively less important values (e.g., lower condition areas), as well as maintaining variation within a community across the project area (e.g., protecting different facies within a community where fine scale variation is present).
- Where disturbance but not complete clearance of native vegetation is required, such as slashing firebreaks or easements, micro-siting may be useful for selecting those areas that will be the least impacted (or may even benefit) from this modification.
- Similarly, where modification areas required for IDF clearance and overhead reticulation occur within native vegetation, the requisite removal of vegetation should be done as selectively as possible to maintain the vegetation in a manner that as closely approximates the original native TASVEG unit as possible and/or maintains any key habitat values – this is likely to require a targeted vegetation management plan for these sectors, which could be a condition of approval to have completed prior to works.
- In cases of redesign, maximise the proportion of the footprint within non-native (modified) vegetation and avoid threatened and/or native vegetation (as well as habitat for threatened fauna, or locations of threatened flora).
- Clearly demarcate the permitted impact area either in situ and/or clearly on construction plans and specify on all contractor agreements that works, vehicles and materials must be confined within the designated impact areas.
- Areas of threatened communities beyond the impact footprint should be designated as exclusion zones and marked on the ground and/or in construction plans to the degree necessary to ensure no inadvertent impacts occur.
- Incorporate a revegetation plan into the post-construction requirements, covering areas where clearance of native vegetation is not required to be a permanent loss (e.g., borrow pits [if required], temporary access routes and temporary construction disturbance footprints). The plan should outline suitable species for revegetation

(sourced from the local environment, with example species in Appendix K), as well as revegetation specifics, such as seed application rates, use of established plants, specific planting details, *etc*.

6.2 Threatened and Conservation Significant Flora

- Apply the recommended exclusion zones within the constructed disturbance buffer to reduce impacts to *Pterostylis pratensis* and *Senecio longipilus*.
- Undertake micro-siting surveys for threatened flora (with scope for repositioning components of the footprint), within the appropriate season for any aspect of the final footprint and a buffer of 20 m (allowing for inadvertent disturbance prevention).
- Specifically, within the IDF clearance areas, targeted surveying should be used to identify conservation significant flora that can be selectively avoided on the basis that their small size and ecology will result in their viable persistence in the area after clearance without resulting in an obstruction to the IDF function. This should be done under the recommended vegetation management plan for these areas.
- Outside of the approved/unavoidable impact area, the general areas around threatened and conservation significant flora locations should be protected from indirect or inadvertent impacts by designating construction exclusion zones around any known occurrences within 20 m of the footprint – exclusion zones must be specified within the construction contracts and the exclusions should cover but not be limited to mechanical disturbance, dumping of fill, alteration of drainage patterns and soil compaction. Physical barriers or cordons should be applied as necessary to reinforce the exclusion requirements.
- Further exclusion zones with the component of the footprint attributed to a construction disturbance buffer may in particular be a viable mechanism to further reduce impacts by protecting some values within this buffer (noting complete disturbance within the construction buffer is unlikely to be necessary).
- In addition, a designated construction exclusion zone should be implemented around the location of *Leucochrysum albicans* var. *tricolor*, which is approximately 200 m from the footprint but as a significant population warrants additional protection.
- The margin of the final footprint should be surveyed for *Eucalyptus gunnii* ssp. *divaricata* to a radius of 15 m (the maximum tree protection zone under Australian Standard for the Protection of Trees on Development Sites (AS 4970-2009) – any individuals of the species found within the buffer (and alive) should be protected with a radial exclusion zone proportional to 12 x diameter at breast height (as per AS 4970-2009).
- For individuals of TSPA listed plants that cannot be avoided, a permit to take threatened flora listed under the TSPA will be required through the *Nature Conservation Act 2002*.

6.3 Weeds

- Undertake surveys of the precise works footprint when it is finalised.
- Following the above surveys, prepare and implement a project specific Weed Management Plan (which must be linked to contractor requirements within a Construction Environment Management Plan or similar), which amongst other things must adhere to the principles of best practice guidelines and contain requirements and prescriptions for:
    - Weed removal and treatment prior to, during, and after civil works.

