Newcrest Mining Ltd

Reconnaissance Flora and Vegetation Survey
Havieron Access Corridor

8 September 2020

JBS&G57634-128494 (Rev 1)

JBS&G Australia Pty Ltd T/A Strategen-JBS&G

www.jbsg.com.au

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Executive Summary

The Havieron Project is a Joint Venture agreement between Newcrest Operations Ltd, and Greatland Gold Pty Ltd. The Project is located approximately 45 km east of the Telfer Gold Mine. As part of the Havieron Mine project, Newcrest Mining proposed to construct a 68 km service corridor between the existing Telfer mine and the Havieron project.

Strategen-JBS&G undertook a reconnaissance flora and vegation assessment to assess the likely environmental impacts of the proposal on vegetation and flora.

A Reconnaissance flora and vegetation survey was conducted along the length of the proposed access corridor in the prime flowering season for the region. This survey level was considered appropriate given the low level of proposed impacts within the Survey area. Flora and vegetation was described across the survey area and vegetation types were delineated using a combination of results, site observations and aerial photographic interpretation. Vegetation condition was also recorded across the Survey area during the field assessment and mapped as for vegetation types.

Across the survey area, 40 native taxa were recorded from 11 families. This represents a low species richness as caused by recent fires across approximately 60% of the survey area. No Threatened or Priority flora species were recorded within the Survey area. There is potential for two priority flora species (*Goodenia hartiana* [P2] and *G. nuda* [P4]) based on habit preference and targeted surveys conducted within the nearby Telfer Mine area. However, site traverses and relevés within identified habitat preferences did not locate either species.

Twelve native vegetation types were mapped within the survey area, comprising Eucalyptus woodlands, Acacia shrublands and Triodia grasslands. The vegetation types identified by the reconnaissance survey are predominantly uncleared and widespread within the bioregion and are fragmented only by fires. Given this, the vegetation mapped within the Survey area in not considered to be locally or regionally significant.

The level of survey detail undertaken is consistent with the requirements of a reconnaissance survey. The expected low diversity and relatively uniform landforms means that the finding of the report are sufficient to inform impact assessment for across the project area.

1. Introduction

1.1 Project background

The Havieron Project is a Joint Venture agreement between Newcrest Operations Ltd, and Greatland Gold Pty Ltd. The Project is located approximately 45 km east of the Telfer Gold Mine (Figure 1.1). As part of the Havieron Mine project, Newcrest Mining proposed to construct a 68 km (299 ha) service corridor between the existing Telfer mine and the Havieron project.

Newcrest engaged Strategen JBS&G to undertake an assessment of 1,300 ha surrounding a proposed alignment of the Havieron Access Corridor (Figure 1.1), in order to assess the likely environmental impacts of the proposal on vegetation and flora.

This report details the Havieron Access Corridor (Figure 1.1) and presents the results of investigations to document flora and vegetation values during field surveys undertaken in April 2020.

1.2 Scope of work

The scope of works for the flora and vegetation assessment included:

1. A flora and vegetation database review for the Havieron Project Study Area to assess of the likelihood of potential conservation significant species. Searches are based on available habitat or groundwater dependent ecosystems;
2. A summary of previous flora and vegetation surveys undertaken within the vicinity of the study area;
3. Conduct a reconnaissance Flora and Vegetation Survey to characterise the vegetation and document vascular plant taxa present within the proposed development envelope for the services corridor;

Legend:

- Project area - mine site
- Project area - service corridor
- Roads (MRWA)

Scale 1:1,750,000 at A4

0 10 20
Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Job No: 57643

Client: Newcrest Mining Ltd and Greatland Gold Ltd

Version: A | Date: 22-Jul-2020

Drawn By: cthatcher | Checked By: HS

Havieron Mine Project, WA

REGIONAL LOCATION

FIGURE 1

strategen JBS&G

File Name: \\008PMPMR004V001.jbsg.aust\JBS Perth\Projects\1)Open\Newcrest\57634 Flora Surveys - Havieron Project\GIS\Maps\R02_ Rev_A\57634_01_1_RegLocn.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2. Context

The Havieron project and most of the proposed service corridor are located within the Great Sandy Desert Bioregion under the Interim Biogeographic Regionalisation for Australia (IBRA). The Great Sandy Desert (GSD) is located in the north west of Western Australia straddling the Pilbara and southern Kimberley regions. It is the second largest desert in Australia after the Great Victoria Desert and encompasses an area of 284,993 square kilometres. The Telfer end of the service corridor extends into a section of the Little Sandy Desert which protrudes into the Great Sandy Desert (Section 2.3.5).

The predominant tenure in the Great Sandy Desert is unallocated crown land, conservation reserves and Aboriginal land, with the main industries being tourism, mining and mineral exploration. The proposed service corridor straddles numerous mining, exploration and prospecting tenements, most of which are held by Newcrest or Greatland Gold (Newcrest's partner in the Havieron Project), with the remainder held by Hamelin Resources Pty Ltd, Encounter Operations Pty Ltd, MK Minerals Pty Ltd and Antipa Resources Pty Ltd.

2.1 Legislative context

Flora and fauna in WA are protected formally and informally by various legislative measures, which are as follows:

- Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) – Australian Government
- Biodiversity Conservation Act 2016 (BC Act) – State
- Environmental Protection Act 1986 (EP Act) – State
- Biosecurity and Agriculture Management Act 2007 (BAM Act) – State.

A short description of each legislative measure is given below.

2.1.1 EPBC Act

The EPBC Act aims to protect Matters of National Environmental Significance (MNES). Under the EPBC Act, the Commonwealth Department of the Environment and Energy (DEE) lists protected species and Threatened Ecological Communities (TECs) by criteria set out in the Act. Species are conservation significant if they are listed as Threatened (i.e. Critically Endangered, Endangered and Vulnerable) or Migratory.

2.1.2 BC Act

DBCA lists taxa (flora and fauna) under the provisions of the BC Act as protected and are classified as according to their need for protection (see Appendix A). The BC Act makes it an offence to 'take' threatened species without an appropriate licence. There are financial penalties for contravening the BC Act.

2.1.3 EP Act

Threatened flora, fauna (and significant habitat necessary for the maintenance of indigenous fauna) and Threatened Ecological Communities (TECs) are given special consideration in environmental impact assessments and have special status as Environmentally Sensitive Areas (ESAs) under the EP Act and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*. Exemptions for a clearing permit do not apply in an ESA.

2.1.4 BAM Act

The BAM Act provides for management and control of listed organisms, including introduced flora species (weeds). Species listed as declared pests under the BAM Act are classified under three categories:

- C1 Exclusion: Pests assigned under this category are not established in Western Australia, and control measures are to be taken to prevent them entering and establishing in the State.
- C2 Eradication: Pests assigned under this category are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
- C3 Management: Pests assigned under this category are established in Western Australia, but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area that is currently free of that pest.

Under the BAM Act, land managers are required to manage populations of declared pests as outlined under the relevant category.

2.2 Climate

The climate ranges from tropical arid in its southern to central parts (described by Beard (1990) as Eremaen), with an annual average rainfall of approximately 350 mm, to Tropical Semi-arid, with increased annual precipitation of approximately 500 mm near its junction with the Fitzroy River (BOM). The regional annual evaporation is approximately 300mm. Cyclones are a major source of rain, crossing the coast on average every 1-2 years, and bringing 200-400 mm of rainfall for a given cyclonic event (BOM).

The Havieron Project Area (weather station 013030) receives an average annual rainfall of 364.9 millimetres (mm) (BOM 2020). The majority of the rainfall occurs in the summer months, with February being the wettest month with an average of 102.7 mm (Figure 2.1).

In 2019, the total rainfall received for Telfer was significantly below average, at 65.4 mm. Rainfall in January 2020 was 119.8 mm, which is above average (43.0 mm). However, February 2020 rainfall was 41.0 mm, significantly below the average February rainfall (96.8 mm) (Figure 2.1).

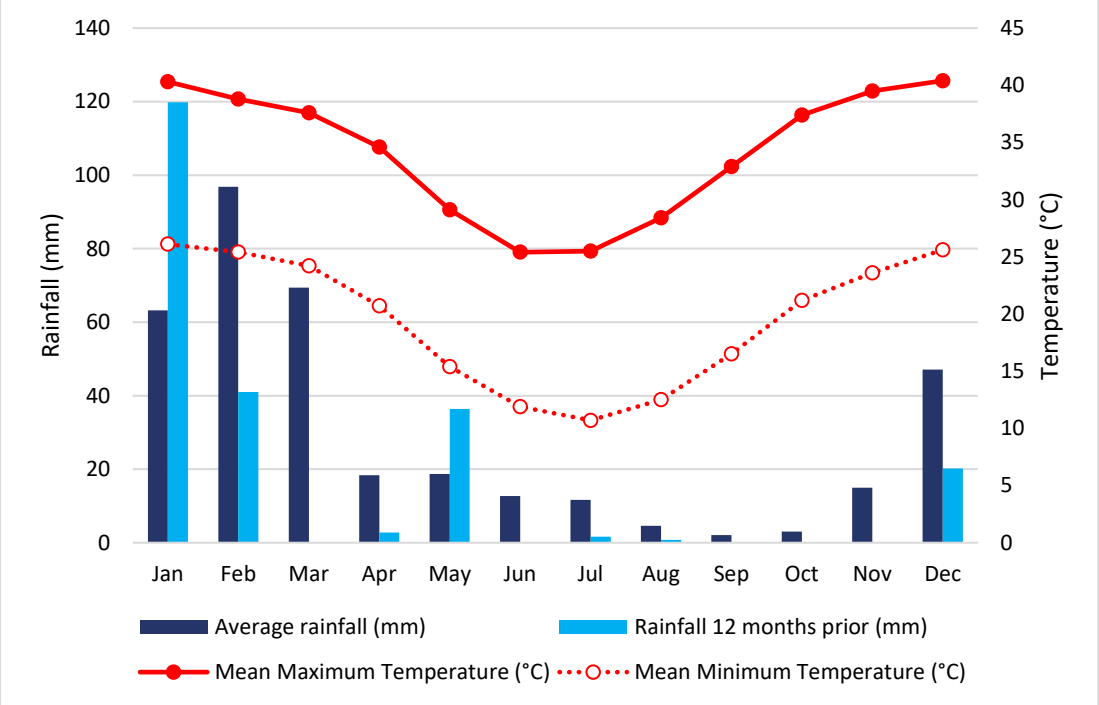


Figure 2.1: Rainfall and temperature data for Telfer Aero weather station (43 km East of Havieron Project Area) for 2019 and January to February 2020. Station ID 012030

