

**FLORA, VEGETATION AND FAUNA
IMPACT ASSESSMENT**

Wodgina Lithium Project

FINAL

October 2022



MARBL Lithium Operations Pty Ltd

FLORA, VEGETATION AND FAUNA IMPACT ASSESSMENT

Wodgina Lithium Project

FINAL

Prepared by
Umwelt (Australia) Pty Limited
on behalf of
MARBL Lithium Operations Pty Ltd

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Executive Summary

MARBL Lithium Operations Pty Ltd (MARBL), a joint venture between Albemarle Lithium Pty Ltd (Albemarle) and Mineral Resources Limited (MRL) propose to expand mining operations associated with the Wodgina Lithium Project (the Proposal), located in the Pilbara region of Western Australia.

The Proposed expansion (the Proposal) is for the 2-year mine expansion which includes a pit and waste dump expansion and associated infrastructure. Clearing of native vegetation is proposed to be authorised pursuant to the proposed Native Vegetation Clearing Permit (NVCP) for the 2-year mine plan.

A previous NVCP application (NVCP CPS 8230/1) was submitted for the Project in 2018 to the Department of Mines, Industry Regulation and Safety (DMIRS) by the previous proponent Wodgina Lithium Pty Ltd (WLPL) a wholly owned subsidiary of MRL. This submission was to support an earlier proposed Project expansion which included a significantly larger footprint compared to the current Proposal. The DMIRS requested additional survey and impact assessment work be completed to support the 2018 submission which was completed and submitted. Due to the Project going into Care and Maintenance in 2019 the NVCP was placed on hold.

Umwelt has been engaged to undertake an Impact Assessment to address the potential impacts of the Proposal on flora, vegetation and fauna. This assessment will address the revised proposal footprint and current conservation status of species as well as previous concerns raised by DMIRS.

Flora and Vegetation

No Threatened Flora, Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) will be impacted by the Proposal. The biodiversity of the Flora Study Area is considered similar to those of other surveyed ranges in the Pilbara region.

Three Priority Flora Taxa, as listed by the Department of Biodiversity, Conservation and Attractions (DBCA), will be impacted by the Proposal. There will be a Low local and Low regional significance of impact on *Euphorbia clementii* (P3), *Terminalia supranitifolia* (P3) and *Triodia chichesterensis* (P3) by clearing and other activities associated with the Proposal. Likewise, the significance of cumulative impacts, taking into account historical impacts at Wodgina, for each of these taxa are considered Low.

The potential for significant cumulative impact on all mapped Vegetation Units (VUs) has been ranked Low or Nil.

Fauna

There are 17 species of conservation significant fauna that have been recorded or potentially occur in the Fauna Study Area. For many species, the scale of the impact at a local level is considered to be Low, Very Low, or Negligible. The scale of impact is not likely to be High or Extreme for any species.

At a local level, the scale of impact for the Proposal is considered to be Moderate for the Northern Quoll, Gane's Blind Snake and Long-tailed Dunnart, as the Proposal will lead to the loss of important habitat, primarily 17.97 ha of Rocky Ridge and Gorge habitat. Although the loss of this habitat is likely to be permanent, the loss is unlikely to lead to the local extinction of these or any species, as sufficient habitat area remains in the Fauna Study Area outside the disturbance footprint.

For the Northern Quoll, the implementation of the Proposal is likely to trigger three of the nine significant impact criteria (Department of Environment 2013).

There is unlikely to be an impact on any conservation significant fauna taxa at a regional scale. Although the local population of some species will decrease, none are likely to be lost from the Fauna Study Area and all are likely to persist in the local area in the long-term. Therefore, there is not likely to be a range reduction, loss of an important population or impact on the ability of these species to disperse through the region.

Abbreviations

Term	Definition
BC Act	<i>Biodiversity Protection Act 2016</i> (State)
Cr	Critically Endangered
DBCA	Department of Biodiversity, Conservation and Attractions
DoE	Department of Environment (now Department of Environment and Energy)
DMIRS	Department of Mines, Industry Regulations and Safety
En	Endangered
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
EPA	Environmental Protection Authority
EP Act	<i>Environmental Protection Act 1986</i> (WA)
EWL	Eastern Waste Landform
GDV	Groundwater Dependent Vegetation
GIS	Geographic Information System
ha	Hectares
IIAZ	Indirect Impact Assessment Zone
km	Kilometres
MARBL	MARBL Lithium Operations Pty Ltd
Mi	Migratory
MNES	Matters of National Environmental Significance
MP	Mining Proposal
MRL	Mineral Resources Limited
NVCP	Native Vegetation Clearing Permit
OEPA	Office of the Environmental Protection Authority
OS	Other Specially Protected Fauna
P	Priority
PEC	Priority Ecological Community
RFI	Request for Information
TEC	Threatened Ecological Community
TSF4	Tailings Storage Facility 4
VU	Vegetation Unit
Vu	Vulnerable
WLPL	Wodgina Lithium Proprietary Limited

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Appendices

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Appendix B	Interrogation of Species Profile and Threats (SPRAT) Database using Protected Matters Search Tool. (DAWE 2021)
Appendix C	Conservation Codes for Western Australian Flora and Fauna (DBCA 2019)

1.0 Introduction

MARBL Lithium Operations Pty Ltd (MARBL), a joint venture between Albemarle Lithium Pty Ltd (Albemarle) and Mineral Resources Limited (MRL) owns and operates the Wodgina Lithium Project (the Project), located 80 km south-east of Port Hedland in the Pilbara region of Western Australia. MARBL propose to expand mining operations associated with the Project. The Proposed expansion (the Proposal) is for the 2-year mine expansion which includes a pit and waste dump expansion and associated infrastructure.

Umwelt (Australia) Pty Ltd (Umwelt) (formerly Woodman Environmental Consulting Pty Ltd (Woodman Environmental)) has been engaged to undertake an Impact Assessment to address the potential impacts of “the Proposal” on flora, vegetation and fauna. This assessment will address the revised proposal footprint (including where possible, a comparison with the 2018 application) and current conservation status of species as well as previous concerns raised by the Department of Mines, Industry Regulation and Safety (DMIRS).

1.1 Regulatory Assessment Context

The Proposal is subject to a Native Vegetation Clearing Permit (NVCP) application that is assessed by the Department of Mines, Industry Regulations and Safety (DMIRS). The proposed NVCP application will be to facilitate the expansion of the pit and waste dump, and associated infrastructure.

The Proposal is also subject to approval under the *Mining Act 1978* (WA).

A previous NVCP application (NVCP CPS 8230/1) was submitted for the Project in 2018 to DMIRS by the previous proponent (Wodgina Lithium Pty Ltd (WLPL)), a wholly owned subsidiary of MRL. This submission was to support an earlier proposed Project expansion which included a larger footprint compared to the current Proposal. The DMIRS requested additional survey and impact assessment work be completed to support the 2018 submission which was completed and submitted; a copy of the Request for Information (RFI) received on 24 January 2019 is included in **Appendix A**. Due to the Project going into Care and Maintenance in 2019 the NVCP was placed on hold.

MARBL engagement with DMIRS on 23 September 2021 to discuss the revised Project expansion occurred via Teams. The outcome of the engagement was that ‘the revised NVCP footprint would be assessed as a new NVCP application however reference should be made to the original submission (NVCP CPS 8230/1)’. The NVCP submission will include, where possible, a comparison between the original 2018 NVCP submission and the new Proposal. Note that direct comparisons are not available with some environmental aspects due to additional survey effort being included in this 2022 EIA.

1.2 Purpose and Scope of this Report

This report provides an assessment of the potential direct, indirect and cumulative impacts of the Proposal on flora, vegetation and fauna. The report is intended to inform:

- The assessment of the 2-year Mining Proposal footprint.
- The application to clear native vegetation required for a purpose permit under Part V of the *Environmental Protection Act 1986* (WA) (EP Act) (NVCP application).

This report, including addressing the RFI received on 24 January 2019, is based on:

- The Woodman Environmental (2020) Detailed Flora and Vegetation Assessment, that collated data from desktop and historical field assessments, particularly data collected in 2019 from a detailed vegetation survey and a targeted flora survey.
- The Western Wildlife (2019) Level 2 Fauna Survey undertaken within relevant areas at Wodgina, including the collation of historical fauna data.

For the purposes of this report the following definitions are provided:

- **Direct impacts** are defined as those impacts on environmental values occurring as a result of direct removal of significant flora, vegetation, fauna and fauna habitat components by the Proposal e.g. impacts arising from clearing of native vegetation or removal of fauna habitat such as caves.
- **Indirect impacts** are defined as those impacts on environmental values through indirect pathways as a result of the Proposal, and include causes such as dust emissions, altered hydrological regimes (groundwater drawdown and/or creation of drainage shadow), fragmentation of habitat and/or populations, increased predation, etc.
- **Cumulative impacts** are defined as those impacts on significant flora, vegetation and fauna values as a combination of the Proposal and impacts through historical clearing, as far as they can be assessed.

1.3 Assessment Area Definition

The potential impacts are assessed for both the area within the proposed NVCP boundary as well as the proposed disturbance footprint for the Proposal. The proposed NVCP boundary and proposed disturbance footprint are shown in **Figure 1.1**.

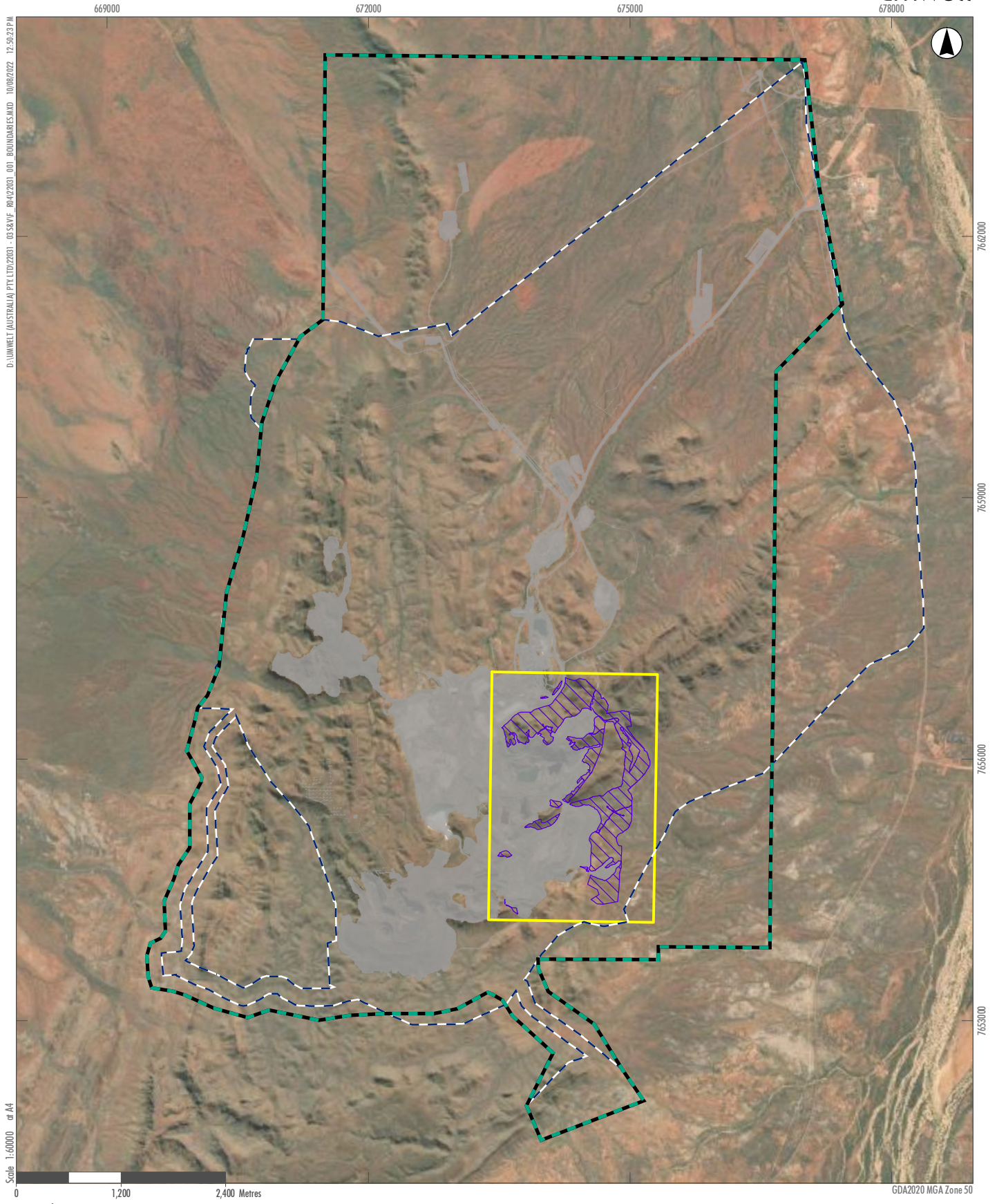
The proposed NVCP boundary and proposed disturbance footprint are smaller in extent compared to the 2018 NVCP application CPS 8230/1. The reduction in extent of the proposed NVCP is due to changes in the Project's mine plan and a revised staged approach.

The total area of the proposed NVCP boundary for the NVCP permit application is provided in **Table 1.1**, together with the corresponding proposed disturbance footprint.

MARBL proposes to undertake clearing of native vegetation within the indicative proposed disturbance footprint; however, the distribution of the area to be cleared may be altered within the permit boundary as required. No clearing of native vegetation will occur outside of the approved NVCP boundary.

Table 1.1 Permit Boundaries and Proposal Footprint

Project	Proposed NVCP Area (ha)	Proposed Disturbance Footprint Area (ha)	Disturbance Footprint as Percent of NVCP boundary
This Proposal	540.56	113.75	21.04
Previous CPS 8230/1	814.9	569.7	69.9



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- Legend**
- Flora Study Area
 - Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - Cleared land

FIGURE 1.1
Biological Study Areas, Proposed NVCP
Boundary and Proposed Disturbance Footprint

1.4 Terminology and Definitions

The terminology used in this report is consistent with the terminology required for a purpose permit under Part V of the *Environmental Protection Act 1986* (WA) (EP Act).

The following definitions apply with reference to the Proposal:

- **Flora Study Area:** the area within which baseline flora and vegetation surveys have been conducted at Wodgina (based on Woodman Environmental 2020). The Flora Study Area has a total area of approximately 6,745.11 ha. Note that survey for significant flora populations extended outside of this study area in some locations where either suitable habitat for such flora was identified, or where populations of significant flora extended outside of the Flora Study Area.
- **Vegetation Study Area:** the area within which baseline vegetation surveys have been conducted at Wodgina (based on Woodman Environmental 2020). The Vegetation Study Area has a total area of approximately 6,745.11 ha. The Vegetation Study Area is equivalent to the extent of the Flora Study Area.
- **Fauna Study Area:** the area within which baseline fauna surveys and studies have been conducted at Wodgina. The Fauna Study Area has a total area of approximately 5,531.30 ha.
- **NVCP boundary:** the proposed NVCP boundary area within which all clearing activities will be undertaken. The total area of the NVCP boundary for the proposed NVCP is approximately 540.56 ha.
- **Disturbance footprint:** the indicative footprint of area required to be cleared. The total area of the proposed disturbance footprint for the Proposal is approximately 113.75 ha.

The location of the proposed NVCP boundary and proposed disturbance footprint, in relation to the Flora, Vegetation and Fauna Study Areas, are presented in **Figure 1.1**.

The following definitions apply with reference to flora, vegetation and fauna:

- **Significant flora** – refers to flora taxa defined as significant by the Environmental Protection Authority (EPA) (EPA 2016a; b):
 - being identified as threatened or priority species
 - locally endemic or associated with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems)
 - new species or anomalous features that indicate a potential new species
 - representative of the range of a species (particularly, at the extremes of range, recently discovered range extensions, or isolated outliers of the main range)
 - unusual species, including restricted subspecies, varieties or naturally occurring hybrids
 - relictual status, being representative of taxonomic groups that no longer occur widely in the broader landscape.

- **Significant vegetation** – refers to vegetation that belongs to one of the following categories as defined by the EPA (EPA 2016a; b):
 - being identified as threatened or priority ecological communities
 - restricted distribution
 - degree of historical impact from threatening processes
 - a role as a refuge
 - providing an important function required to maintain ecological integrity of a Significant ecosystem.

- **Conservation significant fauna** – refers to fauna that belongs to one of the following categories (EPA 2016c):
 - being identified as a threatened or priority species
 - species with restricted distribution
 - degree of historical impact from threatening processes
 - providing an important function required to maintain the ecological integrity of a significant ecosystem.

- **Local** – with regard to the distribution of significant flora taxa and significant vegetation, ‘local’ is defined as the known distribution within the Flora Study Area and locations recorded during surveys for the project immediately outside of this area (for impacts to significant flora taxa) and within the Vegetation Study Area (for impacts to vegetation). With regard to the distribution of conservation significant fauna, ‘local’ is defined as all members of the population within 10 km of the Fauna Study Area.

- **Regional** – with regard to the distribution of significant flora taxa and significant vegetation, ‘regional’ is defined as the total known distribution within Western Australia. Therefore, regional impacts are defined as impacts to significant flora taxa or Vegetation Units (VUs) across their total known distributions. With regard to the distribution of conservation significant fauna, ‘regional’ is defined as the bioregion.

- **Population** – indicative regional populations of the flora taxa assessed have been provided after review of distribution of known locations as presented on NatureMap (Department of Biodiversity, Conservation and Attractions (DBCA) (DBCA 2007-)). Within the Flora Study Area, subpopulations have been defined as those locations (or groups of locations) which are separated by 500 m or more. These subpopulations may in fact represent fewer, larger populations, however additional targeted survey within suitable habitat between them would be required to confirm this.

1.5 Background Summary and Sources of Information

1.5.1 Flora

Various surveys targeting significant flora have been undertaken at Wodgina since 2000.

In April 2019 Woodman Environmental (2019b) undertook a targeted flora survey of the 2018 proposed NVCP CPS8230/1 boundary (since withdrawn) to adequately survey the impact area and immediate surrounds. In June 2019, Woodman Environmental (2020) undertook further targeted flora survey of areas located immediately adjacent to the original survey area (**Figure 1.1**).

Woodman Environmental reported on the results of initial flora and vegetation assessments conducted for the Project in 2018 and 2019 (Woodman Environmental 2019a, b). These survey reports included vegetation mapping of a portion of the Vegetation Study Area not previously mapped, as well as targeted survey for significant flora taxa over several areas. The Woodman Environmental (2020) report includes all methods and findings from these reports, as well as presenting updated floristic analysis of quadrat data and vegetation mapping and historical surveys. The Woodman Environmental (2020) report is the basis for this assessment on the potential project impacts to flora and vegetation. Note, to reduce the potential for 'double counting' within areas where targeted surveys were conducted (2018 and 2019), historical records were excluded from the analysis.

As a result of the surveys undertaken by Woodman Environmental in 2019, it was resolved by relevant experts at the Western Australian Herbarium (WA Herbarium) that entities originally assigned as *Triodia chichesterensis* (P3) and *Triodia scintillans* represent the same entity at Wodgina (*Triodia chichesterensis* (P3)). Therefore, all historical records of *Triodia scintillans* are henceforth treated as *Triodia chichesterensis* (P3) for this site. Historical records of *Triodia* aff. *basedowii* collected within the Flora Study Area and surrounding regional areas are also considered to be this entity and have been included as such.

Many locations of *Euphorbia clementii* (P3) were recorded during historic targeted flora surveys undertaken by Woodman Environmental (2011b; 2012). This taxon responds to fire and was recorded in areas that had been relatively recently burnt prior to that survey period. Representative locations within the then CPS 8230/1 permit boundary were re-examined during surveys in April 2019; however only limited numbers of individuals were located. Likewise, few records of this taxon were recorded during further surveys in June 2019 (Woodman Environmental 2020). Therefore, survey data showing relatively few new locations for this taxon in 2019 are representative of the lack of recent burns in these areas, rather than this taxon being absent.

Searches of relevant government databases, namely, the DBCA Threatened Flora databases (including the Threatened and Priority Flora (TPFL) database and the Western Australian Herbarium (WAHerb) database) (DBCA 2021a), and the Department of Agriculture, Water and the Environment (DAWE) Species Profile and Threats Database (DAWE 2021) were updated as part of this current impact assessment (**Appendix B**) to identify records of any significant flora taxa that have been added to these databases subsequent to the completion of the most recent baseline surveys in the Flora Study Area. These searches used the Desktop Study Area as presented in Woodman Environmental (2020), which is the Flora Study Area with a buffer of 20 km. No records of any significant taxa additional to those identified as part of the most recent baseline surveys in the Flora Study Area were returned by the updated DBCA database searches (DBCA 2021a). The search of the DAWE Species Profile and Threats Database identified one Threatened taxon, or habitat for the taxon, that is likely to occur within the Desktop Study Area, being *Pityrodia* sp. Marble Bar

(G. Woodman & D. Coultas GWDC Opp 4). This taxon has recently been formally published as *Quoya zonalis* (Shepherd & Hislop 2020); therefore all future references to this taxon in this report, including in **Table 1.2**, use the latter name.

A total of six significant flora taxa are known to occur in the Flora Study Area, of which three are also known to occur within the proposed NVCP boundary area. Of the four remaining taxa, two are considered Unlikely to occur in the proposed NVCP boundary area due to lack of habitat; two further taxa are considered to have Potential of occurrence due to presence of habitat, despite the intense survey undertaken across the disturbance footprint areas (Woodman Environmental 2020).

Based on the review by Woodman Environmental (2020), a further eleven significant flora taxa have the potential to occur within the Flora Study Area. Of these taxa, eight are unlikely to be present as there is no suitable habitat available for these taxa (**Table 1.2**). This includes the Threatened taxon *Quoyazonalis*; although suitable habitat for this taxon is present, the Flora Study Area is outside the known restricted range of this taxon, with the known occurrences approximately 25 km east of the Flora Study Area. Although this taxon was not identified by desktop assessment prior to the most recent targeted surveys in the Flora Study Area being conducted, personnel conducting the surveys were aware of this taxon's occurrence in the wider region and its identifying characteristics, as Woodman Environmental were responsible for facilitating the recognition of this taxon by the WAHerb.

Three further taxa have been assessed as Possibly occurring within the Flora Study Area, due to habitat being present; however, targeted survey has been conducted across these areas at an appropriate time of year, and these taxa were not identified as being present in the area. It is unlikely that these taxa occur in the proposed disturbance footprint based on intensive sampling within the proposed NVCP boundary.

An overview of the known locations of significant flora taxa relative to the permit boundary and disturbance footprint is presented in **Figure 1.2**. None of these significant flora taxa are listed as Threatened under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act; Commonwealth), or the *Biodiversity Conservation Act 2016* (BC Act; State). These taxa are all listed as Priority Flora by the DBCA. The conservation codes used by the DBCA (2019) for flora and fauna in Western Australia are provided in **Appendix C**.

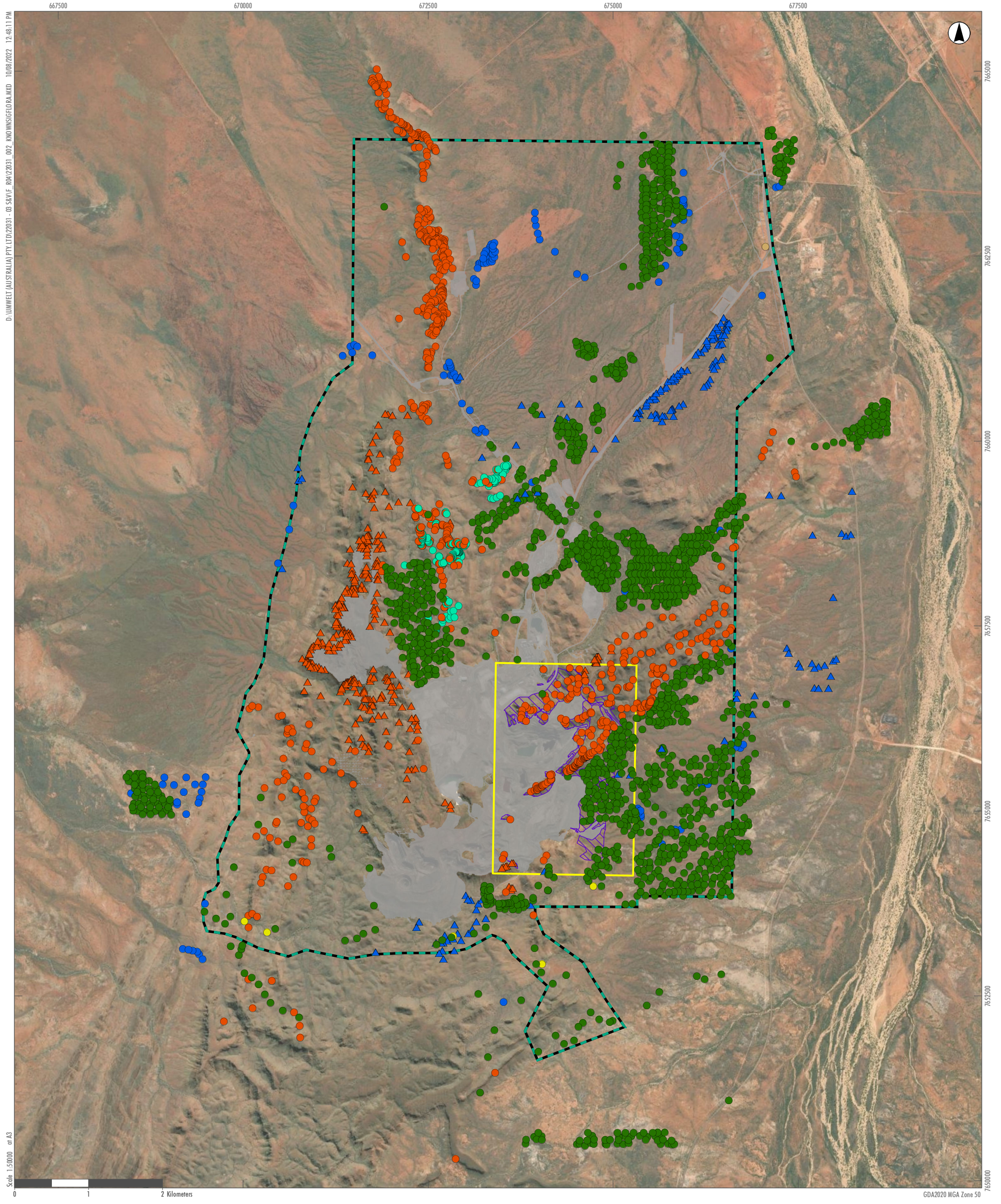
Table 1.2 Significant Flora Taxa Known or Potentially Occurring in the Flora Study Area

Taxon	Status	VU Occurrence	Likelihood of presence in proposed NVCP boundary area*
<i>Abutilon aff. hannii</i>	Potentially undescribed	9, 14 [^]	Unlikely: potential habitat present, however not recorded during targeted survey.
<i>Acacia leeuweniana</i>	P1	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Acacia levata</i>	P3	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Bulbostylis burbridgeae</i>	P4	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Eragrostis crateriformis</i>	P3	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Euphorbia clementii</i>	P3	1, 2 [^] , 4, 5, 6, 7, 9 [^] , 10 [^] , 11 [^] , 12, 13, 14	Present.
<i>Gomphrena leptophylla</i>	P3	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Goodenia nuda</i>	P4	-	Unlikely: habitat not known to be present and not recorded during targeted survey.
<i>Gymnanthera cunninghamii</i>	P3	-	Unlikely: potential habitat not present and not recorded during targeted survey.
<i>Heliotropium muticum</i>	P3	1 [^]	Unlikely: potential habitat present, however, not recorded during targeted surveys.
<i>Nicotiana umbratica</i>	P3	-	Unlikely: potential habitat not present and not recorded during targeted survey.
<i>Phyllanthus hebecarpus</i>	P3	-	Unlikely: potential habitat not present and not recorded during targeted survey.
<i>Quoya zonalis</i>	Threatened	-	Unlikely: potential habitat present, however not recorded during targeted survey. Outside of known range of taxon which is currently very restricted.
<i>Stylidium weeliwolli</i>	P3	-	Unlikely: potential habitat not present and not recorded during targeted survey.
<i>Terminalia supranitifolia</i>	P3	2, 3, 4 [^] , 5, 7, 8, 9 [^] , 14	Present.
<i>Triodia chichesterensis</i>	P3	1, 2, 4 [^] , 5 [^] , 6 [^] , 7 [^] , 8 [^] , 9 [^] , 10, 11, 12 [^] , 13, 14	Present.
<i>Vigna triodiophila</i>	P3	2, 7, 9 [^] , 14	Unlikely: potential habitat present, however not recorded during targeted surveys.

Data from Woodman Environmental (2020).

[^]Designates preferred habitat, based on proportional location representation and landforms/soils.

*Likelihood of occurrence based on availability of potential habitat in permit boundary and collated records from surveys.



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GDA2020 MGA Zone 50

Legend

- Flora Study Area
- Proposed NVCP Boundary
- Proposed Disturbance Footprint
- Cleared land

Significant Flora

- Ecl *Euphorbia clementii* (P3) – 2018/2019 surveys
- ▲ Ecl *Euphorbia clementii* (P3) – previous surveys
- Hmu *Heliotropium muticum* (P3) – 2018/2019 surveys
- Tch *Triodia chichesterensis* (P3) – 2018/2019 surveys
- ▲ Tch *Triodia chichesterensis* (P3) – previous surveys

- Tsu *Terminalia supranitifolia* (P3) – 2018/2019 surveys
- ▲ Tsu *Terminalia supranitifolia* (P3) – previous surveys
- Vtr, Y *Vigna triodiophila* (P3) – 2018/2019 surveys
- ▲ Vtr *Vigna triodiophila* (P3) – previous surveys
- Aah *Abutilon* aff. *hannii* (potentially undescribed) – 2018/2019 surveys
- Tsc *Triodia scintillans* (significant range extension) – 2018/2019 surveys
- ▲ Tsc *Triodia scintillans* (significant range extension) – previous surveys

FIGURE 1.2

Significant Flora Taxa of the Flora Study Area

1.5.2 Vegetation

1.5.2.1 Regional Area

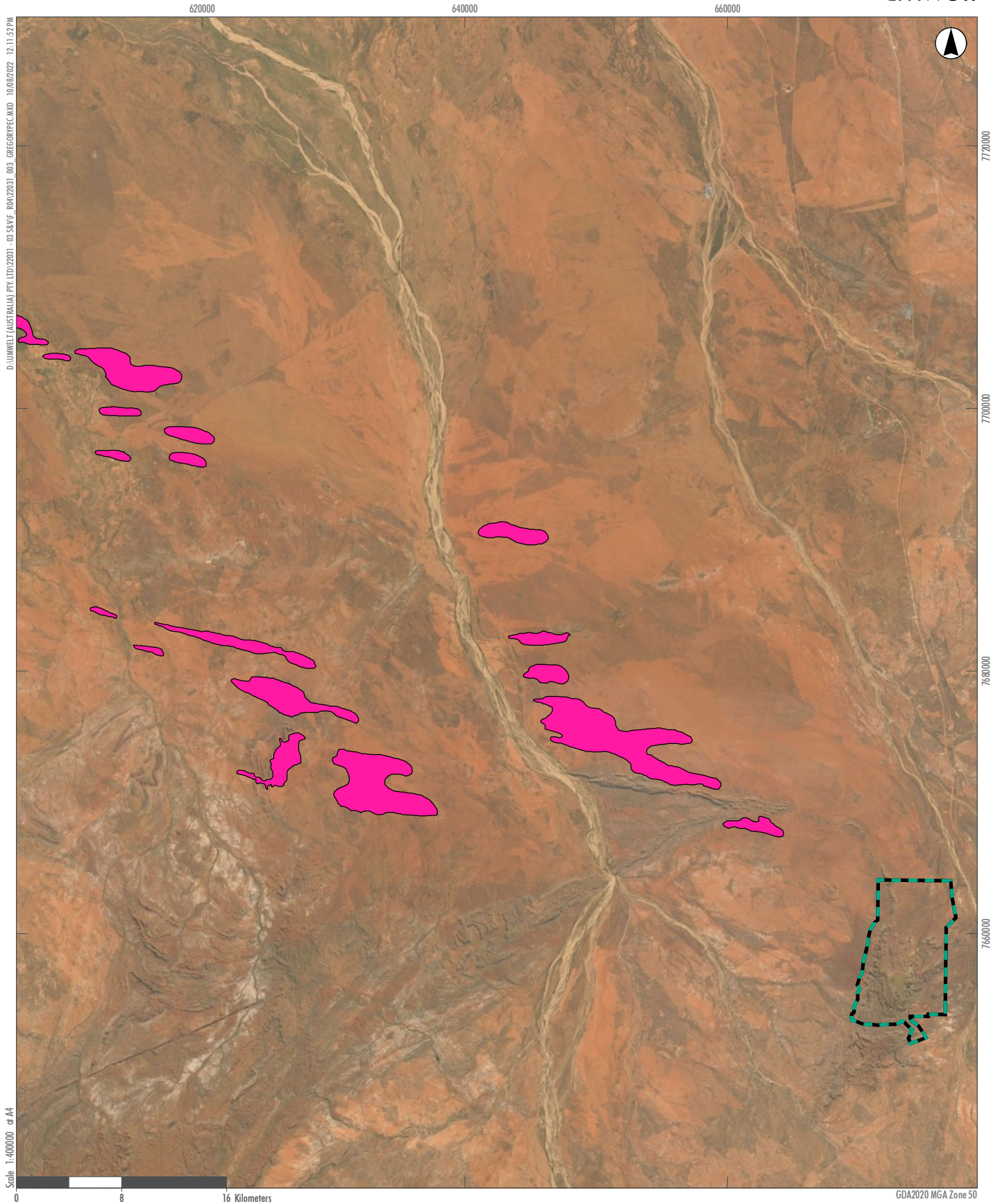
Searches of relevant government databases (DBCA’s Threatened Ecological Community (TEC) and Priority Ecological Community (PEC) database (DBCA 2021b), and the DAWE Species Profile and Threats Database (DAWE 2021) were updated as part of this current impact assessment to identify records of any significant communities that have been added to these databases subsequent to the completion of the most recent baseline surveys in the Vegetation Study Area. These searches used the Desktop Study Area as presented in Woodman Environmental (2020) which is the Vegetation Study Area with a buffer of 20 km. The search of the DAWE Species Profile and Threats Database did not identify any TECs that are likely to occur in the Desktop Study Area.

The search of DBCA’s TEC and PEC database (DBCA 2021b) identified one PEC that occurs within the Vegetation Study Area, being the Gregory Land System (P3). This PEC was listed subsequent to the most recent baseline surveys being conducted as shown on **Figure 1.3** relative to the Vegetation Study Area. No known occurrences of this PEC are within the Vegetation Study Area, with the nearest location approximately 8 km west north-west of the Vegetation Study Area. Although areas of vegetation on red sandplains similar to those described as being part of Gregory Land System (Van Vreeswyck *et al.* 2004) were identified and mapped in the Vegetation Study Area as part of VU 10 (Woodman Environmental 2020), the Gregory Land System only includes sandplains that are within the vicinity of linear sand dunes (Van Vreeswyck *et al.* 2004); no such dunes were identified within the Vegetation Study Area. It is therefore considered that this PEC does not occur within the Vegetation Study Area, and consequently, the proposed NVCP boundary area. This PEC is therefore not discussed further.

The proposed NVCP boundary area is located within two vegetation system associations, as defined by Government of Western Australia (2019) (Woodman Environmental 2019a) as presented in **Table 1.3**. These vegetation system associations are widespread and relatively intact, although one vegetation system association is not well-reserved.

