ECOLOGY AUSTRALIA

Avonbank Mineral Sands Project: Survey Findings 2018

Prepared for: WIM Resource Pty Ltd

Document information

This is a controlled document. Details of the document ownership, distribution, status and revision history are listed below.

All comments or requests for changes to content should be addressed to the document owner.

Owner	Ecology Australia Pty Ltd	
Project	18-043	
Author	Andrew McMahon and Matthew Le Feuvre	
File	Avonbank Mineral Sands Project Surveys 2018 FINAL.docx	
Bioregion	Wimmera	
Distribution	Michael Winternitz	WIM Resource
	John Yeates	Wim Resource

Document History

Status	Changes	Author	Reviewer	Date
Draft 1	Text additions	A McMahon, M Le Feuvre		30/05/2019
Final	Corrections to document	A McMahon		06/06/2019

ECOLOGY AUSTRALIA

88B Station Street, Fairfield VIC 3078
T: (03) 9489 4191
E: admin@ecologyaustralia.com.au
W: ecologyaustralia.com.au

Contents

Tables

Figures

Plates

Appendices

Acknowledgments

We gratefully acknowledge the assistance of:

- Jamie McMahon	Ecology Australia
- Chelsy Maloney	Ecology Australia
- Bernadette Schmidt	Ecology Australia
- John Sharp	Ecology Australia
- Chris Watson	Ecology Australia
- Steve McGain	Ecology Australia
- Sarah Bedggood	Ecology Australia
- Angus McNab	Wildlife Experiences
- Michael Winternitz	WIM Resource

Summary

Ecology Australia was commissioned to undertake ecological assessments in the Avonbank Mineral Sands Project area, based on the results of a desktop survey.

Based on surveys to date the key findings are as follows.

Flora

- The Retention Lease area is mostly a cropped landscape with modified remnants restricted to roadsides and paddocks.
- Approximately 24.7 ha of remnant vegetation is present in the Retention Lease, 9.1 ha is within the proposed mining footprint.
- The dominant EVCs are Plains Grassland and Plains Savannah, both of which are endangered, listed under the FFG Act and potentially under the EPBC Act.
- Plains Grassland EVC does not meet the condition thresholds for EPBC Act listing.
- Plains Savannah EVC does not have patch and condition thresholds under the EPBC Act, but is likely to represent a degraded version of the listed community (Buloke Woodlands of the Riverina and Murray Darling Depression Bioregions)
- No plant species listed under the EPBC Act or FFG Act were recorded in the Retention Lease, however Buloke has an advisory list classification of endangered and is common.
- Darlot and Dooen Swamps support several threatened wetland EVCs in good condition.
- Both Swamps were dry at the time of sampling and one threatened species was recorded.

Fauna

- No Striped Legless Lizards or Golden Sun Moth were recorded during targeted surveys.
- Dry conditions prevented meaningful surveys for Growling Grass Frogs and waterbirds.
- Ten bird species listed under the Marine Schedule of the EPBC Act, two species listed under the Migratory Schedule of the EPBC Act and three species classified on Victorian Advisory List were recorded in the Retention Lease.

1 Introduction

WIM Resource Pty Ltd (WIM) commissioned Ecology Australia Pty Ltd (Ecology Australia) to conduct general and targeted surveys in the Avonbank Mineral Sands Retention Lease. These surveys were informed by a desktop assessment of the significant flora and fauna values of the Retention Lease (Ecology Australia 2018).

WIM is proposing to develop the Avonbank Heavy Mineral Sands Project between the townships of Dooen and Jung, 15 km due north of the rural Victorian township of Horsham (Figure 1).

The Retention Licence 2014 is 6,545 hectares (ha) and the proposed 1-30 years mining footprint lies within the Retention Lease and is approximately 2,500 ha (**the mining footprint**). The Avonbank deposit is hosted within the Loxton Parilla Sands formation and forms a sheet like body, with a surface area of approximately 40km2. The Loxton-Parilla Sands formation forms the Parilla Sands Aquifer (PSA), the upper water table aquifer system in the Retention Lease.