2.3 Geology and Land systems

2.3.1 Geology

The Great Sandy Desert region is underlain by a range of Precambrian, Mesozoic and Cainozoic materials. Precambrian rocks form outcrops in the southern part of the Great Sandy Desert region. Mesozoic sedimentary rocks (Purcell 1984) form subcrops throughout the entire desert region, forming as ranges, local hills, mesas, buttes and exhumed rock pavements (Van Etten 2019). A vast sheet of red aeolian sediment, late Cainozoic to Quaternary in age, forms the near-surface materials through the entire desert (Van Etten 2019).

Regionally, the Havieron Project Area is within the Paterson – Yeneena province (zone 152) (Tille 2006) which overlies the north-western Patterson Orogen and Yeneena Basin.

The Yeneena Basin contains Mesoproterozoic and Neoproterozoic sandstone, shale and carbonate. Also included is a small portion of the Waukarlycarly Embayment (Canning Basin) which contains Phanerozoic sedimentary rocks (Tille, 2006).

The Havieron Access Corridor is within the Paterson province which contains multiple geological formations.

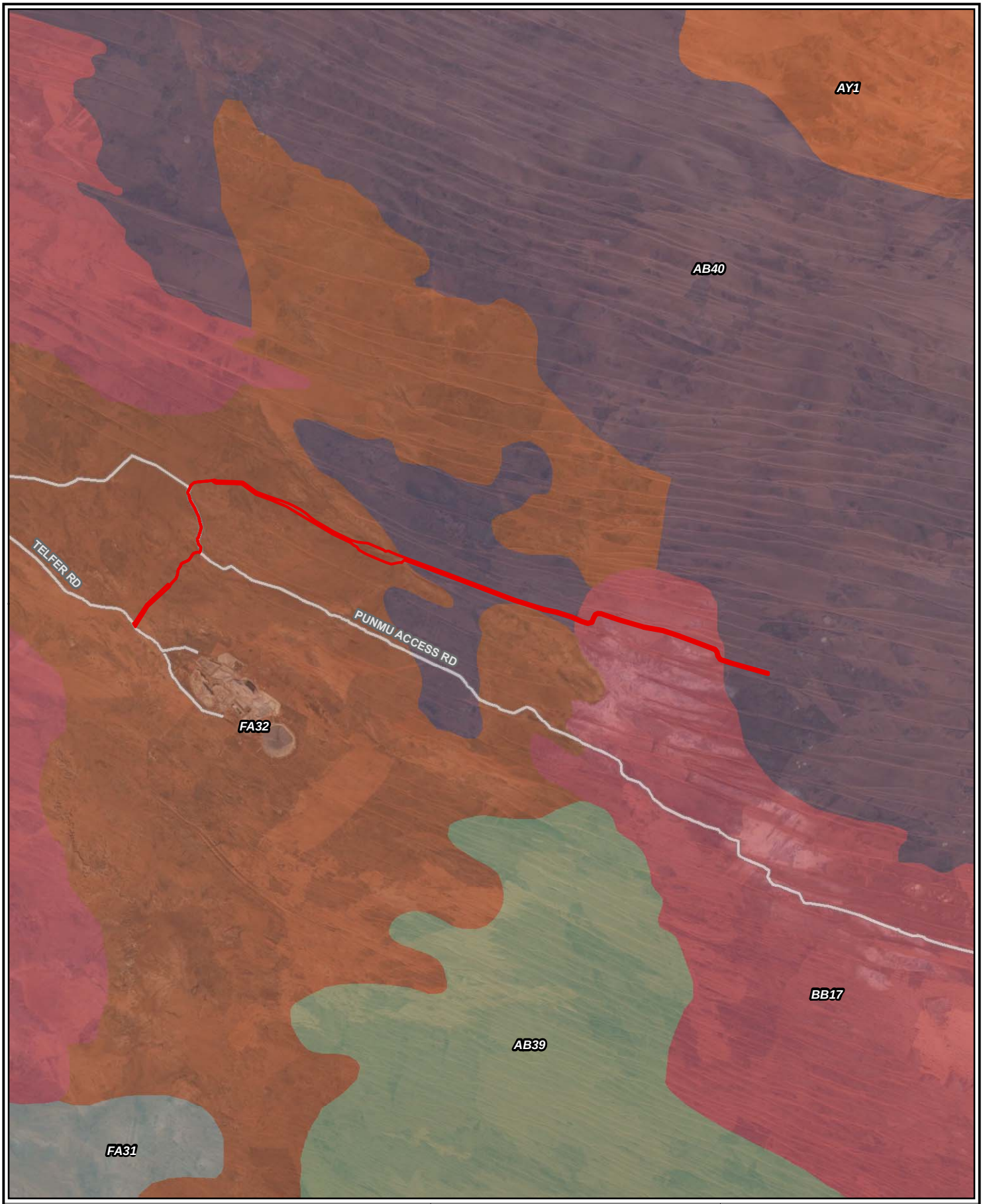
2.3.2 Landsystems

The Great Sandy Desert Zone lies within the Canning Province, located over phanerzoic sedimentary rocks of the Canning Basin (Tille 2006). The inland landforms of the Great Sandy Desert are predominantly linear sand dunes running east to west, with swales opening up onto sandplains. Within the bioregion there are scattered undulating plains such as those near the Telfer Mine site). Within the dune regions, scattered areas of claypans and salt lakes occur with isolated residual sandstone hills and laterite graves and breakaways capped with laterite duricrust (Tille 2006).

Three land systems are mapped within the Survey area (Table 2.1; Figure 2.2)

Table 2.1: Land systems found within the Survey Area

Code	Description of land system
Fa32	Low ranges and hills largely on metamorphics and granites but with some inclusions of sandstones and conglomerates; extensive areas of bare rock; transgressed by dunes in places and flanked by small plains
AB40	Gently undulating plain slightly more elevated than unit AB39, and dominated by longitudinal dunes, many exposures of ironstone gravels and some breakaways capped by ironstone (laterite) duricrust
BB17	Uneven rough calcrete (kunkar) plains with small salt lakes and pans broken by variable proportions of longitudinal sand dunes and occasional low rises or hills



Legend:

Project area - service corridor

Land Systems
- AB39
- AB40
- AY1
- BB17
- Fa31
- Fa32
- Roads (MRWA)

Scale 1:400,000 at A4

0 2.5 5
Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Job No: 57643

Client: Newcrest Mining Ltd and Greatland Gold Ltd

Version: A | Date: 22-Jul-2020

Drawn By: cthatcher | Checked By: HS

Havieron Mine Project, WA

LAND SYSTEMS WITHIN THE SURVEY AREA

FIGURE 2.3

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File Name: \\008PMPMR004V001.jbsg.aust\JBS Perth\Projects\1)Open\Newcrest\57634 Flora Surveys - Havieron Project\GIS\Maps\R02_ Rev_A\57634_02_3_LandSystems.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2.3.3 Soils

The dominant soils of the Great Sandy Desert dune-fields and sandplains are red deep sands and red sandy earths, with some red loamy earths and shallow gravels in depressions between dunes (Tille 2006). Hilly areas typically comprise “red loamy earths, with red shallow loams, red shallow sands, stony soils and shallow gravels” (Tille 2006).

2.3.4 Hydrology

The Great Sandy Desert region can be subdivided into five major hydrologic zones as described by Syrinx Environmental (2013a,b):

- the region to the south of the Salt Creek - Sandfire drainage line, comprising aeolian sand plains, buried channels systems, calcrete and gypsum at the water table, subcrops of Precambrian rock as bedrock aquifers, and proximity of the Pilbara region;
- the region along the Salt Creek - Sandfire drainage line, comprising, again, aeolian sand plains, but superimposed on a major buried channels system, with calcrete at the water table, and subcrops of Mesozoic rock;
- the region to the north of the Salt Creek - Sandfire drainage line, comprising aeolian sand plains, some buried channels systems, subcrop of Mesozoic rock as a regional aquifer;
- the region at the junction of the Great Sandy Desert and the Fitzroy River valley tract, comprising aeolian sand plains, extant rock-incised channels systems, outcrop and subcrop of Mesozoic rock as a regional aquifer;
- the region along the coast, comprising sandy and muddy coastal deposits, where there is local freshwater storage, and seepage induced by seaward discharge from regional aquifers interfacing with coastal muddy deposits.

Havieron is located within Zone 1, the region to the south of the Salt Creek - Sandfire drainage line. These salt-lake associated drainage lines were identified by Syrinx (2013a,b)as being an important part of the ground water systems within the GSD. The salt lakes act as sumps to inflow of freshwater deriving from subsurface drainage during the wet season or the cyclone season, and later in the dry season, when the surface waters have been concentrated to saline by evaporation, act as recharge zones, delivering plumes of salt water to the surrounding aquifers (Syrinx 2013a).