- Requirements for wash-down and inspections of all site plant, including earth-moving machinery[127].

6.4 Threatened Fauna

6.4.1 Devils and quolls

- Avoid impacts to dens/burrows confirmed to support devils based on the current survey results. It is noted however, that if this is not achievable, it may be possible to reassess the status of the dens/burrows closer to works (*i.e.,* the locations may no longer be occupied at that time).
- Implement the recommended den management protocols within the final impact footprint (direct and indirect) to a buffer of 50 m[128] in the lead up to clearance/disturbance.
- Implement roadkill mitigation measures as follows:
  - Internal road use should be limited to daytime hours to the maximum extent possible within the requirements of the project.
  - Speed limits ≤ 40 km/h should be applied to all internal roads during construction and operation.
  - For materials that will be transported to the site using roads, this should primarily occur during daytime hours – any transport required outside daytime hours should be subject to a roadkill risk assessment with mitigation if required.
  - During the construction phase, all internal roads within the works area should be monitored (with documentation) for roadkill whenever the roads are being used, with mortalities removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation (as indicated in a traffic assessment report).
  - During operations, a monitoring program (with documentation) should be established on internal roads for roadkill – with the frequency of monitoring to be established with understanding of how frequent staff will be on site once the site is operational. As part of the program, mortalities would be removed immediately upon location (to limit likelihood of predators being attracted to the carcass). The same should apply to selected arterial roads that will be subject to increased use as contractors commute to the site from places of accommodation.

6.4.2 Ptunarra brown butterfly

- Habitat avoidance should be prioritised on the basis of our habitat quality stratification results from high to low.
- Apply the recommended European wasp (and ptunarra brown butterfly) monitoring strategy (Appendix M).

[127] DPIPWE (2015b)
[128] As per the DPIPWE devil survey guidelines

6.4.3 Miena jewel beetle

- All known potential habitat patches should be excluded from the footprint of the development.
- In addition to avoiding known habitat patches, the host plant *Ozothamnus hookeri* must be considered during micro-siting surveys of the final footprint within the northern half of the project area, to ensure that no potential habitat has currently been overlooked due to the scale of the surveys.
- If all habitats cannot be avoided, an estimate of individuals to be impacted will be required to inform a permit to take under the TSPA (Section 5), with an estimate of individuals likely to require a targeted survey of food plants within the flowering season.

Where complete habitat avoidance is not achievable, an alternative approach may be warranted as follows:

- Conduct an additional survey comparing the density of beetles within the unavoidable impact area to the remaining habitat patches – given that beetle density may fluctuate between years and that the upcoming summer of 2024 will be an alternate year in the species 2-year larval life-cycle, we propose that in lieu of counting beetles, a count of larval bore holes is undertaken instead over the coming winter (2023) – this may in fact be a more reliable measure of the value of the habitat within the impact area, as comparing counts of adult beetles in a given area may be obfuscated by the fact the adults could have moved around to different locations and/or plants once they have emerged from their bore holes and larval stages (notwithstanding that the flowering plants used by the adults represent an important part of the lifecycle too).
- To support the count of larval bore holes, a count (or relative measure of abundance) of *O. hookeri* plants should be collected (concurrently with the bore hole count) within the impact area and patches of habitat outside of the footprint – this will provide a more robust measure of foraging habitat loss/retention than the current habitat patches, which do not account for variable density of the host and foraging plants within each patch.

If the area of habitat to be lost to the footprint is not found to be disproportionately important for bore hole locations (relative measure of abundance for number of beetles) nor for the abundance of food plants (direct measure of habitat availability for adults), the proposed extent of clearance may not be considered a significant loss by the regulator.

Further mitigation is available at the pre-clearance phase to limit the risk of direct impacts to individuals (and thus reduce the overall effect of the habitat loss by not removing these individuals from the breeding population) as follows:

- In the winter of the last even-dated year prior to works commencing (within, or in the immediate vicinity of the known habitat patches, as works beyond this area are irrelevant), all plants found to support larval bore holes of this species should be cut at ground level and translocated to a habitat patch beyond the impact footprint.
- Any larvae within the bore holes can be expected to be able to survive on the wood of the translocated plant until emergence the following summer (Karen Richards pers. comm.) – note this is why the harvesting of the plants must be undertaken in the winter of an even-dated year, as if it was undertaken in the winter of an odd year the larvae could not survive for 18 months on the dead plant and thus would not make it to adulthood.