Table 1.3 Vegetation System Associations of the Study Area

Vegetation System Association/Land System	Extant Area (ha)	Percentage of Pre-European Extent Remaining	Percentage of Current Extent Protected for Conservation
Abydos Plain – Chichester_93 Hummock grasslands, shrub steppe; kanji over soft spinifex	2,478,504	99.9	0.5
Abydos Plain – Chichester_626 Hummock grasslands, shrub-steppe; kanji over soft spinifex and <i>Triodia brizoides</i>	117,198	99.6	15.6



- Legend**
- Flora Study Area
 - Gregory Land System (PEC)

FIGURE 1.3
Gregory Land System PEC in relation to the Flora Study Area

1.5.2.2 Local Area

A detailed analysis of previous assessments of the VUs of the Vegetation Study Area was undertaken by Woodman Environmental (2020) to provide a comprehensive dataset to support approvals applications and assessment of impacts for the Project.

Vegetation Condition

Vegetation condition over the Vegetation Study Area is presented in **Figure 1.4** and summarised in **Table 1.4**. The majority (96.91 %) of the mapped vegetation in the Vegetation Study Area (which comprises equivalent to 87.51 % of the entire Study Area) was rated as 'Excellent'. Cleared areas (includes Completely Degraded, Degraded and areas under rehabilitation) comprised 12.49 % of the Vegetation Study Area.

Table 1.4 Vegetation Condition within the Vegetation Study Area (data from Woodman Environmental 2020)

Condition Category	Area (ha)	As % of Vegetation Study Area	As % of Mapped Vegetation
Excellent	5720.07	84.80 %	96.91 %
Excellent / Very Good	15.87	0.24 %	0.27 %
Very Good	43.35	0.64 %	0.73 %
Good	82.12	1.22 %	1.39 %
Good/Poor	21.37	0.32 %	0.36 %
Poor	19.55	0.29 %	0.33 %
Vegetation (Excellent to Poor)	5902.32	87.51 %	-
*Cleared	842.79	12.49 %	-

*Includes Completely Degraded, Degraded and areas under rehabilitation.

Introduced Flora

Introduced flora locations are presented in **Figure 1.4**. A total of nine introduced flora taxa are known from the Study Area (Woodman Environmental 2020). Location information and comments regarding the significance of these taxa, including ecological impact and invasiveness ratings for each introduced taxon under the Invasive Plant Prioritization Process for the DBCA for the Pilbara Region (DBCA 2014) is presented in Table 1.5. Note that *Calotropis procera* is a Declared Pest under the BAM Act (DPIRD 2019). No Weeds of National Significance (WoNS) were recorded in the Study Area.

Table 1.5 Summary of Introduced Flora Within the Flora Study Area

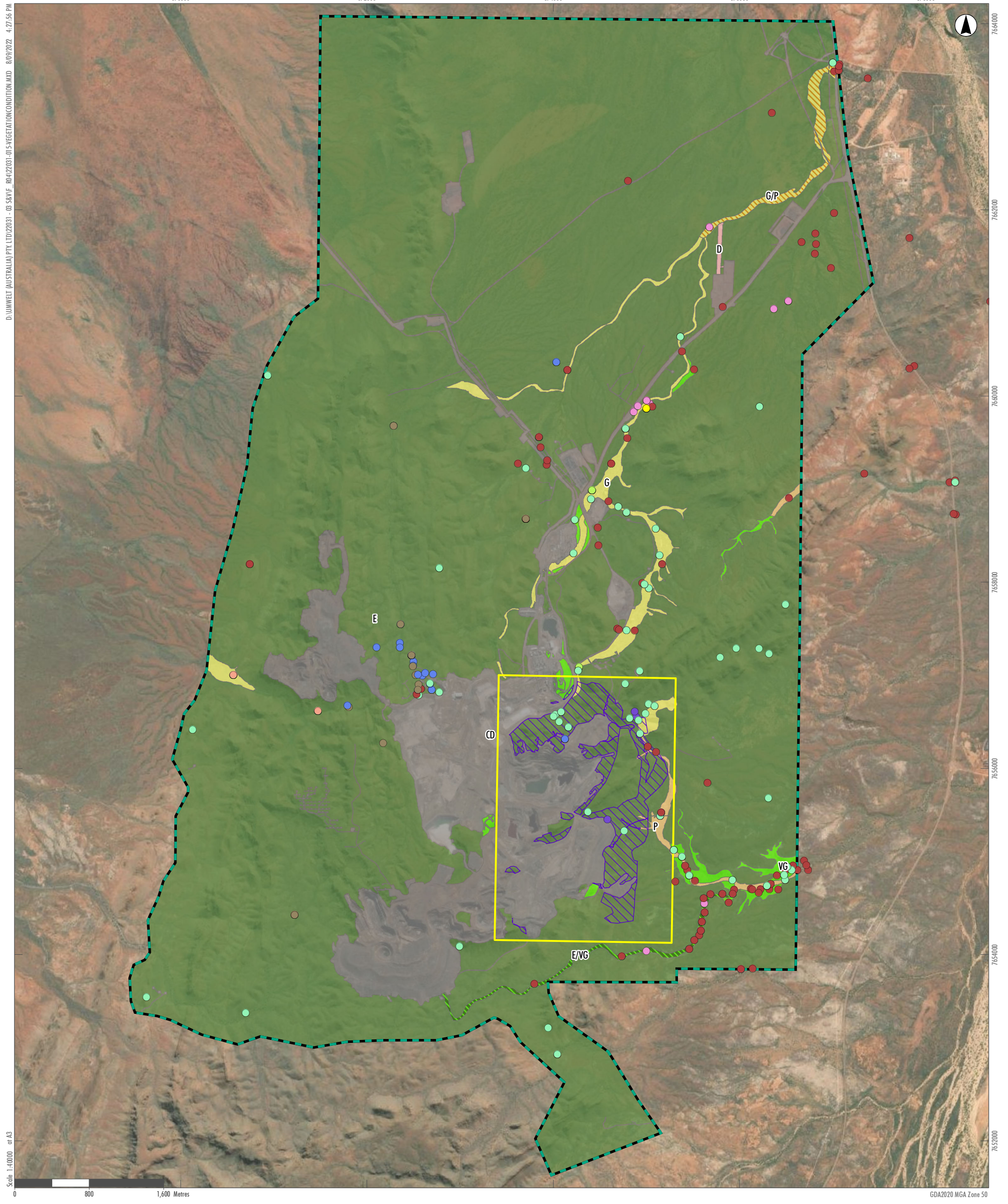
Taxon	Common Name	Comments
<i>Aerva javanica</i>	Kapok	Ecological impact rated High, invasiveness rated Rapid (DBCA 2014)
<i>Calotropis procera</i>	Calotrope	Declared Pest (DPIRD 2019); Priority alert weed (DBCA 2014)
<i>Cenchrus ciliaris</i>	Buffel Grass	Considered by the States and Territories of Australia to pose a particularly significant threat to biodiversity (DoEE 2018a); Ecological impact rated High, invasiveness rated Rapid (DBCA 2014)
<i>Cenchrus setiger</i>	Birdwood Grass	Ecological impact rated High, invasiveness rated Rapid (DBCA 2014)
<i>Cynodon dactylon</i> Couch	Couch	Ecological impact rated High, invasiveness rated Rapid (DBCA 2014)
<i>Eragrostis minor</i>	Smaller Stinkgrass	Not rated by DBCA (2014)
<i>Flaveria trinervia</i>	Speedy Weed	Not rated by DBCA (2014)
<i>Passiflora foetida</i> var. <i>hispida</i>	Stinking Passionflower	Ecological impact rated High, invasiveness rated Rapid (DBCA 2014)
<i>Trianthema portulacastrum</i>	Giant Pigweed	Not rated by DBCA (2014)

Vegetation Units

VUs were mapped and defined from a total of 262 quadrats established throughout the Vegetation Study Area, targeting all landform types identified through review of historical study data and aerial photography (Woodman Environmental, 2020).

Several vegetation studies had previously been undertaken in the Vegetation Study Area; however, these focussed on smaller project areas, were undertaken outside of the relevant season for survey, and/or were not undertaken using the methods as detailed in EPA (2016a). As such, assessment of impact on vegetation is undertaken using the VU dataset presented by Woodman Environmental (2020).

The location of the proposed NVCP boundary area and disturbance footprint with the VUs mapped as detailed by Woodman Environmental (2020) within the Vegetation Study Area is presented in **Figure 1.5**.



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- Legend**
- Flora Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
- Vegetation Condition**
- E Excellent
 - E/VG Excellent / Very Good
 - VG Very Good
 - G Good
 - G/P Good/Poor
 - P Poor
 - D Degraded
 - CD Completely Degraded

- Introduced Flora**
- AeJ *Aerva javanica*
 - Cap *Calotropis procera*
 - Cec *Cenchrus ciliaris*
 - Cse *Cenchrus setiger*
 - Cyd *Cynodon dactylon*
 - Erm *Eragrostis minor*
 - Flt *Flaveria trinervia*
 - Paf *Passiflora foetida* var. *hispid*a
 - Trp *Trianthema portulacastrum*

FIGURE 1.4

Vegetation Condition and Introduced Flora within the Flora Study Area

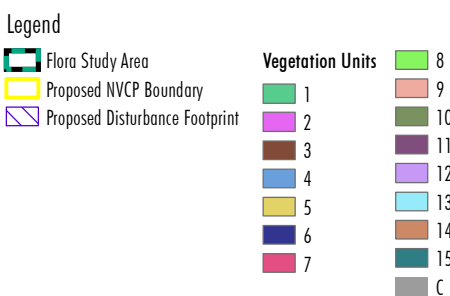
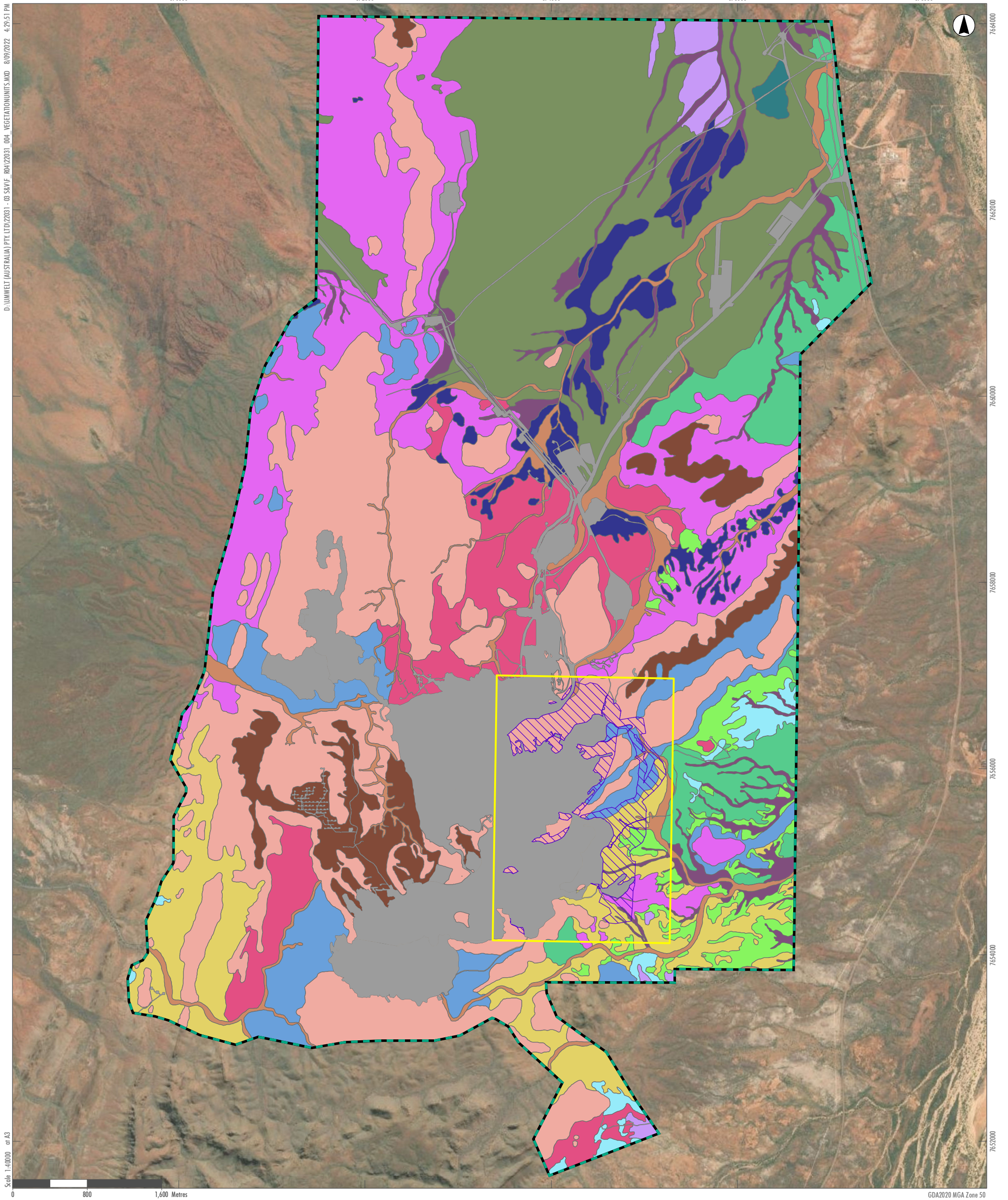


FIGURE 1.5
Vegetation Units of the
Flora Study Area

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Vegetation Units

- 1 Tall open to sparse shrubland dominated by *Acacia orthocarpa*, *A. ancistrocarpa* and occasionally *A. acradenia* over low sparse shrubland of mixed species dominated by *A. stellaticeps* over low hummock grassland dominated by *Triodia lanigera* and occasionally *T. epactia* on red-brown clay loam with granite, quartz or ironstone stones on colluvial stone plains and low flat-topped rises.
- 2 Tall to mid sparse shrubland of mixed species dominated by *Acacia acradenia*, *A. inaequilatera*, *Grevillea wickhamii* subsp. *hispidula* and occasionally *A. tumida* var. *pilbarensis* and *A. ancistrocarpa* over low sparse shrubland of mixed species including *Indigofera monophylla* and *Goodenia stobbsiana* over low hummock grassland dominated by *Triodia epactia* and/or *T. brizoides* on red, brown or red-brown clay loam with metamorphic, ironstone, quartz and occasionally granite stones, occasionally with metamorphosed granite or granite outcropping, on lower slopes and colluvial outwashes of ranges and occasionally on low flat-topped rises.
- 3 Low open woodland to isolated trees of *Eucalyptus leucophloia* subsp. *leucophloia* and/or *Corymbia hamersleyana* over tall to mid sparse to open shrubland dominated by *Acacia acradenia*, *Grevillea wickhamii* subsp. *hispidula* and *A. tumida* var. *pilbarensis* over low sparse shrubland of mixed species including *Dampiera candidans*, *Indigofera monophylla*, *Goodenia stobbsiana* and *Triumfetta maconochieana* over low hummock grassland dominated by *Triodia epactia* and often *T. brizoides* or *T. wiseana* over low sparse tussock grassland dominated by *Eriachne mucronata* on red, brown or red brown clay loam with ironstone or metamorphosed granite stones over ironstone or metamorphosed granite outcropping on plateaus, crests and upper slopes of ranges.
- 4 Tall to mid sparse shrubland dominated by *Acacia inaequilatera*, *A. acradenia* and *Grevillea wickhamii* subsp. *hispidula* over low sparse shrubland of mixed species including *Corchorus parviflorus* and *Indigofera monophylla* over low hummock grassland dominated by *Triodia epactia* and/or *T. wiseana*, or occasionally *T. brizoides* and *T. chichesterensis*, on red, brown or red-brown clay loam with metamorphosed granite, dolerite and occasionally ironstone stones over metamorphosed granite or dolerite outcropping on mid and upper slopes of ranges, and low ridges and hills.
- 5 Tall to mid sparse shrubland of mixed species dominated by *Acacia acradenia*, *A. inaequilatera* and *A. orthocarpa* over low sparse shrubland of mixed species dominated by *Acacia spondylophylla* over low hummock grassland dominated by a combination of *Triodia chichesterensis*, *T. wiseana*, *T. epactia*, *T. brizoides* and *T. lanigera* on red-brown clay loam with metamorphosed granite, ironstone, dolerite, quartz and calcrete stones, occasionally over metamorphosed granite and dolerite outcropping, on lower slopes and colluvial outwashes of ranges and low flat-topped rises.
- 6 Low open woodland to isolated trees of *Corymbia hamersleyana* over tall to mid sparse shrubland dominated by *Acacia inaequilatera*, *A. acradenia* and *Grevillea wickhamii* subsp. *hispidula* over low hummock grassland dominated by *Triodia chichesterensis* and/or *T. wiseana* on brown or occasionally red clay loam with calccrete, quartz and metamorphosed granite stones, occasionally over calccrete outcropping, on colluvial outwashes of ranges and colluvial stony plains.
- 7 Tall to mid sparse shrubland of mixed species including *Acacia inaequilatera*, *Grevillea pyramidalis* subsp. *leucadendron* and *A. orthocarpa* over low hummock grassland dominated by *Triodia chichesterensis* and/or *T. wiseana* on brown, red or red-brown clay loam with dolerite, calccrete and quartz stones, often with dolerite outcropping, on low hills.
- 8 Low isolated trees of *Corymbia hamersleyana* over tall to mid sparse shrubland dominated by *Acacia bivenosa* and *A. inaequilatera* over low hummock grassland dominated by *Triodia chichesterensis* and/or *T. wiseana* and *T. angusta* on brown, red-brown or grey-brown clay loam with dolerite, calccrete, ironstone and quartz stones on colluvial stony plains.
- 9 Low isolated trees of *Corymbia hamersleyana* over mid sparse shrubland to isolated shrubs dominated by *Acacia acradenia*, *A. inaequilatera* and *Grevillea wickhamii* subsp. *hispidula* over low hummock grassland dominated by *T. wiseana*, *T. epactia* and occasionally *T. brizoides* on red, brown or red-brown clay loam with ironstone, metamorphosed granite or occasionally dolerite or quartz stones over ironstone or metamorphosed granite outcropping on cliffs, ridges and crests and upper to mid slopes of ranges.
- 10 Low isolated trees of *Corymbia hamersleyana* and/or *Corymbia zygophylla* over tall to mid open to sparse shrubland dominated by *Acacia ancistrocarpa* and occasionally *A. tumida* var. *pilbarensis*, *A. inaequilatera* and *Grevillea wickhamii* subsp. *hispidula* over low sparse shrubland of mixed species dominated by *Bonamia erecta*, *Indigofera monophylla* and *Ptilotus astrolasius* over low hummock grassland dominated by *Triodia lanigera* and occasionally *T. schinzii* and/or *T. epactia* on red, brown or red-brown sandy or clay loam, often with quartz or ironstone stones, on plains.
- 11 Low isolated trees of *Corymbia hamersleyana* over tall open to sparse shrubland dominated by *A. tumida* var. *pilbarensis*, *A. ancistrocarpa* and *A. acradenia* over low open to sparse shrubland of mixed species including *Bonamia erecta*, *Isotropis atropurpurea* and *Corchorus parviflorus* over low hummock and tussock grassland dominated by *Chrysopogon fallax*, *Triodia epactia* and occasionally *T. lanigera* on red, brown or red-brown sandy or clay loam with colluvial stones in minor drainage features including flats and small creeks.
- 12 Low open woodland of *Corymbia hamersleyana* over tall sparse shrubland dominated by *Acacia inaequilatera* over mid sparse shrubland dominated by *Acacia bivenosa* and *Codonocarpus cotinifolius* over low sparse shrubland of mixed species dominated by *Corchorus parviflorus*, *Indigofera monophylla*, *Heliotropium chrysocarpum* and *Heliotropium pachyphyllum* over low hummock grassland dominated by *Triodia chichesterensis* and occasionally *T. epactia* or *T. angusta* on red, brown or grey-brown clay loam with calccrete or quartz stones on undulating plains.
- 13 Isolated low trees dominated by *Corymbia hamersleyana* over tall to mid sparse shrubland dominated by *Acacia orthocarpa*, *Grevillea wickhamii* subsp. *hispidula* and often *A. maitlandii* and *A. tumida* var. *pilbarensis* over low sparse shrubland of mixed species including *Corchorus parviflorus*, *Dampiera candidans*, *Goodenia stobbsiana*, *Indigofera monophylla* and *Scaevola browniana* subsp. *browniana* over low hummock grassland dominated by *Triodia epactia* and occasionally *T. brizoides* or *T. lanigera* on orange, brown or red-brown sandy or clay loam with granite and quartz stones over granite outcropping on undulating plains or low rises.
- 14 Low open woodland to isolated trees dominated by *Eucalyptus vitrix* and/or *Corymbia hamersleyana* over tall open to sparse shrubland of mixed species dominated by *Acacia pyrifolia* var. *pyrifolia*, *A. tumida* var. *pilbarensis* and *Melaleuca linophylla* over mid to low open to sparse shrubland of mixed species including *Cajanus pubescens*, *Indigofera monophylla*, *Tephrosia rosea* var. *dementii*, *Corchorus parviflorus* and *Jasminum didymum* subsp. *lineare* over low tussock and hummock grassland to open tussock and hummock grassland of mixed species dominated by *Triodia epactia*, *Cenchrus ciliaris*, *Chrysopogon fallax*, *Cymbopogon ambiguus* and *Eriachne tenuiculmis* on red or brown clay or sandy loam, usually with colluvial stones, in major creeks.
- 15 Mid isolated shrubs of *Acacia synchronica* over low isolated chenopod shrubs of *Maireana* sp. over low sparse forbland, tussock grassland and sedgeland of mixed species including *Portulaca oleracea*, *Ptilotus exaltatus*, *Cynodon prostratus*, *Sporobolus australasicus* and *Fimbristylis dichotoma* on red clay loam with colluvial stones on plains.
- C Cleared land

FIGURE 1.5

LEGEND: Vegetation Units of the Flora Study Area

A summary of the extent of VUs mapped by Woodman Environmental (2020) within the Vegetation Study Area is presented in **Table 1.6**. None of these VUs represent State or Commonwealth listed TECs or PECs, listed under the EPBC Act or BC Act. Likewise, none of these communities represent significant vegetation as otherwise defined by the EPA (2016a; b). VUs 12, 13 and 15 were mapped over less than 1 % of the Vegetation Study Area and although not well-represented locally, they are otherwise not of conservation significance.

Table 1.6 Vegetation Units of the Vegetation Study Area (Woodman Environmental 2020)

Vegetation Unit	Mapped Extent in Study Area (ha)	Percentage of Study Area (%)
1	297.86	4.42
2	831.05	12.32
3	243.32	3.61
4	325.69	4.83
5	372.96	5.53
6	208.51	3.09
7	362.87	5.38
8	134.04	1.99
9	1,374.81	20.38
10	1,229.57	18.23
11	182.72	2.71
12	59.57	0.88
13	57.11	0.85
14	207.11	3.07
15	15.50	0.23
Cleared*	842.71	12.49
Total area	6,745.42	-

* Cleared includes areas undergoing rehabilitation.

1.5.3 Fauna

Several fauna surveys have been undertaken across the Fauna Study Area between 2008 and 2022 (e.g. Outback Ecology (2009b; 2012); 360 Environmental (2018a; d), Stantec (2018a; b, 2022) and Western Wildlife (2019)). These have included Level 1 and Level 2 fauna surveys, as well as targeted surveys for conservation significant fauna.

Six fauna habitats were identified in the Fauna Study Area (**Table 1.7, Figure 1.6**). Of these, all are widespread in the bioregion except for the Ironstone Ridgetop and Rocky Ridge and Gorge habitats, both of which are limited in extent. The Rocky Ridge and Gorge and the Drainage Line habitat are also regarded as Important habitat. Important Rocky Ridge and Gorge habitat elements are caves that support diurnal (daytime) roosts for significant bat species: For Drainage Line habitat elements are permanent and semi-permanent pools.

Table 1.7 Fauna Habitats Occurring in the Fauna Study Area (Western Wildlife 2019)

Habitat	Key Habitat Elements	Extent in the Bioregion	Significance	Area currently remaining (ha)	Proportion of Study Area (%)
Ironstone Ridgetop	Small stones suitable for Western Pebble-mound Mouse.	Limited	Limited: although it provides some habitat for the Western Pebble-mound Mouse, this species uses the widespread Spinifex Stony Plain habitat. Located on the top of ridges, this habitat is relatively exposed and lacks microhabitats such as crevices and caves.	208.2	3.8 %
Rocky Ridge and Gorge	Outcropping rocky areas, fallen boulders, caves, overhangs and rock crevices.	Limited	Important: supports several threatened species, including the Northern Quoll, Pilbara Leaf-nosed Bat and Ghost Bat, is limited in extent and may provide refuge from fire. The cracks, crevices and caves provide shelter for reptiles and mammals, many of which occur only in rocky habitats.	371.3	6.7 %
Rocky Foothills	Occasional rocky outcrops.	Widespread	Limited: this habitat is widespread in the region and lacks microhabitats such as crevices and caves.	1,331.8	24.1 %
Stony Rise	No particular elements identified.	Widespread	Limited: this habitat is widespread in the region and lacks microhabitats such as crevices and caves.	175.2	3.2 %
Spinifex Stony Plain	Many minor drainage lines (not mapped separately) provides shelter for fauna; small stones suitable for Western Pebble-mound Mouse; tree hollows.	Widespread	Limited: although it provides habitat for the Western Pebble-mound Mouse, this habitat is very widespread in the region.	2,339.2	42.3 %
Drainage Line	May function as a corridor for fauna movement; permanent and semi-permanent pools; tree hollows; leaf litter accumulations.	Widespread	Important: this habitat provides foraging habitat for threatened bats, is likely to support a greater diversity and abundance of fauna compared to surrounding habitats and may provide a corridor for fauna movement. Semi-permanent and permanent water pools provide water sources for fauna in surrounding habitats.	330.8	6.0 %
Disturbed areas	-	-	-	774.5	14.0 %

The predicted faunal assemblage for the Fauna Study Area was compiled by Western Wildlife (2019), using the results of previous fauna surveys and a review of the relevant databases. A total of ten frog, 107 reptile, 140 bird, 33 native mammal and eight introduced mammal species potentially occur. More than half of these have been recorded within the Fauna Study Area, with the observed assemblage thus far comprising five frog, 59 reptile, 84 bird, 26 native and eight introduced mammal species. Although diverse, the faunal assemblage is representative of similar sites in the Pilbara Bioregion. A search of the EPBC Act Protected Matters Search Tool identified one change since the Western Wildlife (2019) report that listed the Grey Falcon as Vulnerable (Vu). This species is only listed under the State BC Act as Vulnerable.

Seventeen conservation significant fauna species are known from, or have the potential to occur in, the Fauna Study Area (**Table 1.8**). Of these, six species are known to occur, as they have been recorded during previous fauna surveys (Western Wildlife 2019).

Table 1.8 Significant Fauna Known or Potentially Occurring in the Fauna Study Area

Fauna species	Status*			Potential habitat use at Wodgina	Likelihood of occurrence
	EPBC Act	BC Act	DBCA Priority		
<i>Pezoporus occidentalis</i> Night Parrot	En	Cr		<ul style="list-style-type: none"> Spinifex Stony Plain (?) 	Low (?)**
<i>Dasyurus hallucatus</i> Northern Quoll	En	En		<ul style="list-style-type: none"> Rocky Ridge and Gorge Drainage Line 	Known to occur
<i>Rhinioncteris aurantia</i> Pilbara Leaf-nosed Bat	Vu	Vu	•	<ul style="list-style-type: none"> Rocky Ridge and Gorge Drainage Line 	Known to occur
<i>Macroderma gigas</i> Ghost Bat	Vu	Vu		<ul style="list-style-type: none"> Rocky Ridge and Gorge Drainage Line 	Known to occur
<i>Liasis olivaceus barroni</i> Pilbara Olive Python	Vu	Vu		<ul style="list-style-type: none"> Rocky Ridge and Gorge Drainage Line 	High
<i>Falco hypoleucos</i> Grey Falcon	Vu	Vu		<ul style="list-style-type: none"> Drainage Line All other habitats (foraging) 	High
<i>Charadrius veredus</i> Oriental Plover	Mi	Mi		<ul style="list-style-type: none"> Drainage Line 	Moderate
<i>Tringa glareola</i> Wood Sandpiper	Mi	Mi		<ul style="list-style-type: none"> Drainage Line 	Moderate
<i>Tringa hypoleucos</i> Common Sandpiper	Mi	Mi		<ul style="list-style-type: none"> Drainage Line 	Moderate
<i>Apus pacificus</i> Fork-tailed Swift	Mi	Mi		<ul style="list-style-type: none"> May overfly any habitat 	High
<i>Falco peregrinus</i> Peregrine Falcon		OS		<ul style="list-style-type: none"> Rocky Ridge and Gorge (potential breeding habitat) All other habitats (foraging) 	High
<i>Ctenotus nigrilineatus</i> Black-lined Ctenotus			P1	<ul style="list-style-type: none"> Rocky Foothills Stony Rise Spinifex Stony Plain 	Moderate

Fauna species	Status*			Potential habitat use at Wodgina	Likelihood of occurrence
	EPBC Act	BC Act	DBCA Priority		
<i>Anilius ganei</i> Gane's Blind Snake			P1	<ul style="list-style-type: none"> Rocky Ridge and Gorge Rocky Foothills 	Moderate
<i>Lagorchestes conspicillatus</i> Spectacled Hare-wallaby			P4	<ul style="list-style-type: none"> Spinifex Stony Plain 	Known to occur
<i>Sminthopsis longicaudata</i> Long-tailed Dunnart			P4	<ul style="list-style-type: none"> Ironstone Ridgetop Rocky Ridge and Gorge Spinifex Stony Plain Stony Rise Rocky Foothills 	Known to occur
<i>Leggadina lakedownensis</i> Lakeland Downs Mouse			P4	<ul style="list-style-type: none"> Spinifex Stony Plain Drainage Line 	Moderate
<i>Pseudomys chapmani</i> Western Pebble-mound Mouse			P4	<ul style="list-style-type: none"> Ironstone Ridgetop Spinifex Stony Plain 	Known to occur

*Key to status: Cr = Critically Endangered, En = Endangered, Vu = Vulnerable, Mi = Migratory, OS = Other Specially Protected Fauna, P1 – P4 = Priority 1 – 4.

** There are very few records of this species anywhere, thus its habitat requirements and distribution are not well understood.

669000 672000 675000 678000

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766000
765900
765800
765700

Scale 1:60000 at A4

0 1,200 2,400 Metres

GDA2020 MGA Zone 50

Legend

- Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - Permanent Pool
 - Semi-Permanent Pool
- Fauna Habitat**
- Disturbance
 - Drainage Line
 - Ironstone Ridge Top
 - Low Vegetation with Ephemeral Areas
 - Rocky Foothills
 - Rocky Ridge and Gorge
 - Shrubland over Spinifex Sandplain
 - Spinifex Sandplain
 - Spinifex Stony Plain
 - Stony Rises

FIGURE 1.6
Fauna Habitats within the Fauna Study Area

2.0 Methods – Flora and Vegetation

2.1 Identification of Threatening Processes

Direct impacts to flora and vegetation are those attributable to clearing within the disturbance footprint resulting in the removal of vegetation and known flora locations and individuals at these locations.

Indirect impacts to flora and vegetation may occur as a result of processes such as:

- Dust emissions: potential to smother individual plants causing decline in health or death, and potential to reduce the condition of vegetation.
- Water and/or sediment run off (for example, erosion after significant rainfall from waste dumps): potential to smother both individuals of significant flora taxa, and general vegetation resulting in decline in health or death.
- Altered hydrology and drainage shadow: potential for significant reduction or removal of seasonal surface water flow, causing either death or loss of condition to individual plants or vegetation. Drainage shadows are areas with reduced water associated with changes in water movement as a result of drainage.
- Introduction of weeds and pathogens: introduction of weed taxa can lead to competition for available resources with individual plants, and loss of condition of vegetation.
- Changes to groundwater levels on groundwater dependent vegetation (GDV): can lead to death of phreatophytic taxa and change in composition of GDV.
- Fragmentation to local populations of significant flora and vegetation: fragmentation of existing populations or patches of vegetation can lead to decline in health due to decline in quality of populations, or loss of genetic diversity through isolation of segments of a population, leading to reduced genetic fitness of remaining population.

2.2 Assessment of Direct Impacts

The assessment of direct impacts is provided by quantification of the project activities in a Geographic Information System (GIS) environment of the known extent and range of significant environmental factors. Impacts have been calculated using the disturbance footprint within the NVCP boundary on such factors.

2.2.1 Flora

The significant flora dataset for Wodgina is based on the report by Woodman Environmental (2020) that has been used to undertake this assessment. Historical locations of significant flora taxa which occur on areas mapped as previously disturbed have been removed from the determination of non-cumulative impact assessment.

The proposed NVCP boundary and the proposed disturbance footprint (provided by MARBL) were overlaid on locations of significant flora in a GIS environment, to determine the potential extent of impact on these locations and associated individual plants. The extent of proposed impact on preferred habitat VUs for each taxon was also calculated to determine the proportional extent to which such habitat for each taxon will be impacted. The assessment of impacts to flora and vegetation has also utilised the proposed NVCP boundary to allow for some flexibility in the proposed disturbance footprint.

The methods for assessing the scale and significance of impact were developed by Woodman Environmental in consultation with the Environmental Protection Authority Services Unit (previously Office of the EPA) and DBCA (previously Department of Environment and Conservation) as part of previous impact assessment projects. A ranking of the scale of potential local impact on each taxon was determined and is presented in **Table 2.1**.

The impact on the number of known individuals has been assessed for taxa where good contextual information regarding the distribution of the taxon in the disturbance footprint is known (i.e. *Terminalia supranitifolia* (P3) and *Triodia chichesterensis* (P3)). The true extent of *Euphorbia clementii* (P3) within the Flora Study Area is unable to be determined due to the taxon's response to fire, and the lack of recently burnt areas. Although some individuals of this taxon have been recorded in areas significantly post-fire (>1 year), the number of plants occurring is significantly less than post-fire. Given this lack of extent of location data, assessment of the impact on potential habitat in terms of VUs has been undertaken to determine the likelihood of risk of significant impact on *Euphorbia clementii* (P3), and also undertaken for the other significant taxa to provide additional context.

Impact on significant flora taxa at regional context cannot be accurately calculated as there is insufficient data available on the numbers of individuals of significant flora taxa known across their ranges. Assessment of impacts at the regional scale utilises the significance of the local subpopulation(s) to the maintenance of taxon throughout its range and scales the proposed impact on local populations to determine the potential impact on the taxon in terms of conservation status across its entire range.

A qualitative assessment, using data from government databases and Umwelt records, of the significance of the local populations of significant flora to the regional conservation status of the taxon is presented in terms of assessing the:

- number and distribution of regional localities and populations
- the location of the Flora Study Area within the range
- the size of regional populations and
- the reservation status of these populations.

The significance of the scale of impact is assessed based on the importance of local populations to their regional conservation (**Table 2.4**).

Table 2.1 Scale of Potential Local and Regional Impact on Significant Flora Taxa

Scale of Potential Impact	Level	Description of Impact
Low Impact	Local	<25 % of known local individuals or area of habitat may potentially be impacted.
	Regional	<25 % of known regional populations may potentially be impacted. Local subpopulations are not of particular significance in terms of maintaining the survival of the taxon: taxon has a wide distribution; >10 populations some of which are protected in conservation estate; and the local population is likely to have low significance in maintaining the extent of the taxon, for example being located within the known range and not representing a disjunct population, being located in relatively close proximity to other populations.
Moderate Impact	Local	25–50 % (inclusive) of known local individuals or area of habitat may potentially be impacted.
	Regional	25–50 % of known regional populations may potentially be impacted. Local subpopulations are moderately significant in terms of maintaining the taxon through its range: generally <10 populations, which may include those on conservation estate; the taxon may have a wide distribution however the local population is located on the edge of the range or forms a significant disjunct population in comparison to the other populations; few if any nearby populations.
High Impact	Local	>50 % of known local individuals or area of habitat may potentially be impacted.
	Regional	>50 % of known regional populations may potentially be impacted. Local subpopulations to be impacted are relatively significant in terms of maintaining the taxon through its range: there is limited distribution of the taxon (<40 km); limited numbers of known populations (<5), with no populations being located on conservation estate; and the local population potentially contributes significantly to the maintenance of the taxon through being representative of the edge of the known range, forming a significant disjunct population or representing a significantly large population in comparison to other populations.