2.3.5 Biogeographic region

The Havieron Access Corridor is located mostly within the Mackay (GSD02) IBRA subregion. A small portion western most end of the Access Corridor (near the Telfer Mine) is located with the Rudall River subregion of the Little Sandy Desert (LSD01). As the soils and geological features are consistent with the regions to the east, this report will refer to the project as being located within the Great Sandy Desert (GSD).

The Mackay subregion (GSD) comprises open hummock grassland of *Triodia pungens* and *T. schinzii* with scattered trees of bloodwood (*Corymbia* spp.), and shrubs of *Acacia* spp., *Grevillea wickhamii* and *G. refracta*. The subregion is dominated by linear sand dune fields, overlying Jurassic and Cretaceous sandstones of the Canning and Amadeus Basins (Kendrick 2001a). Gently undulating lateritised uplands support shrub steppe, such as *A. pachycarpa* shrublands over *T. pungens* hummock grass. Calcrete and salt lake chains with samphire low shrublands, and *Melaleuca glomerata - M. lasiandra* shrublands occur in low lying areas (Kendrick 2001a).

2.3.6 Regional Vegetation Mapping

The vegetation of Western Australia, including the Great Sandy Desert and Little Sandy Desert regions, was mapped at the 1:1,000,000 scale by Beard (1974) and was subsequently reinterpreted

and updated to reflect the National Vegetation Information System (NVIS) standards (Shepherd et al. 2001).

Two vegetation associations have been mapped within the study area (Table 2.2). Association 134 (mosaic: hummock grassland of *Triodia* species) is the dominant vegetation association within the study area, with smaller areas of Association 157 (sparse low tree-steppe/sparse shrub-steppe).

Most of the pre-European extent of vegetation in the Great Sandy Desert has never been cleared. The remaining extent of pre-European vegetation associations occurring within the Havieron Study Area are listed in Table 2.2:

Table 2.2: Broad vegetation associations within the Havieron Access Corridor

IBRA Subregion	Vegetation Association	Vegetation (Beard 2001)	Area in study area (ha) & proportion (%)	% Remaining	Area mapped in the GSD (ha)	% total extent at the study area
MacKay GSD02	134	Hummock grasslands, grass steppe; soft spinifex	1286	99.98	219,366.88	0.59
	157	Shrublands; teatree scrub	19	100	62,254.34	0.031
Rudall River (LSD01)	134	Mosaic: Hummock grasslands, open low tree steppe; desert bloodwood and feathertop spinifex on sandhills / Hummock grasslands, shrub steppe; mixed shrubs over spinifex between sandhills	5	99.73	25,539.89	0.02
	157	Hummock grasslands, grass steppe; hard spinifex, *Triodia wiseana*	34	97.57	77,536.16	0.04

2.4 Previous Flora and Vegetation Reports

All available hardcopy and digital reports commissioned by Newcrest relating to the areas surrounding the study area were sourced from Newcrest (Table 2.3). The information in the reports was reviewed and the relevant data extracted (e.g. location of significant flora, introduced flora and types of vegetation communities with relevance to landforms).

Data sourced from the reports together with digital mapping information was used to collect information on location, types and extent of vegetation associations mapped within the vicinity of the study area. The literature review also focussed on identifying previously mapped significant flora and vegetation, including TECs, PECs, Threatened and Priority Flora species as well as significant landforms.

Table 2.3: Summary of previous flora and vegetation surveys within the vicinity of Telfer

Report	Proximity to Study Area	Survey Technique + Time of Survey	Vegetation Associations	Floristic Composition	Significant Flora	Completed to EPA Guidance Statement Requirements
Syrinx Environmental (2013) Trotmans, satellite deposits and Pit 15 Study Area- Level 2 Flora and Fauna survey	50 km West of Havieron		Vegetation association 5b: *Acacia wanyu* Open shrubland over *Eremophila tietkensii* and *Senna glutinosa* sub sp. luerssenii Open shrubland over *Triodia basedowii* complies and *T. epactia* Open Hummock grassland over *Maireana melanocoma*	84 species from 19 families and 50 genera. Fabaceae was the most common (22 taxa) in the Satellite deposits site, Goodeniaceae (10 taxa) and Myrtaceae (10 taxa), and Malvaceae (7 taxa).	None found	Methods are compliant with current EPA (2016) guidelines, however survey was single season
Syrinx Environmental (2013)	45 km West of Havieron	Detailed Flora and fauna assessment over three study sites conducted in July 2011 and June 2012	12 Vegetation associations	214 species from 38 families over 97 genera. Fabaceae dominate (38 taxa) Poaceae (35 taxa) Malvaceae (16 taxa) Goodeniaceae (13 taxa)	None reported	Methods compliant with 2016 EPA guidelines, however only singe season survey was conducted

2.5 Local Vegetation Surveys

The only local vegetation surveys to date have been conducted for environmental approvals at Telfer (43 km to the east of the proposed Havieron Project), the nearby Birla Nifty Copper Mine (Nifty) 110 km west of Havieron Project and Kintyre Uranium Project, 105 km south-west of Havieron Project.

Surveys relevant to the current study (in chronological order) are summarised below.

Syrinx Environmental Pty Ltd (2013a) Optimisation Study Area: Level 2 Flora and Fauna Survey

The Optimisation Study Area is a 1,237 ha portion of the overall 10,471 ha Telfer Optimisation Project Greater Study Area and was one of five study sites that comprised the Telfer Optimisation Project Area. All five study areas were assessed simultaneously.

A total of 21, 50 x 50 m quadrats were assessed, resulting in a total of 214 species from 38 families and 97 genera.

Fabaceae was identified as the most common plant family, accounting for 17.8% of all taxa collected in the Optimisation Study Area. Other dominant families recorded were Poaceae (16.3% of taxa), which consisted of 35 taxa from 18 genera), Malvaceae (7.4% of taxa) and 7.5% of taxa) with 16 taxa from seven genera and Goodeniaceae (14.0% of taxa) which consisted of 13 taxa from five genera.

No Threatened Flora (T) listed under the *Wildlife Conservation Act 1950* or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded within the Optimisation Study Area. Two new populations of the Priority 2 species, *Goodenia hartiana*, were recorded in the Optimisation Study Area, and one population previously recorded was reconfirmed.

There were seven range extension species recorded: *Acacia pteraneura*, *Maireana triptera Sclerolaena crenata*, *S. eriacantha* and *S. minuta*, *Peripleura virgata* and *Synaptantha tillaeacea* var. *tillaeacea*.

This vegetation association (134) (described as being a high priority conservation within the study area) was reported to occur across 4.89% of the Optimisation Study Area, on landforms not common regionally, with dominant species commonly associated in the greater Pilbara region. These taxa included; *Acacia pteraneura* and *Maireana triptera,* which were restricted to this vegetation association within the Optimisation Study Area. A total of five species in this report were identified as being restricted to vegetation association 3a.

Acacia pteraneura was not recorded in the other four study areas for the Telfer Optimisation Project. This species and its ecosystem were identified as potentially dependent on sheet flow.

The vegetation condition across the Optimisation Study Area at the time of sampling (2013) ranged from Good to Pristine. The lesser condition assignment was attributed to clearing for mining activities around the waste dumps. The Pristine areas were to the north west and south east of the Optimisation Study Area where there has been no evidence of human disturbance such as tracks and low-level mining activity. A large portion of the Optimisation Study Area was in excellent condition (47%).

Syrinx Environmental Pty Ltd(2013b), Trotmans, Satellite Deposits and Pit 15 Study Areas: Level 2 Flora and Fauna Survey.

The Study Areas represented three of the five Study Areas that comprise the overall 10,471 ha Telfer Optimisation Project, where Newcrest is investigating opportunities for enhancement of current mining activities and potential development of satellite deposits. All five Study Areas were assessed simultaneously.

The Level 2 survey was required in order to inform planning and assess impacts of potential developments on vegetation, flora, groundwater dependent ecosystems, vertebrate fauna and short-range endemics.

A total of 42 50 x 50 m quadrats were sampled across all three study sites, resulting in identification of 161 vascular plant species from 40 families and 83 genera.

A single taxon (*Ptilotus aphyllus*) was recorded as a range extension.

Syrinx Environmental Pty Ltd (2013) O'Callaghan's Study Area: Level 2 Flora and Fauna Survey

The O'Callaghan's Study Area is a 2,728-ha portion of the overall 10,471 ha Telfer Optimisation Project. A total of 36 50 x 50 m quadrats were sampled identifying 176 species from 32 families and 77 genera.

Fabaceae was identified as the most common plant family, accounting for 23.8% of all taxa collected in the O'Callaghan's Study Area. Other dominant families recorded were Poaceae (14.7% of taxa), Malvaceae (7.4% of taxa) and Myrtaceae (7.4% of taxa).

No Threatened Flora (T) were recorded within the O'Callaghan's Study Area. Five *Goodenia hartiana* (P2) populations were recorded in the O'Callaghan's Study Area; however, it is possible three of the populations are part of one larger population containing hundreds of plants.
There were five range extension species recorded: *Fimbristylis leucocolea, F. neilsonii, Maireana triptera, Sclerolaena eriacantha* and *S. minuta.*

A vegetation association (5b), dominated by *Acacia wanyu*, was reported as a unique and distinct vegetation association. This vegetation association occurs across 3.7% of the O'Callaghan's Study Area, on a landform not common regionally and was also found on a contemporaneous survey at Pit 15 (Fallows Field). Eight species were restricted to vegetation association 5b. Almost all of the restricted species are common south of the Great Sandy Desert bioregion. Six of the species were reported as restricted to the O'Callaghan's Study Area when assessed against the remaining four study areas within the Telfer Optimisation Project Area.