Outside the Retention Lease more intact native vegetation is associated with Darlot and Dooen Swamps, Two Mile Creek, Yarriambiack Creek and the Wimmera River. These are identified as potentially Groundwater Dependent Ecosystems (GDEs).

This report documents the key finding of the surveys carried out in spring and early summer 2018.

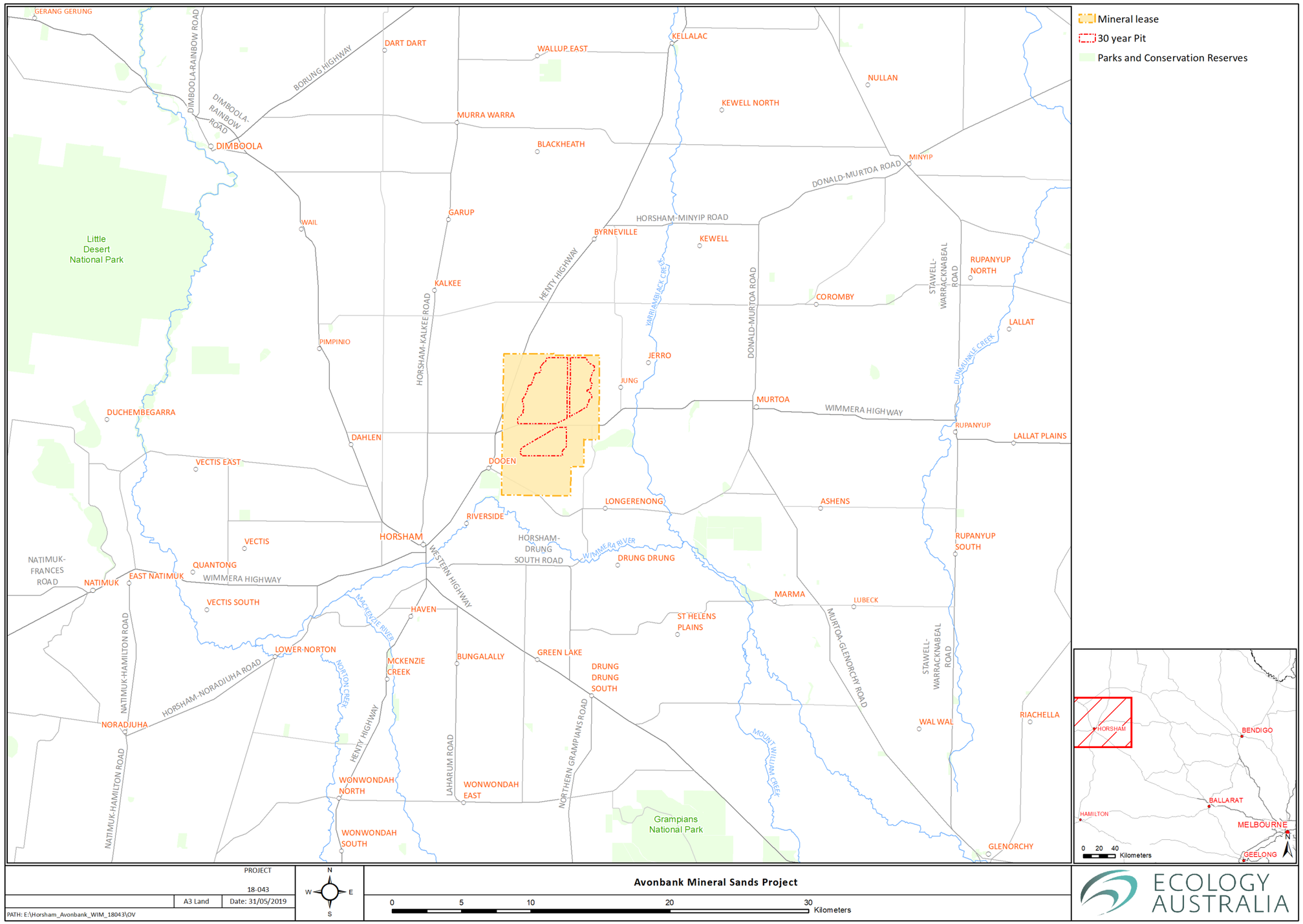

Figure 1 Location of the Avonbank Mineral Sands Project area (Retention Lease) and proposed mining footprint (30 year pit)

2 Scope

The desktop assessment completed by Ecology Australia (2018) recommended that vegetation assessments and targeted flora and fauna surveys should be conducted in the Retention Lease.