2.2.2 Vegetation

The proposed disturbance footprint and NVCP boundary were overlaid on VU polygons mapped in the Flora Study Area in a GIS environment, to determine the area of each VU proposed to be impacted.

A ranking of the level of potential local impact on VUs was determined using the scale presented in **Table 2.2**.

Table 2.2 Level of Potential Local Impact on Vegetation Units

Ranking of Potential Impact	Description of Impact
Low Impact	<25 % of mapped VU in Study Area may potentially be impacted
Moderate Impact	25 - 50 % of mapped VU in Study Area may potentially be impacted
High Impact	>50 % of mapped VU in Study Area may potentially be impacted

The local conservation significance of each VU mapped in the Vegetation Study Area is defined utilising the scale presented in **Table 2.3**. This allows for the significance of potential local impacts to VUs to be ranked, as a function of the level of potential local impact and the local conservation significance of each VU.

The ranking scale of the significance of potential local impacts to VUs is presented in **Table 2.4**.

Table 2.3 Descriptions of Local Conservation Significance Rankings of Vegetation Units

Local Conservation Significance Ranking	Description
1 (low)	<ul style="list-style-type: none"> VU comprises >10 % of the Vegetation Study Area; and Landform/soil type where VU occurs is locally common and widespread.
2 (Low- Moderate)	<ul style="list-style-type: none"> VU comprises 1-10 % of the Vegetation Study Area; and Landform/soil type where VU occurs is locally common and widespread.
3 (Moderate)	<ul style="list-style-type: none"> VU comprises 1-10 % of the Vegetation Study Area; and Landform/soil type where VU occurs is locally uncommon and/or restricted.
4 (Moderate – High)	<ul style="list-style-type: none"> VU comprises < 1 % of the Vegetation Study Area; and Landform/soil type where VU occurs is locally common and widespread.
5 (High)	<ul style="list-style-type: none"> VU comprises < 1 % of the Vegetation Study Area; and either Landform/soil type where VU occurs is locally uncommon and/or restricted.

Table 2.4 Significance of Potential Local Impact on Flora Taxa and Vegetation Units

		Level of Potential Local Impact		
		Low	Moderate	High
Local Conservation Significance of Flora Taxon/VU	Low 1, 2	Low	Low	Low
	Moderate 3	Low	Moderate	Moderate-High
	High 4, 5	Low	Moderate-High	High

Limited information regarding the regional distribution of VUs is available for the Pilbara Region. Impacts to the pre-European extent of vegetation system associations of the Pilbara (Government of Western Australia 2019) are presented. Although a regional flora and vegetation survey of the Pilbara Region has been undertaken by DBCA (McKenzie *et al.* 2009), no reports describing VUs on a regional scale are available. Vegetation mapping of the Turner River Hub Project (Woodman Environmental 2011a) surveyed a relatively extensive area, however the vegetation study areas was not included as part of this assessment.

2.3 Assessment of Indirect Impacts

Indirect impacts to flora and vegetation may occur as a result of the threatening processes as outlined in **Section 2.1**.

Some research has been undertaken at minesites in nearby regions in relation to impact of dust emissions on significant flora taxa. Turner (2013) undertook a study on the effects of mining dust on vegetation health at the Jack Hills. Monitoring by Woodman Environmental (2017) at the Atlas Iron Pty Ltd Pardoo Iron Ore Mine focused on potential impacts to health of flora from dust generated by mining operations including road use, focusing on two ephemeral significant taxa (*Eragrostis crateriformis* (P3) and *Rothia indica* subsp. *australis* (P1)).

There is some evidence to suggest that dust from mining operations can impact flora taxa or vegetation, but the long-term impact is not clear. Turner (2013) did find that heavy dust loading created reduced stomatal conductance on two *Acacia* taxa: likewise, it was observed at sites with heavy dust loads many plants dropped leaves or had died. Turner (2013) found that the leaf surface and dust interaction was more important to stress levels than the actual amount of dust: however, metal-rich dust with low pH may have been the causal factor. The dust levels on ephemeral significant taxa as monitored at the Pardoo site by Woodman Environmental (2017) did not cause significant stress or death to the taxa monitored.

Sediment and water run-off from disturbed areas after significant rainfall events into surrounding native vegetation can occur and there is the possibility of impacts to vegetation. Likewise, introduction of weeds or other pathogens from activities such as clearing can degrade otherwise intact vegetation on a temporal basis.

A potential indirect impact zone surrounding all footprints to an extent of 20 m has been used to quantify potential indirect impacts of these processes on nearby significant flora and vegetation units. This area is referred to as the Indirect Impact Assessment Zone (IIAZ). This zone represents a potential worst-case area of indirect impact only, with actual loss of vegetation within this zone considered unlikely based on no obvious changes observed in the condition of the vegetation bordering the existing Wodgina Operations (Woodman Environmental field observations; Outback Ecology 2009a).

Investigations determining the presence of GDV have been undertaken at Wodgina (Woodman Environmental 2019a), and reference to this assessment has been utilised to present potential impact of groundwater drawdown on GDV by the project in **Section 4.4.1**. A qualitative assessment of the potential impact of drainage shadow is also provided based on the interruption of local creek and drainage systems by the project.

The main drivers of indirect fragmentation effects include reduced patch (habitat) area, increased edge effects (introduction of weeds and other degradation), altered patch shape, increased patch isolation and altered matrix structure. Smaller patches, including smaller areas of known populations of significant flora, can result in reduction of reproductive success of individual species and reduce overall species composition (Didham 2010). The length of time of which a patch has been isolated is also important, with species richness decreasing over time.

With respect to individual species, several traits may assist in predicting their sensitivity to fragmentation (Henle *et al.* (2004) as referenced by Didham 2010):

- Population size: smaller populations are more prone to extinction.
- Population variability: greater temporal variability in population size reduces the probability of population persistence.
- Competitive ability and sensitivity to disturbance: competitively-dominant species in undisturbed habitats may reduce at the expense of disturbance-opportunists.
- Degree of habitat specialisation: specialist species are more susceptible than generalists.
- Rarity: rare, patchily distributed species are more susceptible than common species.
- Biogeographical location: tropical and Mediterranean biomes are more sensitive to fragmentation than temperate biomes.

The impact of fragmentation of populations of significant flora and vegetation is difficult to quantify at a site level. Literature searches have revealed no studies that have been undertaken to determine the genetic diversity of significant flora subpopulations at Wodgina, or between the subpopulations at Wodgina and in the region. A qualitative assessment of the possible impacts of fragmentation by the proposals is provided in **Section 4.4.3**.

2.4 Assessment of Cumulative Impacts

A summary of the cumulative impact of both historical clearing (where data is available), the impacts of the proposed disturbance footprint and indirect impacts at Wodgina is provided in **Section 4.5**. This assessment is based on a worst-case scenario, assuming total clearing of the disturbance footprint areas and total loss of flora and vegetation within the IIAZ.

The impact of historical clearing on significant flora and vegetation at Wodgina is more difficult to quantify. Impacts through mining-related activities occurred at Wodgina prior to the identification of significant flora taxa in the area, and therefore historical data in relation to the extent of populations of these taxa within areas that were cleared is not complete. Impacts to flora and vegetation are based on the report by Woodman Environmental (2020) that collated results for relevant previous surveys.

Locations of significant flora recorded prior to surveys by Woodman Environmental (2019a), which occur in areas mapped as Cleared, have been included in the cumulative assessment as representation of historical impacts to such flora taxa; however, it is potentially an underestimate of the historical clearing impact. This is particularly pertinent to *Triodia chichesterensis* (P3).

There are historically cleared areas at Wodgina that were mapped as Cleared or Disturbed, and therefore have not been able to be allocated to any VU. Quadrats established in previously cleared areas (Outback Ecology 2009a) were established using a different sample size than that required by EPA (2016a), and as such are statistically incompatible with the data collected by Woodman Environmental (2019a). Therefore, the vegetation mapping undertaken by Outback Ecology has not been included in this assessment. The extent of clearing of VUs as mapped by Woodman Environmental (2012) have been determined using GIS, and an assessment of historical clearing of vegetation in this area has been provided.

2.5 Limitations

A number of flora and vegetation surveys have been undertaken at Wodgina. The Woodman Environmental (2020) report (the basis for this flora and vegetation impact assessment) summarises all methods and findings from these reports and provides an updated floristic analysis of quadrat data and vegetation mapping. The report identifies the impact of fire on the extent of *Euphorbia clementii* (P3) as a limitation based on the species being a fire-responder. A decline in individuals was recorded during the 2019 targeted survey in areas where individuals had previously been recorded (as discussed in **Section 1.5.1**). Due to the fire response of *Euphorbia clementii* (P3), and the lack of recently burnt areas in the study area at the time of survey, the impact on preferred habitat is considered to provide a more accurate representation of local impact on this taxon than the impact on the number of individuals (as discussed in **Section 4.3.3**).

3.0 Methods – Fauna

3.1 Identification of Threatening Processes

The current and future threats to significant species in the Pilbara Bioregion were identified by Carawardine *et al.* (2014), and include the following:

- **Fire:** Too frequent or too intense fires that results in loss of sheltering understorey and food resources.
- **Overgrazing and feral herbivores:** Livestock, mainly cattle (*Bos taurus*), and feral herbivores such as Donkeys (*Equus asinus*) and Camels (*Camelus dromedarius*) can result in habitat changes through trampling, selective grazing, introduction of weeds and simplification of vegetation structure.
- **Introduced predators:** Cats (*Felis catus*) occur throughout the Pilbara and Foxes (*Vulpes vulpes*) occur mainly on the coastal plains. These species have caused population declines and the contraction in the range of Pilbara fauna, particularly small and medium-sized mammals.
- **Cane toads:** Cane toads (*Rhinella marina*) periodically arrive in the Pilbara (e.g. on trucks) and their establishment is likely to impact native predators, reptiles and invertebrates.
- **Invasive plants:** Weeds are often associated with inappropriate fire and grazing regimes and may be introduced by mining activities. Weeds threaten habitats, particularly in wetlands or riparian areas.
- **Hydrological change:** Mine dewatering results in impacts below the surface, where it may affect groundwater dependent ecosystems, and above the surface, where it may change water flow regimes or create permanent waters. Permanent water may support introduced predators.
- **Mining:** Mining has direct impacts on fauna through habitat loss, alteration and fragmentation from both the mine and supporting linear infrastructure. Indirect impacts include altered hydrological and fire regimes and contamination of soil and water.
- **Agriculture:** though agriculture in the Pilbara is currently small-scale, future expansion of irrigated agriculture has the potential to alter hydrological regimes and result in habitat loss in potential croplands.
- **Tourism expansion:** tourism outside of DBCA-managed lands may result in impacts such as increased fire and introduction of exotic plants and animals.

Based on the list above, there are various threatening processes to native flora and fauna already operating in the Pilbara bioregion. To combat these threatening processes, Carawardine *et al.* (2014) suggest that the most cost-effective strategies are (in order) to control feral ungulates, establish predator-free wildlife sanctuaries and control cat predation around key wildlife assets.

Threatening processes specifically associated with the Proposal are listed in **Table 3.1**. These threats potentially cause impacts on fauna, which may be direct (e.g. loss of habitat or individuals within the project footprints) or indirect (e.g. altered fire regimes leading to habitat change, resulting in impacts to fauna populations). Impacts may also be cumulative, where the impacts of several projects or project stages combine.

These impacts were considered in relation to the fauna populations and habitats within the disturbance footprint, fauna populations in adjacent habitats (i.e. fauna in the local area and the remainder of the rocky range) and regional fauna populations. A 'local population' of fauna can vary from species to species depending on a range of factors including the mobility of the species, its habitat specificity and population structure. For the purpose of this assessment, the local population refers to all individuals of the species within 10 km range of the Fauna Study Area; however, the distribution of each species within this area is strongly influenced by the habitats available.

Note that for fauna there is generally no quantitative data available regarding direct or indirect impacts. The amount of habitat cleared is used as a substitute for the likely proportion of the fauna population lost. Indirect impacts are qualitatively assessed against known threatening processes for each species as presented in the literature. For example, if predation by feral cats is considered a threatening process for a species and the project is likely to result in the increase in feral cats, then it is considered likely that the project will cause an indirect impact on this species.

Table 3.1 Key Direct and Indirect Threats that may impact fauna

Threatening Process	Potential Impacts on fauna or fauna habitat	
	Direct Impact	Indirect Impact
<p>Clearing</p> <p>Land clearing is recognised as a Key Threatening Process under the EPBC Act. Clearing of native vegetation will occur in the NVCP boundary area.</p>	<p>For most fauna, the loss of habitat is regarded as being the most significant direct impact on fauna in the NVCP boundary area. Although some fauna may relocate ahead of clearing, the loss of habitat will result in a proportional loss of fauna from the local population and mortality considered a high likelihood for fauna that do not relocate. The loss of some habitat features may be permanent, when structures such as rocky outcrops or caves cannot be recreated through rehabilitation. For some species habitat loss may be temporary and these species may return to sites post-rehabilitation. However, recolonisation of rehabilitated areas by fauna is a complex issue, and it does not necessarily follow that successful rehabilitation of vegetation will lead to successful recolonization by fauna.</p>	<p>Fragmentation of habitat may occur when habitat is cleared within the NVCP boundary area, fragmenting the remaining habitat into smaller, isolated patches. Widespread habitats such as Spinifex Stony Plains are less vulnerable to habitat fragmentation, however, linear habitats such as rocky ridges or drainage lines, may be broken up into separate areas. Fauna reliant on these habitats must either negotiate areas of cleared land or they will be isolated. Some fauna, such as birds, are highly mobile and less likely to be affected by habitat fragmentation. Small ground-dwelling species are more likely to be impacted by habitat fragmentation.</p>
<p>Road mortalities</p> <p>Road mortalities may occur when fauna and vehicles interact. It may be exacerbated by night driving and driving on roads that pass close to important habitat areas.</p>	<p>Many species have the potential to interact fatally with traffic, including nocturnal species crossing roads, low-flying bats, reptiles crossing/basking on tracks and kangaroos crossing tracks.</p>	-
<p>Other accidental mortalities</p> <p>Other mortalities of fauna may occur when native species are attracted to or interact with mining operations and infrastructure.</p>	<p>Fauna may become trapped in bins, skips, artificial water sources or steep-sided trenches. Fauna may shelter in pipes or other construction materials and become trapped or killed. Barbed-wire fences may cause entanglement and mortalities of bats.</p>	-

Threatening Process	Potential Impacts on fauna or fauna habitat	
	Direct Impact	Indirect Impact
<p>Noise and vibration</p> <p>Noise and vibration occur in association with mining activities and may include the operation of light and heavy vehicles, workshop noise, use of generators and power tools, drilling and blasting.</p>	<p>Increase in noise and vibration events in adjacent habitats.</p>	<p>At its lowest level, noise and vibration (e.g. from vehicle movements and generators) may cause fauna to avoid areas of otherwise suitable habitat. This may occur both within the NVCP boundary area and in adjacent habitats, though the overall effect on populations is not likely to be large. Drilling and blasting may also result in larger impacts such as the collapse or abandonment of bat roosts and abandonment of nests and/or eggs, burrows and/or young.</p>
<p>Dust</p> <p>Dust is likely to be produced during clearing, by driving on unsealed roads and tracks or through drilling and blasting.</p>	<p>Increase in production of dust, which may lead to dust clouds and dust deposition in surrounding habitats including waterbodies.</p>	<p>Where it impacts surrounding habitats, (e.g. roadsides), dust may reduce the potential of that habitat to supply food and shelter to fauna. Dust in waterbodies, such as water pools on drainage lines, may impact water quality and reduce the potential of these to support fauna.</p>
<p>Artificial light</p> <p>Artificial lighting occurs in association with night shift activities and includes vehicle lights and lighting of work areas.</p>	<p>Increase in artificial light spill into adjacent habitats.</p>	<p>Exposure to artificial light sources has the potential to impact fauna behaviour, including foraging and breeding behaviours. It may lead to fauna being attracted to light sources (where they may then be impacted by other processes) or preventing fauna from accessing otherwise suitable habitats.</p>
<p>Altered fire regimes</p> <p>Fires may be accidentally lit through ignition sources such as hot vehicles coming into contact with dry vegetation, sparks from hot works, inappropriate cigarette disposal and other ignition sources.</p>	<p>Increase in the frequency and intensity of fires in surrounding habitats. Note that the real risk of this impact is low, as standard operating procedures (e.g. firebreaks, fire extinguishers in vehicles) limit the sources of accidental ignition and prevent the spread of spot-fires.</p>	<p>Although fire is a natural part of the ecosystem, fires that are too frequent, too intense or very widespread can impact fauna by removing shelter (such as old-growth spinifex) and reducing productivity. While fauna populations can recover after fire as habitats regenerate, frequent fires may prevent this, causing local extinction.</p>

Threatening Process	Potential Impacts on fauna or fauna habitat	
	Direct Impact	Indirect Impact
<p>Altered hydrological regimes</p> <p>Clearing and modification of the landscape through the construction of pits and waste landforms can alter surface water flows. Artificial water sources such as dams and sumps may be constructed.</p>	<p>Increase in artificial water sources or permanent water, or changes to water-flows in drainage lines.</p> <p>Changes to groundwater levels in proximity to the pit footprint.</p>	<p>Artificial water sources and new sources of permanent water are likely to change the native faunal assemblage in a region where many species are adapted to the lack of water. Water sources may support populations of introduced predators that then prey on native species. Changes to underground water levels may impact the humidity of important bat roost caves.</p>
<p>Invasive plants</p> <p>Invasive plants may be introduced and/or spread around the site through the movement of seeds or soil.</p>	<p>Introduction of new weeds or spread of existing weeds resulting in the modification of habitats and simplification of habitat structure.</p>	<p>Habitats modified by weeds potentially support fewer fauna species. Weeds may prevent regeneration of fauna habitats after fire or rehabilitation.</p>
<p>Introduced predators</p> <p>Cats and wild dogs can be attracted to putrescible waste (e.g. landfill sites), be purposely fed by staff or be attracted to artificial water sources.</p>	<p>Increase in population of introduced predators such as cats and wild dogs.</p>	<p>Introduced predators prey on a variety of native fauna. Predation by feral cats is identified as a threatening process for significant fauna species, including the Northern Quoll, Pilbara Olive Python (particularly juveniles) and Spectacled Hare-wallaby.</p>
<p>Introduction of Cane Toads</p> <p>Cane Toads may be brought into the mine area on vehicles or freight.</p>	<p>Introduction of Cane Toads to water sources in the NVCP boundary area.</p>	<p>Cane Toads are likely to have a detrimental effect on native fauna species. Native predators such as the Northern Quoll and goannas may ingest them and die. Cane Toads prey on native frogs and invertebrates.</p>
<p>Human disturbance</p> <p>Human disturbance, such as entry of bat roosts or handling of fauna, may occur when staff are not appropriately educated.</p>	<p>Human entry of bat roosts may cause abandonment of the roost. Non-essential handling or harassment of fauna may result in stress to individual fauna handled. Fauna egress from areas of human interaction.</p>	<p>-</p>

3.2 Cumulative Impacts on Fauna

Cumulative impacts have been assessed in the context of the previous mining activities at Wodgina, most recently the MARBL Lithium Project and Atlas DSO Project, as well as the backdrop of the current pattern of mining and other disturbances in the Pilbara Bioregion. A summary of historical clearing is included in **Section 5.1**. Note that 525.6 ha (9.5 %) of the Fauna Study Area was cleared prior to the MARBL Lithium Project and Atlas DSO Project, and no fauna habitat mapping is available for this area.

3.3 Assessment of the Scale of Impact

The scale of impact on the vertebrate faunal assemblage and significant fauna species was assessed according to the categories in **Table 3.2**. The scale of impact on each species was assessed in the context of:

- the characteristics of the fauna population known (or likely) to be present in the Fauna Study Area, such as the population size, the number of individuals likely to be present, whether the species is resident or visiting, or whether the species is likely to breed in the area
- the likely regional significance of the local fauna population, such as whether the population in the Fauna Study Area is likely to be of particular importance to maintaining the species in the bioregion, or for maintaining genetic diversity in the species
- the likely regional significance of the habitats present to the fauna population, such as whether the habitats are more important than those in surrounding areas for providing breeding, foraging or shelter habitat.

Except where specifically indicated, the scale of impact was assessed on the basis that no active management of threats is undertaken, and that the entire disturbance footprint area is cleared. Standard and targeted management and mitigation strategies may reduce the scale of impact for some species.

Table 3.2 Scale of impact on local fauna populations

Local Scale of impact	Description	Explanation
Negligible	No perceived impact on population.	Species infrequently occurs and/or is not reliant on the habitats that are impacted.
Very Low	No reduction in population size expected.	Although there may be impacts to some individuals, the population as a whole is unlikely to be reduced.
Low	Temporary reduction in population size; expected recovery of population after life of project.	The population may decline somewhat due to impacts on some individuals or due to loss of habitat. After the project has finished, habitats are rehabilitated and the population returns to the pre-impact state.
Moderate	Permanent reduction in population size; no threat to persistence of local population.	Although habitat critical to the survival of the species is reduced, the remaining area of habitat is sufficient to maintain a self-sustaining population of the species after the life of the project.
High	Permanent reduction in population size; persistence of local population in doubt.	Habitat critical to the survival of the species is reduced, fragmented or altered to the point that it is uncertain if the species can persist in the local area.
Extreme	Local extinction of population.	Habitat critical to the survival of the species is reduced, fragmented or altered to the point that the species can no longer be sustained in the local area.

3.4 Assessment of Impacts on Regional Fauna Populations

When the scale of impact on the local fauna population is assessed as Negligible, Very Low or Low, then it is considered that there is unlikely to be a regional impact. Where the scale of impact on the local fauna population is assessed as Moderate, High or Extreme, then there is the possibility of a regional impact. A regional impact may occur when the impact on a local population results in:

- the reduction in the range of the species in the region
- the loss of a genetically distinct population
- the loss of a population or habitat important for dispersal between other regional populations
- the loss of the entire known population or a loss in a significant proportion of the known regional population.

3.5 Assessment of the Significance of Impact on Fauna that are Matters of National Environmental Significance

Fauna listed as Matters of National Environmental Significance (MNES) under the EPBC Act were assessed as to whether the potential impacts of the development were likely to constitute a ‘significant’ impact on the species. A significant impact is one that is ‘important, notable or of consequence, having regard to its context or intensity’ (DoE 2013). Only species for which the local scale of impact was considered to be Moderate, High or Extreme (as per **Table 3.2**) were considered.

The determination on the risk of a ‘significant’ impact was undertaken with reference to ‘Matters of National Environmental Significance: Significant Impact Guidelines 1.1’ (DoE 2013). Additional guidance on what constitutes a significant impact was obtained from the ‘EPBC Act referral guideline for the endangered northern quoll *Dasyurus hallucatus*’ (DoE 2016), ‘Conservation listing advice for *Macroderma gigas* Ghost Bat (TSSC 2016a) and ‘Conservation listing advice for *Rhinonictoris aurantia* (Pilbara form) Pilbara leaf-nosed Bat’ (TSSC 2016c). The risk of a significant impact was determined to be High, Moderate or Low, as per **Table 3.3**. Note that according to DoE (2013) for a significant impact to be ‘likely’, it does not need to have a greater than 50 % chance of occurring, it is sufficient that the significant impact has a real chance of occurring. Where there is scientific uncertainty about a serious or irreversible impact, the precautionary principle applies.

Table 3.3 Risk of a Significant Impact–Fauna

Risk of a significant impact	Description	Example
Low	Low risk of a significant impact on the species.	Species infrequently occurs; no critical habitat is present or likely to be impacted; indirect impacts are few or none.
Moderate	Moderate risk of a significant impact on the species.	Species is recorded or likely to be present; only supporting habitats present or little impact on critical habitat if present; may be some indirect impacts on populations or habitats.
High	High risk of a significant impact on the species.	An important population of the species is known to be present; the project is likely to result in loss of critical habitat; indirect impacts are likely to have a large impact on the local population or on critical habitat.

Key to determining the risk of a significant impact is identifying the importance of the local population of the species and identifying habitat critical to the survival of the species.

An 'important population' is one that is necessary for the long-term survival and recovery of the species (DoE 2013). This may include key source populations, populations on the edge of the species range and/or populations important for maintaining genetic diversity. This may include a geographically distinct regional population, or collection of local populations, or a population, or collection of local populations that occurs within a particular bioregion.

'Habitat critical to the survival of the species' is defined by DoE (2013) as areas that are necessary for activities such as breeding, foraging, roosting or dispersal, areas necessary for the long-term maintenance of the species, areas necessary for maintaining genetic diversity and/or areas necessary for the reintroduction of population or recovery of the species.

3.6 Limitations

Many fauna surveys and several years of fauna monitoring has been undertaken across the Fauna Study Area between 2008 and 2022. This data has been collected by a range of consulting groups and personnel. This impact assessment is reliant on the accuracy of the data collection and findings of those reports. Although some vertebrate fauna species have been relatively well-studied, there are still information gaps. For some species, basic data such as total population estimates, home-range sizes, patterns of dispersal or seasonal habitat use are not known or have only been subject to studies in other bioregions.

4.0 Results – Flora and Vegetation

4.1 Flora

4.1.1 Significant Flora of the NVCP Permit Boundary

Numerous surveys for significant flora taxa have been undertaken at Wodgina, as detailed in Woodman Environmental (2020-Table 4).

This impact assessment considers the three significant flora taxa recorded within the proposed NVCP boundary:

- *Euphorbia clementii* (P3).
- *Terminalia supranitifolia* (P3).
- *Triodia chichesterensis* (P3).

A further three taxa (*Abutilon* aff. *hannii*, *Heliotropium muticum* (P3) and *Vigna triodiophila* (P3)) have been recorded in the wider Flora Study Area (Woodman Environmental 2020) but were not recorded in the proposed NVCP boundary despite intensive survey effort. Suitable habitat occurs in the proposed NVCP boundary for a further three significant taxa (*Eragrostis crateriformis* (P3), *Gomphrena leptophylla* (P3) and *Goodenia nuda* (P4)); however, these taxa have not been recorded at Wodgina, despite targeted survey over multiple survey events and are unlikely to be present in the NVCP boundary.

No flora taxa listed as Threatened under the EPBC Act or BC Act are known to occur at Wodgina.

4.1.2 Regional Significance of Local Subpopulations of Significant Flora

Although *Euphorbia clementii* (P3) is not known to occur within the conservation estate, it has a relatively wide known distribution (330 km from near Port Hedland to east of the southern corner of Karajini National Park in the south) with 35 records representing approximately 25 populations (Woodman Environmental 2020). This taxon is a known fire-responder, and comprehensive survey is difficult in areas which have not experienced a burn within 12 months preceding the survey. Hence, its regional distribution, number of populations and number of individuals are difficult to quantify and are likely to be larger than current data suggests.

Although the local subpopulations of *Euphorbia clementii* (P3) at Wodgina are located on the western edge of its known range, the overall range of this taxon is extensive. Woodman Environmental (2011a) recorded at least 32 other locations of this taxon extending north-east of the eastern boundary of the Flora Study Area for approximately 6.5 km. The local Wodgina subpopulations are considered to have low regional significance, due to the large number of populations known, the large regional spatial distribution, the large distribution of the subpopulations at Wodgina and the high potential for further populations of this taxon to occur regionally.

Terminalia supranitifolia (P3) has a wide distribution (275 km from Kangan Station in the east to near Pannawonica in the west), with two of the 10 populations occurring in DBCA tenure (Murujunga National Park and Dolphin Island Nature Reserve). However, the population at Wodgina occurs over 190 km to the east of all other known populations, with Wodgina forming the eastern extent of the known range of this taxon. The habitat for this taxon is relatively restricted on a regional scale, occurring predominantly on higher rocky mesas and escarpments in the areas where it is known to occur. This taxon is relatively long-lived, with very few seedlings or otherwise younger individuals observed; the taxon is known to re-sprout following fire (Woodman Environmental field observations).

The subpopulations at Wodgina can be considered of moderate regional significance. Although this taxon is known to occur in the conservation estate in the western extent of its range, the locations at Wodgina are geographically disjunct from all other known populations and is itself not located on secure tenure.

Triodia chichesterensis (P3) occurs over a range of approximately 91 km from the north of Indee Station (south of Port Hedland) in the north to east of Mungaroona Nature Reserve in the south (DBCA 2007-); however, it is not currently known to occur in conservation estate. There are four known broad localities of this taxon known, including approximately 10 populations, extending in a north-south direction directly centred along the Great Northern Highway. It has been noted that the distribution of this taxon is confined to a narrow area in the central Chichester region of the Pilbara. Areas immediately to the west and east of its known distribution are poorly explored, but it is likely to be restricted to an area <100 km beyond current collections given the extensive nature of flora collecting efforts in the Pilbara (Andersoner *et al.* 2017). Where available, plant density information for specimens on *Naturemap* (DBCA 2007-) have stated that the taxon is mainly dominant in the areas from which it has been collected. However, population data across its range is limited, with the most comprehensive data collected at Wodgina. The nearest known populations of this taxon to Wodgina are located within 20 km.

The Wodgina populations of *Triodia chichesterensis* (P3) are not located at a geographical edge of its range. Although the population data suggests that Wodgina is the largest population, notes regarding its density at other locations suggest that it is dominant where it occurs. It is considered that the Wodgina populations are of moderate regional significance.

4.2 Vegetation

No TECs or PECs are known from the Vegetation Study Area, and therefore are not known from within the NVCP boundary.

An assessment of the local conservation significance of each VU is presented in **Table 4.1**. A ranking of:

- 1 (Low) applied to VUs 2 and 10.
- 2 (Low-Moderate) applied to VUs 1, 5, 6, 7, and 8.
- 3 (Moderate) applied to VUs, 2, 4, 9, 11, and 14, due to the more limited extent present in the Vegetation Study Area and regionally restricted nature of the landform.
- 4 (Moderate-High) applied to VUs 12, 13 and 15 due to the limited extent of the VUs within the Vegetation Study Area and the potentially restricted nature of its regional extent.
- 5 (High). No VUs were considered to have a High local Conservation significance.

Table 4.1 Local Conservation Significance Assessment of Vegetation Units within the Vegetation Study Area

Vegetation Unit	Percentage of Study Area (%)	Landform Description	Preferred Habitat for Significant Flora	Local Conservation Significance Ranking (Table 2.3)
1	4.42	Red-brown clay loam with granite, quartz or ironstone stones on colluvial stone plains and low flat-topped rises. – locally common and not regionally restricted.	Nil	2
2	12.32	Red, brown or red-brown clay loam with metamorphic, ironstone, quartz and occasionally granite stones, occasionally with metamorphosed granite or granite outcropping, on lower slopes and colluvial outwashes of ranges and occasionally on low flat-topped rises. – locally common and not regionally restricted.	<i>Euphorbia clementii</i> (P3)	1
3	3.61	Red, brown or red brown clay loam with ironstone or metamorphosed granite stones over ironstone or metamorphosed granite outcropping on plateaus, crests and upper slopes of ranges. – locally common and potentially regionally restricted.	Nil	3
4	4.83	Red, brown or red-brown clay loam with metamorphosed granite, dolerite and occasionally ironstone stones over metamorphosed granite or dolerite outcropping on mid and upper slopes of ranges, and low ridges and hills. – locally common and potentially regionally restricted.	<i>Terminalia supranitifolia</i> (P3) <i>Triodia chichesterensis</i> (P3)	3
5	5.53	Red-brown clay loam with metamorphosed granite, ironstone, dolerite, quartz and calcrete stones, occasionally over metamorphosed granite and dolerite outcropping, on lower slopes and colluvial outwashes of ranges and low flat-topped rises. – locally common and not regionally restricted.	<i>Triodia chichesterensis</i> (P3)	2
6	3.09	Red clay loam with calcrete, quartz and metamorphosed granite stones, occasionally over calcrete outcropping, on colluvial outwashes of ranges and colluvial stony plains. – locally common and not regionally restricted.	<i>Triodia chichesterensis</i> (P3)	2

Vegetation Unit	Percentage of Study Area (%)	Landform Description	Preferred Habitat for Significant Flora	Local Conservation Significance Ranking (Table 2.3)
7	5.38	Red or red-brown clay loam with dolerite, calcrete and quartz stones, often with dolerite outcropping, on low hills. – locally common and not regionally restricted.	<i>Triodia chichesterensis</i> (P3)	2
8	1.99	Brown, red-brown or grey-brown clay loam with dolerite, calcrete, ironstone and quartz stones on colluvial stony plains. – locally common and not regionally restricted.	<i>Triodia chichesterensis</i> (P3)	2
9	20.38	Red, brown or red-brown clay loam with ironstone, metamorphosed granite or occasionally dolerite or quartz stones over ironstone or metamorphosed granite outcropping on cliffs, ridges and crests and upper to mid slopes of ranges. – locally common however regionally restricted. Although this VU was mapped at >10 % of the study area it is mapped on landform/soil types that is regionally restricted.	<i>Euphorbia clementii</i> (P3) <i>Terminalia supranitifolia</i> (P3) <i>Triodia chichesterensis</i> (P3)	3
10	18.23	Red, brown or red-brown sandy or clay loam, often with quartz or ironstone stones, on plains. – locally common, not regionally restricted.	<i>Euphorbia clementii</i> (P3)	1
11	2.71	Red, brown or red-brown sandy or clay loam with colluvial stones in minor drainage features including flats and small creeks. – locally common, regionally restricted.	<i>Euphorbia clementii</i> (P3)	3
12	0.88	Red, brown or grey-brown clay loam with calcrete or quartz stones on undulating plains. – locally restricted but not regionally restricted.	<i>Triodia chichesterensis</i> (P3)	4
13	0.85	Orange, brown or red-brown sandy or clay loam with granite and quartz stones over granite outcropping on undulating plains or low rises. – locally restricted but not regionally restricted.	Nil	4

Vegetation Unit	Percentage of Study Area (%)	Landform Description	Preferred Habitat for Significant Flora	Local Conservation Significance Ranking (Table 2.3)
14	3.07	Red or brown clay or sandy loam, usually with colluvial stones, in major creeks. – locally common and however regionally restricted.	Nil	3
15	0.23	Red clay loam with colluvial stones on plains. – locally restricted however not restricted regionally.	Nil	4
Cleared	12.48	Previously disturbed / developed areas (includes areas undergoing rehabilitation).	NA	NA

4.3 Assessment of Direct Impact

4.3.1 Direct Local Impact on Significant Flora Taxa – Locations and Individuals

Three significant flora taxa are known to occur in the proposed NVCP boundary, and two are present to some extent, in the proposed disturbance footprint:

- *Euphorbia clementii* (P3).
- *Terminalia supranitifolia* (P3) (present in the proposed disturbance footprint).
- *Triodia chichesterensis* (P3) (present in the proposed disturbance footprint).

The locations of significant flora taxa within the proposed NVCP boundary and the proposed disturbance footprint are shown in **Figure 4.1**. The numbers and percentages of locations and individuals within the proposed NVCP boundary and the proposed disturbance footprint are summarised in **Table 4.2** and **Table 4.3**, respectively.

Potential direct impacts to flora species of clearing (**Table 4.3**) are:

- *Euphorbia clementii* (P3): 0.00 % of individuals known in the Flora Study Area.
- *Terminalia supranitifolia* (P3): 5.26 % of individuals known in the Flora Study Area.
- *Triodia chichesterensis* (P3): 3.32 % of individuals known in the Flora Study Area.