The vegetation condition across the majority of the O'Callaghan's Study Area was reported as Pristine to Excellent. The lesser condition ranking was attributed to tracks and exploration drilling in the south east corner of the O'Callaghan's Study Area.

There were no introduced species recorded in the O'Callaghan's Study Area.

Eight vegetation and substrate associations were identified across the Telfer (and Havieron project) areas: sand dunes; interdune plains, possible groundwater dependent ecosystems in plains, calcrete rises; rocky hills, Mulga woodland, artificial wetlands and disturbed areas. Most were widespread within the region with the O'Callaghan's Study Area, dominated by sand dunes and interdune plains, with small areas of rocky hills and calcrete rises.

3. Methods

The survey methods are consistent with for the EPA's Technical Guidance - *Flora and Vegetation Surveys for Environmental Impact Assessment* (2016a) for reconnaissance level surveys.

3.1 Desktop assessment

The following searches were undertaken for the Havieron Access Corridor survey area using a 100 km radial buffer to determine potential conservation significant flora species:

- Protected Matters search tool for matters listed under the EPBC Act
- Threatened (Declared Rare) and Priority Flora (TPFL) database (ref 20-0611FL)
- Western Australian Herbarium (WAH) specimen database for Threatened (DRF) and Priority Flora (ref 20-0611FL)
- NatureMap database for all flora species records occurring within the study area (DEC 2011c)

Searches of the DBCA Threatened Flora database, the WAH Specimen database were conducted on the 12th of February 2020 to provide information on Threatened and Priority Flora in the study area.

The search co-ordinates (GDA94) used were defined by circle with the centre point located 122° 24' 59'' E,21° 40' 58'' S

3.2 Reconnaissance survey, Havieron Access Corridor

A Reconnaissance flora and vegetation survey was conducted along the length of the proposed access corridor. This survey level is considered appropriate given the low level of proposed impacts within the Survey area. The survey was conducted in the prime flowering season for the region.

A total of 19 relevés were sampled along the corridor (Figure 4.1), with flora and vegetation described and inventoried within each relevé. Additional opportunistic samples were collected wherever previously unrecorded plants were observed while traversing the study area. At each site, the following floristic and environmental parameters were recorded:

- GPS location
- topography
- soil type and colour
- outcropping rocks and their type
- percentage cover and average height of each vegetation stratum.

For each vascular plant species, the average height, number of plants and percent cover was recorded.

Between relevé locations, opportunistic observations were recorded. These observations include:

- changes in vegetation structure and composition
- changes in vegetation condition
- taxa not previously recorded
- flora of conservation significance
- significant weed populations.

All plant specimens collected during the field surveys were identified using appropriate reference materials or through comparisons with specimens housed at the Western Australian Herbarium. Nomenclature of the species recorded is in accordance with Western Australian Herbarium (1998-).

3.3 Data analysis

3.3.1 Vegetation units

Vegetation types (VT) were delineated using a combination of results and site observations. Aerial photography interpretation and field notes taken during the survey were then used to develop VT mapping polygon boundaries over the Survey area. These polygon boundaries were then digitised using Geographic Information System (GIS) software.

Vegetation type descriptions (through floristic in origin) have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 7.0 (NVIS Technical Working Group 2017), a system of describing structural vegetation units (based on dominant taxa). This model follows nationally-agreed guidelines to describe and represent VTs, so that comparable and consistent data is produced nation-wide. For the purposes of this report, a VT is considered equivalent to a NVIS sub-association as described in ESCAVI (2003).

3.3.2 Vegetation condition

Vegetation condition was recorded at all relevés, and opportunistically within the Survey area during the field assessment where required. Vegetation condition was described using the vegetation condition scale for the Eremaean Botanical Province (EPA 2016; Table 3.1). Vegetation condition polygon boundaries were developed using this information in conjunction with aerial photography interpretation and were digitised as for vegetation type mapping polygon boundaries.

Table 3.1: Vegetation Condition Scale (adapted from Trudgen 1988)(EPA 2016)

Vegetation Condition	Description
Excellent	Pristine or nearly so, no obvious signs of damage caused by the activities of European man.
Very Good	Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fires and the presence of some relatively non-aggressive weeds such as Ursinia or Briza species, or occasional vehicle tracks.
Good	More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones.
Poor	Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man such as grazing or partial clearing (chaining or very frequent fires. Weeds as above, probably plus some more aggressive ones such as Ehrharta species.
Very Poor	Severely impacted by grazing, fire, clearing, or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including aggressive species.
Completely Degraded	Areas that are completely or almost completely without native species in the structure of their vegetation, i.e. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs.

3.4 Survey limitations and constraints

There are possible limitations and constraints that can impinge on the adequacy of vegetation and flora surveys. The flora and vegetation assessment has been evaluated against a range of potential limitations (Table 3.2). Based on this evaluation, the assessment was subject to minor limitations and constraints that may have affected the assessment and the conclusions reached.

Table 3.2: Flora and vegetation survey potential limitations and constraints

Potential limitation	Impact on assessment	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	**Not a constraint**	Several reports are available for flora and vegetation surveys near the survey area.
Scope (i.e. what life forms, etc., were sampled).	**Not a constraint**	Number of species recorded, number of quadrats sampled, and timing of the survey were adequate for this level of survey.
Proportion of flora/fauna collected and identified (based on sampling, timing and intensity).	**Not a constraint**	The proportion of flora surveyed was adequate. The entire Survey area was traversed, and flora species were recorded systematically. The detailed flora and vegetation assessment was conducted during spring which is the optimal time for survey within the bioregion.
Flora determination.	**Minor constraint**	Approximately 30% of the site was recently burned. This meant that often only stunted growth or new regrowth was present to determine taxa from.
Completeness and further work which might be needed (i.e. was the relevant Survey area fully surveyed).	**Not a constraint**	The Great Sandy Desert region is typified by a low level of floristic biodiversity (DBCA/WAHERB). Based on the number of species identified in each relevé, the survey effort was adequate for the bioregion
Mapping reliability.	**Minor Constraint**	Aerial photography is commonly used to map vegetation. Potential sample sites were chosen from aerial photography to reflect changes in community structure. As a significant portion of the study had been recently burnt, current aerial photography of vegetation was only available for part of the site. Therefore, ground-truthed data formed the basis of the vegetation type mapping.
Timing, weather, season, cycle.	**Minor constraint**	Flora and vegetation surveys in the Pilbara are normally conducted following winter rainfall, ideally 4 to 6 weeks post wet season (EPA 2016a). The field assessment was conducted in April 2020 in typical weather conditions for the region and therefore these factors are not deemed to be a constraint for the post wet survey. However, Rainfall in the 3 months prior to the survey (June to August) was below average, and therefore may be a limiting factor
Disturbances (fire flood, accidental human intervention, etc.).	**Minor constraint**	The site had undergone extensive natural burning and some species had re-sprouted and grown sufficiently to be identified. The recent fires may have impacted the composition of the flora in favour of fire tolerant species and species whose germination is stimulated by fire. This may skew the floristic associations and diversity indices towards ephemeral and fire tolerant taxa.
Intensity (in retrospect, was the intensity adequate).	**Not a constraint**	The survey area was easily accessible, and a sufficient number of relevés were recorded. A total of 19 releves were conducted within the survey area, with each vegetation type being represented by at least one relevé. This provided sufficient coverage to adequately describe the floristic community and associations within the study site
Resources (i.e. were there adequate resources to complete the survey to the required standard).	**Not a constraint**	The available resources were adequate to complete the survey.
Access problems (i.e. ability to access Survey area).	**Not a constraint**	The study area was easily traversed by a light vehicle, enabling adequate access to vegetation within the Survey area.
Experience levels (e.g. degree of expertise in species identification to taxon level).	**Not a constraint**	Survey personnel had the appropriate training in sampling and identifying the flora and fauna of the region.

4. Results

4.1 Desktop assessment

4.1.1 Conservation Significant Flora

Eleven taxa of conservation significance were identified by database searches as potentially occurring within a 100 km buffer zone around the project area.

Of the eleven taxa that have been reported to occur within the 100km buffer zone (refer to Appendix B for full regional species list), only four priority taxa have been previously recorded within the Telfer Mine area. *Goodenia nuda* (P4), *G. hartiana* (P2) have been extensively mapped with the Greater Telfer mine area (Syrinx 2008, 2013) with *Eremophila tenella* and *Comesperma sabulosum* likely to occur based on habitat preference (Table 4.1). The potential for these plants to occur within the site was assessed based on general habitat requirements and distribution (Table 4.1). None of the conservation significant flora species identified from the desktop assessment were observed during the current survey; however, survey timing was not optimal for all species listed and the evidence of recent fires over 30% of the survey area may have skewed the vegetation communities toward pyrophytic and fire ephemeral species. The survey targeted likely habitat within the proposed development envelope.