- Translocation of the habitat plants containing larval bore holes (and presumably larvae within) will require a permit to take threatened wildlife under the TSPA/NCA.

6.5 Consideration of Offsets

Vegetation

- If significant residual impacts to threatened native vegetation remain after avoidance and mitigation, offset priorities should be the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve condition of these units could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing landuse for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.

Threatened flora

- After avoidance and mitigation, if residual impacts to threatened native flora are sufficient to require offsets, the site has significant scope to contribute to an improved reservation status of several species. There is also significant scope on site for applying management agreements designed to maintain or improve habitat for threatened flora, including through grazing prescriptions, control of woody plants (within non-forest environments), and ecological burning. As per native vegetation, paid stewardship agreements are recommended as the mechanism for such agreements.
- Based on current impacts, the need for offsets of threatened flora is unlikely, particularly with the option to implement targeted exclusion zones for *Senecio longipilus* and *Pterostylis pratensis*. Specific to these species however, additional consideration of offsets may be warranted if proportional impacts to the overall population estimates cannot be reduced (such as if the recommended exclusion zones aren't applied).
    - For the *Senecio longipilus* the species is considered to be highly suited to seed collection and propagation of replacement plants, noting the construction disturbance buffer post-works would be a highly suitable location for establishing an offset planting, which could be self-sustaining along the new habitat edges where they occur adjacent to native grasslands on basalt outcrops in particular.
    - For *Pterostylis pratensis* the most effective offset outcome would be to place a conservation covenant (or similar reservation mechanism) around a concentration of plants, noting the species is poorly reserved as per the NRE listing statement.

Threatened fauna

- The prevention of impacts to potential den sites is considered to be adequate for maintaining the potential population persistence of devils and quoll species in the

area. If at some point during construction or mitigation, natal den locations are found and are required to be decommissioned, these should result in an offset – replacement dens from artificial structures are not seen as useful in an environment with so many natural alternatives, so a more beneficial offset may involve a monetary contribution to research and/or species conservation.

- Similarly, roadkill mortalities to threatened fauna, if they are considered to constitute significant residual impacts, may best be offset with a monetary contribution to research and/or species conservation, particularly if it can be linked to roadkill mitigation priorities.
- In terms of the overall loss of potential habitat for devils and quolls, the permanent loss of only 102.79 ha, plus the additional loss of denning suitability within 0.20 ha (but remaining suitable for foraging) is not considered to constitute a significant residual impact (as per the assessments in Section 5.1). If there is a requirement to offset this loss of habitat however, there is limited value to these species in the offset being a covenant of additional land, as this is not considered likely represent a net gain for the species, considering available land is not limiting their populations, and tenure and reservation status have little relationship to devil density[129]. In equivalent scenarios a monetary offset has been accepted as the most beneficial mechanism for loss of habitat, and if required in this scenario could be scaled according to the measured habitat quality and supported density of devils (from available local data).
- After avoidance and mitigation, if residual impacts to ptunarra brown butterfly habitat are sufficient to require offsets, offset priorities should be the highest quality butterfly habitat and, more broadly, the GPH and MGH communities, with significant scope to contribute to the State's reservation estate and/or implement management agreements to improve the condition of the units on site. Management agreements designed to maintain or improve habitat for the butterfly could include grazing prescriptions, control of woody plants, and ecological burning. To provide a mechanism that is compatible with existing land use for primary production, it is recommended to explore opportunities for the management agreements to be implemented in the form of stewardship agreements, where landowners are compensated for managing the habitat to maintain/improve the conservation significant values – in situations where the stewardship agreement was not upheld (informed by periodical monitoring) the associated stipend could be redirected as a monetary contribution to research and/or conservation efforts specific to the value.
- If the proportional loss of Miena jewel beetle habitat (or number of individuals) is considered significant following the recommended additional survey work, there is ample scope to undertake replacement planting of the key habitat plant within or supplementary to equivalent habitat patches.