The desktop review, site inspection and preliminary project details, indicated that the project required two main lines of investigation:

- ecological values potentially impacted within the Retention Lease; and
- ecological values mostly outside the Retention Lease that may be affected by changes to surface hydrology or groundwater conditions, should these be predicted by WIM's hydrological or hydrogeological studies.

In broad terms these correspond to terrestrial and wetland environments respectively.

The initial investigations also revealed that a considerable number of federally and/or state listed or otherwise threatened species or communities could be present, and these are outlined below.

2.1 Flora

2.1.1 Ecological communities

The following listed ecological communities were investigated for distribution, size and condition: The relationship between the various listed communities is also provided (Table 1).

Table 1 Potential listed ecological communities in the Avonbank Retention Lease. Communities in the same row are largely equivalent.

EPBC Act 1999	FFG Act 18	EVC (status)
Buloke Woodlands of the Riverina and Murray-Darling Depression	Semi-arid Northwest Plains Buloke Grassy Woodland Community	826 Plains Savannah
Natural Grasslands of the Murray Valley Plains	Northern Plains Grassland Community	132 Plains Grassland and/or parts thereof: 826 Plains Savannah 829 Chenopod Grassland
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	no equivalent for Wimmera bioregion	125 Plains Grassy Wetland 306 Aquatic Grassy Wetland 647 Plains Sedgy Wetland 678 Ephemeral Drainage-line Grassy Wetland 778 Gilgai Wetland 920 Sweet Grass Wetland 956 Herb-rich Gilgai Wetland

Further, numerous threatened (but not listed) EVCs associated with other wetland communities, including those associated with Darlot and Dooen Swamps and catchment related streams were also investigated. These included:

- Red Gum Swamp EVC 292
- Black Box Lignum Woodland EVC 663
- Lignum Swampy Woodland EVC 942
- Cane Grass Wetland EVC 291
- Lignum Wetland EVC 104

2.1.2 Plant species

Threatened plant species identified as having a moderate or higher likelihood of occurrence in the Retention Lease were targeted for survey (Ecology Australia 2018) (Table 2). A floristic inventory was also compiled.

2.1.3 The Guidelines

In accordance with Victoria's Guidelines for the removal, destruction or lopping of native vegetation (DELWP 2017) the scope of work included vegetation condition score assessments for patches of remnant vegetation that could be directly or indirectly impacted by the proposal. This included remnants within the mining footprint, remnants within the Retention Lease and the wetland communities associated with Darlot and Dooen swamps.

In addition, preliminary estimates were made of scattered trees within the Retention Lease.

Table 2 Threatened flora species identified from the VBA with a moderate or higher likelihood of occurrence in the Retention Lease (Ecology Australia 2018)

Key:
EPBC = listing status under the Commonwealth EPBC Act
VU = listed as vulnerable, EN = listed as endangered, CR = listed as critically endangered, Mi = listed migratory species, Ma = listed marine overfly species
VIC Adv = conservation status on Victorian advisory list of threatened (DEPI 2014)
e = classified as endangered, v = classified as vulnerable, r = rare, k = poorly known
FFG = listing status under the Victorian FFG Act 1988
L = listed as threatened under the FFG Act 1988
* indicates species identified from the Retention Lease, Dooen and Darlot Swamps and the Wimmera River and associated waterbodies.
Search = search tool where species was identified
VBA = Victorian Biodiversity Atlas, EPBC = EPBC Act Protected Matters Search Tool