Table 4.1: Threatened and Priority flora potentially occurring within the survey area

Species	Conservation status	Description	Potential to occur (prior to survey)	Potential to occur (post to survey)
Eremophila tenella	P1	A straggly shrub to 2.5 m high with a weeping appearance. Foliage greyish. Flowers are pale blue. Flowers in May or Aug to Sep.	Likely to occur	Likely to occur based on habitat preference
Ptilotus wilsonii	P1	Shrub, ca 0.5 m high. Flowers are green-white. Stony gravelly soils. Rocky hills. Flowers in October.	Not Likely to occur	Likely to occur
Acacia auripila	P2	Tree, to 3 m high, bark grey & fissured. Flowers are yellow. Rocky quartz soils. Hillsides, gullies. Flowers in August.	Likely to occur	Unlikely to occur based on habitat preference
Eremophila sp. Rudall River (P.G. Wilson 10512*)*	P2	Clumped plant/shrub 25 cm high x 25 cm wide. Creamy/white flowers. Leaves silvery, hairy, narrow linear.	Likely to occur	Occurrence is possible based on habitat preference
Goodenia hartiana (Hart's Goodenia)	P2	Herb/shrub, 40 cm high. Flowers blue. Flowers in August and September	Highly likely to occur	Highly Likely to occur based on habitat type and previous records
Thysanotus sp. Desert East of Newman (R.P. Hart 964)	P2	Self-supporting perennial, herb (with tuberous roots), distinguished by the long, equal anthers and pseudo-cymose branching. Red-brown loamy sand or red sand, sometimes silty. Sand plain, pisolitic buckshot plain. Flowers August to October.	Not likely to occur	Not likely to occur based on habitat (soil type) preference

Species	Conservation status	Description	Potential to occur (prior to survey)	Potential to occur (post to survey)
Comesperma sabulosum	P3	Perennial shrub 0.5 m high x 0.2 m wide.	Likely to occur	Not likely to occur
Goodenia purpurascens	P3	Erect perennial or annual, herb, 0.1-0.3 m high. Flowers are blue-purple/white/yellow. Clay, mud. Swamps & seasonally wet depressions. Flowers January or April or June of September or December.	Not Likely to occur	Not likely to occur based on habitat preference
Indigofera ammobia	P3	Many-stemmed shrub, to 0.5 m high. Flowers are green & purple. Red sand. Sand dunes. Flowers in September.	Likely to occur	Likely to occur based on habitat preference
Goodenia nuda E.Pritz	P4	Erect to ascending herb, to 0.5 m high. Flowers are yellow, from April to August.	Likely to occur	Highly Likely to occur based on habitat type and previous records
Ptilotus mollis	P4	Compact, perennial shrub, to 0.5 m high, soft grey foliage. Stony hills and screes. Flowers white/pink in May or September	Not Likely To occur	May occur based on habitat preference

4.1.2 Conservation significant vegetation

No state or federally listed Threatened Ecological Communities (TECs) or Priority Ecological Communities (PEC) were identified by the database searches as potentially occurring in the area.

4.2 Field Survey

The field assessment for the Reconnaissance flora and vegetation survey was conducted by two Botanists, between 3rd and 7thApril 2020. The survey was completed in accordance with the EPA Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment.

Table 4.2: Field Survey Dates

Date	Survey	Notes
3 – 7 April 2020	Reconnaissance Flora and vegetation	Very little flowering due to low rainfall and high heat

All plants collected were taken under flora collecting permits listed in Table 4.3, pursuant to Regulation 62 of the Biodiversity Conservation Regulations 2018.

Table 4.3: Personnel

Name	Role	Flora collection permit
Jason Webb Senior Botanist	Planning, fieldwork, plant identification, data interpretation and report preparation.	FB62000168 (07 Oct 2019 - 06 Oct 2022) TFL 75-1920 (28 Sept 2019- 30 Nov 2022)
Rachael Pratt Senior Botanist	Planning, plant identification, data interpretation and report preparation.	FB62000141 (19 Aug. 2019-18 Aug. 2022) TFL 49-1920 (4 Sep. 2019-15 Dec. 2022)

4.2.1 Native flora

A total of 19 relevés were conducted during the survey resulting in identification of 47 species from 12 families and 26 genera (refer to Appendix D for locations).

The most commonly recorded family was Fabaceae, which accounted for 35% of all taxa collected in the Havieron Access Corridor, constituting 13 taxa and 5 genera. Other dominant families recorded were Poaceae (21% of taxa), Myrtaceae (19% of taxa) and Proteaceae (11% of taxa) genera. Refer to Appendix B for full species list.

4.2.2 Vegetation

Within the Survey area, 12 vegetation types were recorded and mapped. In addition, two vegetation units recently burnt were also classified; however, due to the recent nature of the fires, these areas were not able to be classified into existing vegetation types. Vegetation codes have been matched with those presented in Syrinx 2013 a,b,c. The most dominant vegetation type recorded was type 4b (849.27 ha) which is 61.07% of the entire Survey area. This vegetation type is typified by scattered Corymbia trees and dominated by *Acacia stellaticeps* and *Triodia* grass lands dominated by *T. basedowii*.

Table 4.4: Description of vegetation types mapped within the Survey Area

Code	Vegetation types	Dominant Landform	Veg Cond	Area	% survey area
***Corymbia* Open Woodland**					
1d	*Corymbia caricinus* and *C. opaca* Open Woodland over Scattered Shrubs of *Grevillea wickhamii* subsp. *hispidula* over *Triodia pungens* and *T.* aff. *basedowii* Very Open Hummock Grassland	Dune swale	Excellent	22.89	1.63
***Acacia* High Shrubland**					
3c	Scattered Mallees of *Eucalyptus kingsmillii* subsp. *kingsmillii* and *E. odontocarpa* over *Acacia adsurgens*, *A. ligulata* and *A. sericophylla* High Shrubland over *A. stellaticeps* Low Open Shrubland over *Triodia* aff. *basedowii* Hummock Grassland	Dune swale	Excellent	8.76	0.62
Mixed High Shrubland					
4b	Scattered Trees *of Corymbia* over *Acacia* stipuligera and *Grevillea wickhamii. Acacia stellaticeps*, *Jacksonia aculeata* and *Calytrix carinata* Low Open Shrubland over *Triodia basedowii* complex and *T. schinzii* Closed Hummock Grassland	Dune swale	Excellent	859.27	61.07
4e	Scattered mallees over *Grevillea wickhamii* over *Acacia stellaticeps* over *Triodia basedowii*	Dune swale	Excellent	85.65	6.09
4f	Eucalyptus over open Mallee over *Grevillea wickhamii* and *Triodia* Hummock Grass	Dune swale	Excellent	59.80	4.25
Triodia Hummock Grassland					
6a	*Scattered Acacia* spp. *over Triodia schinzii*	Dune	Excellent	76.74	5.45
6b	*Grevillea wickhamii* Open Shrubland over *Acacia stellaticeps*, *Halgania solanacea* and *Goodenia azurea* Low Open Shrubland over *Triodia epactia* Hummock Grassland *Acacia sp. Over Triodia.*	Plain	Excellent	6.52	0.46
6c	*Grevillea stenobotrya* over *Triodia cf. basedowii* Hummock Grass	Ironstone rocky hill	Excellent	41.02	2.92
6f	Scattered Trees of *Corymbia opaca* over Scattered Tall Shrubs of *Hakea chordophylla* Low Open Shrubland over *Triodia* aff. *basedowii Hummock Grassland.* Very Open Bunch Grassland	Plain	Excellent	0.06	0.62

Code	Vegetation types	Dominant Landform	Veg Cond	Area	% survey area
6g	Scattered Tall Shrubs of *Grevillea wickhamii* and *Hakea chordophylla* over *Triodia* aff. *basedowii* Hummock Grassland	Plain	Excellent	94.42	6.71
6h	Scattered Trees of *Corymbia* over scattered Grevillea and Acacia stipuligera over Triodia schinzii Hummock Grassland over D Low Open Shrubland	Salt Flat	Excellent	10.23	100.00
Recently Burnt Areas					
Bu	Recently Burnt	-	n/a	95.81	6.81
Br	Recently Burnt but showing signs of recovery	-	n/a	8.27	0.59
Cleared	Cleared Areas		Completely Degraded	37.59	2.67