Table 4.2 Significant Flora Taxa within the proposed NVCP Boundary

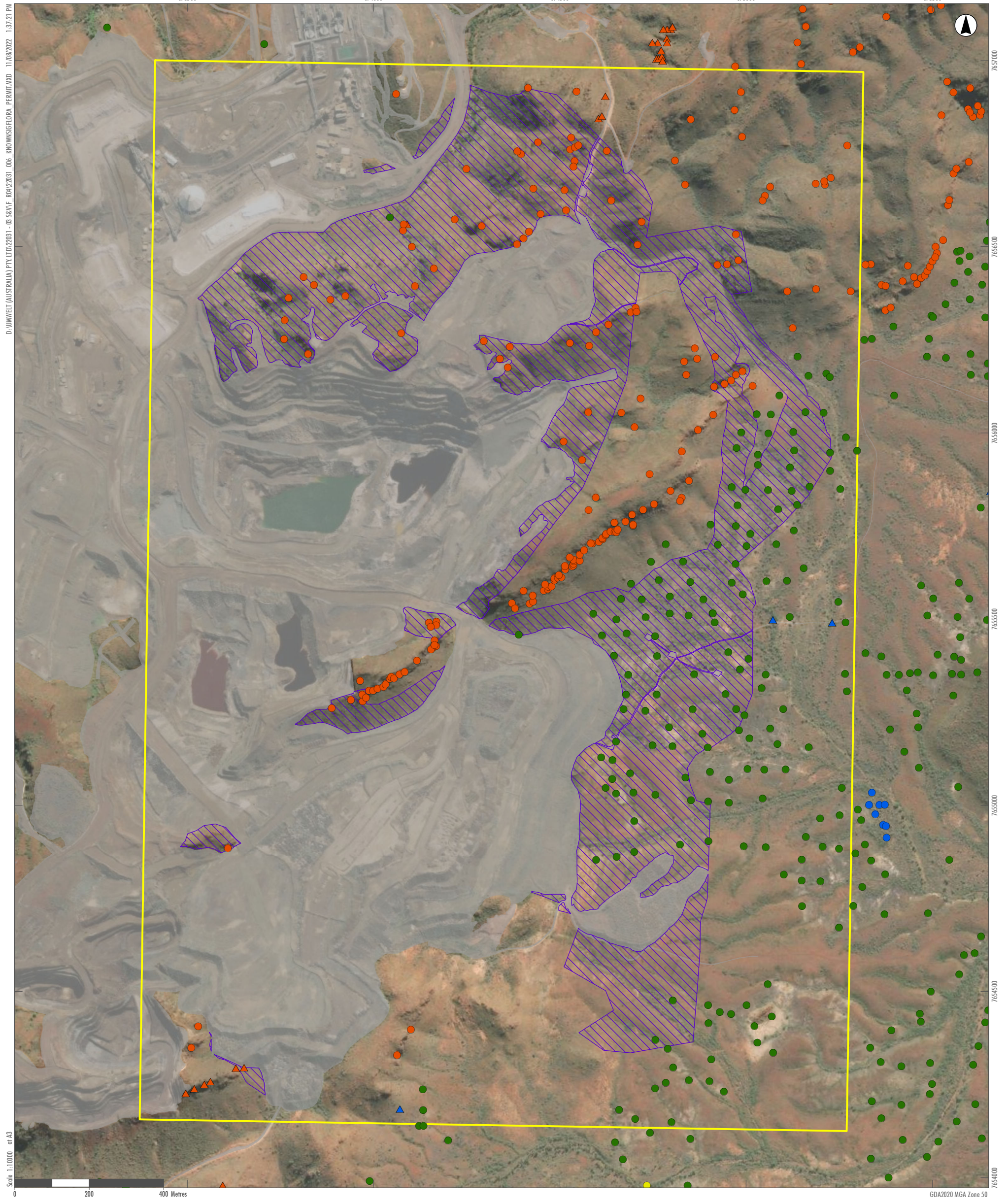
Significant Flora Taxa	Code*	Flora Study Area**		NVCP Boundary			
		# Locations	# Individuals	# Locations	% Locations	# Individuals	% Individuals
<i>Euphorbia clementii</i>	P3	322	61,529	3	0.93	20	0.03
<i>Terminalia supranitifolia</i>	P3	1,100	2,378	186	16.91	340	14.30
<i>Triodia chichesterensis</i>	P3	1,928	1,951,574	163	8.45	127,870	6.55

Table 4.3 Impact on Significant Flora Taxa within the proposed Disturbance Footprint

Significant Taxa	Code*	Flora Study Area**		Proposed Disturbance Footprint			
		# Locations	# Individuals	# Locations	% Locations	# Individuals	% Individuals
<i>Euphorbia clementii</i>	P3	322	61,529	0	0	0	0
<i>Terminalia supranitifolia</i>	P3	1,100	2,378	71	6.45	125	5.26
<i>Triodia chichesterensis</i>	P3	1,928	1,951,574	80	4.15	64,740	3.32

*Note: Conservation Code as presented by DBCA (2019) and DBCA (2007-).

**Note: records include survey information collected from outside the Flora Study Area as a result of surveys for the Project.



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- Legend**
- Flora Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - Cleared
- Significant Flora**
- Ecl *Euphorbia clementii* (P3) – 2018/2019 surveys
 - ▲ Ecl *Euphorbia clementii* (P3) – previous surveys
 - Tch *Triodia chichesterensis* (P3) – 2018/2019 surveys
 - Tsu *Terminalia supranitfolia* (P3) – 2018/2019 surveys
 - ▲ Tsu *Terminalia supranitfolia* (P3) – previous surveys
 - Aah *Abutilon* aff. *hannii* (potentially undescribed) – 2018/2019 surveys

FIGURE 4.1

Significant Flora Locations within the Proposed NVCP Boundary

4.3.3 Direct Local Impact on Significant Flora Taxa - Habitat

An assessment of the impact of the proposed NVCP boundary area on the preferred habitat for significant flora taxa, including *Euphorbia clementii* (P3) is presented in **Table 4.4**. This assessment quantifies the proposed impact on the preferred habitat (VUs) for taxa as presented in **Table 1.2**. Although suitable habitat for each known significant flora taxon within the entire proposed NVCP boundary was surveyed (summarised by Woodman Environmental 2020), survey effort in 2018-2019 for *Euphorbia clementii* (P3) was hampered due to lack of recently burnt areas (<12 months). As such, the impact on preferred habitat is considered to provide a more accurate representation of local impact on this taxon than the impact on the number of individuals. The impact on preferred habitat for the other taxa has been included for comparative purposes.

Table 4.4 Impact on Significant Flora Habitat by the Proposal

Significant Taxon	Preferred Habitat (VUs)	Total Habitat (ha)	NVCP Boundary		Disturbance Footprint	
			Area (ha)	% of preferred habitat	Area (ha)	% of preferred habitat
<i>Euphorbia clementii</i> (P3)	2, 9, 10, 11	3,618.15	145.58	4.02	61.46	1.70
<i>Terminalia supranitifolia</i> (P3)	4, 9	1,700.50	162.12	9.53	71.00	4.18
<i>Triodia chichesterensis</i> (P3)	4, 5, 6, 7, 8, 9, 12	2,838.46	250.21	8.81	105.71	3.72

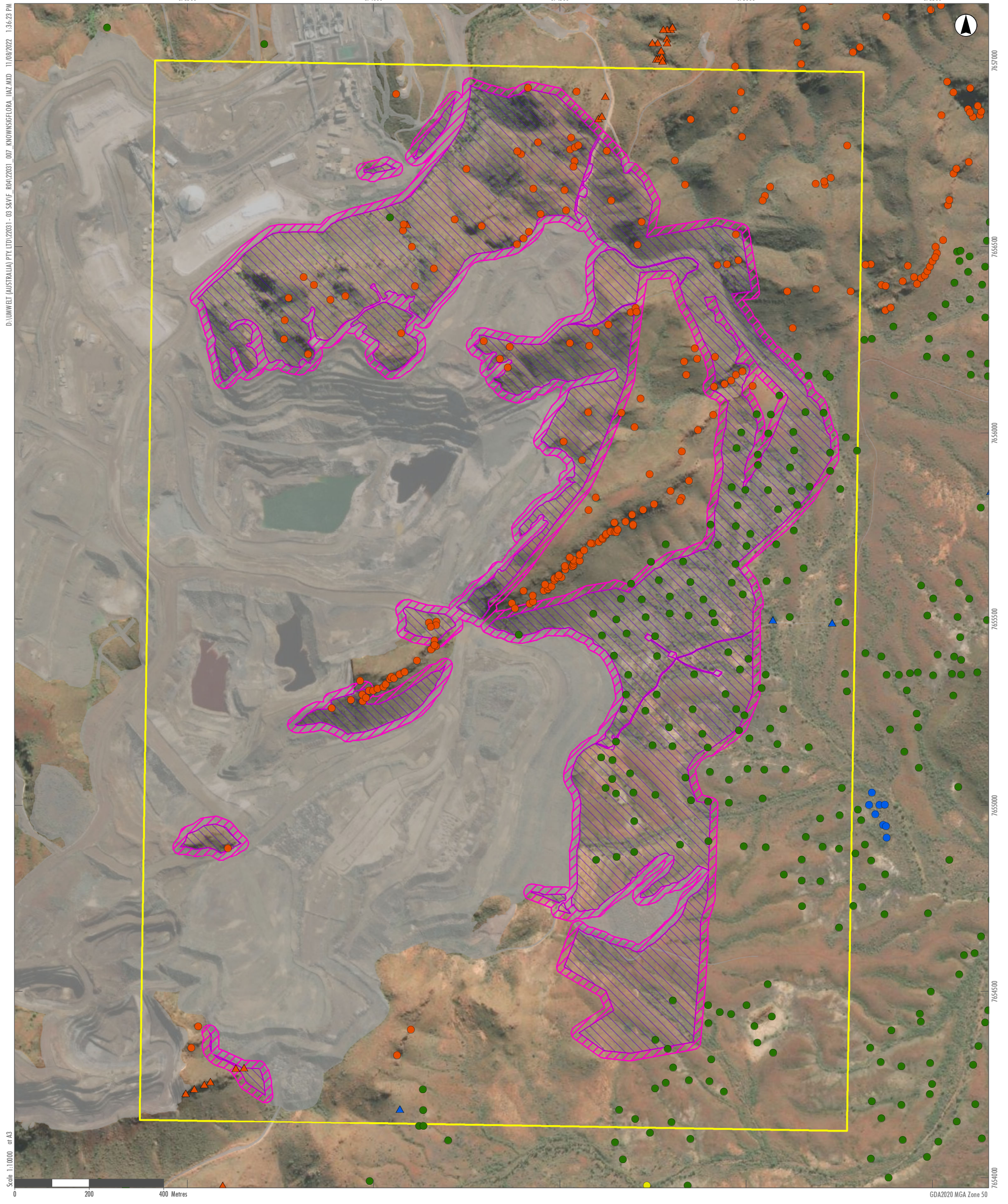
4.3.4 Indirect Impacts to Significant Flora Taxa – Quantitative Assessment

An assessment of the potential indirect impacts on significant flora and vegetation in areas that may be subject to factors such as dust and sediment run-off within the IIAZ of the proposed NVCP boundary area is presented in **Table 4.5** and **Table 4.6**, and shown on **Figure 4.2**. The total IIAZ is 38.67 ha, with 17.58 ha of native vegetation, all of which occurs in the Flora Study Area and therefore has been surveyed for significant flora taxa.

The potential Indirect impacts of the Proposal include:

- *Euphorbia clementii* (P3): 0 % of individuals known in the Flora Study Area.
- *Terminalia supranitifolia* (P3): 0.80 % of individuals known in the Flora Study Area.
- *Triodia chichesterensis* (P3): 0.63 % of individuals known in the Flora Study Area.

The potential indirect impacts to numbers of significant flora taxa, or their preferred habitat is minor in relation to the extent of direct impacts.



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- Legend**
- Flora Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - Indirect Impact Assessment Zone
 - Cleared
- Significant Flora**
- Ecl *Euphorbia clementii* (P3) – 2018/2019 surveys
 - ▲ Ecl *Euphorbia clementii* (P3) – previous surveys
 - Tch *Triodia chichesterensis* (P3) – 2018/2019 surveys
 - Tsu *Terminalia supranitfolia* (P3) – 2018/2019 surveys
 - ▲ Tsu *Terminalia supranitfolia* (P3) – previous surveys
 - Aah *Abutilon* aff. *hannii* (potentially undescribed) – 2018/2019 surveys

FIGURE 4.2

Significant Flora Locations and Indirect Impact Assessment Zone within the Proposed NVCP Boundary

Table 4.5 Impact on Significant Flora Taxa within the Indirect Impact Assessment Zone

Significant Flora Taxa	Status	Flora Study Area		IIAZ			
		# Locations	# Individuals	# Locations	% Locations	# Individuals	% Individuals
<i>Euphorbia clementii</i>	P3	322	61,529	0	0	0	0.00
<i>Terminalia supranitifolia</i>	P3	1,100	2,378	11	1.00	19	0.80
<i>Triodia chichesterensis</i>	P3	1,928	1,951,574	13	0.67	12,250	0.63

Table 4.6 Impact on Habitat of Significant flora taxa within the Indirect Impact Assessment Zone

Significant Taxon	Status	Preferred Habitat (VUs)	Total Habitat in Study Area (ha)	IIAZ	
				Area (ha)	Percentage of Vegetation Study Area
<i>Euphorbia clementii</i>	P3	2, 9, 10, 11	3618.15	7.67	0.21
<i>Terminalia supranitifolia</i>	P3	4, 9	1700.50	11.65	0.69
<i>Triodia chichesterensis</i>	P3	4, 5, 6, 7, 8, 9, 12	2838.46	15.92	0.56

4.3.5 Significance of Local Impact on Significant Flora Taxa

The significance of impact on the significant flora taxa potentially impacted by the Proposal are presented in **Table 4.7**.

Table 4.7 Significance of Local Impact on Significant Flora Taxa

Significant Taxon	Impact Type	Percentage of Locations Proposed to be Impacted	Percentage of Individuals Proposed to be Impacted	Percentage of Preferred Habitat Proposed to be Impacted*	Overall Significance of Impact (Table 7)
<i>Euphorbia clementii</i> (P3)	Direct	0	0	1.70	Low
	Indirect	0	0	0.21	Low
	Total	0	0	1.91	Low
<i>Terminalia supranitifolia</i> (P3)	Direct	6.45	5.26	4.18	Low
	Indirect	1.00	0.80	0.69	Low
	Total	1.45	6.06	4.87	Low
<i>Triodia chichesterensis</i> (P3)	Direct	4.15	3.32	3.72	Low
	Indirect	0.67	0.63	0.56	Low
	Total	4.82	3.95	4.28	Low

*Note: impact on preferred habitat calculations used for *Euphorbia clementii* (P3) only, due to targeted survey for this taxon in the permit/footprint areas deemed to be incomplete due to taxon's response to fire.

Overall, there is a Low significance of local impact proposed to all significant flora taxa *Euphorbia clementii* (P3), *Terminalia supranitifolia* (P3), and *Triodia chichesterensis* (P3) by clearing of the proposed disturbance footprint.

4.3.6 Impact on Significant Flora at the Regional Scale

4.3.6.1 *Euphorbia clementii* (P3)

The potential impact of the proposed disturbance footprint is Low in terms of both the known number of individuals and the extent of preferred habitat within the Flora Study Area (**Table 4.3**; summarised in **Table 4.7**). In combination with the Low regional significance of the local subpopulations (**Section 4.1.2**), the impact of the proposed disturbance at the regional scale is ranked Low (as per **Table 2.4**).

4.3.6.2 *Terminalia supranitifolia* (P3)

The potential impact of the proposed disturbance footprint is Low in terms of both the known number of individuals and extent of preferred habitat within the Flora Study Area (**Table 4.3**; summarised in **Table 4.7**). In combination with the Moderate regional significance of the local subpopulations (**Section 4.1.2**), the significance of the impact of the proposed disturbance at the regional scale is ranked Low (as per **Table 2.4**).

Although the regional significance of impact on this taxon has been ranked Low, the loss of individuals of this taxon and extant local habitat would have potentially higher impacts on this taxon in comparison to taxa such as *Euphorbia clementii* (P3) due to differences in life history (response to events such as fire; recruitment/regrowth strategies) and distribution of habitat in which they occur. The known subpopulations extend to the north, south and west outside of the Study Area (**Figure 1.2**).

4.3.6.3 *Triodia chichesterensis* (P3)

The potential impact of the proposed disturbance footprint is Low in terms of both the known number of individuals and extent of preferred habitat within the Flora Study Area (**Table 4.3**; summarised in **Table 4.7**). In combination with the Moderate regional significance of the local subpopulations, the significance of the impact of the proposed disturbance at the regional scale is ranked Low (as per **Table 2.4**).

Although the regional significance of the local populations has been ranked Moderate, this taxon is relatively widespread through the Flora Study Area, with further records to the west, south and east of the Flora Study Area (**Figure 1.2**).

4.3.7 Local Direct Impact on Vegetation

4.3.7.1 Vegetation Condition

The representation of vegetation condition within the Vegetation study area is summarised in **Table 4.8**. Over 96 % of the vegetation was in Excellent condition. The area of vegetation in Excellent condition in the NVCP boundary represents 4.80 % of vegetation in Excellent condition mapped in the Vegetation study area. The area of vegetation in Excellent condition in the Proposed Disturbance Boundary represents 1.86 % mapped in the Vegetation Study Area.

Table 4.8 Vegetation Condition within the Vegetation Study Area, Proposed NVCP Boundary and Disturbance Footprint

Condition Category	Vegetation Study Area		NVCP Boundary		Proposed Disturbance Footprint	
	Area (ha)	As % of Mapped Vegetation	Area (ha)	As % of Mapped Condition	Area (ha)	As % of Mapped Condition
Excellent	5720.07	96.91 %	274.39	4.80 %	109.58	1.86 %
Excellent / Very Good	15.87	0.27 %	0.00	0.00 %	0.00	0.00 %
Very Good	43.35	0.73 %	5.00	11.53 %	0.43	0.01 %
Good	82.12	1.39 %	8.14	9.91 %	2.15	0.04 %
Good/Poor	21.37	0.36 %	0.00	0.00 %	0.00	0.00 %
Poor	19.55	0.33 %	9.65	49.37 %	1.39	0.02 %
*Cleared	842.79	-	243.37	28.97 %	0.21	0.004 %
Native Vegetation (Excellent to Poor)	5902.32	-	297.18	5.08	113.54	1.92
Total Area	6745.11	-	540.56	-	113.75	-

*Includes Completely Degraded, Degraded and areas under rehabilitation.



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- Legend**
- Proposed NVCP Boundary
 - Proposed Disturbance Footprint
- Vegetation Condition**
- E Excellent
 - E/VG Excellent / Very Good
 - VG Very Good
 - G Good
 - P Poor
 - CD Completely Degraded

- Introduced Flora**
- AeJ *Aerva javanica*
 - Cap *Calotropis procera*
 - Cec *Cenchrus ciliaris*
 - Cse *Cenchrus setiger*
 - Cyd *Cynodon dactylon*
 - Flt *Flaveria trinervia*
 - Paf *Passiflora foetida* var. *hispida*

FIGURE 4.3

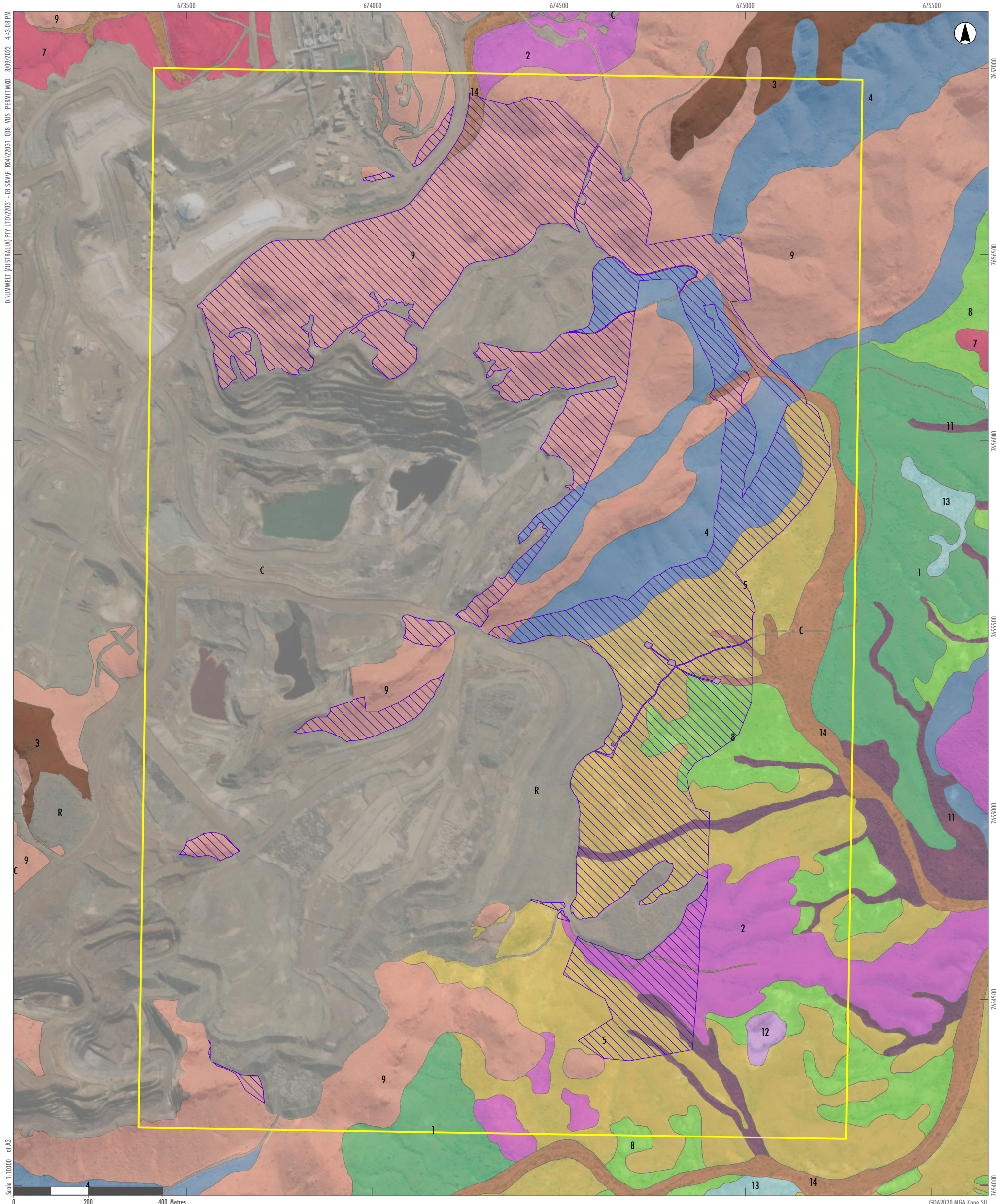
Vegetation Condition and Introduced Flora within the Proposed NVCP Boundary

4.3.7.2 Vegetation Units

Eight VUs are proposed to be directly impacted by clearing within the proposed NVCP boundary area. The NVCP boundary and disturbance footprint in association with VUs is shown in **Figure 4.4**. The extent of proposed footprint impact by areas and percentage of mapped extent of VUs within the Vegetation Study Area is presented in **Table 4.9**. The significance of local impact on VUs by the Proposal is ranked Nil or Low (see **Table 2.2**).

Table 4.9 Local Direct Impact on Vegetation Units by the proposed NVCP Boundary and Proposed Disturbance Footprint

VU	Total Vegetation Study Area Extent (ha)	Area within NVCP Boundary (ha)	Area within Disturbance Footprint (ha)	Disturbance Area as Percentage of Total VU Area mapped	Local Impact
1	297.86	9.76	0	0.00	Nil
2	831.05	18.38	4.29	0.52	Low
3	243.32	3.05	0	0	Nil
4	325.69	40.12	15.33	4.71	Low
5	372.96	70.34	30.45	8.16	Low
6	208.51	0	0	0	Nil
7	362.87	0.66	0.00	0	Nil
8	134.04	16.03	4.25	3.17	Low
9	1,374.81	122.00	55.67	4.05	Low
10	1,229.57	0	0	0	Nil
11	182.72	5.20	1.49	0.82	Low
12	59.57	1.06	0	0	Nil
13	57.11	0	0	0	Nil
14	207.11	10.58	2.05	0.99	Low
15	15.50	0	0	0	Nil
Cleared	842.71	243.37	0.21	0.03	-
Total area	6,745.42	540.55	113.74	-	-



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Scale: 1:10000 at A3

- Legend**
- Flora Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
- Vegetation Units**
- | | |
|--|--|
| <ul style="list-style-type: none"> 1 2 3 4 | <ul style="list-style-type: none"> 5 7 8 9 11 12 13 14 Cleared land |
|--|--|

FIGURE 4.4

Vegetation Units within the Proposed NVCP Boundary

4.3.8 Indirect Impact on Vegetation–Quantitative Assessment

The VUs within the IIAZ associated with the disturbance footprint is presented in **Figure 4.5**.

The potential impact on VUs within the IIAZ is presented in **Table 4.10**. The total IIAZ is 38.66 ha of which 17.57 has native vegetation (**Figure 4.5**); the remaining area within the IIAZ is previously ‘cleared’.

All VUs that are known to occur in the IIAZ will also potentially be impacted by direct impacts. The local direct impact on all VUs has been ranked as Nil or Low.

Table 4.10 Local Indirect Impacts of the IIAZ on Vegetation Units

VU	Total Study Area Extent (ha)	Proposed IIAZ (ha)	Percentage of Study Area mapped	Local Impact – IIAZ
1	297.86	0.00	0.00	Nil
2	831.05	1.01	0.12	Low
3	243.32	0.00	0.00	Nil
4	325.69	5.15	1.58	Low
5	372.96	3.58	0.96	Low
6	208.51	0.00	0.00	Nil
7	362.87	0.00	0.00	Nil
8	134.04	0.69	0.51	Low
9	1,374.81	6.49	0.47	Low
10	1,229.57	0.00	0.00	Nil
11	182.72	0.17	0.09	Low
12	59.57	0.00	0.00	Nil
13	57.11	0.00	0.00	Nil
14	207.11	0.48	0.23	Low
15	15.50	0.00	0.00	Nil
Cleared	842.71	17.57	-	-
Total Area	6,745.42	38.66	-	-

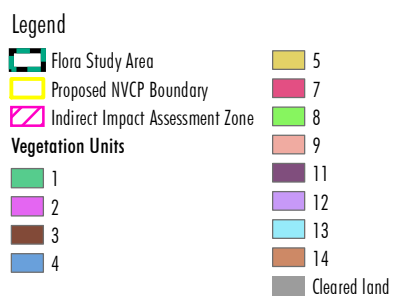
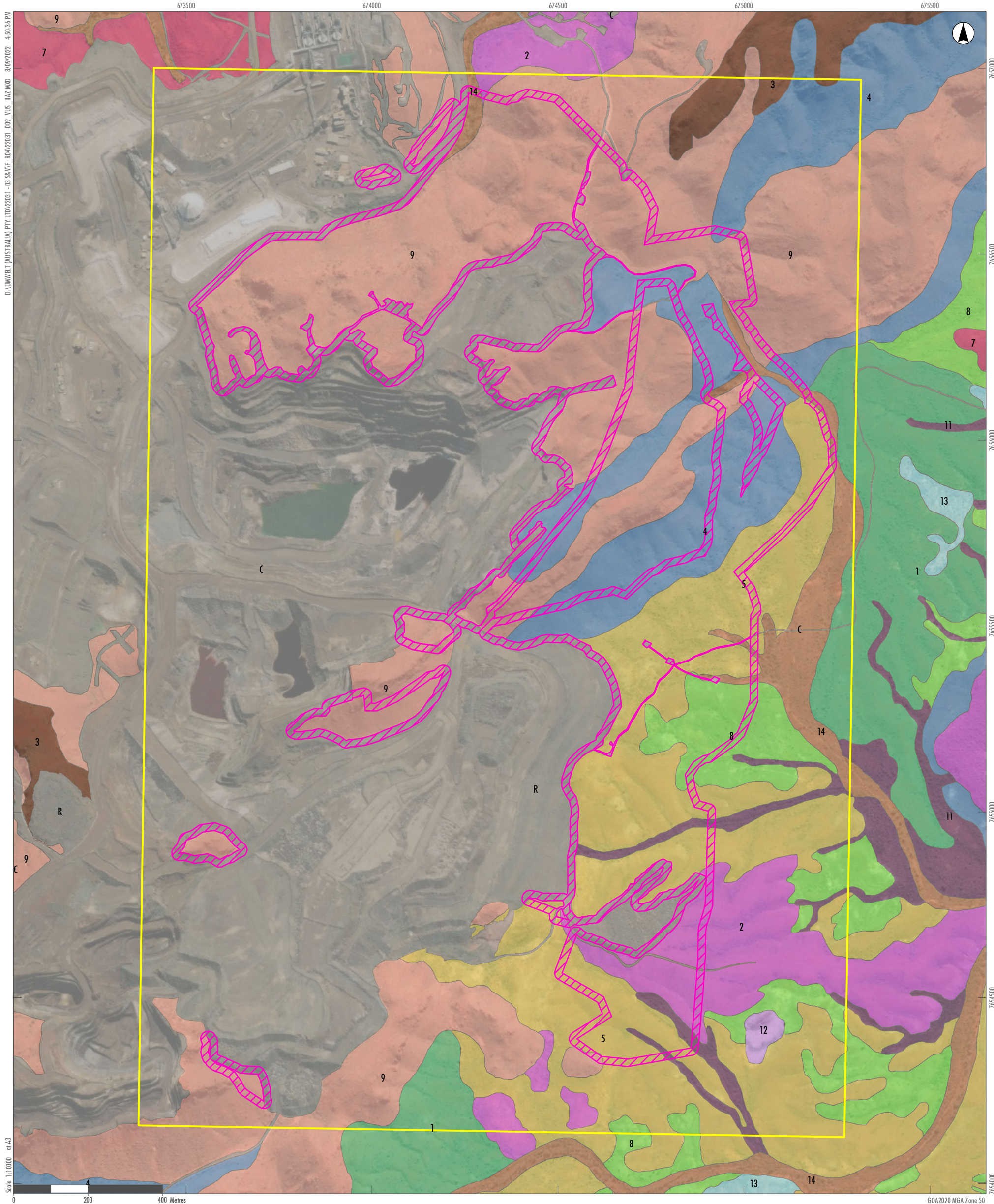


FIGURE 4.5

Vegetation Units and Indirect Impact Assessment Zone within the Proposed NVCP Boundary

4.3.9 Significance of Local Impact on Vegetation

There will be Nil or Low significance of impact at the local scale to all VUs by the direct and indirect potential impacts of the proposed disturbance footprint as presented in **Table 4.11** (see **Table 2.4**).

Table 4.11 Significant of Local Impact on Vegetation Units

VU	Direct Impact % (Table 4.8)	Indirect Impact % (Table 4.9)	Total Percentage Impact	Proposed Overall Impact on VUs (Table 2.2 Table 1.7)	Local Conservation Significance of VU (Table 2.3)	Significance Ranking of Impact (Table 2.4)
1	0.00	0.00	0.00	Nil	2	Nil
2	0.52	0.12	0.64	Low	1	Low
3	0.00	0.00	0.00	Nil	3	Nil
4	4.71	1.58	6.29	Low	3	Nil
5	8.16	0.96	9.12	Low	2	Low
6	0.00	0.00	0.00	Nil	2	Nil
7	0.00	0.00	0.00	Nil	2	Nil
8	3.17	0.51	3.69	Low	2	Low
9	4.05	0.47	4.52	Low	3	Low
10	0.00	0.00	0.00	Nil	1	Nil
11	0.82	0.09	0.91	Low	3	Low
12	0.00	0.00	0.00	Nil	4	Nil
13	0.00	0.00	0.00	Nil	4	Nil
14	0.99	0.23	1.22	Low	3	Low
15	0.00	0.00	0.00	Nil	4	Nil

4.3.10 Regional Impact on Vegetation

There is no published Pilbara vegetation dataset to undertake regional analysis on the impact of clearing of vegetation units on a regional scale. Given that no vegetation in the permit boundary constitutes any listed TECs or PECs, and the significance of local impact is ranked as Low (**Table 4.11**), it is considered that the regional impact on vegetation is likewise Low.

Both of the vegetation system associations located within the permit boundary will be impacted by the footprint; the percentage of the pre-European extent after impact is presented in **Table 4.12**. The impact will not reduce the extent of these vegetation system associations to below the 30 % pre-European extent threshold (EPA 2008).

Table 4.12 Impact on the Vegetation System Associations of the Footprint

Vegetation System Association/Landsystem	Pre-European Extent (ha)	Current Extant Area (ha)	Footprint Area (ha)	Percentage of Pre-European Extent Remaining
Abydos Plain – Chichester_93	2,476,377.6	2,473,007	51.06	99.86
Abydos Plain – Chichester_626	117,724.4	117,198.1	62.69	99.50

4.4 Qualitative Assessment of Indirect Impacts – Flora and Vegetation

4.4.1 Impacts to Groundwater Dependent Vegetation/Species

Based on the presence of several phreatophytic species, it is possible that some occurrences of VU 14 are dependent on groundwater, if the local water table is within reach of the root systems of these taxa (generally within 10 m of the ground surface). The obligate phreatophyte *Melaleuca argentea* is known from the Study Area, however only from three locations. It is not common or widespread at any of these locations. In one, there appears to be an extended period of seepage after significant rainfall events; this therefore may be from surface water infiltration rather than groundwater. Another location is within an artificial drain area in proximity to the Wodgina camp that is being influenced by anthropogenic factors, and therefore this location also may not be associated with shallow groundwater. It is unlikely that GDV occurs within the proposed NVCP boundary area.

The potential facultative phreatophyte *Melaleuca glomerata* is also known to occur at three locations in VU 14, while both *Eucalyptus victrix* (considered to be a vadophyte) and *Melaleuca linophylla* (potential facultative phreatophyte) are common in this VU. However, available evidence indicates that vegetation that is groundwater dependent is not extensive in the Study Area; it should be noted that depth to groundwater within elevated parts of Wodgina (main range) is generally at least 20 m from the surface (Golder 2018), and therefore would not be accessible to any occurrences of VU 14 in these areas (Woodman Environmental 2020).

4.4.2 Impacts from Surface Water Hydrology Changes

Riparian vegetation is defined as plant habitats and communities occurring in association with watercourses, both ephemeral and permanent. Woodman Environmental (2020) mapped two VUs in the Study Area containing riparian vegetation:

- VU 11: mapped in minor drainage features including flats and small ephemeral creeklines. This VU was mainly located on small drainage lines; however, it was also mapped on associated flats in the north-east of the Study Area. A total of 182.72 ha of VU 11 were mapped in the Study Area with only 1.49 ha within the disturbance footprint.
- VU 14: mapped in major ephemeral creek-lines. A total of 207.11 ha of VU 14 were mapped in the Study Area with only 2.05 ha within the disturbance footprint.

The main drainage line mapped with VU 14 occurs immediately to the east of the edge of the proposed disturbance footprint within the proposed NVCP boundary area. Water flow of both areas of VU 11 and 14 flow away from the proposed disturbance footprint, and therefore any resulting drainage shadow impact is likely to be minor provided any potential hydrology changes are managed through measures such as appropriate engineering controls.

No other VUs mapped within the Study Area are considered to represent wetlands (Woodman Environmental 2020).

4.4.3 Impacts from Increased Fragmentation

Table 4.13 presents the approximate number of subpopulations of significant flora taxa in the Flora Study Area, the number of subpopulations located in the disturbance footprint, and potential fragmentation of these subpopulations by the proposed clearing. It is likely that there are fewer but more extensive populations occur in the Flora Study Area for the three significant flora taxa, with suitable habitat for each taxon occurring between currently known locations.

The clearing associated within the proposed NVCP boundary will increase the fragmentation of the known extent of subpopulations of both *Terminalia supranitifolia* (P3) and *Triodia chichesterensis* (P3), by separating existing subpopulations. The long-term impact of this fragmentation, if any, is not considered to be significant for *Triodia chichesterensis* (P3), due to the close proximity of the remaining subpopulations, and likely further extent of populations of this taxon surrounding the proposed NVCP boundary.