[129] DPIPWE (2010); Cunningham *et al.* (2021)

REFERENCES

Allen and Gartenstein (2010). *Keeping it clean - A Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens*. Published by NRM South.

Archer ME (2012). Vespine wasps of the world: behaviour, ecology & taxonomy of the Vespinae. Siri Scientific Press, Manchester

Andersen, G. E., Johnson, C. N., Barmuta, L. A., & Jones, M. E. (2017). Use of anthropogenic linear features by two medium-sized carnivores in reserved and agricultural landscapes. Scientific Reports, 7(1), 11624. https://doi.org/10.1038/s41598-017-11454-z

Andersen, G. E., Johnson, C. N., & Jones, M. E. (2020). Space use and temporal partitioning of sympatric Tasmanian devils and spotted-tailed quolls. Austral Ecology, 45(3), 355–365. https://doi.org/10.1111/aec.12865

Barker, P.C.J. & Wardlaw, T.J. (1995). Susceptibility of selected Tasmanian rare plants to *Phytophthora cinnamomi*. Australian Journal of Botany, 43(4), pp. 379-386.

Bashford R. (2001). The spread and impact of the introduced vespine wasps 'Vespula germanica' (F.) and 'Vespula vulgaris' (L.) (Hymenoptera: Vespidae: Vespinae) in Tasmania. *The Australian Entomologist*, 28:11-12.

Bell, P.J. (1998). Ptunarra Brown Butterfly Recovery Plan 1998-2003. Department of Primary Industries, Water and Environment, Hobart.

Caley, P., Ramsey, D. S. L., & Barry, S. C. (2015). Inferring the distribution and demography of an invasive species from sighting data: The red fox incursion into Tasmania. PLOS ONE, 10(1), e0116631. https://doi.org/10.1371/journal.pone.0116631

Commonwealth of Australia (2020a). Protected Matters Search Tool, www.environment.gov.au. Report – PMST_I63KLI.

Commonwealth of Australia (2020b):

http://www.environment.gov.au/cgi-bin/wetlands/report.pl

Commonwealth of Australia (2012). *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012*.

Commonwealth of Australia (1999). *Environment Protection and Biodiversity Conservation Act 1999. No. 91, 1999.*

Cunningham, C. X., Comte, S., McCallum, H., Hamilton, D. G., Hamede, R., Storfer, A., Hollings, T., Ruiz-Aravena, M., Kerlin, D. H., Brook, B. W., Hocking, G., & Jones, M. E. (2021). Quantifying 25 years of disease-caused declines in Tasmanian devil populations: Host density drives spatial pathogen spread. Ecology Letters, 24(5), 958–969. https://doi.org/10.1111/ele.13703

Cunningham, C. X., Johnson, C. N., & Jones, M. E. (2020). A native apex predator limits an invasive mesopredator and protects native prey: Tasmanian devils protecting bandicoots from cats. Ecology Letters, 23(4), 711–721. https://doi.org/10.1111/ele.13473

Department of the Environment (2020). Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat.

Department of the Environment and Energy (2018). National Strategy for Ecologically Sustainable Development.

https://www.environment.gov.au/about-us/esd/publications/national-esd-strategy

Department of the Environment, Water, Heritage and the Arts (2010). Lowland Native Grasslands of Tasmania — a nationally threatened ecological community. Environment Protection and Biodiversity Conservation Act 1999 Policy Statement 3.18. Australian Government, Canberra.

de Salas M.F. and Baker M.J. (2019). *A Census of the Vascular Plants of Tasmania*. Tasmanian Herbarium, Tasmanian Museum and Art Gallery.

DPIPWE (2020a). Natural Values Report # 1_03-Jun-2020, DPIPWE, Natural Values Atlas, Threatened Species Section, Department of Primary Industries, Parks, Water and Environment, Hobart.

DPIPWE (2020b). Department of Primary Industries, Parks, Water and Environment. TASVEG 4.0, Released May 2020. Tasmanian Vegetation Monitoring and Mapping Program, Resource Management and Conservation Division.