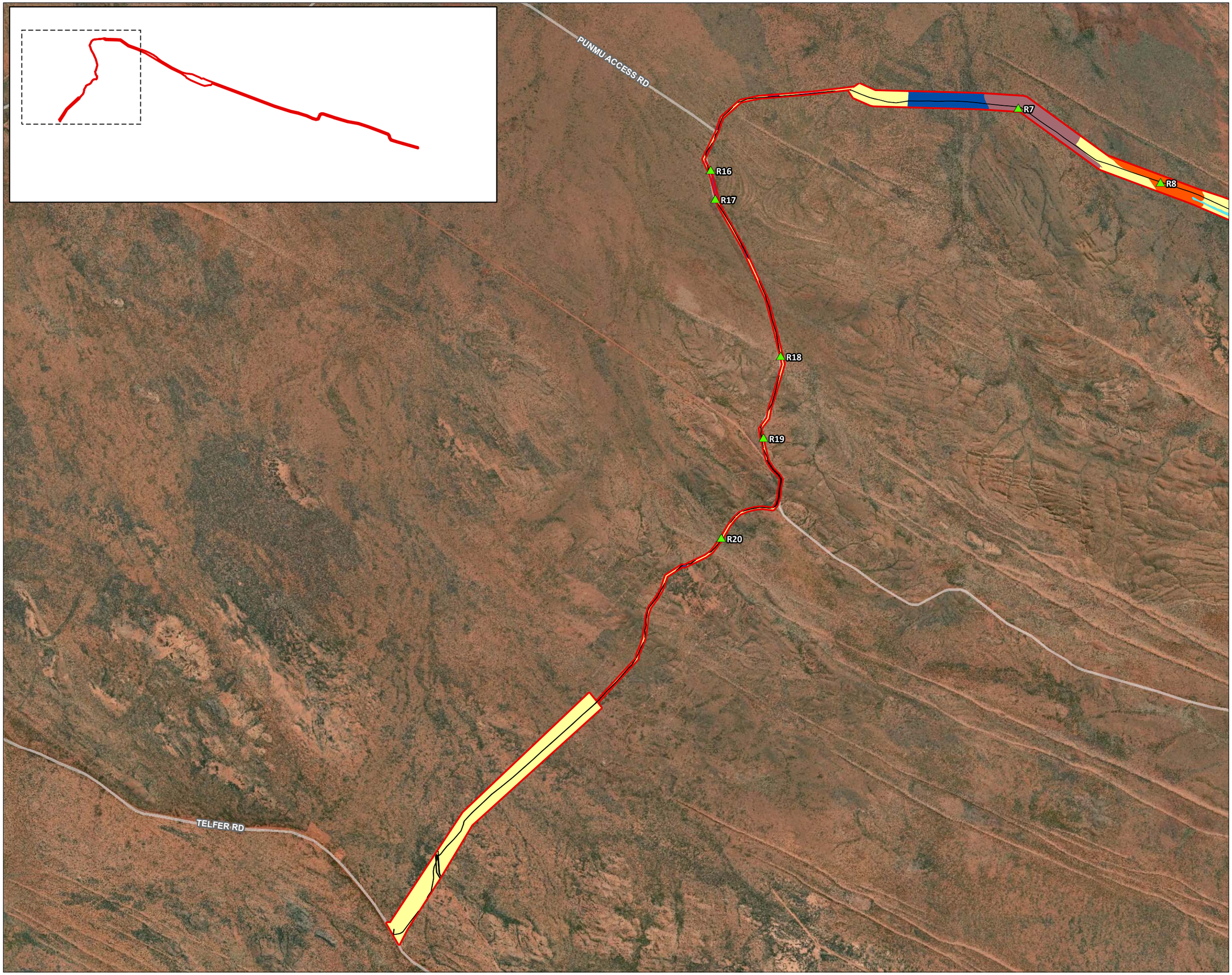
None of the vegetation associations mapped and described are listed as Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs).

4.2.2.1 Vegetation Condition

The average vegetation condition across the Access Corridor was Excellent (excluding existing cleared areas). A few small areas at the western and eastern extremities of the Project area are considered to be in a poor condition due to mining operations in the area. These areas had reduced vegetation cover consistent with partial clearing. Overall, 99% of the Havieron Access Corridor was in excellent condition.

4.2.3 Introduced and exotic taxa

No introduced or exotic flora were found within the relevés conducted along the access corridor.



Legend:

- Project area - service corridor

Vegetation type

- 1d
- 4b
- 4f
- 4fr
- 6a
- 6c
- 6f
- 6g
- Bu
- Cleared
- Relevé
- Roads

strategen JBS&G

Job No: 57634

Client: Newcrest Mining Ltd and Greatland Gold Ltd

Version: A	Date: 22-Jul-2020
Drawn By: cthatcher	Checked By: HS

Scale 1:47,500

0 1 2
Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Havieron Mine Project, WA

VEGETATION TYPE WITHIN THE PROJECT AREA

FIGURE 4.1 **PAGE 1 OF 4**

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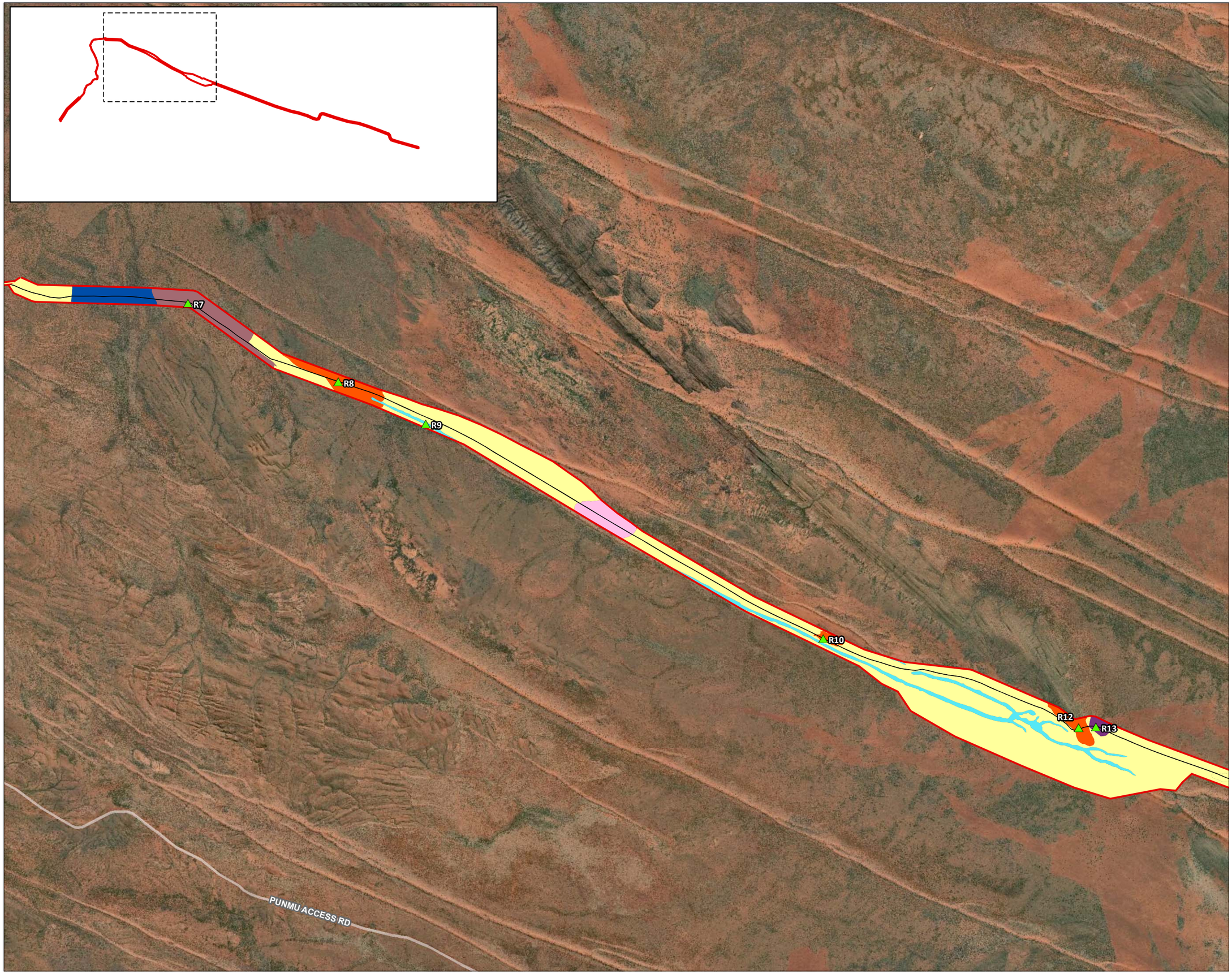
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend:

- Project area - service corridor

Vegetation type

- 1d
- 4b
- 4f
- 6a
- 6c
- 6g
- Bu
- Cleared
- Relevé
- Roads

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Job No: 57634

Client: Newcrest Mining Ltd and Greatland Gold Ltd

Version: A	Date: 22-Jul-2020
Drawn By: cthatcher	Checked By: HS

Scale 1:45,000

0 1 2
Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Havieron Mine Project, WA

VEGETATION TYPE WITHIN THE PROJECT AREA

FIGURE 4.1 **PAGE 2 OF 4**

File Name: \\008PMPMR004V001.jbsg.aust\JBS Perth\Projects\1)Open\Newcrest\57634 Flora Surveys - Havieron Project\GIS\Maps\R02_ Rev_A\57634_04_1_VegTypesMB.mxd
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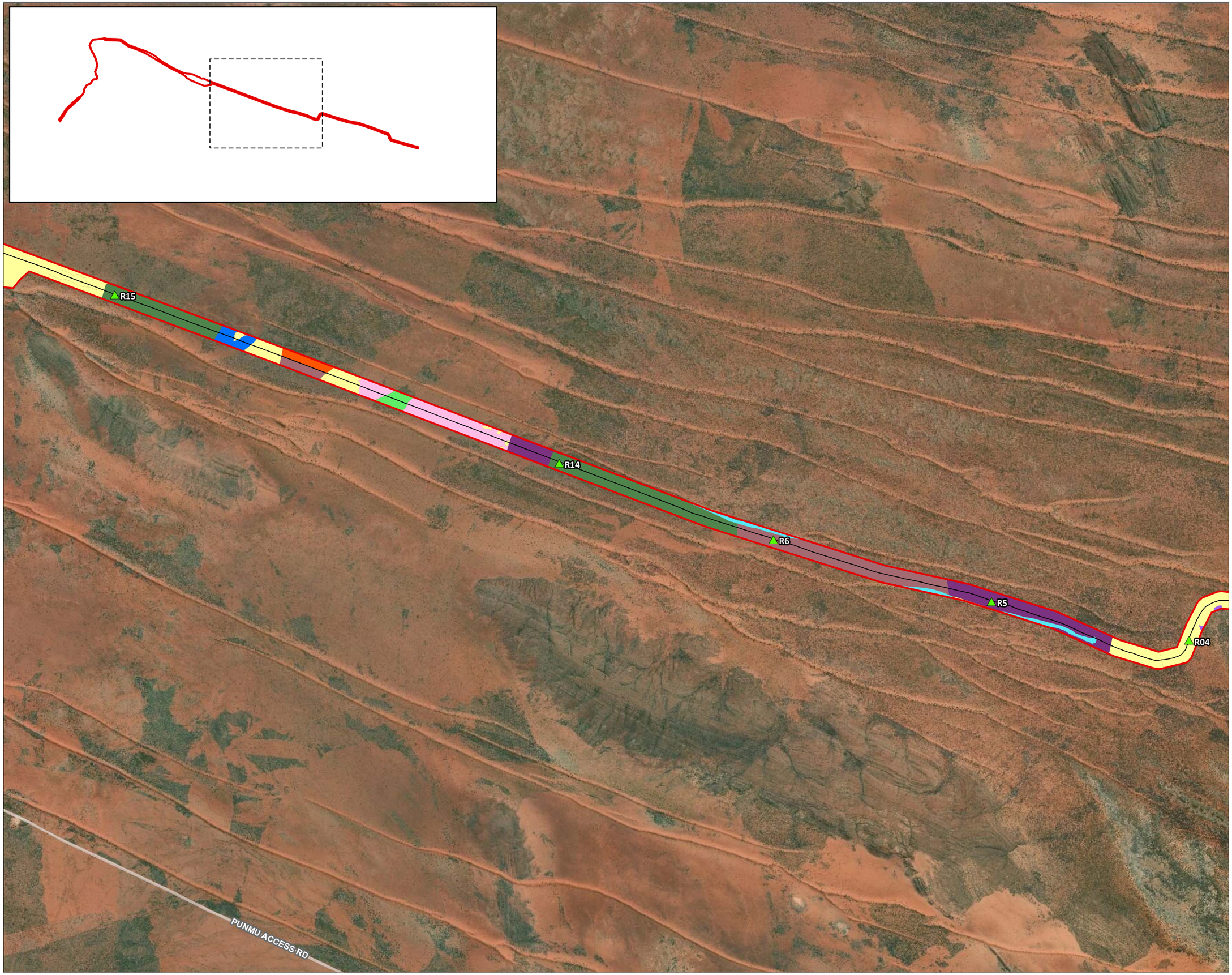