A subpopulation of *Terminalia supranitifolia* (P3) will be created (**Figure 1.2**). Considering the known distribution of this taxon within the Flora Study Area and known locations to the south and north outside of the Flora Study Area, it is unlikely that the long-term reproductive viability of this population would be impacted by the project (**Figure 1.2**).

The habitat of *Euphorbia clementii* (P3) is generally not associated with extractive mining operations, although it may have been impacted by clearing for associated infrastructure. This taxon is likely to be more widespread than the current data indicates. It is unlikely that current clearing has fragmented the distribution of subpopulations of *Euphorbia clementii* (P3) in the Study Area.

Although not directly or indirectly impacted, the proposed mine extension footprint will also not fragment the known subpopulations of *Vigna triodiophila* (P3) or *Ablution aff. hannii*.

Table 4.13 Impact of further fragmentation of subpopulations of Significant Flora Taxa at Wodgina

Taxa	Subpopulation Extent and Taxon Characteristics	Potential Fragmentation Impact (Proposed NVCP Footprint)
<i>Euphorbia clementii</i> (P3)	<ul style="list-style-type: none"> • 23 subpopulations within Flora Study Area. • Two large subpopulations, extending outside the Flora Study Area and other populations known immediately outside the Flora Study Area. • Remainder are known from fewer grouped locations or single locations. • Subpopulations located on habitat other than the main range of the Flora Study Area. • Current clearing extent and extension of range associated with the proposed disturbance footprint separates north and south populations in the Flora Study Area; however, populations are linked by locations known further east (Figure 1.2). • Taxon is a disturbance opportunist; there will be large temporal variability in population size; relatively large population within the Flora Study Area. • Generalist habitat taxon. 	<ul style="list-style-type: none"> • Two small subpopulations to be impacted. • Clearing layout will not lead to further or increased fragmentation of remaining subpopulations. • Impacts through fragmentation are unlikely significant.
<i>Terminalia supranitifolia</i> (P3)	<ul style="list-style-type: none"> • 17 subpopulations. • Two extensive subpopulations, both of which extend outside the Flora Study Area. • Remainder of subpopulations are known from fewer grouped locations or single locations. • Subpopulations on suitable habitat on the ranges within the Flora Study Area. • Current clearing extent separates the two large subpopulations (Figure 1.2). • Taxon is not a disturbance-opportunist (competitively dominant taxon in undisturbed habitat); little temporal variability in population size; relatively large population in Wodgina area but in specific habitat only. • Specialist habitat taxon. 	<ul style="list-style-type: none"> • Three subpopulations (one of which are large populations) to be impacted. • Clearing layout will lead to the far north-eastern and southern extents of the main subpopulation at the EWL pit extension area remaining after clearing to be separated from the rest of the range, by approximately 1 km; there is a relatively large number of locations in this area that will remain. • Impacts through fragmentation are unlikely to reduce the long-term viability of the taxon at Wodgina; localised impacts to the long-term viability of remaining far eastern extent the large population to be impacted by the proposed disturbance footprint unlikely to occur due to the extent of the population remaining to the north-east on the range, although no suitable habitat between this area and the other main population at Wodgina occurs.

Taxa	Subpopulation Extent and Taxon Characteristics	Potential Fragmentation Impact (Proposed NVCP Footprint)
<i>Triodia chichesterensis</i> (P3)	<ul style="list-style-type: none"> 25 subpopulations. 3 large subpopulations and five moderately large subpopulations. Remainder known from fewer grouped locations or single records. Subpopulations on suitable habitat throughout the Flora Study Area. Current clearing extent separates main subpopulations in the north-west and south-east, with the third subpopulation located on the relatively flat lands to the north-east of the project area (Figure 1.2). Taxon is most likely not a disturbance opportunist (competitively dominant taxon in undisturbed habitat); little potential temporal variability in population size; relatively large population in Wodgina area extending outside of the Flora Study Area. Moderately specialist habitat taxon however habitat area is relatively large in local area. 	<ul style="list-style-type: none"> One subpopulation to be impacted. Clearing layout will impact main south-eastern population (Figure 1.2). Clearing layout will further separate south-eastern and north-western subpopulations, increasing historical fragmentation by approximately 1 km, however the subpopulations are still potentially linked outside the Study Area. Impacts through fragmentation are not considered significant, due to likelihood of further linkages between the remaining subpopulations due to location of appropriate habitat.

4.5 Cumulative Impacts

4.5.1 Historical Impacts – Significant Flora

Table 4.14 presents the number of historically recorded locations and individuals recorded for significant taxa that occur on areas that have previously been cleared. Historical clearing of *Terminalia supranitifolia* (P3) can be considered worst case scenario; this assessment has been undertaken purely using GIS and assuming impact on a number of individuals which were recorded on the edge of ridges and on cliff faces, and inspection of such locations may reveal these to be extant.

The historical impact on *Triodia chichesterensis* (P3) is relatively unknown due to the uncertainty of the distribution of this taxon in these areas, with only 16 known locations likely to have been cleared. Further historical impacts were likely, however are unable to be quantified.

Table 4.14 Historically Cleared Significant Flora Taxa Locations and Individuals

Taxa	Number of Locations ¹	Number of Individuals ¹
<i>Euphorbia clementii</i> (P3)	46	606
<i>Terminalia supranitifolia</i> (P3)	96	179
<i>Triodia chichesterensis</i> (P3)	16	17,012

¹ Based on available data: Some cleared areas were never surveyed.

4.5.2 Historical Impacts – Vegetation

There is no VU dataset that covers the entire extent of original vegetation in the Flora Study Area prior to historical clearing activities. The VU dataset used in this assessment covers a total of 842.71 ha of cleared area (includes areas under rehabilitation).

Areas survey by Outback Ecology (2009a) was not mapped using classification analysis of flora data, and the structural groupings presented cannot be allocated to VUs as presented in Woodman Environmental (2020). Quadrat data collected during that survey was collected from quadrats of a different size to those required by EPA (2016b) and therefore is statistically incompatible with data collected and analysed by Woodman Environmental (2020). The main structural vegetation types mapped by Outback Ecology (2009a) that have been impacted include:

- 3b: Scattered *Grevillea wickhamii* subsp. *hispidula* over *Acacia acradenia* shrubland over mixed *Triodia* hummock grassland.
- 1a: *Acacia inaequilatera* Low Open Woodland over *Acacia acradenia* Open Shrubland over mixed *Triodia* hummock grassland.
- 4a: *Acacia acradenia* Open Shrubland over mixed *Triodia* hummock grassland.
- 8a *Eucalyptus leucophloia* subsp. *leucophloia* Open Woodland over *Grevillea wickhamii* subsp. *hispidula* Tall Open Scrub and *Acacia acradenia* Shrubland over mixed *Triodia* hummock grassland.

It was noted by Outback Ecology (2009a) that none of these structural vegetation types were significant, or otherwise unusual. VUs 3, 4, 7 and, 9 (as described by Woodman Environmental 2020) were most likely dominant in these cleared areas based on representation with the current VU mapping (**Figure 4.2**) and the above-mentioned descriptions.

The quadrats originally assessed by Woodman Environmental (2012) were used in the statistical analysis of the current VU dataset (Woodman Environmental 2020). An assessment of the original mapped VUs against the current extent of clearing in that survey area has been undertaken, and a delineation of the extent of VUs that have been cleared since the original mapping is presented in **Table 4.15**.

Table 4.15 Extrapolated Extent of Historical Clearing of Vegetation Units within the Hercules Project Survey Area

VU (Woodman Environmental 2012)	VU (Woodman Environmental 2020)	Extent of Historical Clearing (ha)
1	2	12.19
2	9	17.07
3	9	75.06
4	9	2.61
5	14	7.20
6	10	5.56

With reference to the information above, the VUs which have been most likely cleared due to historical mining activities is VU 9, with some impact on VUs 2, 10 and 14. VUs 2 and 10 were ranked '1' (Low) in terms of local significance (**Table 4.1**); VUs 9 and 14 was ranked '3' (Moderate).

4.5.3 Cumulative Impact on Significant Flora

The cumulative direct and indirect impacts of clearing for the proposed disturbance footprint and historical clearing on significant flora taxa are presented in **Table 4.16**, **Table 4.17** and **Table 4.18**.

4.5.3.1 *Euphorbia clementii* (P3)

The cumulative impacts to *Euphorbia clementii* (P3) will not be significantly increased by the clearing and other activities associated within the proposed NVCP boundary. Historically, clearing associated with mining activities at Wodgina has not been associated with habitat suitable for this taxon, and the impacts to known locations and habitat likewise by the project are small. It is not considered that fragmentation of the taxon will be a significant issue as a result of clearing activities.

The cumulative local impact on this taxon is ranked Low; the cumulative impact on this taxon at a regional scale is also ranked Low (**Table 4.16**, **Table 4.17** and **Table 4.18**).

4.5.3.2 *Terminalia supranitifolia* (P3)

The proposed disturbance footprint will largely impact the eastern subpopulation of *Terminalia supranitifolia* (P3) in the Flora Study Area, (**Figure 1.2** and **Figure 4.1**). It is likely that this impact extends on impact from the original Hercules minesite, and it is possible that this taxon occurred in other currently cleared areas; however, this is not possible to quantify.

The cumulative local and regional impact on *Terminalia supranitifolia* (P3) locations is ranked Moderate; the cumulative local and regional impacts on both individuals and habitat is ranked Low (**Table 4.16**, **Table 4.18**). The significance of impact on individuals is preferentially assessed, as those locations remaining incorporating greater numbers of individuals are of higher significance in terms of longevity of the populations.

4.5.3.3 *Triodia chichesterensis* (P3)

The impact of the proposed disturbance footprint will be on a portion of the central sub-population that extends to the east of this area (**Figure 1.2** and **Figure 4.1**). The degree of historical clearing of this taxon is unable to be ascertained, however it may have occurred in the current Tailings Storage Facility and Waste Dump areas: clearing associated with the proposed NVCP boundary would therefore increase historical impacts. Although some fragmentation will occur, there are known records and suitable habitat for this taxon surrounding the proposed disturbance footprint, and the effects of the potential fragmentation are unlikely significant.

The cumulative local and regional impact on *Triodia chichesterensis* (P3) locations, individuals and habitat is ranked Low (**Table 4.16**, **Table 4.17**, **Table 4.18**).

Table 4.16 Cumulative Impacts of the proposed disturbance footprint and historical clearing on Significant Flora Locations

Significant Taxon	Total Number of Locations	Flora Study Area - Extant	Historical Impact	Proposed Impact	Total Cumulative Impact	Total Cumulative Impact (%)	Local Scale of Potential Impact	Regional Significance of Local Population	Regional Impact Ranking
<i>Euphorbia clementii</i> (P3)	368	322	46	0	46	12.50	Low	Low	Low
<i>Terminalia supranitifolia</i> (P3)	1196	1100	96	71	167	13.96	Low	Moderate	Low
<i>Triodia chichesterensis</i> (P3)	2094	1928	166	80	246	11.75	Low	Moderate	Low

Table 4.17 Cumulative Impacts of the proposed disturbance footprint and historical clearing on Significant Flora Individuals

Significant Taxon	Total Number of Individuals	Flora Study Area - Extant	Historical Impact	Proposed Impact	Total Cumulative Impact	Total Cumulative Impact (%)	Local Impact Ranking	Regional Significance of Local Population	Regional Impact Ranking
<i>Euphorbia clementii</i> (P3)	62,135	61,529	606	0	606	0.98	Low	Low	Low
<i>Terminalia supranitifolia</i> (P3)	2,557	2,378	179	125	304	11.89	Low	Moderate	Low
<i>Triodia chichesterensis</i> (P3)	1,968,586	1,951,574	17012	64,740	81,752	4.15	Low	Moderate	Low

Table 4.18 Cumulative Impacts of the proposed disturbance footprint and historical clearing on Significant Flora Preferred Habitat

Significant Taxon	Total Area (ha)	Vegetation Study Area - Extant (ha)	Historical Impact (ha)	Proposed Impact (ha)	Total Cumulative Impact	Total Cumulative Impact (%)	Local Impact Ranking	Regional Significance of Local Population	Regional Impact Ranking
<i>Euphorbia clementii</i> (P3)	3,695.52	3,583.03	112.49	61.46	173.95	4.71	Low	Low	Low
<i>Terminalia supranitifolia</i> (P3)	1,868.78	1,774.04	94.74	71.00	165.74	8.87	Low	Moderate	Low
<i>Triodia chichesterensis</i> (P3)	3,044.83	2,950.09	94.74	105.71	200.45	6.58	Low	Moderate	Low

4.5.4 Cumulative Impact on Vegetation

The potential cumulative impact on vegetation consists of the total proposed impact on each VU, including potential impact in the IIAZ, by proposed NVCP boundary, and extent of historical clearing, where data is available (**Table 4.19**).

Table 4.19 Cumulative Impact of the proposal on Vegetation Units

VU	Pre-Clearing Extent (ha)*	Cumulative Footprint (ha)	Percentage of Pre-Clearing Extent	Local Scale of Impact (Table 2.2)	Potential for Significance (Table 2.4)
1^	297.86	0.00	0.00 %	Nil	Nil
2	843.24	17.49	2.07 %	Low	Low
3^	243.32	0.00	0.00 %	Nil	Nil
4	325.69	20.48	6.29 %	Low	Low
5	372.96	34.03	9.12 %	Low	Low
6^	208.51	0.00	0.00 %	Nil	Nil
7^	362.87	0.00	0.00 %	Nil	Nil
8	134.04	4.94	3.69 %	Low	Low
9	1,469.55	156.90	10.68 %	Low	Low
10^	1,235.13	5.56	0.45 %	Low	Low
11	182.72	1.66	0.91 %	Low	Low
12^	59.57	0.00	0.00 %	Nil	Nil
13^	57.11	0.00	0.00 %	Nil	Nil
14	214.31	9.73	4.54 %	Low	Low
15^	15.50	0.00	0.00 %	Nil	Nil

*Note: this area includes the area originally mapped in the Hercules Project Area which has since been cleared

^Note: impacts in these VUs are from historical clearing only; no further impact from the Proposal

The cumulative impact on all of the VUs has been ranked Low or Nil with reference to **Table 2.2**.

The significance of cumulative impact on all of these VUs is ranked Low, with reference to **Table 2.4**.

5.0 Results – Fauna

5.1 Local Impact on Fauna Habitat

Land clearing is recognised as a key threatening process under the EPBC Act, and as a key threatening process in the Pilbara by Carawardine *et al.* (2014). Clearing of native vegetation and structures such as rocky outcrops will result in a direct loss of fauna habitats. The occurrence of fauna habitat and previously cleared areas within the Fauna Study Area is shown in **Figure 5.1**. The Fauna Study Area is 5,531.3 ha in total, of which 525.67 ha (9.5 %) was cleared before 2009 (prior to the Atlas Wodgina DSO Project). This was prior to fauna habitat mapping being undertaken so no data are available on the proportion of each fauna habitat lost prior to 2009. The current extent of clearing in the Fauna Study Area, including the pre-2009 clearing, is 896.87 ha, representing 16.2 % of the Fauna Study Area (**Table 5.1**).

The proposed disturbance footprint within the NVCP boundary area is 113.75 ha, representing 2.1 % of the Fauna Study Area. The disturbance footprint comprises 105.03 ha of fauna habitat with the remaining 8.7 ha being already disturbed. This will bring the cumulative habitat loss since 2009 to 476.13 ha, or 9.5 % of the Fauna Habitat Area (**Table 5.1**).

Of the six broad fauna habitats that have been mapped in the Fauna Study Area, two are considered of particular importance to fauna: The Rocky Ridge and Gorge, and Drainage Line (**Table 5.1**).

The Rocky Ridge and Gorge habitat is important as it is of limited extent in the bioregion (in comparison to habitats such as Spinifex Stony Plains and Sandplain) and supports a suite of significant fauna including MNES. This habitat contains denning sites for the Northern Quoll and, in some parts of the Fauna Study Area, diurnal roost sites for the Pilbara Leaf-nosed Bat and Ghost Bat. Although not recorded at Wodgina, the Pilbara Olive Python has a high likelihood to occur and would also favour the Rocky Ridge and Gorge habitat. A total of 17.97 ha of Rocky Ridge and Gorge habitat will be cleared in the disturbance footprint, which represents 4.5 % of the original extent of Rocky Ridge and Gorge habitat in the Fauna Study Area. When considering the clearing undertaken for the MARBL Lithium and Atlas DSO Projects, the cumulative total for clearing of this habitat will be 55.80 ha or 13.9 % of the original extent of Rocky Ridge and Gorge habitat in the Fauna Study Area.

Important features in the Rocky Ridge and Gorge habitat are caves that support diurnal (daytime) roosting by the Pilbara Leaf-nosed Bat and/or Ghost Bat (**Figure 5.3** and **Figure 5.4**). Although caves that support diurnal roosting have been recorded in the western part of the range, no such features were found within the proposed disturbance footprint during surveys by Stantec (2018a, 2022). Although small caves were present, these were considered to provide nocturnal refuges for foraging bats, rather than diurnal roosts. It is unlikely the clearing within this habitat will result in the loss of diurnal bat roosts for the Ghost Bat or Pilbara Leaf-nosed Bat. Diurnal bat roosts in adjacent areas may be indirectly impacted by altered hydrological regimes causing changes in cave humidity. Bat monitoring 2010–2018 has found that the mining of the Atlas DSO Project had not significantly impacted the use of monitoring caves by bats when protected with a 100 m buffer (Stantec 2017, Biologic 2018b).

The Northern Quoll is also supported by the Rocky Ridge and Gorge habitat, where the cracks, crevices and caves provide shelter and breeding sites. Northern Quolls are known to occur in the disturbance footprint and clearing of this habitat is likely to lead to the permanent loss of the rocky structures that support this species. Rocky features are difficult to replicate in the rehabilitation process. An attempt at Mt Dove, 34 km to the north of Wodgina, had not yet met with success in 2015 despite construction of an artificial habitat in 2014 (MWH 2015).

The Drainage Line habitat is important; although it is widespread in the bioregion, it provides a range of important habitat elements (**Table 1.7**), a seasonal source of water and a potential corridor for fauna dispersal. Significant species such as the Northern Quoll may disperse along drainage lines, and the Pilbara Leaf-nosed Bat forages along drainage lines. A total of 5.63 ha of Drainage Line habitat is proposed to be cleared, which represents 1.7% of the original extent of Drainage Line habitat in the Fauna Study Area. When considering the clearing undertaken for the MARBL Lithium and Atlas DSO Projects, the cumulative total for clearing in this habitat will be 15.84 ha representing 4.7% of the original extent of Drainage Line habitat in the Fauna Study Area.

Important features associated with both the Rocky Ridge and Gorge and Drainage Line habitats are permanent and semi-permanent pools. None of the pools currently mapped are situated within the NVCP boundary area or disturbance footprint, thus are unlikely to be directly impacted. There is a potential for indirect impacts on some of these pools due to altered surface runoff or contamination.

Table 5.1 Extent of Fauna Habitats in the Fauna Study Area

Habitat	Extent in the Bioregion	Importance of habitat	Extent of each habitat remaining (ha)				Extent Cleared (ha) of each habitat (% of pre MARBL Lithium and Atlas DSO Projects habitat extent)		
			Fauna Study Area		Proposed Disturbance Footprint		Cleared 2009 – 2019 (% of pre-2009)	Proposed Disturbance Footprint (% of pre-2009)	Cumulative clearing: 2009-2019 + proposed clearing (as % of pre-2009)
			Pre MARBL Lithium & Atlas DSO Projects (2009) (% of Fauna Study Area)	Post MARBL Lithium & Atlas DSO Projects– Current state (% of Fauna Study Area)	Permit Area ha (%)	Disturbance Footprint ha (%)			
Ironstone Ridgetop	Limited	Limited	339.37 (6.1 %)	206.26 (3.7 %)	16.07 (3.1 %)	5.17 (4.5 %)	133.12 (39.2 %)	5.17 (1.5 %)	138.29 (40.7 %)
Rocky Ridge and Gorge	Limited	Important	401.94 (7.3 %)	364.11 (6.6 %)	47.23 (9.0 %)	17.97 (15.8 %)	37.83 (9.4 %)	17.97 (4.5 %)	55.80 (13.9 %)
Rocky Foothills	Widespread	Limited	1,415.39 (25.6 %)	1,286.23 (22.3 %)	90.76 (17.3 %)	35.16 (30.9 %)	129.16 (9.1 %)	35.16 (2.48 %)	164.32 (10.6 %)
Stony Rise	Widespread	Limited	175.15 (3.2 %)	174.34 (3.2 %)	2.19 (0.4 %)	0.11 (0.1 %)	0.82 (0.5 %)	0.11 (0.1 %)	0.93 (0.5 %)
Spinifex Stony Plain	Widespread	Limited	2,365.53 (42.2 %)	2,276.57 (41.1 %)	96.35 (18.4 %)	40.99 (36.0 %)	59.96 (2.6 %)	40.99 (1.8 %)	100.95 (4.3 %)
Drainage Line	Widespread	Important	334.35 (6.0 %)	324.14 (5.9 %)	12.91 (2.5 %)	5.63 (5.0 %)	10.21 (3.1 %)	5.63 (1.7 %)	15.84 (4.7 %)
Subtotal (fauna habitat only)	-	-	5,002.74 (90.4 %)	4631.64 (83.7 %)	265.5 (50.6 %)	105.03 (92.3 %)	371.1 (7.4 %)	105.03 (2.1 %)	476.13 (9.5 %)
Cleared	-	-	525.67 (9.5 %)	896.87 (16.2 %)	258.78 (49.4 %)	8.7 (7.7 %)	-	8.72	-
Totals (% of Fauna Study Area)	-	-	5,531.3	5,531.30	524.29 (9.5 %)	113.75 (2.1 %)	-	113.75	-

* Note Minor differences in totals are due to cumulative discrepancies in spatial data (polygon alignments, 'slithers', etc).

5.2 Local Impact on Vertebrate Faunal Assemblages –

The scale of the impact on the local vertebrate assemblage is assessed as Low overall, but Moderate for saxicoline (rock-dwelling) species (**Table 5.2**). Species that are specifically associated with rocky habitats are likely to be impacted by the loss of 17.97 ha of Rocky Ridge and Gorge habitat. For smaller species, fragmentation of this habitat may present challenges to dispersal between remaining areas. However, these species are likely to be widespread through the remainder of the rocky range and in other ranges in the region. The remaining populations of saxicoline species are likely to be self-sustaining in the long-term, as there are substantial areas of suitable habitat remaining.

5.3 Local Impact on Significant Fauna Taxa

There are 17 species of conservation significant fauna that have been recorded or potentially occur in the Fauna Study Area (**Table 1.8**). For many species, the scale of impact is considered to be Low, Very Low, or Negligible, in that the population is either unlikely to be impacted, or the impact is likely to be small and temporary (**Table 5.2**).

The scale of impact is considered to be Moderate for the Northern Quoll, Gane's Blind Snake and Long-tailed Dunnart, as this Proposal will potentially lead to the loss of important habitat, primarily 17.97 ha of Rocky Ridge and Gorge habitat. The loss of this habitat is likely to be permanent, and lead to a permanent reduction of the carrying capacity of the rocky range for these species. However, the loss of this habitat is unlikely to lead to the local extinction of these or any species, as sufficient habitat area remains in the Fauna Study Area outside the disturbance footprint, and in the remainder of the rocky range outside the Fauna Study Area. The scale of impact is not likely to be High or Extreme for any species.

5.4 Regional Impact on Significant Fauna

There is unlikely to be an impact on any significant fauna taxa at a regional scale. Although the local population of some species will decrease, none are likely to be lost from the Fauna Study Area and all are likely to persist in the local area in the long-term. Therefore, there is not likely to be a range reduction, loss of an important population or impact on the ability of these species to disperse at a regional scale.

5.5 Cumulative Impacts

Habitat loss is the key threat to vertebrate fauna. Clearing of the disturbance footprint will result in the loss of 105.03 ha of fauna habitat. This is in addition to the 371.1 ha cleared for the MARBL Lithium and MARBL Lithium and Atlas DSO Projects and the 525.67 ha historically cleared. The cumulative loss of habitat is presented in **Table 5.1** and presented on **Figure 5.1**. Of key concern is the loss of Rocky Ridge and Gorge habitat, as this has been identified as limited in the region and important for significant fauna species. One of its key values is the presence of rocky crevices, cracks, caves and boulders, all features that are difficult to replicate in rehabilitation. Therefore, when cleared, the loss of this habitat is likely to be permanent. Currently, at least 9.4 % of this habitat type within the Fauna Study Area has been cleared as part of the MARBL Lithium and Atlas DSO Projects, with clearing under the proposed NVCP boundary will bring this total to 13.9 %.

The cumulative impacts of the Proposal are difficult to quantify on a regional scale. The key impact is habitat loss, particularly of the Rocky Ridge and Gorge habitat. The additional habitat loss associated with this project is small on a regional scale, however, rocky ranges in the Pilbara are often targeted for mining developments, with mining developments recognised by Carawardine *et al.* (2014) as a threat to fauna in the Pilbara Bioregion. Although rocky ranges are a feature of the bioregion, this habitat is more limited in extent than, for example, stony plains or sandplains. Targeting these ranges for mining development results in a disproportionate loss of these rocky habitats compared with more widespread habitat types. The rocky habitats are important as they provide habitat for Threatened species such as the Northern Quoll, Ghost Bat, Pilbara Leaf-nosed Bat and Pilbara Olive Python.

Table 5.2 Potential Impacts on the Vertebrate Faunal Assemblage and Significant Fauna Species

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
Vertebrate Fauna Assemblage 10 frogs (5 known to occur) 107 reptiles (59 known to occur) 140 birds (84 known to occur) 33 native mammals (26 known to occur) 8 introduced mammals (6 known to occur)	Most species, particularly birds, are widely distributed in the bioregion. Many arid zone species use a variety of habitats, though more productive habitats, such as Drainage Lines, may attract proportionally more species and individuals.	<ul style="list-style-type: none"> Clearing the disturbance footprint will result in the loss of 105.03 ha of habitat. Native fauna are reliant on these habitats to provide their needs for shelter, foraging and breeding. Direct mortality of fauna whiles clearing, particularly ground-dwelling species, nocturnal species and dependent young. Road mortalities. Reduced access to adjacent habitats due to dust, noise, vibration, human disturbance or artificial lighting. Increase in feral cats and dogs leading to increased predation on fauna. Altered hydrological regimes leading to additional water sources (that may attract feral species) or impacts on permanent or semi-permanent pools downstream. 	Although the vertebrate fauna assemblage is diverse, it is similar in composition to that in the vicinity of other rocky ranges in the region.	Low The loss of 105.03 ha of fauna habitat is likely to result in the loss of almost all fauna from the disturbance footprint. No species are likely to be lost from the Fauna Study Area and many species are likely to recolonise rehabilitated areas.
	The faunal assemblage includes a suite of saxicoline (rock-dwelling) species that are likely to be reliant on the rocky range, and in particular the rocky microhabitats associated with the Rocky Ridge and Gorge habitat. This includes mainly reptiles and mammals.	<ul style="list-style-type: none"> Loss of Rocky Ridge and Gorge habitat, which provides the cracks, caves and crevices on which these species rely. Fragmentation of the Rocky Ridge and Gorge habitat, hindering dispersal between the western and eastern parts of the range for small terrestrial species such as geckos. Direct mortality of individuals during clearing. 		Moderate Loss of 17.97 ha of Rocky Ridge and Gorge habitat, and fragmentation of the remaining habitat, is likely to lead to a permanent population decline in species that rely on these habitats. However, the remaining habitat areas in the rocky range are sufficient to support these species in the long-term.

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<p><i>Pezoporus occidentalis</i></p> <p>Night Parrot</p> <ul style="list-style-type: none"> Endangered – EPBC Act Critically Endangered – BC Act 	<p>This species remains unrecorded in the Fauna Study Area despite sampling using recommended methods (Western Wildlife 2019). The Night Parrot is rare throughout its range and is known from very few locations. Any known Night Parrot population would be an important population, given its rarity, but this species has only a low likelihood of occurring in the Fauna Study Area.</p>	<ul style="list-style-type: none"> Clearing of Spinifex Stony Plain habitat (particularly long-unburnt areas with large hummocks) may reduce the area of habitat available for this species, however, it is very unlikely that this species occurs and these habitats are extensive in the landscape. 	<p>It is difficult to make an assessment on the regional status of this species, other than that it is thought to be extremely rare. There is a sighting from the Fortescue Marsh in the Pilbara Bioregion in 2005 (Davis and Metcalf 2008) and then two confirmed sightings in recent times from near Lake Gregory and near Wiluna (NPRT 2019). There are other areas of habitat in the region that are more likely to be potential habitat, such as the Fortescue Marsh and alluvial plains associated with major watercourses (TSSC 2016b). The habitats in the survey area are unlikely to be of particular significance for this species as they lack the chenopod shrublands thought to be important for foraging and the Spinifex grasslands are more heavily wooded than at known Night Parrot sites.</p>	<p>Very Low</p> <p>This species is unlikely to be present, the habitats present are unlikely to be of particular importance to the species and the clearing of 40.99 ha of Spinifex Stony Plain habitat is considered to be a small reduction in total habitat area available in the Fauna Study Area (1.8 %) and the broader Pilbara.</p>
<p><i>Dasyurus hallucatus</i></p> <p>Northern Quoll</p> <ul style="list-style-type: none"> Endangered – EPBC Act Endangered – BC Act 	<p>Recorded. This species is known to occur in the Fauna Study Area and the population is likely to be a high density breeding population, though the annual population size is likely to be</p>	<ul style="list-style-type: none"> Clearing of habitat critical to the survival of the Northern Quoll is likely to be the driver of the greatest potential impact on this species. The Rocky Ridge and Gorge habitat represents critical habitat that is important for shelter and breeding. 	<p>The Northern Quoll occurs in rocky ranges in the Pilbara, and genetic evidence suggests that the population is a single continuous population (Spencer <i>et al.</i> 2013). Northern Quolls are known to</p>	<p>Moderate</p> <p>Loss of 17.97 ha of Rocky Ridge and Gorge shelter and breeding habitat, and 105.03 ha of foraging and dispersal habitat (i.e. all remaining native vegetation in</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
	<p>influenced by environmental factors such as annual rainfall and bushfire. The population is likely to extend throughout the rocky range both within and outside the Fauna Study Area. In 2018 this species was recorded on six cameras and 12 scat locations (Stantec 2018b), and annual monitoring as part of the Abydos DSO Project captured seven individuals (including one female) and recorded Northern Quolls at three camera locations (Biologic 2018a). In 2019, the species was recorded at three camera locations and captured once (Western Wildlife 2019).</p>	<p>Reducing the area of this habitat is likely to result in a long-term decrease in the carrying capacity of the of the site and thus the total population size that can be supported locally. All habitat within 1 km of the Rocky Ridge and Gorge habitat, or within 1 km of northern quoll records, is potential foraging and dispersal habitat (Figure 5.2).</p> <ul style="list-style-type: none"> • Fragmentation of Rocky Ridge and Gorge habitat, resulting in increasing isolation of populations in the eastern parts of the range. • Increase in vehicle mortalities, particularly at night or in areas adjacent to shelter habitat (Rocky Ridge and Gorge). • Increase in the frequency or intensity of fire in Northern Quoll habitat. • Increase in feral cats and dogs leading to increased predation on Northern Quolls. • Direct mortality during clearing of shelter habitat (Rocky Ridge and Gorge) or by entrapment of individuals in bins or skips. • Altered hydrological regimes changing the amount of water available in Drainage Lines or changing water quality. 	<p>occur in other rocky ranges in the region and are often targeted as part of fauna surveys, including at Abydos (42 km east of Wodgina), Mt Dove (34 km northwest), Mt Webber (75 km southeast) and Corunna Downs (105 km southeast).</p>	<p>the disturbance footprint). The loss of shelter and breeding habitat is likely to be permanent, as it is difficult to re-create with rehabilitation. There may also be a temporary impact on individuals through direct mortality of individuals sheltering in rocky habitats during clearing and/or road mortalities during night shift operations. However, the reduction in population size is unlikely to prevent the long-term persistence of the species in the rocky range at Wodgina.</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<p><i>Rhinonictis aurantia</i> Pilbara Leaf-nosed Bat</p> <ul style="list-style-type: none"> • Vulnerable – EPBC Act • Vulnerable – BC Act 	<p>Recorded. A single transitory diurnal roost and several nocturnal refuges are known to occur in the Fauna Study Area, and bats are likely to preferentially forage along Drainage Lines, gorges and over water pools, as well as in all other habitats present. Foraging bats have been recorded across the Fauna Study Area (Figure 5.3). No breeding sites (i.e. at permanent or temporary diurnal roosts) are known or likely to occur (Stantec 2018b).</p>	<ul style="list-style-type: none"> • Loss of habitat. Rocky Ridge and Gorge habitat potentially contains caves that may be used as nocturnal refuges-while foraging, however, no significant roosts (transitory, non-permanent or permanent diurnal roosts) were found to occur in the proposed NVCP boundary area during a targeted survey (Stantec 2018a). Drainage Lines are likely to be important foraging habitat. • Human disturbance at roost sites. • Mortality of individuals in barbed wire fencing. • Road mortalities of individuals foraging close to the ground at night. • Disturbance to roost sites or important foraging areas from artificial lighting. • Altered hydrological regimes may change the amount of water available in Drainage Lines, impacting foraging habitat quality or the internal humidity of roosting caves. 	<p>On the basis of genetic work, the Pilbara leaf-nosed Bats that occur in the Pilbara and upper Gascoyne are considered to be a single population (TSSC 2016c). This population is divided among a series of colonies. This species only uses warm underground roosts with high humidity. Important sites are permanent and non-permanent diurnal roosts, which are used during the breeding cycle. The closest known permanent diurnal roosts are located about 25 km from the NVCP boundary area at Yule River, East Turner River and Glacier Valley (Stantec 2018b). Timing of the calls recorded at Wodgina suggest that the bats that forage in the Fauna Study Area may originate from one of these roosts, and the transitory diurnal roost (cave C2) at Wodgina may be a satellite roost of one of these colonies (Stantec 2018b). The habitats at Wodgina may be of local importance in maintaining gene flow between regionally important roosts.</p>	<p>Low</p> <p>Although 17.97 ha of Rocky Ridge and Gorge habitat will be cleared, this area has been subject to targeted survey and no diurnal roosting caves were found or considered likely to occur inside the NVCP boundary area (Stantec 2018a). The nearest known transitory roost at cave C2 is located approximately 1.6 km to the west of the NVCP boundary area. Despite being located near the Wodgina DSO disturbance footprint, bat activity at this cave has been consistent during monitoring 2012 – 2018 (Biologic 2018b). Loss of 5.63 ha of Drainage Line foraging habitat, and road mortalities may have a temporary impact on the local foraging population.</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<p><i>Macroderma gigas</i> Ghost Bat</p> <ul style="list-style-type: none"> Vulnerable – EPBC Act Vulnerable – BC Act 	<p>Recorded. This species has been recorded in the Fauna Study Area, and monitoring at caves in the western part of the range has consistently recorded the species 2012 – 2018 (Biologic 2018b). No maternity or permanent diurnal roost sites are known from the Fauna Study Area, but transitory diurnal roosts and diurnal roosts that are potential maternity roosts are known to occur. A count of 65 bats at cave C2 in 2012 represents a significant proportion (4.3 %) of the estimated 1500 bats in the regional population of the Chichester Ranges.</p>	<ul style="list-style-type: none"> Loss of habitat. Rocky Ridge and Gorge habitat contains caves and overhangs that may be used as nocturnal refuge, however, no significant roosts (permanent diurnal roosts, maternity roosts) were found to occur during a targeted survey (Stantec 2018a). A single diurnal roost with many scats and 2 bats was recorded in 2009 (Outback Ecology 2009). Human disturbance at roost sites. Mortality of individuals in barbed wire fencing. Accidental introduction of cane toads, brought in to site on trucks or in freight. 	<p>The Pilbara population of the Ghost Bat is genetically distinct and separate from other populations in Australia (Woinarski <i>et al.</i> 2014, TSSC 2016a). Ghost Bats roost in both natural structures (such as caves), and old mine shafts. Intermittent roosts are used by a few individuals, and may be relatively shallow caves, rock crevices or smaller mines (Armstrong and Anstee 2000, Woinarski <i>et al.</i> 2014). Maternity roosts are regionally significant, and are situated in caves or deep mines with a high relative humidity, often with a small entrance opening into a larger chamber (Armstrong and Anstee 2000).</p>	<p>Low</p> <p>A total of 17.97 ha of Rocky Ridge and Gorge habitat will be lost, however, no known roost sites will be lost. The closest diurnal roost, where two bats were recorded in 2009, is located 100 m from the disturbance footprint (Figure 5.4). The relative importance of this roost site to the local colony of Ghost Bats is unknown. A Regionally significant roost at cave C2 is located approximately 1.6 km from the NVCP boundary area. Loss of 105.03 ha of foraging habitat. Although this species is not specific in its foraging habitat requirements, the foraging habitat lost is within 3 km of known diurnal roost sites. There may also be some temporary population decline due to loss of individuals to vehicle mortalities.</p>
<p><i>Liasis olivaceus barroni</i> Pilbara Olive Python</p> <ul style="list-style-type: none"> Vulnerable – EPBC Act Vulnerable – BC Act 	<p>This species remains unrecorded in the Fauna Study Area; however, it is highly likely to occur as it is known to occur in similar habitats in the region (Western Wildlife 2019). The lack of records despite many surveys over the past decade</p>	<ul style="list-style-type: none"> Loss of habitat. Rocky Ridge and Gorge habitat is likely to be the most important for this species, and Drainage Line habitats, particularly in close proximity to the rocky range, may be dispersal and foraging habitat. As a large, slow-moving snake, this species is vulnerable to road mortalities. 	<p>The Pilbara Olive Python occurs throughout the Pilbara Bioregion, on ranges with gorges and waterholes. They use waterholes for hunting and spend the winter in rocky areas away from water, and adults can range widely (DEWHA 2008). At least 21 populations are</p>	<p>Low</p> <p>Loss of 17.97 ha of Rocky Ridge and Gorge habitat will permanently reduce the total area of habitat available to support this species, however, this species has yet to be recorded in the Fauna Study</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
	indicate that the population is unlikely to be high density.	<ul style="list-style-type: none"> Altered hydrological regimes may lead to downstream changes in the availability of water pools for foraging. Increased numbers of feral cats may result in increased predation on juvenile pythons. Direct mortality of pythons sheltering in rock crevices during land clearing. 	known (DEWHA 2008). Only a single permanent water hole is known from the Fauna Study Area, so the habitat is possibly less important to this species than areas with many waterholes.	Area. Possible downstream impacts to water pools on drainage lines may impact the ability of these habitats to support this species.
<i>Falco hypoleucos</i> Grey Falcon <ul style="list-style-type: none"> Vulnerable – EPBC Act Vulnerable – BC Act 	This species remains unrecorded in the Fauna Study Area, however, it is highly likely to occur as a foraging visitor. As this species occurs at very low densities (Garnett <i>et al.</i> 2011), only a single bird or pair of birds is likely to occur, and the survey area is likely to represent only part of a larger foraging range.	<ul style="list-style-type: none"> Loss of foraging habitat. All habitats other than the Rocky Ridge and Gorge may be used for foraging by this species. Altered fire regimes may lead to loss of foraging habitat both within the survey area and in adjacent habitats. 	The Grey Falcon is widespread across much of arid and semi-arid northern and eastern Australia and is thought to represent a single subpopulation that occurs at very low densities (Garnett <i>et al.</i> 2011). Breeding habitat (tall trees in major watercourses) is absent from the Fauna Study Area but occurs throughout the region on larger rivers such as the Turner River. Although birds may forage in the Fauna Study Area, the habitats present are unlikely to be of particular importance to this species.	<u>Very Low</u> Clearing is unlikely to impact breeding habitat. A total of 105.03 ha of potential foraging habitat will be lost, but this is small in extent compared to the large home-range size of this species.
<i>Charadrius veredus</i> Oriental Plover <ul style="list-style-type: none"> Migratory – EPBC Act Migratory – BC Act 	This species remains unrecorded in the Fauna Study Area, however, it is moderately likely to occur as a non-breeding visitor in ones, twos or small groups. Nationally significant numbers (230 birds) or internationally significant	<ul style="list-style-type: none"> Altered hydrological processes may result in the loss of permanent or semi-permanent water pools in the Drainage Line habitat. Mining activities may result in additional habitat for this species, such as sewage ponds, turkey's nest dams or tailings 	Suitable habitat in the Fauna Study Area is of negligible importance compared other habitats available in the region, such as larger water pools on major water courses, marshland and coastal habitats.	<u>Negligible</u> Any potential impact is on very low numbers of non-breeding birds, and on habitats that are not important in maintaining populations of this species.