DPIPWE (2020c). Department of Primary Industries, Parks, Water and Environment. TASVEG 4.0 area by VEGCODE. Tasmanian Vegetation Monitoring and Mapping Program, Resource Management and Conservation Division.

DPIPWE (2015a). *Guidelines for Natural Values Surveys - Terrestrial Development Proposals.* Department of Primary Industries, Parks, Water and Environment (Natural and Cultural Heritage Division).

DPIPWE (2015b). *Weed and Disease Planning and Hygiene Guidelines - Preventing the spread of weeds and diseases in Tasmania.* (Eds.) Karen Stewart and Michael Askey-Doran. Department of Primary Industries, Parks, Water and Environment, Hobart, Tasmania.

DPIPWE. (2010). Recovery Plan for the Tasmanian devil (*Sarcophilus harrisii*). Department of Primary Industries, Parks, Water and Environment.
https://nre.tas.gov.au/Documents/Draft-Tasmanian-Devil-Recovery-Plan.pdf

Department of Sustainability, Environment, Water, Population and Communities/ DSEWPaC (2011). Survey guidelines for Australia's threatened mammals: guidelines for detecting mammals listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*. Australian Government, Canberra.

Fancourt, B. A. (2016) Diagnosing species decline: a contextual review of threats, causes and future directions for management and conservation of the eastern quoll. *Wildlife Research*, 43, pp. 197-211.

Forest Practices Authority (2005). Forest Botany Manual: Module 7 – Central Highlands Region. Forest Practices Authority, Tasmania.

Godsell, J. (1983). *Ecology of the eastern quoll Dasyurus viverrinus,(Dasyrudae: Marsupialia)*. The Australian National University (Australia).

Goff, F.G, Dawson, G.A. and Rochow, J.J. (1982). Site examination for threatened and endangered plant species. *Environmental Management 6 (4) pp 307-316*.

Google Earth Pro (2020). Various images referenced in text, by DigitalGlobe, TerraMetrics and CNES/ Airbus. Accessed March 2020.

Guiler, E. R. (1970). Observations on the Tasmanian Devil, Sarcophilus harrisii (Marsupialia: Dasyuridae) I. Numbers, home, range, movements and food in two populations. *Australian Journal of Zoology*, *18* (1), 49-62.

Hamede, R. K., McCallum, H., & Jones, M. (2013). Biting injuries and transmission of Tasmanian devil facial tumour disease. Journal of Animal Ecology, 82(1), 182–190. https://doi.org/10.1111/j.1365-2656.2012.02025.x

Harris, S. and Kitchener, A. (2005). *From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation.* Department of Primary Industries, Water and Environment, Printing Authority of Tasmania, Hobart.

IBRA 7 (2012). Interim Biogeographic Regionalisation for Australia, Version 7. Map produced by Environment Resources Information Network (ERIN), Australian Government Department of the Environment and Energy, Canberra, Commonwealth of Australia.

International Union for Conservation of Nature and Natural Resources (2012). The IUCN Red List of Threatened Species – www.iucnredlist.org

Jones, E. M., Koch, A. J., Mann, D. F., Hamede, R. K., & Jones, M. E. (2023). What drives the abundance of marsupial carnivores in production forest landscapes?. *Forest Ecology and Management*, pp. *529*.

Jones, M. E., & Barmuta, L. A. (2000). Niche differentiation among sympatric Australian dasyurid carnivores. Journal of Mammalogy, 81(2), 14.

Kirkpatrick, J.B. and Nunez, M. (1980). Vegetation-radiation relationships in mountainous terrain: eucalypt-dominated vegetation in the Risdon Hills, Tasmania. *Journal of Biogeography* v. 7, pp. 197-208.

Kitchener, A. and Harris, S. (2013). *From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation*. Edition 2. Department of Primary Industries, Parks, Water and Environment, Tasmania.

Kuchler, A.B. and Zonneveld, S. (2012). *Vegetation Mapping*. Kluwer Academic Publishers, United States, pp. 648.