Legend:

- Project area - service corridor

Vegetation type

- 4b
- 4e
- 4f
- 6a
- 6b
- 6c
- 6g
- 6h
- Br
- Bu
- Cleared
- Relevé
- Roads

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Scale 1:45,000

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Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Havieron Mine Project, WA

VEGETATION TYPE WITHIN THE PROJECT AREA

FIGURE 4.1 **PAGE 3 OF 4**

File Name: \\008PMPMR004V001.jbsg.aust\JBS Perth\Projects\1)Open\Newcrest\57634 Flora Surveys - Havieron Project\GIS\Maps\R02_ Rev_A\57634_04_1_VegTypesMB.mxd
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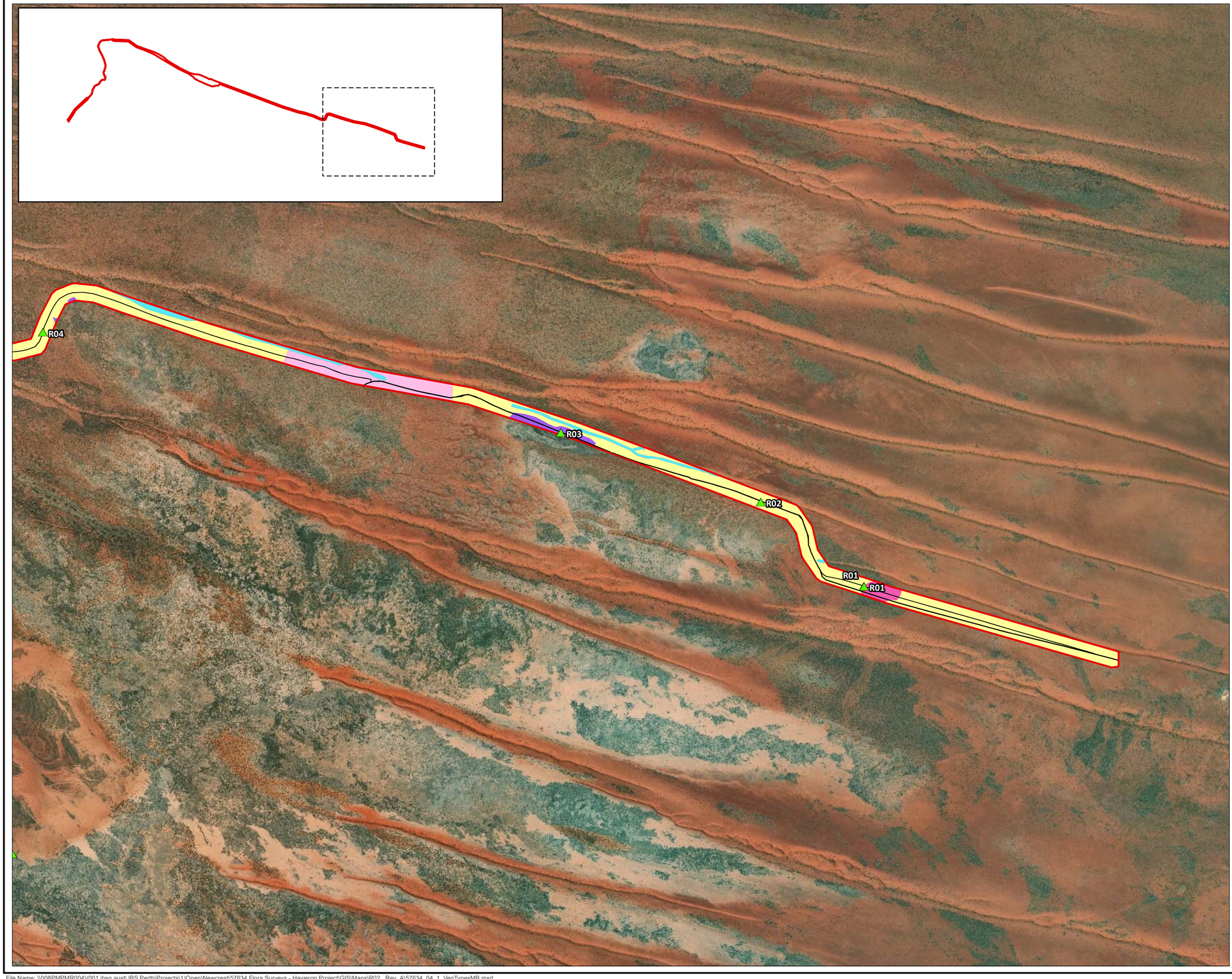

Legend:

- Project area - service corridor

Vegetation type

- 3c
- 4b
- 6a
- 6h
- Bu
- Cleared
- Relevé

strategen JBS&G

Job No: 57634	
Client: Newcrest Mining Ltd and Greatland Gold Ltd	
Version: A	Date: 22-Jul-2020
Drawn By: cthatcher	Checked By: HS

Scale 1:45,000

0 1 2
Kilometres

Coord. Sys. GDA 1994 MGA Zone 51

Havieron Mine Project, WA

VEGETATION TYPE WITHIN THE PROJECT AREA

FIGURE 4.1 **PAGE 4 OF 4**

File Name: \\008PMPMR004V001.jbsg.aust\JBS Perth\Projects\1)Open\Newcrest\57634 Flora Surveys - Havieron Project\GIS\Maps\R02_ Rev_A\57634_04_1_VegTypesMB.mxd
Image Reference: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

5. Discussion

The overall vegetation condition within the survey area was considered to be in excellent condition (with the exception of the cleared areas shown in Figure 4.1). The species diversity and abundance is consistent with the ecology and diversity of the region and previous surveys of this level within the local area. No conservation significant flora or ecological communities were identified within the access corridor survey area. The survey also found no weeds of national significance (WoNS) or introduced/exotic taxa within the survey area.

Previously mapped vegetation associations across Western Australia were assessed in terms of their reservation priorities as part of the WA Biodiversity Audit (Kendrick 2001a, 2001b). Vegetation Association 134 (Table 3.1) is a high priority for reservation in the Little Sandy Desert, however it is considered a low priority for preservation in the Great Sandy Desert. The vegetation types identified by the reconnaissance survey are predominantly uncleared and widespread within the bioregion and are fragmented only by fires. Given this, the vegetation mapped within the Survey area in not considered to be locally or regionally significant.

Only a small percentage of taxa were in flower at the time the Post Wet Season (March 2020) survey was conducted. The follow up winter survey (July 2020) was conducted six weeks after 36mm of rain was recorded at the Telfer Weather station (approx. 65km west of Havieron). Although many of the species were still not reproductive, most taxa were identifiable based on vegetative features. While this impacted the identification of some species, it did not affect the overall outcome of the reconnaissance survey. The large proportion of burnt areas (approximately 60%) contributed some variation in the type of species recorded, with fire ephemerals and pyrophytic plants represented in larger numbers than would be expected in unburnt areas.

The large, recently burnt areas may have obscured the presence of the priority taxa. From the desktop study, 11 species were identified as potentially occurring with the study site. Of these 11 taxa, two can be excluded and not likely to be found within the study area based on habitat preference. *Goodenia purpurascens* is associated with swamps and seasonal wetlands, these landforms are not found within the survey area. *Thysanotus* sp. Desert East of Newman (R.P. Hart 964) is also not likely to occur based on the preferred soil type for this species.

Five other species, *Eremophila tenella* (P1), *Ptilotus wilsonii* (P1), *Acacia auripila* (P2) and *Ptilotus mollis* (P4) maybe excluded based on habitat preference (limited to rocky ridgelines) *Indigofera ammobia* (P3) may also be found within survey area, as this species has a preference for deep red sands commonly associated with sand dunes. *Comesperma sabulosum* may possibly be located with the survey area, however as no preferred habitat information is available the probability of this species occurring is based on location records held by the WA Herbarium.