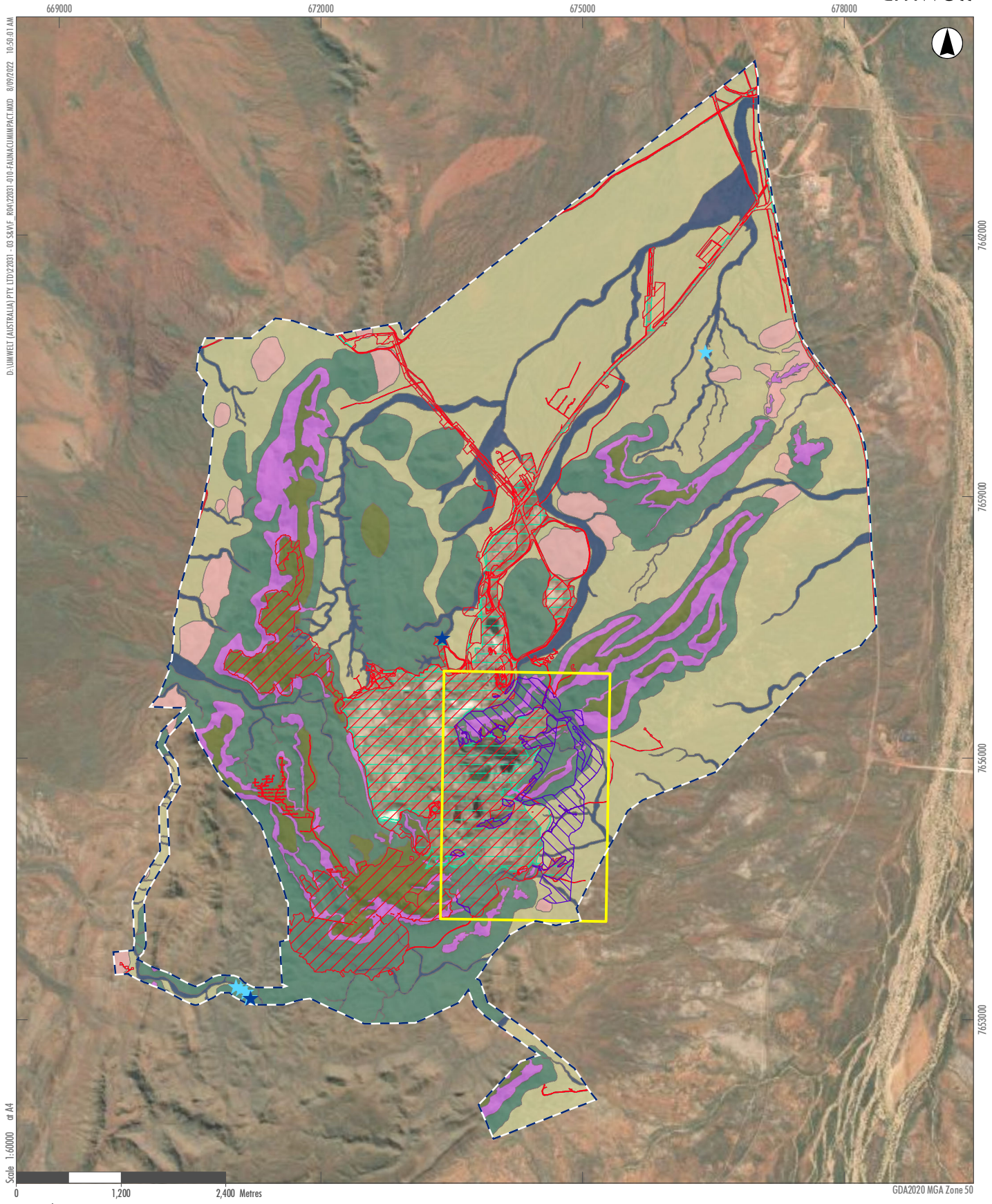
Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
	<p>numbers (2,300 birds) are not likely to occur, thus the habitats in the Fauna Study Area are not important for maintaining populations of this species.</p>	<p>facilities.</p>		
<p><i>Tringa glareola</i> Wood Sandpiper</p> <ul style="list-style-type: none"> • Migratory – EPBC Act • Migratory – BC Act 	<p>This species remains unrecorded in the Fauna Study Area, however, it is moderately likely to occur as a non-breeding visitor in ones, twos or small groups. Nationally significant numbers (130 birds) or internationally significant numbers (1,300 birds) are not likely to occur, thus the habitats in the Fauna Study Area are not important for maintaining populations of this species.</p>	<ul style="list-style-type: none"> • Altered hydrological processes may result in the loss of permanent or semi-permanent water pools in the Drainage Line habitat. • Mining activities may result in additional habitat for this species, such as sewage ponds, turkey’s nest dams or tailings facilities. 	<p>Suitable habitat in the Fauna Study Area is of negligible importance compared other habitats available in the region, such as larger water pools on major water courses, marshlands, and coastal habitats such as mangroves.</p>	<p><u>Negligible</u> Any potential impact is on very low numbers of non-breeding birds, and on habitats that are not important in maintaining populations of this species.</p>
<p><i>Tringa hypoleucos</i> Common Sandpiper</p> <ul style="list-style-type: none"> • Migratory – EPBC Act • Migratory – BC Act 	<p>This species remains unrecorded in the Fauna Study Area, however, it is moderately likely to occur as a non-breeding visitor in ones, twos or small groups. Nationally significant numbers (190 birds) or internationally significant numbers (1,900 birds) are not likely to occur, thus the habitats in the Fauna Study Area are not important for maintaining populations of this species.</p>	<ul style="list-style-type: none"> • Altered hydrological processes may result in the loss of permanent or semi-permanent water pools in the Drainage Line habitat. • Mining activities may result in additional habitat for this species, such as sewage ponds, turkey’s nest dams or tailings facilities. 	<p>Suitable habitat in the Fauna Study Area is of negligible importance compared other habitats available in the region, such as larger water pools on major water courses, marshlands, and coastal habitats such as mangroves.</p>	<p><u>Negligible</u> Any potential impact is on very low numbers of non-breeding birds, and on habitats that are not important in maintaining populations of this species.</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<p><i>Apus pacificus</i> Fork-tailed Swift</p> <ul style="list-style-type: none"> Migratory – EPBC Act Migratory – BC Act 	<p>This species remains unrecorded in the Fauna Study Area; however, it is highly likely to occur. As the Fork-tailed Swift is almost entirely aerial in Australia, no terrestrial habitat present in the Fauna Study Area is likely to be of particular importance to this species.</p>	<ul style="list-style-type: none"> There is unlikely to be any potential impacts to this species. 	<p>This species has a very large global population, is widespread across Australia, and is almost entirely aerial. Although it may overfly the Fauna Study Area, no terrestrial habitat in the study area is likely to be important for this species.</p>	<p>Negligible</p> <p>Changes to the proposed disturbance footprint are unlikely to impact individuals or populations of this species.</p>
<p><i>Falco peregrinus</i> Peregrine Falcon</p> <ul style="list-style-type: none"> Other Specially Protected Fauna – BC Act 	<p>This species remains unrecorded in the Fauna Study Area, however, it is highly likely to occur, at least as a foraging visitor. If present, one or at most two pairs of birds are likely to occur, given a home range size of about 20 - 30 km² (Birdlife International 2019).</p>	<ul style="list-style-type: none"> Possible loss of breeding/nesting habitat (Rocky Ridge and Gorge habitat). Possible disturbance to breeding birds or young in nest during clearing, both within and adjacent to the disturbance footprint. Disturbance may be due to noise, light, vibration or dust. 	<p>This species has an extremely large range, encompassing Australia and most other continents. Its global population size is also extremely large (Birdlife International 2019). Potential breeding habitat is present in the remainder of the rocky range outside the survey area, and on other ranges and major watercourses in the region. Foraging habitat is very widespread in the region.</p>	<p>Low</p> <p>Potential loss of 17.97 ha of breeding habitat (Rocky Ridge and Gorge) for one pair of birds. It is likely that a pair of birds can find an alternative breeding site, and this species is known to nest in abandoned open pits. Loss of 105.03 ha of potential foraging habitat, though this is on a very small scale when compared to the 20 – 30 km² (2,000 – 3,000 ha) home range for a single pair of birds.</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<i>Ctenotus nigrilineatus</i> Black-lined Ctenotus <ul style="list-style-type: none"> Priority 1 – DBCA Priority list 	<p>This species remains unrecorded in the Fauna Study Area; however, it is considered moderately likely to occur given that the type locality¹ (Woodstock) is about 40 km south of the Fauna Study Area and potentially suitable habitat is present.</p> <p>¹ The place where the type specimen for the species was found</p>	<ul style="list-style-type: none"> Clearing of habitat is likely to be the greatest potential impact on this species. The Spinifex Stony Plain habitat may be potential habitat for this species. Increase in feral cats leading to increased predation on the Black-lined Ctenotus. Increased frequency of fire may impact the presence of spinifex cover in potential Black-lined Ctenotus habitat. 	<p>Little is known about this rarely recorded species. It's thought that it is naturally patchily distributed and its current known distribution is in the Pilbara interior between Woodstock, Nullagine, Meentheena and Karajini National Park (IUCN 2019). It may be associated with stony plains near watercourses, and this habitat is widespread in the region.</p>	<p>Low</p> <p>Loss of 40.99 ha of Spinifex Stony Plain habitat is likely to result in some loss of potential habitat. However, this species remains unrecorded at Wodgina, despite trapping in this habitat, and the habitat area lost is small in relation to the area of habitat available in the remainder of the Fauna Study Area and the region.</p>
<i>Anilius ganei</i> Gane's Blind Snake <ul style="list-style-type: none"> Priority 1 – DBCA Priority list 	<p>This species remains unrecorded in the Fauna Study Area; however, it is moderately likely to occur in association with Rocky Ridge and Gorge habitat and the Rocky Foothills habitat.</p>	<ul style="list-style-type: none"> Loss of Rocky Ridge and Gorge and Rocky Foothills habitats are potentially the most important for this species. Fragmentation of Rocky Ridge and Gorge habitat. This species is not very mobile and is unlikely to navigate across cleared lands. However, the Rocky Foothills habitat will remain relatively well-connected. Altered fire regimes leading to increased fire frequency and loss of spinifex cover. 	<p>This species occurs in the Pilbara interior and is tentatively associated with moist gorges and gullies, though some of the early specimens are from the Newman townsite and Mt Whaleback waste dump (Aplin 1998). This species is probably associated with ranges throughout the region. If present, a population in the Fauna Study Area is unlikely to be of particular regional significance, and large areas of habitat remain in the adjacent ranges outside the disturbance footprint.</p>	<p>Moderate</p> <p>Loss of 17.97 ha of Rocky Ridge and Gorge habitat may result in a permanent loss of habitat for this species. However, this species has not been recorded within the proposed NVCP Boundary Area.</p>
<i>Lagorchestes conspicillatus</i> Spectacled Hare-wallaby <ul style="list-style-type: none"> Priority 4 – DBCA 	<p>Recorded. A single dead individual (possibly roadkill) was recorded opportunistically in the Fauna Study Area in 2018 (Biologic 2018a) It was also recorded approximately 14 km</p>	<ul style="list-style-type: none"> Loss of Spinifex Stony Plain habitats, particularly long-unburnt areas. Increase in vehicle mortalities, particularly at night, in areas of Spinifex Stony Plain habitat. 	<p>This species is patchily distributed in the Pilbara, where it is generally uncommon and sparsely distributed (Van Dyck and Strahan 2008, Woinarski <i>et al.</i> 2014). The Spinifex grasslands on which this</p>	<p>Very Low</p> <p>The loss of potential habitat (40.99 ha of Spinifex Stony Plains) is likely to represent habitat for a single individual and is unlikely to lead to the permanent decline in</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
<p>Priority list</p>	<p>from the Fauna Study Area (Western Wildlife 2019). It is likely to occur at low densities in the Spinifex Stony Plain habitat.</p>	<ul style="list-style-type: none"> Increase in feral cats leading to increased predation on the Spectacled Hare-Wallaby, both within and adjacent to the proposed disturbance footprint area. Altered fire regimes leading to increased fire frequency and loss of spinifex cover (and the large hummocks important for shelter) in the Spinifex Stony Plain habitat. 	<p>species depends are widespread in the region, and the habitats in the Fauna Study Area are unlikely to be of particular importance for this species. If a population of Spectacled Hare-Wallaby is present, it is likely to be part of a wider population that extends well beyond the boundaries of the disturbance footprint.</p>	<p>this species in the local area or region.</p>
<p>Sminthopsis longicaudata Long-tailed Dunnart</p> <ul style="list-style-type: none"> Priority 4 – DBCA Priority list 	<p>Recorded. This species was recorded in the Fauna Study Area in 2009 (Western Wildlife 2019). Though there have been no subsequent records, this is likely because this species is difficult to trap rather than an indication of rarity. The Long-tailed Dunnart is likely to be present as a resident breeding species with its population centred on the Rocky Ridge and Gorge and Rocky Foothills habitats.</p>	<ul style="list-style-type: none"> Loss of Rocky Ridge and Gorge and Rocky Foothills habitats are the most important for this species. Spinifex Stony Plains and Stony Rise habitats may be used for dispersal and foraging, though their relative importance is unknown. Fragmentation of Rocky Ridge and Gorge habitat, leading to possible isolation of any population in the eastern part of the rocky range. Increase in feral cats leading to increased predation on Long-tailed Dunnart. Direct mortality during clearing of shelter habitat (Rocky Ridge and Gorge). 	<p>This species has a wide distribution through central Western Australia (Pilbara, Murchison and Gibson Desert), extending into central Australia. Habitat for this species is relatively common in the region, wherever there are rocky ranges. This species has been recorded from habitats near rocky ranges (such as stony plains) and presumably disperses between more rugged habitats, however, little is known about their pattern of dispersal.</p>	<p>Moderate</p> <p>Loss of important habitat, 17.97 ha of Rocky Ridge and Gorge, 35.16 ha of Rocky Foothills is likely to reduce the total habitat area available to this species, leading to a permanent population reduction. However, this species is likely to persist in the remainder of the rocky range.</p>
<p>Leggadina lakedownensis Lakeland Downs Mouse</p> <ul style="list-style-type: none"> Priority 4 – DBCA Priority list 	<p>This species remains unrecorded in the Fauna Study Area, however, it is moderately likely to occur. The populations of this species can fluctuate dramatically, so it may be common one year and virtually</p>	<ul style="list-style-type: none"> Loss of Drainage Line and Spinifex Stony Plains habitats are the most likely to support this species. Increase in feral cats leading to increased predation on the Lakeland Downs Mouse. 	<p>This species has an extensive but discontinuous population across the Pilbara and northern Australia, and is generally uncommon (Woinarski <i>et al.</i> 2014). Although known to occur in a range of habitats, in the</p>	<p>Low</p> <p>Although 46.62 ha of suitable habitat will be lost (40.99 ha of Spinifex Stony Plains and 5.63 ha of Drainage Line), this is unlikely to impact populations of this species on a regional level.</p>

Species/Assemblage	Local Population	Potential Impacts	Regional Context	Scale of impact (local)
	<p>undetectable the next (Van Dyck and Strahan 2008).</p>		<p>Pilbara Bioregion it is thought to prefer blacksoil plains and calcareous clays (Gibson and McKenzie 2009). As these habitats are absent from the Fauna Study Area, it is unlikely that the survey area is of particular importance to this species.</p>	
<p><i>Pseudomys chapmani</i> Western Pebble-mound Mouse</p> <ul style="list-style-type: none"> Priority 4 – DBCA Priority list 	<p>Recorded. The distinctive pebble-mounds of this species have been recorded in the Fauna Study Area, including recent records in 2019 (Western Wildlife 2019). This species is likely to be resident anywhere there are suitable small stones for mound building.</p>	<ul style="list-style-type: none"> Loss of habitat. Spinifex Stony Plain and/or Ironstone Ridgetop habitats with small stones for mound-building. Increase in feral cats leading to increased predation on Western Pebble-mound Mouse, both within and adjacent to the disturbance footprint. Direct mortality during clearing of Spinifex Stony Plains or Ironstone Ridgetop. Altered fire regimes leading to increased fire frequency and loss of spinifex cover in the Spinifex Stony Plain habitat. 	<p>This species occurs in suitable stony habitats throughout the Pilbara. Its favoured habitat is widespread in the region, and the population at Wodgina is likely to extend outside the survey area boundary, throughout the gentle lower slopes of the rocky range that extends to the south and north. It is unlikely that the population of this species in the Fauna Study Area is of particular regional importance.</p>	<p>Low</p> <p>Although 46.16 ha of suitable habitat will be lost (40.99 ha of Spinifex Stony Plains and 5.17 ha of Ironstone Ridgetop), this is unlikely to impact populations of this species on a regional level. Adjacent habitat within the Fauna Study Area is likely to continue to support this species, and the remaining population is likely to persist in the long-term.</p>



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GDA2020 MGA Zone 50

Legend

- | | | |
|--------------------------------|-------------------------------------|-----------------------------------|
| Fauna Study Area | Fauna Habitat | Rocky Ridge and Gorge |
| Proposed NVCP Boundary | Drainage Line | Shrubland over Spinifex Sandplain |
| Proposed Disturbance Footprint | Ironstone Ridge Top | Spinifex Sandplain |
| Current Cleared Areas | Low Vegetation with Ephemeral Areas | Spinifex Stony Plain |
| Old Cleared Areas | Rocky Foothills | Stony Rises |
| Permanent Pool | | |
| Semi-Permanent Pool | | |

FIGURE 5.1

Cumulative Impact on Fauna Habitat

5.6 Risk of a Significant Impact on Significant Fauna Taxa

Of the 17 significant fauna known to occur or potentially occurring in the Fauna Study Area, nine are listed as MNES under the EPBC Act. Of these, the scale of impact at a local level has been assessed as ‘Negligible’ for the four Migratory species and ‘Very Low’ for the Night Parrot, thus the potential impact on these species is not considered to be significant under the EPBC Act (**Table 5.2**). For the remaining four species, the scale of impact at a local level has been assessed as Low or Moderate (**Table 5.2**), indicating the potential for temporary decline in the local population.

The risk of a potential significant impact (**Table 3.3**) on the Pilbara Olive Python, Ghost Bat and Pilbara Leaf-nosed Bat is considered likely to be Low, however, the risk of a potential significant impact is considered to be High for the Northern Quoll. The impact on the Northern Quoll is primarily due to the loss of Rocky Ridge and Gorge habitat, which is important for shelter and breeding. Each of these has been considered further in the sections below and **Table 5.3**, **Table 5.4**, **Table 5.5** and **Table 5.6**.

5.6.1 Northern Quoll

Northern Quolls were monitored at eight sites between 2010 and 2018 in the western part of the range as part of the Atlas DSO Project. Initial captures were high (15 individuals), although captures dropped significantly in 2013/2014. This decline in capture rates was inferred to be due to the impacts of bushfire rather than mining (Stantec 2017). The monitoring in 2018 recorded an increase in quoll numbers (seven individuals including one female) as they recover after fire (Biologic 2018a). In 2018 this species was recorded on six cameras and 12 scat locations (Stantec 2018b), in 2019 the species was recorded opportunistically at three camera locations and caught once (Western Wildlife 2019). The Stantec (2022) survey recorded the species six times over 72 camera nights. The most recent survey within the Proposal area suggested the Northern Quoll population in the Survey area is currently low density that is recovering post-fire (Stantec 2022).

The known records and critical habitat for Northern Quoll is presented in **Figure 5.2**.

5.6.1.1 Important Population

For the Northern Quoll, an ‘important population’ is defined by (DoE 2016) as being one or more of the following:

- High density Northern Quoll populations, which occur in refuge-rich habitat critical to the survival of the species, including where cane toads are present.
- Populations occurring in habitat that is free of cane toads and unlikely to support cane toads upon arrival i.e. granite habitats in WA, populations surrounded by desert and without permanent water.
- Populations subject to ongoing conservation or research actions i.e. populations being monitored by government agencies or universities or subject to reintroductions or translocations.

Although Northern Quolls are present at Wodgina in low numbers (Western Wildlife, 2019), it is considered an important population as it occurs in the refuge-rich habitat of the rocky range and is in habitat that is free of cane toads. This population is likely to extend throughout the rocky range, both inside and outside the Fauna Study Area. Northern Quolls have been recorded throughout the rocky parts of the Fauna Study Area (**Figure 5.2**).

5.6.1.2 Habitat Critical for the Survival of the Species

For the Northern Quoll, 'habitat critical to the survival of the species' is defined by DoE (2016) as:

- Offshore islands where the Northern Quoll is known to exist.
- Rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields, major drainage lines or treed creek lines.
- Structurally diverse woodland or forest areas containing large diameter trees, termite mounds or hollow logs.
- Dispersal and foraging habitat, when connected with populations considered important for the long-term survival of the Northern Quoll.

The Rocky Ridge and Gorge habitat in the Fauna Study Area is critical habitat (for breeding and shelter) for the Northern Quoll (Commonwealth of Australia 2016). This habitat is also likely to extend outside the Fauna Study Area, though this has not been mapped. The Rocky Ridge and Gorge habitat is refuge-rich, containing caves and crevices likely to be used by the Northern Quoll for shelter and breeding. Dispersal and foraging habitat is not generally well-understood, but is considered by DoE (2016) to be all habitat within 1 km of Northern Quoll records or breeding habitat (**Figure 5.2**). As the Northern Quolls at Wodgina are part of an 'important population', dispersal and foraging habitat is also considered to be critical habitat.

The potential reduction in population size due to potential impacts to habitat is considered unlikely to prevent the long-term persistence of the species in the rocky range at Wodgina (**Table 5.2**).

An assessment of significant impact on the Northern Quoll is presented in **Table 5.3**. The implementation of the Proposal is likely to trigger three of the nine significant impact criteria for the Matters of National Environmental Significance under the EPBC ACT (DoE 2013).

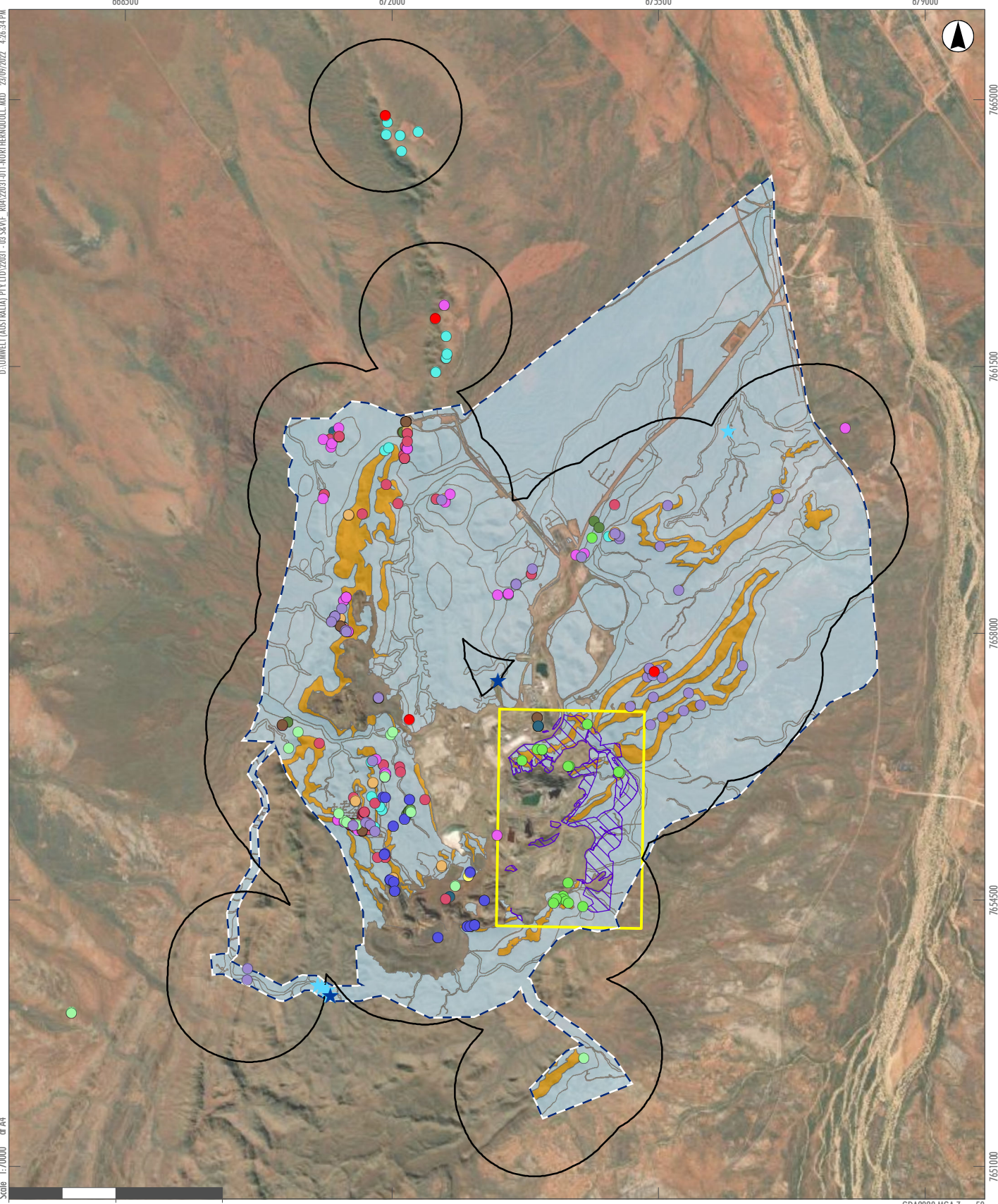
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- Legend**
- Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - Northern Quoll Habitat**
 - Critical Habitat
 - Supporting Habitat
 - Foraging Habitat
 - ★ Permanent Pool
 - ★ Semi-Permanent Pool
- | Northern Quoll Record | |
|--|---|
| ● 2019 | ● 2012 |
| ● 2018 | ● 2011 |
| ● 2017 | ● 2010 |
| ● 2016 | ● 2009 |
| ● 2015 | ● 2008 |
| ● 2014 | ● Other |

FIGURE 5.2

Northern Quoll Records and Habitat within the Fauna Study Area

Image Source: ESRI Basemap (2021) Data source: Mineral Resources (2021), Western Wildlife (2019)

Table 5.3 Assessment of potential impacts of the on the Northern Quoll (En) against Significant Impact Guideline Criteria (DoE 2013)

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Lead to a long-term decrease in the size of a population	<p>Likely</p> <p>The loss of 17.97 ha of Rocky Ridge and Gorge habitat is likely to result in a permanent reduction in the area of shelter habitat with the associated potential for breeding. The loss of this habitat is likely to reduce the carrying capacity of the rocky range leading to a permanent decrease in the local population size. The Northern Quoll occurs in a variety of habitats across its range, but in the Pilbara, favours dissected rocky escarpments (Hill and Ward 2010, Van Dyck and Strahan 2008). Where shelter habitat occurs within the Northern Quolls predicted range, it is considered 'habitat critical to the survival of the species' (Commonwealth of Australia 2016). In the Pilbara, shelter habitat (with associated denning habitat), consists of rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields and major drainage lines (Commonwealth of Australia 2016). In the proposed disturbance footprint area, shelter habitat is primarily the 17.97 ha of Rocky Ridge and Gorge habitat (Figure 5.2).</p>
Reduce the area of occupancy of the species	<p>Likely</p> <p>Loss of 17.97 ha of Rocky Ridge and Gorge habitat is likely to lead to a permanent loss of these habitats.</p> <p>Other habitat in the proposed disturbance area can be considered critical foraging and dispersal habitat, of which 105.03 ha will be lost to clearing.</p>
Fragment an existing population into two or more populations	<p>Unlikely</p> <p>Although the Rocky Ridge and Gorge habitat will be cleared within the proposed disturbance footprint, it is unlikely to lead to fragmentation and genetic isolation of the population on either side of the proposed disturbance footprint. The Northern Quoll is very mobile and capable of dispersing long distances, for example, 2.5 km in one day (Schmitt <i>et al.</i> 1989), 3.5 km in seven days (King 1989), 2–3 km at Poondano (Process Minerals International, unpublished data) and 2 km at the Buckland Project (Phoenix Environmental Sciences 2012). DoE (2016) recognise all native vegetation within 1 km of shelter habitat or Northern Quoll records as foraging and dispersal habitat. Figure 5.2 maps potential dispersal and foraging habitat, showing that the population is likely to remain connected across the Fauna Study Area.</p>
Adversely affect habitat critical to the survival of a species	<p>Likely</p> <p>The Northern Quoll occurs in a variety of habitats across its range, but in the Pilbara, favours dissected rocky escarpments (Hill and Ward 2010, Van Dyck and Strahan 2008). Where shelter habitat occurs within the Northern Quolls predicted range, it is considered 'habitat critical to the survival of the species' (Commonwealth of Australia 2016). In the Pilbara, shelter and denning habitat consists of rocky habitats such as ranges, escarpments, mesas, gorges, breakaways, boulder fields and major drainage lines (Commonwealth of Australia 2016). In the Fauna Study Area, shelter habitat is primarily the 17.97 ha of Rocky Ridge and Gorge habitat (Figure 5.2).</p>

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Disrupt the breeding cycle of a population	<p>Unlikely</p> <p>Although the loss of 17.97 ha of Rocky Ridge and Gorge habitat is likely to result in a permanent reduction in the area of potential breeding and shelter habitat reducing the carrying capacity of the rocky range, it is unlikely to disrupt the breeding cycle of the population. The Northern Quoll population in the Fauna Study Area is likely to be a breeding population, as indicated by presence of females (Western Wildlife, 2019).</p>
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	<p>Unlikely</p> <p>The loss of potential 17.97 ha of breeding and shelter habitat is likely to reduce the carrying capacity of the rocky range leading to a permanent decrease in the local population size, however the species is unlikely to continue to decline. There may also be impacts to individuals (e.g. through road mortalities and other accidental deaths) or indirect impacts (e.g. increase in feral predators) that may lead to population reduction, at least on a temporary level, during the operation of the project.</p>
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	<p>Unlikely</p> <p>Feral cats are already known to occur in the Fauna Study Area, with cats recorded on camera traps in eight of 40 locations sampled in April 2019 (Western Wildlife 2019). Although it is possible that feral cats may increase in abundance due to the Proposal, it is likely that feral cats are an on-going existing threat, attracted to the current landfill site, accommodation village and water sources. Cane toads may potentially be brought into site on trucks or in freight, though the chance of this species establishing itself in the Fauna Study Area is low, as there is little permanent water available.</p>
Introduce disease that may cause the species to decline	<p>Unlikely</p> <p>The Proposal is unlikely to result in the introduction or transmission of disease, as it is unlikely that bats potentially carrying disease will be moved either purposely or accidentally; Pets (i.e. cats and dogs) are not permitted within the project and landfill and waste water treatment facilities are managed as per DWER licence conditions.</p>
Interfere with the recovery of the species	<p>Unlikely</p> <p>No recovery actions for the Northern Quoll are currently underway or proposed within the NVCP boundary area.</p>

5.6.2 Pilbara Leaf-nosed Bat

5.6.2.1 Important Population

On the basis of genetic work, the Pilbara leaf-nosed Bats are considered to be a single population (TSSC 2016c). This population is divided among a series of colonies. As known breeding colonies are relatively few, they are likely to be regionally important in maintaining the species. The Pilbara Leaf-nosed Bats in the Fauna Study Area are part of the important population that occurs across the Pilbara, but no regionally important colonies (breeding roosts) are known or likely to occur within the Fauna Study Area. However, transitory diurnal roosts (of which one is present) may be important for maintaining gene—flow between larger colonies.