Long, K & J. Nelson (2010). *(Draft) National Recovery Plan for the Spotted-tailed Quoll* Dasyurus maculatus. Victorian Department of Sustainability and Environment.

Lyall, J. M. (2018). *Native and invasive mammalian carnivores in a forestry and agricultural landscape in northwest Tasmania* (Doctoral dissertation, University of Tasmania).

Natural and Cultural Heritage Division (2015). *Survey Guidelines and Management Advice for Development Proposals that may impact on the Tasmanian Devil (Sarcophilus harrisii)*. Department of Primary Industries, Parks, Water and Environment.

Pemberton, D. (1990). Social organisation and behaviour of the Tasmanian devil. Ph.D. Thesis. University of Tasmania.

Podger, F.D. & Brown, M.J. (1990). Vegetation damage caused by Phytophthora cinnamomi on disturbed sites in temperate rainforest in western Tasmania. Australian Journal of Botany, 37(6), pp. 443-480.

Potter-Craven J. Kirkpatrick JB. McQuillan PB. Bell P. (2018). The effects of introduced vespid wasps (Vespula germanica and V. vulgaris) on threatened native butterfly (Oreixenica ptunarra) populations in Tasmania. Journal of Insect Conservation 22:521-532. https://doi.org/10.1007/s10841-018-0081-9.

Smith, J. (2012). The denning ecology of the Tasmanian devil [Honours thesis]. University of Tasmania.

Tasmanian State Government (1993). *Land Use Planning and Approvals Act 1993.* No.70 of 1993. Government Printer, Hobart, Tasmania

Tasmanian State Government (1995). *Threatened Species Protection Act 1995.* No.83 of 1995. Government Printer, Hobart, Tasmania

Tasmanian State Government (1999). *Weed Management Act 1999.* No.105 of 1999. Government Printer, Hobart, Tasmania.

Tasmanian State Government (2002). *Nature Conservation Act 2002.* No.63 of 2002. Government Printer, Hobart, Tasmania.

Tasmanian State Government (2006). *Nature Conservation Amendment (Threatened Native Vegetation Communities) Act 2006*. Government Printer, Hobart, Tasmania.

Tasmanian Vegetation Monitoring and Mapping Program/ TVMMP (2013). TASVEG 3.0 Metadata Statement. DPIPWE, Conservation Values Information Section, Hobart, Tasmania.

Thalmann, S., Peck, S., Wise, P., Potts, J. M., Clarke, J., & Richley, J. (2015). Translocation of a top-order carnivore: tracking the initial survival, spatial movement, home-range establishment and habitat use of Tasmanian devils on Maria Island. *Australian Mammalogy*, *38*(1), pp. 68-79.

The Nature Conservancy (1994). *Field Methods for Vegetation Mapping – USGS/NPS Vegetation Mapping Program*. Report prepared for the United States Department of Interior, United States Geology Survey and the United States National Parks Service.

Threatened Species Section (2006). Recovery Plan: Tasmanian Galaxiidae 2006-2010. Department of Primary Industries, Water, Hobart.

Threatened Species Section (2017). Threatened Tasmanian Orchids Flora Recovery Plan. Department of Primary Industries, Parks, Water & Environment, Hobart

Threatened Species Section (2019). DRAFT (pending approval and release) Listing Statement for *Castiarina insculpta* (Miena Jewel Beetle). Department of Primary Industries, Parks, Water and Environment, Tasmania.

Threatened Species Section (2020). Species Management Profiles from Tasmania's Threatened Species Link. http://www.threatenedspecieslink.tas.gov.au. Department of Primary Industries, Parks, Water and Environment, Tasmania.

Threatened Species Unit (2012). Threatened Species Notesheet for *Schoenoplectus tabernaemontani*.

Triggs, B. (1996). Tracks, Scats and Other Traces – A field guide to Australian Mammals. Oxford Press, pp. 352.

Troy, S. N. (2014). *Spatial ecology of the Tasmanian spotted-tailed quoll* (Doctoral dissertation, University of Tasmania).

Wapstra, M. (2018). Flowering Times of Tasmanian Orchids: A Practical Guide for Field Botanists, 4th edition. Self-published by the author (July 2018 version).