The two Goodenia species (*G, hartiana* (P2) and *G. nuda* (P4) are highly likely to be found with the survey area, this is based on habit preference and targeted surveys conducted within the Telfer Mine area (Syrinx 2008). Within the greater Telfer area (site of the 2008 Syrinx targeted survey) *G. hartiana* was only found in large numbers when in association with low lying hills with silcrete sands 1-10cm thick, always overlaying rock, that have been burnt with the last 12 months. Unburnt areas of similar habitat type still supports *G. hartiana* populations, but at much lower densities. Site traverses and relevés within identified habitat preferences did not locate *G. hartiana or G. nuda* with the Havieron Survey area.

The level of survey detail undertaken is consistent with the requirements of a reconnaissance survey. The expected low diversity and relatively uniform landforms means that the findings of the report are sufficient to inform impact assessment across the project area.

6. Conclusion

The key results and outcomes of the flora and vegetation survey were:

- Twelve native vegetation types were mapped within the Survey area.
- no TECs or PECs were recorded within the Survey area
- no significant vegetation was mapped within the survey area
- no Threatened or Priority flora species were recorded within the Survey area.

7. Limitations

Scope of services

This report ("the report") has been prepared by Strategen-JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen-JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen-JBS&G has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen-JBS&G has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen-JBS&G has also not attempted to determine whether any material matter has been omitted from the data. Strategen-JBS&G will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen-JBS&G. The making of any assumption does not imply that Strategen-JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen-JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

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Appendix A Conservation Code Definitions

Conservation Code	Description	
T	Threatened species	***Threatened flora*** is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora. ***The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.***
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. Published under schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for critically endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for critically endangered flora.
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. Published under schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice 2018 for endangered fauna or the Wildlife Conservation (Rare Flora) Notice 2018 for endangered flora.
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". 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".
Priority 1 (P1)	Poorly-known species	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, e.g. 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 and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.
Priority 2	Poorly-known species	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, e.g. 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 and appear to be under threat from known threatening processes. Such species are in urgent need of further survey
Priority 3 (P3)	Poorly-known species	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. Such species are in need of further survey.
Priority 4 (P4)	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 Conservation Dependent. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Appendix B Database search results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 05/02/2020

Conservation Status	Conservation Taxon (T, X, IA, S, P1-P5)
Current Names Only	Yes
Core Datasets Only	Yes
Species Group	All Plants
Method	'By Circle'
Centre	122° 24' 59" E,21° 40' 58" S
Buffer	40km
Group By	Family

Family	Species	Records
Goodeniaceae	1	14
Scrophulariaceae	2	9
TOTAL	**3**	**23**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Goodeniaceae					
1.	18638	*Goodenia hartiana (Hart's Goodenia)*		P2	
Scrophulariaceae					
2.	40644	*Eremophila sp. Rudall River (P.G. Wilson 10512)*		P2	
3.	14507	*Eremophila tenella*		P1	

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1
2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

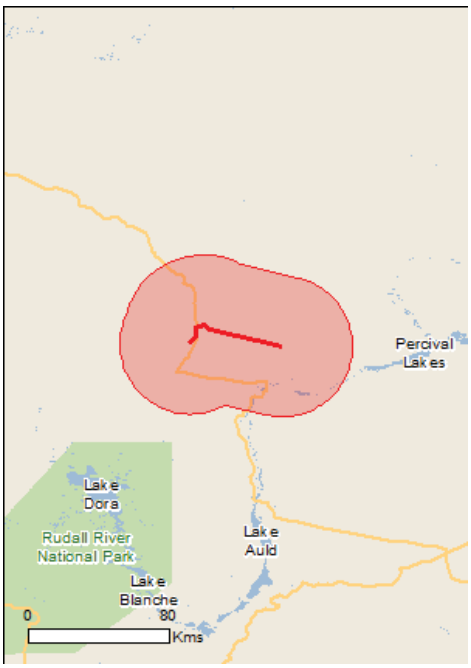
EPBC Act Protected Matters Report

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.

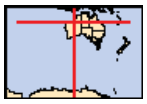
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 12/02/20 14:44:24



Coordinates
Buffer: 40.0Km



Summary

Matters of National Environmental 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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	8
Listed Migratory Species:	10

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 environment anywhere.

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 Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	8
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat likely to occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
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
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

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
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
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		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
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Nyangumarta Warrarn	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Mammals		
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus asinus Donkey, Ass [4]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, 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 distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for 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 reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

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

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

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

Coordinates

-21.36174 123.427393,-21.329124 123.459665,-21.285623 123.458292,-21.271547 123.502237,-21.292661 123.52833,-21.375169 123.897745

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 Havieron Access Corridor Species list

Family	Taxa
Asteraceae	*Streptoglossa macrocephala*
Boraginaceae	*Halgania solanacea*
Chenopodiaceae	*Atriplex* sp.
Chenopodiaceae	*Chenopodiaceae* sp.
Chenopodiaceae	*Tecticornia* sp.
Fabaceae	*Acacia adoxa*
Fabaceae	*Acacia ancistrocarpa*
Fabaceae	*Acacia colei*
Fabaceae	*Acacia hilliana*
Fabaceae	*Acacia monticola*
Fabaceae	*Acacia sabulosa*
Fabaceae	*Acacia stellaticeps*
Fabaceae	*Gompholobium polyzygum*
Fabaceae	*Gompholobium simplicifolium*
Fabaceae	*Lotus cruentus*
Fabaceae	*Mirbelia viminalis*
Fabaceae	*Petalostylis cassioides*
Goodeniaceae	*Goodenia armitiana*
Goodeniaceae	*Goodeniaceae* sp.
Goodeniaceae	*Scaevola parvifolia* subsp. *pilbarae*
Gyrostemonaceae	*Gyrostemon tepperi*
Myrtaceae	*Calytrix carinata*
Myrtaceae	*Calytrix* sp.
Myrtaceae	*Corymbia candida*
Myrtaceae	*Eucalyptus leucophloia*
Myrtaceae	*Eucalyptus pachyphylla*
Myrtaceae	*Malvaceae* sp.
Myrtaceae	*Melaleuca glomerata*
Myrtaceae	*Melaleuca lasiandra*
Myrtaceae	*Melaleuca linophylla*
Myrtaceae	*Melaleuca* sp.
Poaceae	*Aristida contorta*
Poaceae	*Poaceae* sp.
Poaceae	*Triodia basedowii*
Poaceae	*Triodia basedowii*
Poaceae	*Triodia epactia*
Poaceae	*Triodia schinzii*
Poaceae	*Triodia* sp.
Proteaceae	*Grevillea stenobotrya*
Proteaceae	*Grevillea wickhamii*
Proteaceae	*Hakea chordophylla*
Proteaceae	*Hakea lorea* subsp. *lorea*
Proteaceae	*Proteaceae* sp.
Scrophulariaceae	*Eremophila tietkensii*
Zygophyllaceae	*Trianthema turgidifolia*
Zygophyllaceae	*Tribulus suberosus*
Zygophyllaceae	*Tribulus hirsutus*

Appendix D Havieron Access Corridor Relevé sites

Site	Latitude	Longitude	GDA94 z51 Easting	GDA94 z51 Northing	Landform	Aspect	Slope	Rock type	Soil type
R1	-21.7027	122.5851	457084.707	7600021.931	Plain	N	-	-	Sandy loam
R2	-21.6928	122.5721	455737.005	7601114.047	Plain	N	-	-	Sandy loam
R3	-21.6846	122.5469	453127.566	7602014.251	Clay pan	N	-	-	Clay
R4	-21.6725	122.4816	446367.787	7603332.377	Plain	W	-	-	Sandy loam
R5	-21.6679	122.4568	443800.211	7603832.75	Swale	N	4	-	Sandy loam
R6	-21.6605	122.4295	440972.66	7604641.687	Swale	N	3	-	Sandy loam
R7	-21.5731	122.2108	418294.654	7614216.754	Plain	N	6	Laterite	Sandy loamy gravel
R8	-21.5824	122.2296	420246.183	7613197.1		N	3	-	Sandy loamy gravel
R9	-21.5874	122.2406	421387.68	7612649.255	Dune	W	55	-	Sandy loam
R10	-21.6128	122.2903	426545.594	7609862.078	Dune swale	N	3	-	Sandy loamy gravel
R12	-21.6234	122.3222	429852.494	7608703.527	Quartz ridge	-	-	Quartz	Sandy loam
R13	-21.6233	122.3244	430080.138	7608715.587	Swale	N	10	-	Sandy loam
R14	-21.6515	122.4027	438195.867	7605627.428	Swale	N	3	-	Sandy loam, loamy clay
R15	-21.6316	122.3471	432433.363	7607806.928	Swale	S		-	Sandy loam
R16	-21.5806	122.1702	414095.575	7613364.75	Plain	W	3	Quartz and laterite	Sandy loamy gravel
R17	-21.5841	122.1707	414149.402	7612977.614	Plain	W	-	Quartz and laterite	Sandy loamy gravel, gravely loam, loamy clay
R18	-21.6036	122.1793	415051.113	7610823.897	Plain, swale	SW	4	Laterite and quartz	Sandy loamy gravel
R19	-21.6137	122.1769	414808.597	7609704.625	Ridge	NE	46	Laterite	Sandy clay
R20	-21.626	122.1713	414236.219	7608340.068	Plain, escarpment	NE	10	Laterite and quartz	Sandy loam

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