5.6.2.2 Habitat Critical for the Survival of the Species

For the Pilbara Leaf-nosed Bat, ‘habitat critical to the survival of the species’ is defined by TSSC (2016c) as underground diurnal roosts with warm temperatures and high humidity, listed in order of priority for conservation, they are:

- Permanent Diurnal Roosts (Priority 1).
- Non-permanent Diurnal Roosts (Priority 2).
- Transitory Diurnal Roosts (Priority 3).

Habitat important for the persistence of the local population, although not considered to be critical habitat, is:

- Nocturnal refuges (Priority 4).

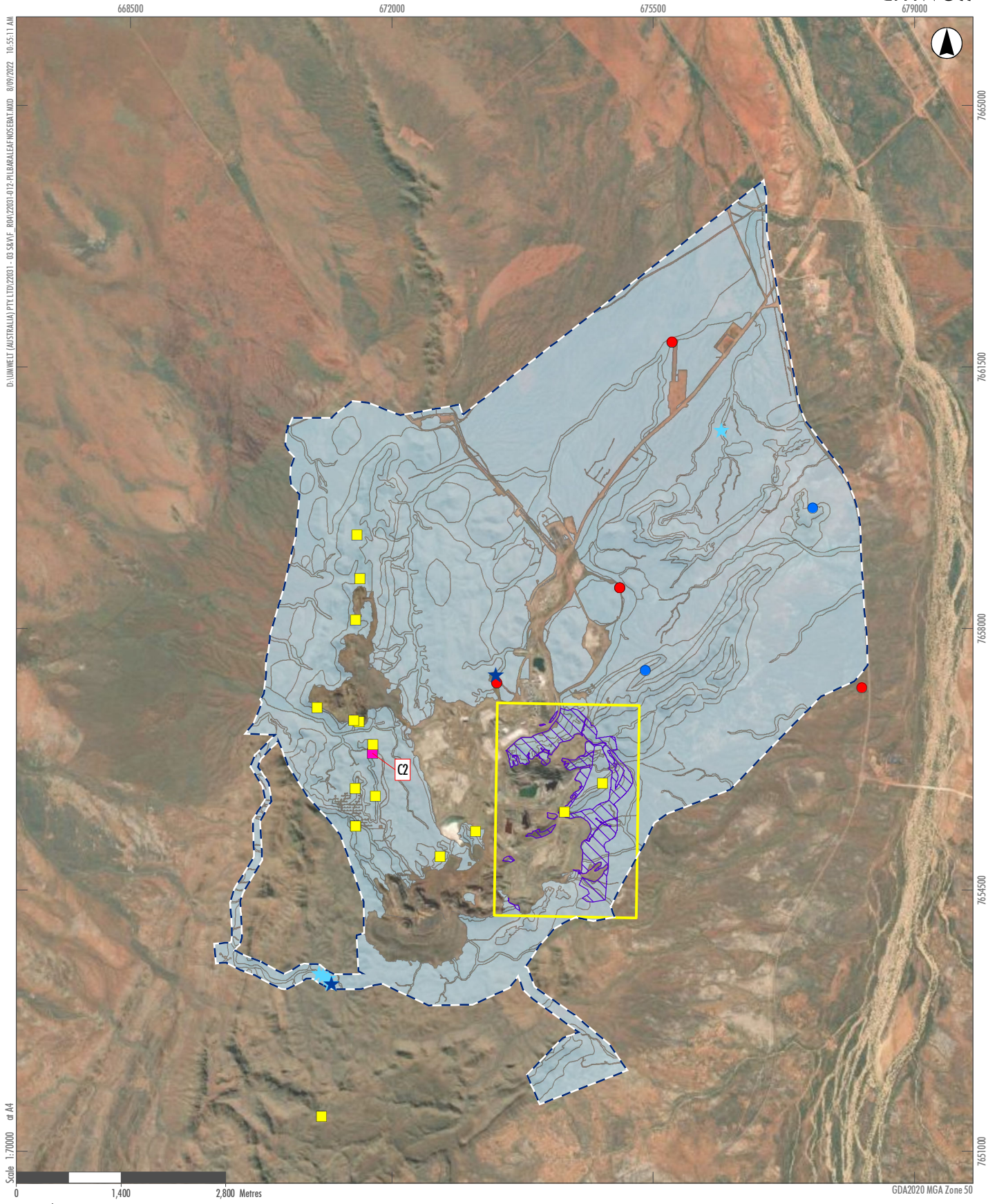
It is difficult to define critical foraging habitat (TSSC 2016c). However, suitable foraging habitat located within vicinity of a diurnal roost in order of priority for conservation includes:

- gorges with pools (Priority 1)
- gullies (Priority 2)
- rocky outcrops (Priority 3)
- major watercourses (Priority 4)
- open grasslands and woodlands (Priority 5).

In the Fauna Study Area, roosting habitat critical to the survival of the Pilbara Leaf-nosed Bat is a single known transitory diurnal roost at cave C2 (**Figure 5.3**). A second transitory diurnal roost is known from outside the Fauna Study Area at cave C6, approximately 21 km east of the Fauna Study Area. No permanent or non-permanent diurnal roosts are known or considered likely to occur in the Fauna Study Area, the nearest located about 25 km away at Yule River, East Turner River and Glacier Valley (Stantec 2018a, 2018b). Timing of the calls recorded in the Fauna Study Area suggest that the bats that forage in the Fauna Study Area may originate from one of these roosts, and the transitory diurnal roost (cave C2) may be a satellite roost of one of these colonies (Stantec 2018b). The habitats at may be of local importance in maintaining gene flow between regionally important roosts. After a targeted bat survey in 2018, it was considered that no critically important roosting habitat was likely to occur within the NVCP boundary area (Stantec 2018a). The results of a targeted survey in 2022 align with the previous surveys of the Rocky Ridge habitat that also failed to identify suitable roosting habitat and recorded foraging in low numbers (Stantec 2022).

Critical foraging habitat is likely to be present, as this species is known to roost at cave C2 and bats may fly 10 km or more from a roost to forage (TSSC 2016c). Bats have been recorded foraging across the Fauna Study Area, including on the most recent surveys in 2018 and 2019 (**Figure 5.3**). Pilbara Leaf-nosed Bats are likely to forage in several habitats, including Drainage Lines (aligns with 'major watercourses, priority 4'), Rocky Ridge and Gorge (aligns with 'rocky outcrops, priority 3' and 'gullies, priority 2') and over permanent and semi-permanent pools in Drainage Lines (aligns with 'gorges with pools, priority 1'). Within the Rocky Ridge and Gorge habitat are caves that may be used as nocturnal refuges i.e. used while feeding at night but not used for day roosting. The known records and critical habitat are presented in **Figure 5.3**.

Table 5.4 presents the assessment of the potential impacts of the Proposal against the significant impact criteria for the Pilbara Leaf-nosed Bat (Department of Environment 2013). The implementation of the Proposal is unlikely to trigger any of the nine significant impact criteria.



- Legend**
- Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - ★ Permanent Pool
 - ★ Semi-Permanent Pool
 - Pilbara Leaf-nosed Bat Habitat**
 - Supporting Habitat
 - Pilbara Leaf-nosed Bat Cave**
 - Nocturnal Refuge

- Pilbara Leaf-nosed Bat Critical Habitat**
- Transitory Diurnal Roost
- Pilbara Leaf-nosed Bat Record**
- 2019
 - 2018

FIGURE 5.3

Pilbara Leaf-nosed Bat Records and Habitat within the Fauna Study Area

Image Source: ESRI Basemap (2021) Data source: Mineral Resources (2021), Western Wildlife (2019)

Table 5.4 Assessment of potential impacts of the on the Pilbara Leaf-nosed Bat (Vu) against Significant Impact Guideline Criteria

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Lead to a long-term decrease in the size of an important population of a species	<p>Unlikely</p> <p>Loss or disturbance to permanent or non-permanent diurnal roosts is considered likely to cause a long-term decrease in population size (TSSC 2016c). The nearest permanent diurnal roosts are 25 km from the project (Stantec 2018b). As there will be no loss or disturbance to these roost types, there is unlikely to be a significant impact on the population.</p>
Reduce the area of occupancy of an important population	<p>Unlikely</p> <p>The area of occupancy of this species is determined by the presence of suitable warm, humid underground roost sites (TSSC 2016c, Woinarski <i>et al.</i> 2014). As the Proposal is not likely to impact a permanent or transient diurnal roost site, the area of occupancy is unlikely to be reduced.</p>
Fragment an existing important population into two or more populations	<p>Unlikely</p> <p>Supporting habitat surrounds the disturbed areas with the proposed clearing unlikely to fragment the population of the Pilbara Leaf-nosed Bat.</p>
Adversely affect habitat critical to the survival of a species	<p>Unlikely</p> <p>There are no permanent or non-permanent diurnal roosts present within the proposed NVCP boundary area, and the single transitory diurnal roost present is located approximately 1.6 km outside the proposed disturbance footprint.</p>
Disrupt the breeding cycle of an important population	<p>Unlikely</p> <p>Wodgina is not known to support a permanent diurnal roost of Pilbara Leaf-nosed Bats. One of the five roosts identified in the western part of the range and monitored between 2012 and 2018 is considered to be a transitory diurnal roost, the remaining four are nocturnal refuges, and bat call activity has been consistently recorded in these caves each year (Biologic 2018b, Stantec 2018b). The closest known permanent diurnal roosts (breeding sites) are located about 25 km from the proposed disturbance footprint at Yule River, East Turner River and Glacier Valley. Timing of the calls recorded at Wodgina suggest that the bats that forage in the Fauna Study Area may originate from one of these roosts (Stantec 2018b). Although 17.97 ha of Rocky Ridge and Gorge habitat will be cleared, this has been subject to a targeted survey and no diurnal roosts were located or considered likely to occur (Stantec 2018a). It is unlikely that the Proposal will disrupt a breeding roost of this species.</p>

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	<p>Unlikely</p> <p>The individuals that roost at cave C2 potentially forage 10 km or more from the roost when present and are particularly likely to favour Drainage Line and Rocky Ridge and Gorge habitats for foraging. Clearing the proposed disturbance footprint will result in the loss of 23.60 ha of potential foraging habitat, comprising 5.63 ha of Drainage Line and 17.97 ha of Rocky Ridge and Gorge. Bats were recorded foraging within the footprint by Stantec (2018a) and nocturnal refuges (used at night while foraging) are likely to be lost. However, the loss of habitat is small compared to that available in the local area and is unlikely to lead to a substantial population decline.</p>
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	<p>Unlikely</p> <p>Feral cats are already known to occur in the Fauna Study Area, with cats recorded on camera traps in eight of 40 locations sampled in April 2019 (Western Wildlife 2019). Although it's possible that feral cats may increase in abundance due to the Proposal, it is likely that feral cats are an on-going existing threat, attracted to the current landfill site, accommodation village and water sources.</p>
Introduce disease that may cause the species to decline	<p>Unlikely</p> <p>Implementation of the Proposal is unlikely to result in the introduction or transmission of disease, as it is unlikely that bats potentially carrying disease will be moved either purposely or accidentally. Pets (i.e. cats and dogs) are not permitted within the project and landfill and waste water treatment facilities as per licence conditions.</p>
Interfere substantially with the recovery of the species	<p>Unlikely</p> <p>No recovery actions for the Pilbara Leaf-nosed Bat are currently underway or proposed within the Project area.</p>

5.6.3 Ghost Bat

5.6.3.1 Important Population

The Ghost Bats of the Pilbara region are disjunct and genetically distinct to those that occur in the Kimberley, Northern Territory and Queensland. The Pilbara population is divided between those in the Hamersley Ranges and those in the Chichester Ranges, though the genetic differentiation is low, suggesting bats move between these populations (Ottewell *et al.* 2017). The Ghost Bats of the Fauna Study Area fall within the Chichester Range subpopulation, which is estimated to be about 1,500 individuals (TSSC 2016a). In the Chichester region, Ghost Bats are often found in large maternal roosts, and these congregations are important for the survival of the species. However, smaller roosts are also likely to be important, allowing bats to occupy and forage through more of the landscape, resulting in dispersal and gene-flow between larger roosts. As the overall Chichester population is so small, all populations are likely to be important. Ghost Bats at Wodgina are part of an important population that is likely to utilise a number of caves throughout the range (**Figure 5.4**). The largest numbers of bats physically observed, as reported by (Biologic 2018b, Stantec 2018b, Outback Ecology 2009b; 2012) were:

- Cave C1 – 23 bats in 2014.
- Cave C2 – 65 bats in 2012, including young.
- Cave C5 (4 km south of the Fauna Survey Area, formerly known as Cave AC-54) – 60 bats in 2009.
- Cave AC-80 (4 km south of the Fauna Survey Area) – 60 bats in 2009.
- Cave C6 (21 km east of Fauna Survey Area, formerly known as Cave SC-21) – 40 bats in 2009 and 2 bats in 2010.
- Cave PC3 – 3 bats in 2017.
- Cave C7a – 14 bats in 2017 (flew to Cave C7b, 20 m from Cave C7a).

A count of 65 bats at Cave C2 in the Fauna Study Area is regionally significant, as this represents 4.3 % of the estimated 1,500 individuals in Chichester subpopulation. No known diurnal roost caves are within the disturbance footprint, the nearest being cave SC-10 at which 2 bats were recorded in 2009, and this cave is proposed to be avoided by WLPL through a 100 m exclusion area. The results of the Stantec (2022) target survey align with a previous survey (Stantec, 2018b) of the Rocky Ridge habitat which also failed to identify suitable roosting habitat and only recorded PLNB foraging in low numbers.

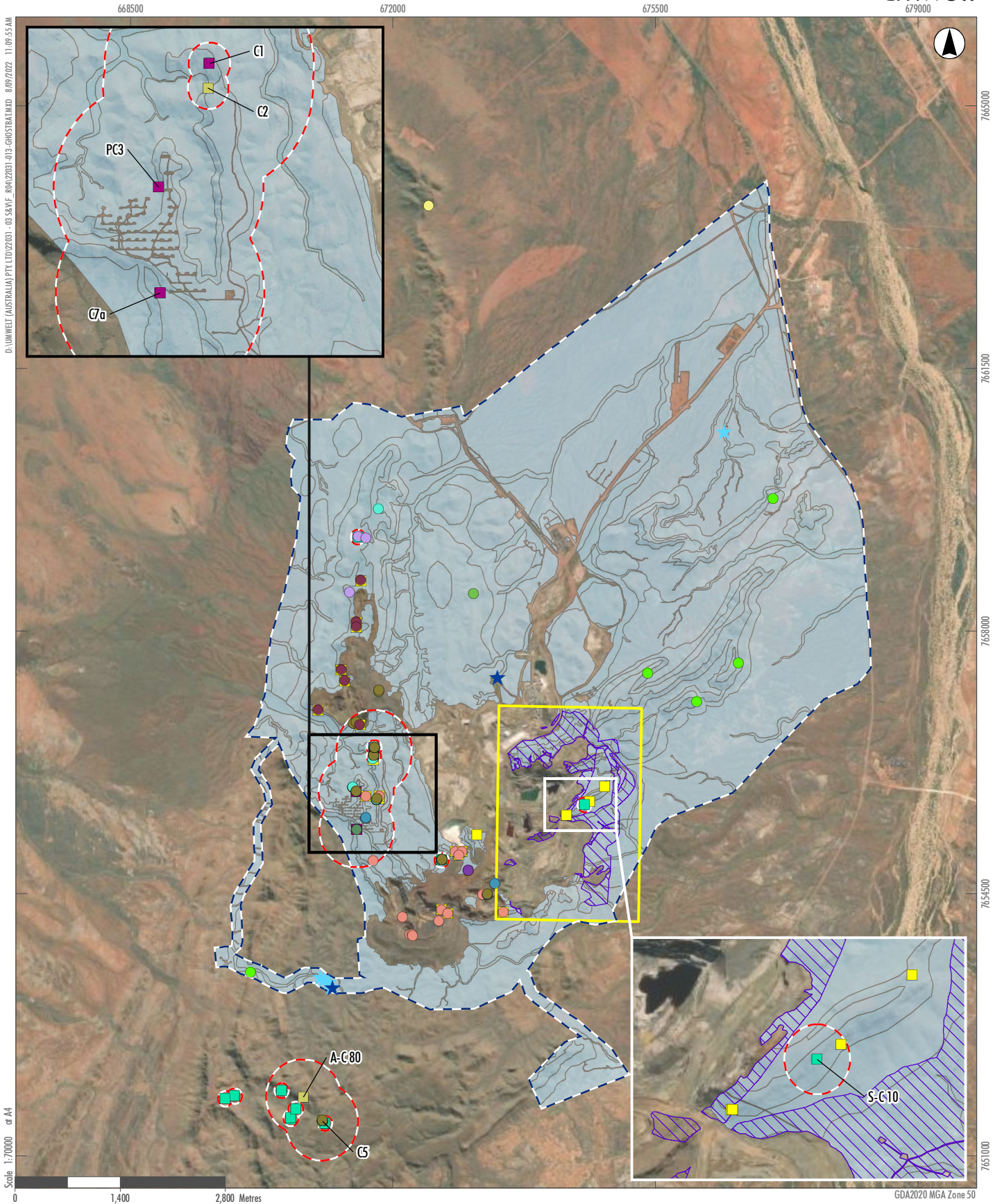
Assessment of risks on the Ghost Bat is hampered by a lack of quantitative data on this species. The Ghost Bat is difficult to monitor as even low-level disturbance at caves can cause this species to leave a site or go to alternative roost sites. Little is known about the relative importance of the habitats surrounding roost sites as foraging sites. The information available for this species within the Fauna Study Area is still sparse, despite over ten years of monitoring.

Habitat Critical for the Survival of the Species

Similarly to the Pilbara Leaf-nosed Bat, the Ghost Bat requires deep caves for diurnal roosting and breeding. These caves are usually deep natural caves or disused mines (TSSC 2016a). As the overall population is so small, it is likely that all diurnal roost sites are 'habitat critical for the survival of the species', with maternity (breeding) roosts the most significant. There are several caves in and around the Fauna Study Area that have been identified as either diurnal roosts or diurnal roosts that are potential maternity roosts (Biologic 2018b, Outback Ecology 2009b). Ghost Bats are likely to move between several caves seasonally or on the basis of weather conditions (TSSC 2016a), so it is likely that caves in the Fauna Study Area are part of a network of caves used by the local Ghost Bat population.

Although the foraging ecology of the Pilbara populations has not been studied, a recent Queensland study has found that male Ghost Bats forage up to 11.8 km from the roost, while lactating females forage within 3 km (Augusteyn *et al.* 2018). A study in the Northern Territory found that bats foraged on average 1.9 km from their diurnal roost (Tidemann *et al.* 1985). Ghost Bats have large wings and are capable of flying considerable distances to forage, but there is uncertainty around the relative importance of close foraging habitats. If bats are forced to fly further to forage, this may impact on breeding success and cause population decline (Augusteyn *et al.* 2018). Therefore, any foraging habitat within 3 km of a diurnal roost or potential maternity roost may be considered important foraging habitat.

The assessment of the potential impacts of the Wodgina project expansion against the significant impact criteria for the Ghost Bat (Department of Environment 2013) is presented in **Table 5.5**. Implementation of the Proposal is unlikely to trigger any of the nine significant impact criteria.



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- Legend**
- Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - ★ Permanent Pool
 - ★ Semi-Permanent Pool
 - Ghost Bat Habitat**
 - Supporting Habitat
 - Critical Habitat - Exclusion Zone
 - Ghost Bat Critical Habitat**
 - Diurnal roost
 - Potential Maternity roost
 - Regionally significant diurnal roost
 - Transitory Diurnal Roost
 - Ghost Bat Cave**
 - Nocturnal Refuge
 - Ghost Bat Record**
 - 2018
 - 2016
 - 2015
 - 2014
 - 2013
 - 2012
 - 2011
 - 2010
 - 2009
 - 2008
 - 1975

FIGURE 5.4
Ghost Bat Records and Habitat within the Fauna Study Area

Table 5.5 Assessment of potential impacts of the on the Ghost Bat (Vu) against Significant Impact Guideline Criteria

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Lead to a long-term decrease in the size of an important population of a species.	<p>Unlikely</p> <p>Loss or disturbance to diurnal and/or maternity roosts is likely to lead to a long-term decrease in the Ghost Bat population. The proposed disturbance footprint contains 17.97 ha of Rocky Ridge and Gorge habitat, but no roosts sites are known from within this area. The nearest at cave SC-10 is protected from the disturbance footprint by a 100 m. Cave C2, which is regionally significant, is located approximately 6 km to the west. As no roost sites are likely to be lost, there is unlikely to be a decrease in the size of the population.</p>
Reduce the area of occupancy of an important population.	<p>Unlikely</p> <p>The area of occupancy of this species is likely to be determined by the presence of caves that may be suitable underground diurnal roost sites. The proposed disturbance footprint contains 17.97 ha of Rocky Ridge and Gorge habitat, but no roosts sites are known from within this area. As no roost sites are likely to be lost, there is unlikely to be a decrease in the size of the population.</p>
Fragment an existing important population into two or more populations.	<p>Unlikely</p> <p>The Ghost Bat is a large, mobile species. Its population may be fragmented if a swathe of roost sites are lost or disturbed, preventing bats from moving through the landscape. No roost sites are likely to be lost, and bats are known to forage 2–11.8 km from the roost (Tidemann <i>et al.</i> 1985, Augusteyn <i>et al.</i> 2018), indicating the Proposal is unlikely to result in population fragmentation.</p>
Adversely affect habitat critical to the survival of an important population.	<p>Unlikely</p> <p>Threats such as habitat clearing (resulting in loss of roost sites or foraging habitat), disturbance through drilling and blasting, road mortalities and altered hydrology may adversely affect habitat that is critical to this species. The Ghost Bat has a relatively slow reproductive rate, it is vulnerable to localised threats (TSSC 2016a). Loss or disturbance to diurnal and/or maternity roosts is likely to lead to a long-term decrease in the Ghost Bat population.</p> <p>The proposed disturbance footprint contains 17.97 ha of Rocky Ridge and Gorge habitat, but no roosts sites are known from within this area. As no roost sites are likely to be lost, there is unlikely to be a decrease in the size of the population. Part of the proposed NVCP boundary area is within 3 km of known diurnal roost sites (Figure 5.4), so potentially important foraging habitat may be impacted. Bats flying in these areas may also be impacted by nocturnal road mortalities. Despite this, significant areas of foraging habitat remain, including areas beyond the Fauna Study Area and including, high value foraging habitat such as Drainage Lines.</p>

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
<p>Disrupt the breeding cycle of an important population.</p>	<p>Unlikely</p> <p>Loss or disturbance to a maternity roost would disrupt the breeding cycle of this species. While most of the bats in this region are thought to congregate on relatively few large maternity roosts in disused mines, caves C1, PC3, C7a and C7b have been identified as potential maternity roosts in the Fauna Study Area (Biologic 2018b), but none were found in the proposed disturbance footprint (Stantec 2018a). Clearing in the proposed disturbance footprint is unlikely to result in the loss of maternity roosts, therefore no disruption to breeding is anticipated.</p>
<p>Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.</p>	<p>Unlikely</p> <p>No diurnal roost sites are known from the proposed disturbance footprint. The closest cave (SC-10, where 2 bats were recorded in 2009) is proposed to be avoided by WLPL by a 100 m exclusion zone. Foraging bats may be impacted through loss of habitat in proximity to diurnal roost caves and road mortalities. As the Ghost Bat has a relatively slow reproductive rate, it is vulnerable to localised threats (TSSC 2016a). Part of the proposed disturbance footprint is within 3 km of known diurnal roost sites, including Cave C2 which is a regionally significant diurnal roost, so important foraging habitat may be impacted. Bats flying in these areas may also be impacted by nocturnal road mortalities. Despite this, significant areas of foraging habitat remain, including areas beyond the Fauna Study Area and including high value foraging habitat such as Drainage Lines.</p>
<p>Result in invasive species that are harmful to the species becoming established in the species' habitat.</p>	<p>Unlikely</p> <p>Although introduced predators such as cats may compete with the Ghost Bat for prey, it is unknown whether this is a significant threat. However, Cane Toads are likely to be a severe threat to the species (TSSC 2016a). Cane toads may potentially be brought into site on trucks or in freight. Although possible, the real risk of a successful Cane Toad introduction into Ghost Bat foraging habitat is low, as there is a single permanent water pool.</p>
<p>Introduce disease that may cause the species to decline.</p>	<p>Unlikely</p> <p>The Proposal is unlikely to result in the introduction or transmission of disease, as it is unlikely that bats potentially carrying disease will be moved either purposely or accidentally. Pets (i.e. cats and dogs) are not permitted within the project and landfill and waste water treatment facilities as per licence conditions.</p>
<p>Interfere substantially with the recovery of the species.</p>	<p>Unlikely</p> <p>No recovery actions for the Pilbara Leaf-nosed Bat are currently underway or proposed within the Project area.</p>

5.6.4 Pilbara Olive Python

5.6.4.1 Important Population

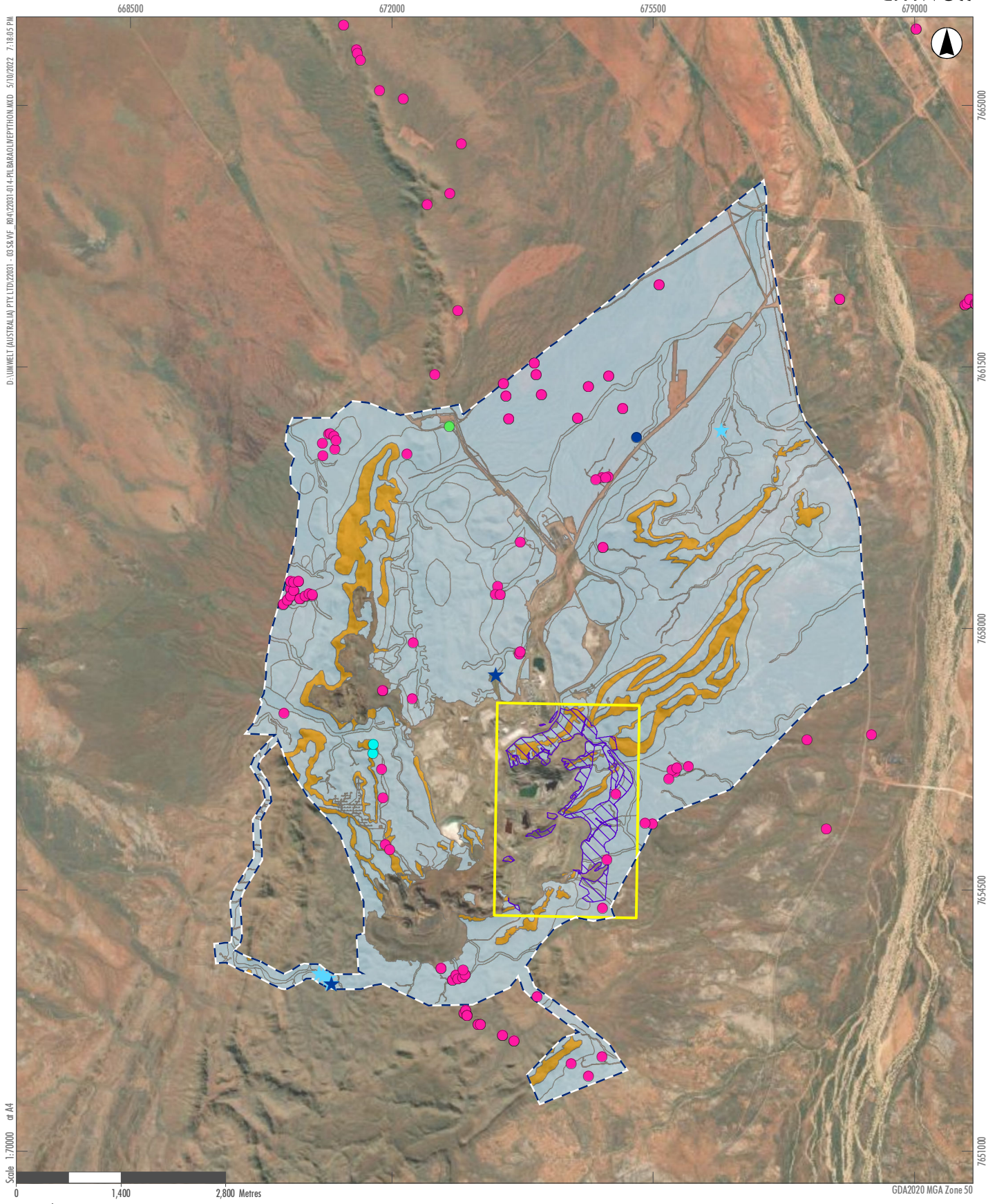
The Pilbara Olive Python occurs throughout the Pilbara Bioregion, on ranges with gorges and waterholes. They use waterholes for hunting and spend the winter in rocky areas away from water, and adults can range widely (DEWHA 2008). At least 21 locations are known to support the species (Department of the Environment, Water, Heritage and the Arts (DEWHA) 2008).

Despite many surveys within suitable habitat areas (e.g. eight to ten years of targeted surveys for bats, Northern Quolls and as part of Level 1 and 2 fauna surveys (see Stantec 2018b)), the Pilbara Olive Python has not been recorded in the Fauna Study Area, though it is known to occur in other rocky ranges in the region and is considered likely to occur (Western Wildlife 2019, Stantec 2018b). If present, the population is unlikely to be an important population. While likely to be present, the population is unlikely to be a large source population that is important for maintaining the presence of this species in the region.

5.6.4.2 Habitat Critical for the Survival of the Species

Rocky Ridge and Gorge habitat, particularly areas with permanent or semi-permanent water pools, are critical habitat for this species. Drainage Lines that traverse the Spinifex Stony Plains are supporting habitat, allowing for dispersal and foraging, but this species is likely to be strongly associated with rocky habitats. The occurrence of the Pilbara Olive Python habitat is presented in **Figure 5.5**.

The assessment of the potential impacts of the Proposal against the significant impact criteria for the Pilbara Olive Python (Department of Environment 2013) is presented in **Table 5.6**. Implementation of the Proposal is unlikely to trigger any of the nine significant impact criteria.



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- Legend**
- Fauna Study Area
 - Proposed NVCP Boundary
 - Proposed Disturbance Footprint
 - ★ Pilbara Olive Python Record (2011)
- Pilbara Olive Python Habitat**
- Critical Habitat
 - Supporting Habitat
 - ★ Permanent Pool
 - ★ Semi-Permanent Pool

- Other Fauna (Capture or Evidence of)**
- *Lagorchestes conspicillatus leichardti*, Spectacled Hare-wallaby (mainland)
 - *Pseudomys chapmani*, Western Pebble-mound Mouse
 - *Sminthopsis longicaudata*, Long-tailed Dunnart

FIGURE 5.5

Pilbara Olive Python Habitat and Other Fauna Records within the Fauna Study Area

Table 5.6 Assessment of potential impacts of the Proposal on the Pilbara Olive Python (Vu) against Significant Impact Guideline Criteria

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Lead to a long-term decrease in the size of an important population of a species.	<p>Unlikely</p> <p>This species has not yet been recorded in the Fauna Study Area, despite surveys within its habitat, and considerable areas of its favoured habitats remain outside the proposed disturbance footprint. The Pilbara Olive Python population in the Fauna Study Area is unlikely to represent an important population.</p>
Reduce the area of occupancy of an important population.	<p>Unlikely</p> <p>This species has not yet been recorded in the Fauna Study Area, despite surveys within its habitat, and considerable areas of its favoured habitats remain outside the proposed disturbance footprint. The Pilbara Olive Python population in the Fauna Study Area is unlikely to represent an important population.</p>
Fragment an existing important population into two or more populations.	<p>Unlikely</p> <p>The Pilbara Olive Python is a large snake that is highly mobile, capable of traversing considerable distances. Even though 17.97 ha of critical habitat (Rocky Ridge and Gorge) and 5.63 ha of supporting habitat (Drainage Line) is to be cleared, this species is likely to be able to disperse around the proposed project footprint. Therefore, it is unlikely that a Pilbara Olive Python population, if present, would be fragmented into two or more populations.</p>
Adversely affect habitat critical to the survival of the species.	<p>Unlikely</p> <p>The project involves clearing 17.97 ha of critical habitat (Rocky Ridge and Gorge), a habitat that is unlikely to be replicated through site rehabilitation and thus permanently lost. This represents 4.47 % of this habitat type within the Fauna Study Area. No permanent or semi-permanent pools are within the proposed disturbance footprint. Although this habitat will be lost, it is not thought to be supporting an important population of this species. Considerable areas of habitat remain outside the proposed disturbance footprint and outside the Fauna Study Area.</p>
Disrupt the breeding cycle of an important population.	<p>Unlikely</p> <p>This species has not yet been recorded in the Fauna Study Area, despite surveys within its habitat, and considerable areas of its favoured habitats remain outside the proposed disturbance footprint. The Pilbara Olive Python population in the Fauna Study Area is unlikely to represent an important population.</p>

Significant Impact Criteria (Guideline 1.1)	Likelihood and Rationale
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	<p>Unlikely</p> <p>This species has not yet been recorded in the Fauna Study Area, despite surveys within its habitat, and considerable areas of its favoured habitats remain outside the proposed disturbance footprint. Loss of 17.97 ha of Rocky Ridge and Gorge habitat may lead to a localised impact on this species but is unlikely to lead in a significant population decline in the Pilbara Olive Python.</p>
Result in invasive species harmful to the species becoming established in the species' habitat.	<p>Unlikely</p> <p>Feral cats are a threat to this species, as they prey on juvenile pythons, and foxes prey on pythons and compete for prey (DEWHA 2008). Feral cats are already known to occur at in the Fauna Study Area, with cats recorded on camera traps in eight of 40 locations sampled in April 2019 (Western Wildlife 2019). It is possible that feral cats may increase in abundance due to the Proposal, but it is more likely that feral cats are an on-going existing threat, attracted to the current landfill site, accommodation village and water sources. Cane toads may potentially be brought into site on trucks or in freight, though Cane Toads are not identified as a significant threat for this species.</p>
Introduce disease that may cause the species to decline.	<p>Unlikely</p> <p>The project is unlikely to result in the introduction or transmission of disease, as it is unlikely that pythons potentially carrying disease will be moved either purposely or accidentally.</p>
Interfere substantially with the recovery of the species.	<p>Unlikely</p> <p>The proposed NVCP boundary area is not within or near a population being managed for conservation. Several actions for the conservation of the Pilbara Olive Python have been identified by DEWHA (2008). These include identification of high conservation priority populations, ensuring road-widening, maintenance and mining do not adversely impact populations, managing changes to hydrology that may impact water tables or surface run-off, control of cats and foxes, raising awareness of the species with road-users and investigation of options to link populations. Although 17.97 ha of Rocky Ridge and Gorge habitat will be cleared, this is not likely to significantly reduce any population present in the rocky range overall.</p>

6.0 Conclusions

6.1 Summary of Impact Assessment

6.1.1 Flora and Vegetation

Three significant flora taxa have been recorded within the proposed NVCP boundary. The impact assessment considered the following significant flora taxa, as the presence and distribution of these taxa are known within the proposed NVCP boundary area:

- *Euphorbia clementii* (P3).
- *Terminalia supranitifolia* (P3).
- *Triodia chichesterensis* (P3).

***Euphorbia clementii* (P3)**

Although *Euphorbia clementii* (P3) occurs within the NVCP boundary the species is not known from within the proposed disturbance footprint. The impact of the Proposal on *Euphorbia clementii* (P3) is ranked Zero in terms the known number of individuals and Low in terms of extent of preferred habitat. The significance of impact at the local and regional scales, and the significance of cumulative impact are also assessed as being Low.

***Terminalia supranitifolia* (P3)**

The impact of the disturbance footprint on *Terminalia supranitifolia* (P3) is ranked Low in terms of both the number of individuals and extent of preferred habitat, and the significance of impact on this taxon at the local and regional scales were also assessed as Low. Loss of individuals and extant local habitat of this taxon may have longer-lasting impacts in comparison to taxa such as *Euphorbia clementii* (P3), due to differences in life history (response to events such as fire; recruitment/regrowth strategies) and distribution of habitat in which they occur.

The significance of cumulative impact was assessed as Low in terms of impact to numbers of individuals, although a higher proportion of locations are at risk for impact. *Terminalia supranitifolia* occurs within habitats, that whilst are not rare in the region, occupy a small proportion of the landscape and can be highly prospective for mining activity.

***Triodia chichesterensis* (P3)**

The impact of the Proposal on *Triodia chichesterensis* (P3) is ranked Low in terms of both the known number of individuals and extent of preferred habitat. The significance of impact at the local and regional scales, and the significance of cumulative impact are also assessed as Low.

Vegetation Units

No vegetation unit mapped in the NVCP boundary area at Wodgina comprises conservation significant vegetation as defined by the EPA (EPA 2016a; b).

The impact of the footprint on all VUs was ranked as Nil or Low; the significance of these impacts was likewise ranked Nil or Low.

The cumulative impact on all VUs has been ranked Low or Nil.

6.1.2 Fauna

There are 17 species of significant fauna that have been recorded or potentially occur in the Fauna Study Area. For many species, the scale of impact on a local level is considered to be Low, Very Low, or Negligible.

The scale of impact is considered to be Moderate for the Northern Quoll, Gane's Blind Snake and Long-tailed Dunnart, as this project will lead to the loss of important habitat, primarily 17.97 ha of Rocky Ridge and Gorge habitat. The loss of this habitat is likely to be permanent, and lead to a permanent reduction of the carrying capacity of the rocky range for these species. However, the loss of this habitat is unlikely to lead to the local extinction of these or any species, as sufficient habitat area remains in the Fauna Study Area outside the disturbance footprint, and in the remainder of the rocky range outside the Fauna Study Area. The scale of impact is not likely to be High or Extreme for any species.

There is unlikely to be an impact on any significant fauna taxa at a regional scale. Although the local population of some species may decrease, none are likely to be lost from the Fauna Study Area and all are likely to persist in the local area in the long-term. Therefore, there is not likely to be a range reduction, loss of an important population or impact on the ability of these species to disperse through the region.

For fauna that are MNES, there is a high risk of a significant impact on the Northern Quoll with the Proposal likely to trigger five of the nine significant impact criteria (Department of Environment 2013). The risk of a significant impact on other fauna that are MNES is considered to be low.

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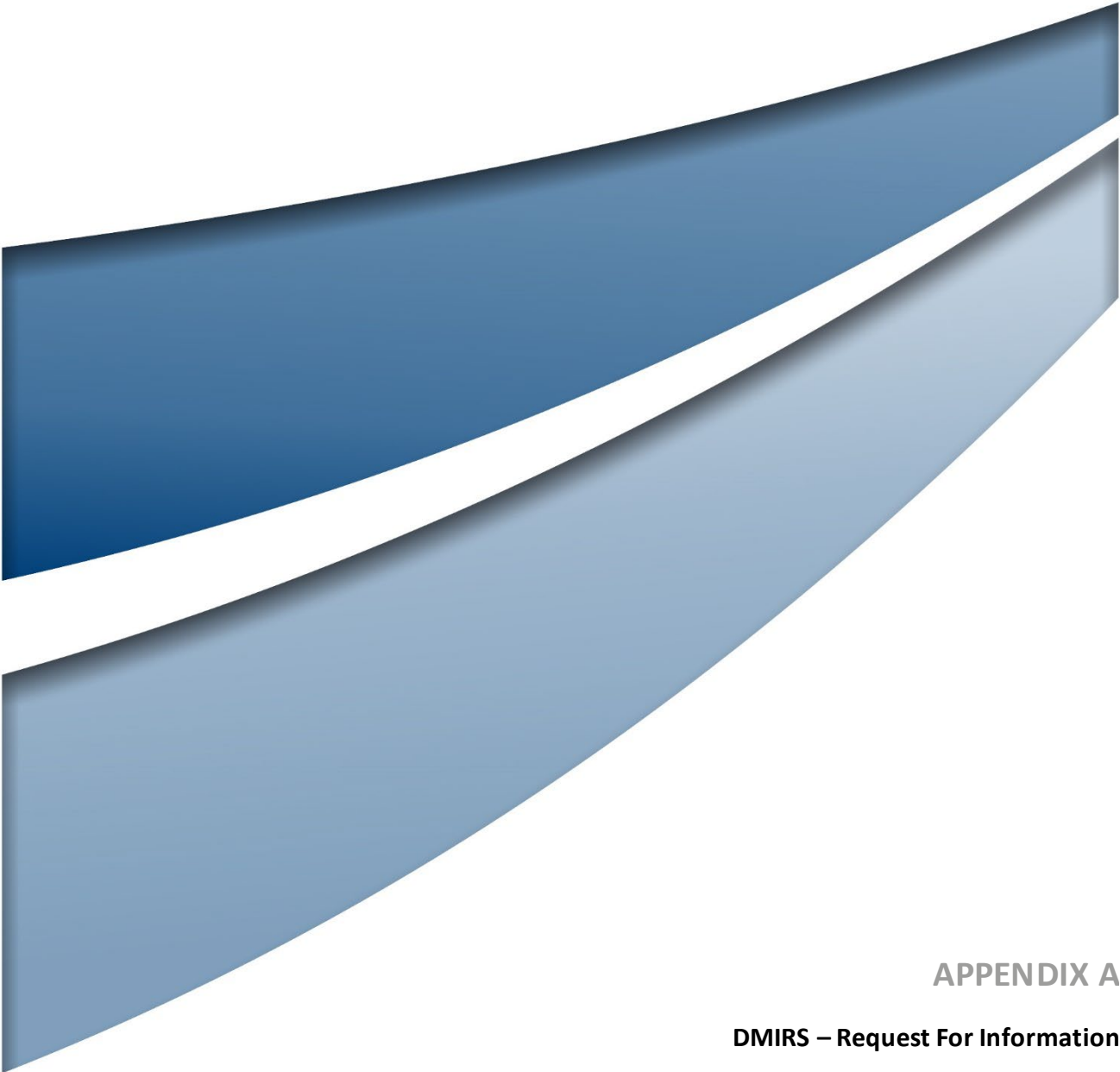
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APPENDIX A

DMIRS – Request For Information



Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**

Our ref CPS 8230/1 / A2323/201801
CPS 8295/1 / A2778/201801
Enquiries Alicia Dudzinska
Ph 08 9222 3231
alicia.dudzinska@dmirs.wa.gov.au

The Registered Manager
Mineral Resources Limited
1 Sleat Road
APPLECROSS WA 6153

Attention: David Swain

Dear Sir,

**Application to Clear Native Vegetation under the *Environmental Protection Act 1986*
Wodgina Lithium Pty Ltd - Wodgina Lithium Project (CPS 8230/1 and CPS 8295/1)**

The Department of Mines, Industry Regulation and Safety (DMIRS) has commenced assessment of your native vegetation clearing permit CPS 8230/1 for the purpose of mineral production, and CPS 8295/1 for the purposes of a lithium conversion plant and associated infrastructure. The Wodgina Significant Species Management Plan (SSMP) was referred to the Department of Biodiversity, Conservation and Attractions (DBCA) for comments and further recommendations as part of the assessment for CPS 8230/1. Further information is required to enable the Department to adequately assess your application. The items requiring further information is outlined below.

General

- DMIRS requires that MRL utilises the results of the detailed flora and vegetation survey, and the level 1 and targeted fauna surveys, to form the basis of a revised impact assessment, quantifying impacts to each conservation significant species and key habitats. The revised impact assessment should consider the regional and local context, including which habitat areas have already been lost and removed, and potential loss of connectivity between populations on the western and eastern ranges as a result of the proposed clearing. MRL are required to demonstrate how they will avoid, minimise or offset impacts to each conservation significant species. Exclusions zones must be determined from the survey findings and presented in figures within the SSMP.

- For CPS 8295/1, please provide the Woodman (2018) detailed flora and vegetation spatial data in shapefile (.shp) format (not GDB). Additionally, exclusion zones for significant fauna habitat types (e.g. ridges) intersected by CPS 8295/1 will need to be established. Please provide DMIRS with an updated shapefile of the application area, or a shapefile of the exclusion zones. Please note that if the application area is reduced, a second advertisement period is not required.

Fauna component of the SSMP

- The NVCP supporting document provides capture rates of Northern Quolls (individuals) from 2010 to 2018 from within the Wodgina area. Please confirm that this relates to the monitoring program for Atlas Iron. Furthermore, there are no discussions around whether Northern Quoll are successfully utilising the artificial habitats installed by Atlas Iron (e.g. denning/breeding). Please provide further information on the location and utilisation rates of these artificial habitats.
- It is understood that approximately 36.6 hectares (9.86% of the current extent) of the Rocky Ridges habitat type is likely to be cleared under CPS 8230/1. However, as potential Northern Quoll denning locations have not been identified within the area proposed to clear, the extent of the proposed impact is unclear. Potential denning locations need to be identified and exclusion zones/buffers should be proposed for these sensitive areas.
- It is stated in the Stantec (2018) report that Northern Quolls at Wodgina occur in similar densities at Abydos Project, Mt Dove, Mt Webber and Corunna Downs. However, it is unknown whether the data from these other mine sites are pre-mining or post-mining. When revising the impact assessment and developing the SSMP, only contemporary data should be considered.
- Specific DBCA comments are provided within an edited version of the SSMP pdf. As the file is too large to attach via email, an ad-hoc file transfer link will be set up for Mr David Swain and Mr David Temple-Smith to access the document. Please be advised that the ad-hoc file transfer link will be valid for two weeks from the date of this letter.

Flora component of the SSMP

- The flora component of the SSMP appears to be written in the context of fauna management and therefore lacks the specific details for flora that has been provided for the fauna species. For example, the Management Level 2 flora species have not been described as it has been for the Management Level 2 fauna species.
- It is noted that the gas pipeline native vegetation clearing permit CPS 8068/1 was approved to clear a total of 67 individuals of *Terminalia supranitifolia*, and CPS 8230/1 proposes to clear an additional 348 individuals from a total of 1,136 individuals recorded within the Study Area. No other Priority flora species are proposed to be cleared as part of CPS 8230/1. It is noted in the supporting document for CPS 8230/1 that *'in terms of reasonably foreseeable cumulative impacts on conservation significant flora at the Wodgina Project, there are no proposals for significant additional clearing in areas considered to be important*

habitat for these taxa'. However, the application area for CPS 8295/1 (Lithium Hydroxide) contains vegetation units that are considered to be preferred habitats for all conservation significant flora taxa recorded by Woodman during the 2018 survey. As such, there is a risk that some species are likely or have the potential to be impacted outside of CPS 8230/1 by the clearing proposed under CPS 8295/1. MRL must demonstrate understanding of the likelihood of Priority flora species occurring within the application areas, and then apply appropriate management actions to mitigate the cumulative impacts (e.g. exclusion zones).

- The risk assessment model on the “potential risk of harm to conservation significant species” is based on the likelihood of Priority flora occurring within a proposed clearing area – ‘present’ and ‘likely’ species are listed as Management Level 2 and ‘potential’ and ‘unlikely’ as Management Level 3. In both levels of management, surveys are proposed to be undertaken prior to new clearing activities in areas where appropriate surveys have not previously been undertaken, and the main management objectives are to avoid or minimise clearing of these species. However, once planning has been undertaken for infrastructure development, it is recognised that relocating infrastructure is difficult to achieve, and the experience is that it rarely happens. If exclusion zones are to be utilised, they should be determined and included within the SSMP. Additionally, Level 3 species have no specific management actions identified. Please clarify the objective and proposed management actions for Level 3 species.
- In section 4.2 it is stated that four Level 1 and four Level 2 flora and vegetation surveys have been undertaken at various areas at Wodgina since 2017, and 11 historical surveys (dated 2000-2013) have been conducted. Using this information, vegetation mapping should be presented in relation to the proposed and approved disturbance footprint (as shown in figure 2), to determine if suitable habitat is present for any Threatened or Priority flora within the project area. All the survey information should be collated and used to inform the likelihood of Threatened and Priority flora occurring within the area, or an explanation provided as to why only one set of data is used (the risk assessment model is only based on one report, Woodman 2018). A table should be included in the SSMP on the likelihood assessment, presenting the reason for why the species were considered /likely/potential etc.

Once the likelihood assessment is completed, the following process should be followed:

- Conservation significant flora which are already known to occur in the project area should first be checked to see if a targeted survey has been undertaken to determine the full size and extent of the population, and their locations mapped in relation to the disturbance footprint.
- Conservation significant flora which are indicated as ‘likely’ or ‘potential’ should have their suitable habitat identified and mapped in relation to the proposed disturbance footprint. Any suitable habitat found within the proposed disturbance area should have a targeted survey undertaken to determine the presence/absence of the Threatened/Priority flora, and if present, the full size and extent mapped in relation to the disturbance footprint.

- Please note that if any Threatened flora is identified as present as a result of targeted surveys, authorisation under section 40 of the *Biodiversity Conservation Act 2016* will be required in addition to any other clearing permit approval issued by DMIRS.
- Conservation significant flora which are indicated as 'unlikely' (based on the absence of suitable habitat) should not require any targeted surveys (on the condition that the habitat assessment is considered correct).
- If targeted surveys do not locate any Threatened or Priority species – no further management actions are required (on the condition that the targeted surveys is undertaken in accordance with the Technical Guide for flora and vegetation surveys for EIA).

Once the presence/absence of Threatened/Priority flora has been adequately determined, management actions such as those identified in table 15 can be applied to all Threatened/Priority flora present. Exclusion areas should be mapped and presented in the plan (preferably with a minimum 10 m buffer to reduce the risk of accidental clearing/secondary impacts for Priority flora and 50m buffer for any Threatened flora).

Where impacts can't be avoided, proposed impacts for each species should be presented in the plan, and management actions discussed demonstrating what efforts have been made to minimise impacts. Separate maps may need to be provided for each species if it is not able to be clearly presented in a single map. The additional information within the revised SSMP will allow DBCA to determine if the proposed management actions can adequately mitigate the proposed impacts.

Other comments include:

- It is noted that the management of conservation significant flora has been classified (Level 1, 2 or 3) based on the Woodman (2018) detailed flora and vegetation survey report. However, the locations of the Level 2 flora species (Figure 6) appears to not include all the locations as identified by Woodman (2018; Figures 8.1 - 8.10 from the Woodman report). Figure 6 should be updated to ensure consistency.
- Table 10 (pg 20) showing the management level summary has no reference to flora.
- Table 15 (pg 37) –
 - A proposed management action states that MRL will ensure “no unauthorised clearing activities through implementation of an internal clearing permit procedure”. This procedure should be provided in an appendix.
 - The proposed management action of ‘Shall not be cleared without a licence to take flora under the WC Act or BC Act’ should only reference Authorisation to take Threatened flora required under the *Biodiversity Conservation Act 2016*.
 - Minimise impacts from construction and mining operations and changed fire regimes are management objectives. Management actions need to be outlined to meet these objectives, and indirect impacts should also be considered. For example, fire management actions are not specially

- discussed. How will dust as a result of mining activities be managed – what are the dust suppression activities?
- Monitoring is proposed but this needs to be discussed in more detail i.e. what will be monitored? (e.g. if the species was cleared, how many populations were cleared, plant health of remaining populations). What parameters will be used to determine this? What is the frequency of monitoring?
 - Management triggers and contingency actions where decline or deaths are noted during the monitoring, needs to be detailed.
 - Table 17 (pg 44) listing clearing procedure appears to mainly apply to fauna. This should be updated to consider flora as well.
 - Section 7.9. Reporting –
 - As per Table 22 (pg 54) it appears that reporting is included as part of Management Level 3. A separate section on reporting should be included in the relevant management level sections, providing details on what will be reported and to who.
 - Clearing of conservation significant flora to be notified to DBCA (flora.data@dbca.wa.gov.au).

In view of this, the assessment of your clearing application will be deferred until Wodgina Lithium Pty Ltd provides the Department with the requested information.

If you have any queries regarding this notice, please contact Alicia Dudzinska, Environmental Officer on (08) 9222 3231 or email Alicia.dudzinska@dmirs.wa.gov.au

Yours sincerely

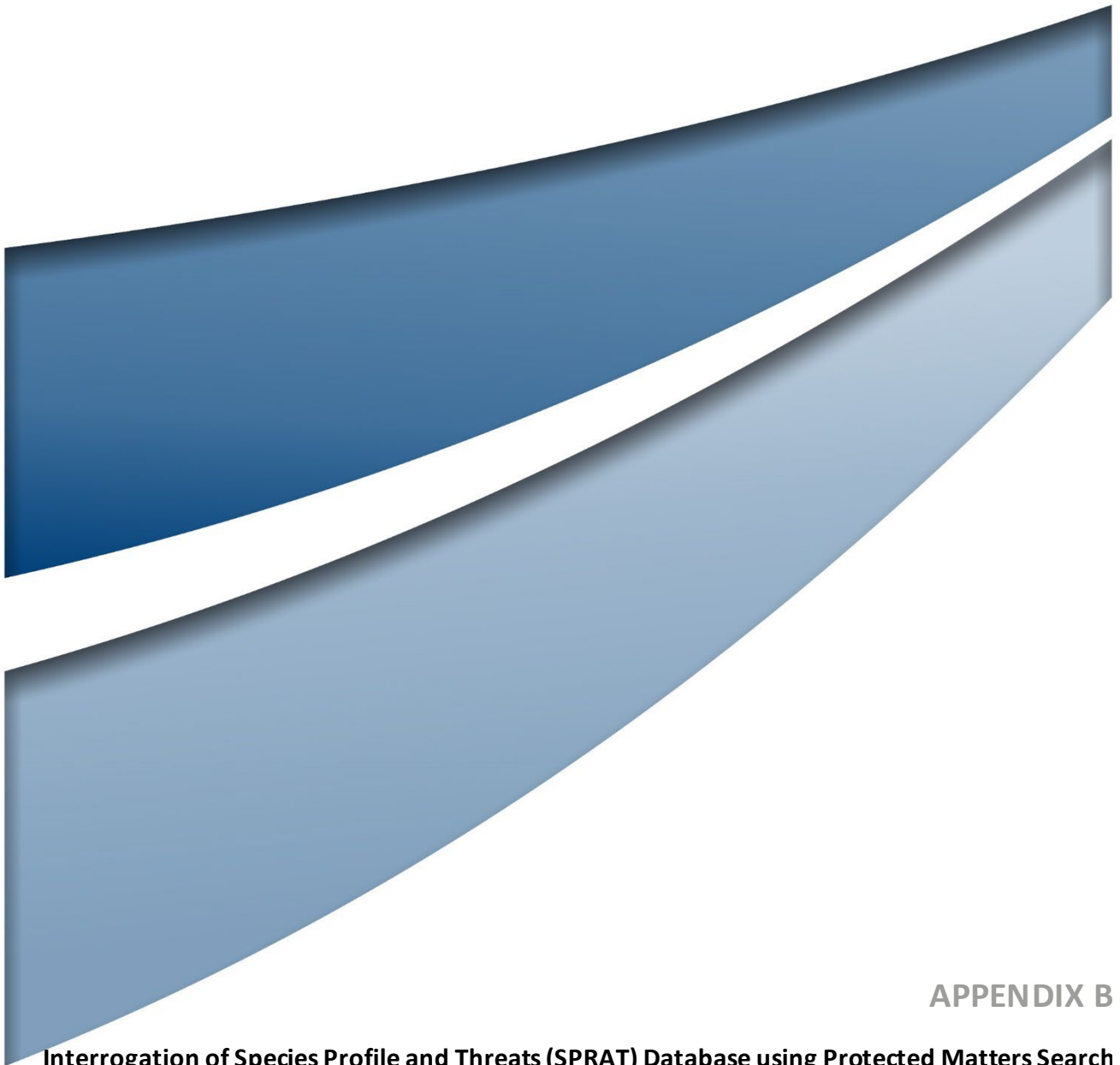


Melissa Harrison

Team Leader

Resource and Environmental Compliance Division

24 January 2019



APPENDIX B

Interrogation of Species Profile and Threats (SPRAT) Database using Protected Matters Search Tool. (DAWE 2021)



EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 01-Dec-2021

[Summary](#)

[Details](#)

[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

[Caveat](#)

[Acknowledgements](#)

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar)	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	11
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at <http://www.environment.gov.au/heritage>

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	16
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	18
Key Ecological Features (Marine):	None
Biologically Important Areas:	1
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Species

[[Resource Information](#)]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name

Threatened Category

Presence Text

BIRD

[Calidris ferruginea](#)

Curlew Sandpiper [856]

Critically Endangered

Species or species habitat may occur within area

[Falco hypoleucos](#)

Grey Falcon [929]

Vulnerable

Species or species habitat known to occur within area

[Numenius madagascariensis](#)

Eastern Curlew, Far Eastern Curlew [847]

Critically Endangered

Species or species habitat may occur within area

[Pezoporus occidentalis](#)

Night Parrot [59350]

Endangered

Species or species habitat may occur within area

[Rostratula australis](#)

Australian Painted Snipe [77037]

Endangered

Species or species habitat may occur within area

MAMMAL

[Dasyurus hallucatus](#)

Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]

Endangered

Species or species habitat known to occur within area

[Macroderma gigas](#)

Ghost Bat [174]

Vulnerable

Species or species habitat likely to occur within area

[Macrotis lagotis](#)

Greater Bilby [282]

Vulnerable

Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Pityrodia sp. Marble Bar (G.Woodman & D.Coultas GWDC Opp 4) [88310]	Endangered	Species or species habitat likely to occur within area
REPTILE		
Liasis olivaceus barroni Olive Python (Pilbara subspecies) [66699]	Vulnerable	Species or species habitat likely to occur within area
Listed Migratory Species [Resource Information]		
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area overfly marine area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Abydos Direct Shipping Ore Project	2012/6345	Controlled Action	Post-Approval
Additional Rail Infrastructure between Herb Elliott Port Facility and Cloudbreak Mine Site	2010/5513	Controlled Action	Post-Approval
Development of the Wodgina Direct Shipping Ore Project, Stage 2	2011/5975	Controlled Action	Post-Approval
North Star Hematite Project	2012/6530	Controlled Action	Post-Approval
North Star Magnetite Project	2012/6689	Controlled Action	Post-Approval
Roy Hill to Port Hedland Rail Line and Associated Infrastructure	2010/5424	Controlled Action	Post-Approval
Wodgina Direct Shipping Ore Project	2009/5167	Controlled Action	Post-Approval
Not controlled action			
Development of iron ore resources in eastern Pilbara region, including port at P	2004/1562	Not Controlled Action	Completed
Expansion of the Talison Minerals Storage Facility, Wodgina Mine	2008/4675	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
Pilbara Bulk Ore Transport System Project, WA	2016/7637	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Pilbara Transmission Project, Pilbara, WA	2018/8349	Not Controlled Action	Completed
Rail and Port Facilities	2001/474	Not Controlled Action	Completed
Wodgina Lithium Mine Expansion, Pilbara, NT	2018/8194	Not Controlled Action	Completed
Not controlled action (particular manner)			
Additional Rail Infrastructure	2012/6314	Not Controlled Action (Particular Manner)	Post-Approval
Atlas Boodarie Link Project, WA	2012/6506	Not Controlled Action (Particular Manner)	Post-Approval
Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project Stage 3	2013/6789	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Mine the Hercules Deposit under the Wodgina Direct Shipping Ore Project ??? Stage 3	2013/6777	Referral Decision	Completed
Biologically Important Areas			
Scientific Name		Behaviour	Presence
Seabirds			
Ardena pacifica			
Wedge-tailed Shearwater [84292]		Breeding	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [-Office of Environment and Heritage, New South Wales](#)
- [-Department of Environment and Primary Industries, Victoria](#)
- [-Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [-Department of Environment, Water and Natural Resources, South Australia](#)
- [-Department of Land and Resource Management, Northern Territory](#)
- [-Department of Environmental and Heritage Protection, Queensland](#)
- [-Department of Parks and Wildlife, Western Australia](#)
- [-Environment and Planning Directorate, ACT](#)
- [-Birdlife Australia](#)
- [-Australian Bird and Bat Banding Scheme](#)
- [-Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [-Museum Victoria](#)
- [-Australian Museum](#)
- [-South Australian Museum](#)
- [-Queensland Museum](#)
- [-Online Zoological Collections of Australian Museums](#)
- [-Queensland Herbarium](#)
- [-National Herbarium of NSW](#)
- [-Royal Botanic Gardens and National Herbarium of Victoria](#)
- [-Tasmanian Herbarium](#)
- [-State Herbarium of South Australia](#)
- [-Northern Territory Herbarium](#)
- [-Western Australian Herbarium](#)
- [-Australian National Herbarium, Canberra](#)
- [-University of New England](#)
- [-Ocean Biogeographic Information System](#)
- [-Australian Government, Department of Defence](#)
- [Forestry Corporation, NSW](#)
- [-Geoscience Australia](#)
- [-CSIRO](#)
- [-Australian Tropical Herbarium, Cairns](#)
- [-eBird Australia](#)
- [-Australian Government – Australian Antarctic Data Centre](#)
- [-Museum and Art Gallery of the Northern Territory](#)
- [-Australian Government National Environmental Science Program](#)
- [-Australian Institute of Marine Science](#)
- [-Reef Life Survey Australia](#)
- [-American Museum of Natural History](#)
- [-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania](#)
- [-Tasmanian Museum and Art Gallery, Hobart, Tasmania](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

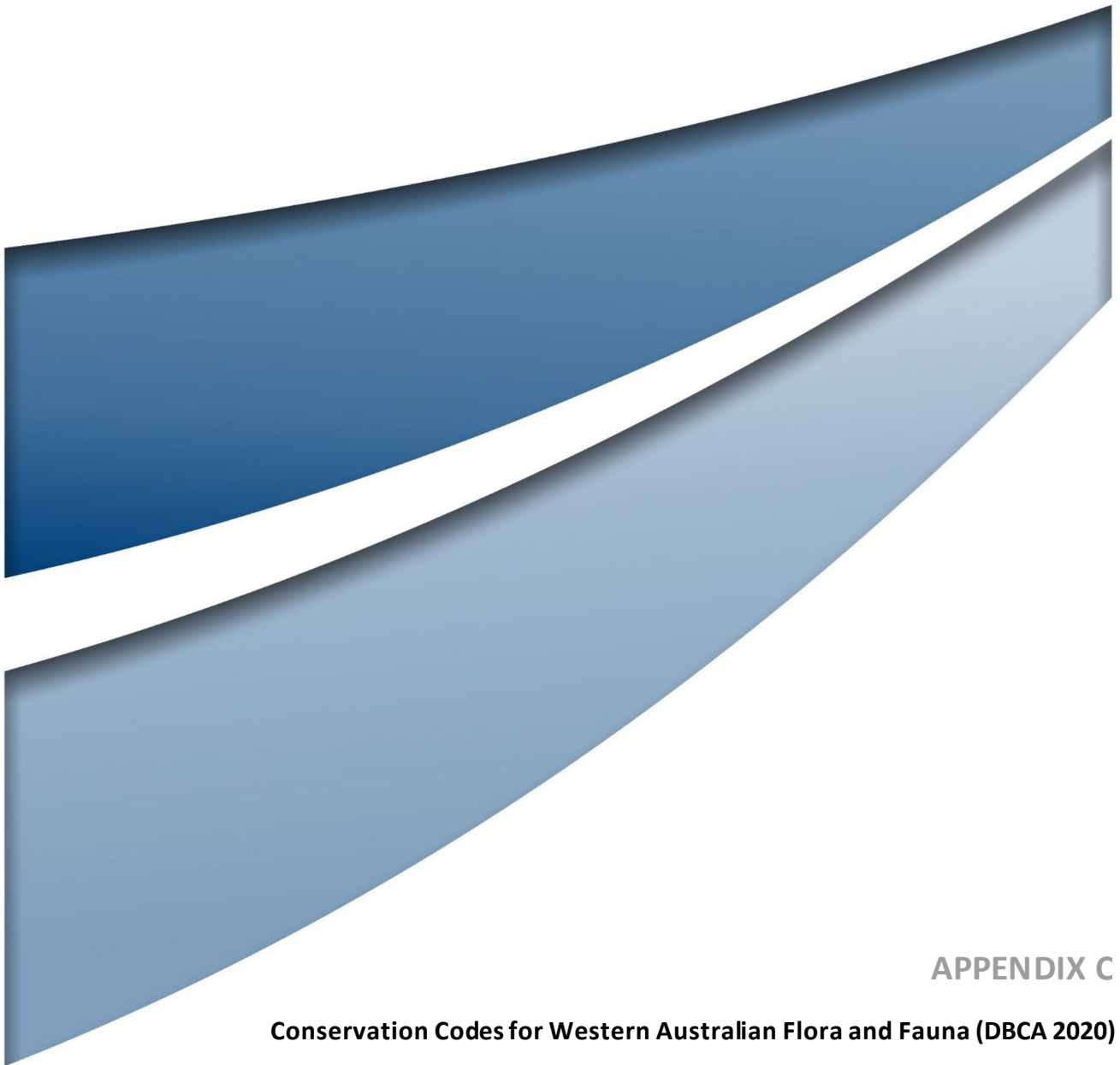
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APPENDIX C

Conservation Codes for Western Australian Flora and Fauna (DBCA 2020)

CONSERVATION CODES

For Western Australian Fauna and Flora

Threatened, Extinct and Specially Protected fauna or flora¹ are species² which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species³ under Part 2 of the *Biodiversity Conservation Act 2016*.

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is the species of fauna that are listed as critically endangered, endangered or vulnerable threatened species.

Threatened flora is the species of flora that are listed as critically endangered, endangered or vulnerable threatened species.

The assessment of the conservation status of threatened species is in accordance with the BC Act listing criteria and the requirements of Ministerial Guideline (Number 1) and Ministerial Guideline (Number 2) that adopts the use of the International Union for Conservation of Nature (IUCN) Red List of Threatened Species Categories and Criteria⁴, and is based on the national distribution of the species.

CR **Critically endangered species**

Threatened species considered to be “*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*”.

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines.

Examples of use:

- The western ringtail possum (*Pseudocheirus occidentalis*) is listed as a critically endangered threatened species under the *Biodiversity Conservation Act 2016*.
- Western ringtail possum is listed as critically endangered under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: CR.

EN **Endangered species**

Threatened species considered to be “*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*”.

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines.

Examples of use:

- *Caladenia hopperiana* is listed as an endangered threatened species under the *Biodiversity Conservation Act 2016*.
- *Caladenia hopperiana* is listed as endangered under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: EN.

VU Vulnerable species

Threatened species considered to be “facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines”.

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines.

Examples of use:

- The forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) is listed as a vulnerable threatened species under the *Biodiversity Conservation Act 2016*.
- Forest red-tailed black cockatoo is listed as vulnerable under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: VU.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where “there is no reasonable doubt that the last member of the species has died”, and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Examples of use:

- *Acacia kingiana* is listed as an extinct species under the *Biodiversity Conservation Act 2016*.
- *Acacia kingiana* is listed as extinct under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: EX.

EW Extinct in the wild species

Species that “is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form”, and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no fauna or flora species listed as extinct in the wild.

SP Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered, or vulnerable) or extinct species under the BC Act cannot also be listed as specially protected species.

MI Migratory species

Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Migratory species include birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA)⁵, China (CAMBA)⁶ or The Republic of Korea (ROKAMBA)⁷, and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention)⁸, an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Examples of use:

- The wedge-tailed shearwater (*Ardenna pacifica*) is listed as a specially protected migratory species under the *Biodiversity Conservation Act 2016*.
- Wedge-tailed shearwater is listed as migratory under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: MI.

CD Species of special conservation interest (conservation dependent)

Species of special conservation need that are dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Currently only fauna are listed as species of special conservation interest.

Examples of use:

- The wambenger, south-western brush-tailed phascogale (*Phascogale tapoatafa wambenger*) is listed as a specially protected species of special conservation interest under the *Biodiversity Conservation Act 2016*.
- Wambenger, south-western brush-tailed phascogale, is listed as conservation dependent under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: CD.

OS Species otherwise in need of special protection (other specially protected)

Species otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Currently only fauna are listed as species otherwise in need of special protection.

Examples of use:

- The dugong (*Dugong dugon*) is listed as a specially protected species otherwise in need of special protection under the *Biodiversity Conservation Act 2016*.
- Dugong is listed as other specially protected fauna under the *Biodiversity Conservation Act 2016*.
- Listing reference in a table: column heading: BC Act, row text: OS.

P Priority species

Priority is not a listing category under the BC Act.

All fauna and flora are protected in WA following the provisions in Part 10 of the BC Act. The protection applies even when a species is not listed as threatened or specially protected, and regardless of land tenure (State managed land (Crown land), private land, or Commonwealth land).

Species that may possibly be threatened species that do not meet the criteria for listing under the BC Act because of insufficient survey or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of prioritisation for survey and evaluation of conservation status so that consideration can be given to potential listing as threatened.

Species that are adequately known, meet criteria for near threatened, or are rare but not threatened, or that have been recently removed from the threatened species list or conservation dependent or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of priority status is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species - known from few locations, none on conservation lands

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, for example, agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under immediate threat from known threatening processes. These species are in urgent need of further survey.

Examples of use:

- *Borya stenophylla* is listed as a Priority 1 species by the Department of Biodiversity, Conservation and Attractions.
- *Borya stenophylla* is listed as Priority 1 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P1.

2 Priority 2: Poorly-known species - known from few locations, some on conservation lands

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, for example, national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation.

Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements for threatened listing and appear to be under threat from known threatening processes. These species are in urgent need of further survey.

Examples of use:

- *Caladenia nivalis* is listed as a Priority 2 species by the Department of Biodiversity, Conservation and Attractions.
- *Caladenia nivalis* is listed as Priority 2 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P2.

3 Priority 3: Poorly-known species - known from several locations

Species that are known from several locations and the species does not appear to be under imminent threat or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat.

Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. These species need further survey.

Examples of use:

- *Acacia nitidula* is listed as a Priority 3 species by the Department of Biodiversity, Conservation and Attractions.
- *Acacia nitidula* is listed as Priority 3 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P3.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as a conservation dependent specially protected species.

(c) Species that have been removed from the list of threatened species or lists of conservation dependent or other specially protected species, during the past five years for reasons other than taxonomy.

(d) Other species in need of monitoring.

Examples of use:

- *Banksia aculeata* is listed as a Priority 4 species by the Department of Biodiversity, Conservation and Attractions.
- *Banksia aculeata* is listed as Priority 4 on the DBCA Priority Flora List.
- Listing reference in a table: column heading: DBCA, row text: P4.

¹ The definition of flora includes algae, fungi, and lichens.

² Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

³ Schedules are not referred to when stating the listing status of threatened, extinct or specially protected species under the BC Act. See the examples provided under each listing category.

⁴ Western Australia has assigned species to threat categories using the *IUCN Red List of Threatened Species Categories and Criteria* since 1996 (referencing all criteria). At the national level, threatened species listings under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) reference only some of the IUCN criteria (<http://www.environment.gov.au/biodiversity/threatened/nominations/forms-and-guidelines>).

⁵ JAMBA - first included in the WA migratory species list in 1980.

⁶ CAMBA - first included in the WA migratory species list in 2010.

⁷ ROKAMBA - first included in the WA migratory species list in 2010.

⁸ Bonn Convention (Birds) - first included in the WA migratory species list in 2015.