Scientific Name	Common Name	EPBC	VIC Adv	FFG	VBA		Likelihood of Regular Occurrence	Search
					Count of Records	Last Record		
Allocasuarina luehmannii	Buloke		en	L	93	25/01/2012	Known	VBA
Alternanthera sp. 1 (Plains)	Plains Joyweed		k		1	9/06/2011	Moderate	VBA
Amyema linophylla subsp. orientalis	Buloke Mistletoe		vu		20	1/10/2011	High	VBA
Aristida calycina var. calycina	Dark Wire-grass		r		6	5/02/2010	Moderate	VBA
Asperula wimmerana	Wimmera Woodruff		r		4	24/01/2012	Moderate*	VBA
Austrostipa hemipogon	Half-bearded Spear-grass		r		1	11/04/2011	Moderate	VBA
Brachyscome chrysoglossa	Yellow-tongue Daisy		vu	L	6	31/10/2013	Moderate	VBA
Callitriche umbonata	Winged Water-starwort		r	X	4	3/11/2010	Moderate*	VBA
Calotis anthemoides	Cut-leaf Burr-daisy		L		4	12/12/1996	Moderate	VBA
Centipeda nidiformis	Cotton Sneezeweed		r		2	14/09/1902	Moderate	VBA
Convolvulus angustissimus subsp. omnigracilis	Slender Bindweed		k		5	22/12/2011	Moderate	VBA
Dianella sp. aff. longifolia (Riverina)	Pale Flax-lily		vu		4	22/12/2011	Moderate	VBA
Duma horrida subsp. horrida	Spiny Lignum		r		3	5/11/1996	Moderate*	VBA
Eleocharis macbarronii	Grey Spike-sedge		k		1	3/11/2010	Moderate*	VBA
Eleocharis pallens	Pale Spike-sedge		k		6	10/06/2011	Moderate*	VBA
Eucalyptus camaldulensis	River Red-gum		X		47	14/03/2012	Known*	VBA
Goodenia lunata	Stiff Goodenia		vu		5	20/03/1904	Moderate	VBA
Isolepis congrua	Slender Club-sedge		vu	L	1	3/11/2010	Moderate*	VBA
Maireana aphylla	Leafless Bluebush		k		2	16/03/2010	Moderate	VBA
Ptilotus erubescens	Hairy Tails		vu	L	7	22/12/2011	Moderate	VBA
Ranunculus sessiliflorus var. pilulifer	Annual Buttercup		k		1	5/11/1996	Moderate	VBA
Ranunculus undosus	Swamp Buttercup		vu		2	15/09/1990	Moderate*	VBA
Sclerolaena napiformis	Turnip Copperburr	EN	en	L	9	30/06/2011	Moderate	VBA, EPBC
Senecio macrocarpus	Large-headed Fireweed	VU	en	L	1	18/09/1860	Moderate	VBA
Swainsona behriana	Southern Swainson-pea		r		7	5/10/2005	Moderate	VBA

2.2 Fauna

Based on the desktop assessment (Ecology Australia 2018), Ecology Australia recommended targeted surveys for:

- Striped Legless Lizards (SLL) *Delma impar*- listed as vulnerable under the EPBC Act, listed as threatened under the FFG Act and is classified as endangered in Victoria (DSE 2013).
- Golden Sun Moth (GSM) *Synemon plana* - listed as critically endangered under the EPBC Act, listed as threatened under the FFG Act and is classified as critically endangered in Victoria (DSE 2009)
- Growling Grass Frog *Litoria raniformis* - listed as vulnerable under the EPBC Act, listed as threatened under the FFG Act and is classified as endangered in Victoria (DSE 2013).
- The Pale Sun Moth *Synemon selene* - classified as critically endangered in Victoria (DSE 2009).
- The Reddish Orange Sun Moth *Synemon jcaria* - classified as critically endangered in Victoria (DSE 2009).
- Waterbird Surveys – a number of waterbird species listed under the EPBC Act and/or FFG Act, listed under the EPBC Act Marine and Migratory Schedules, or classified as threatened in Victoria are known from the Retention Lease, or may occur in the Retention Lease.

In 2018, targeted surveys were conducted for SLL and GSM in areas of potentially suitable habitat in the Retention Lease. In addition, any further fauna species encountered were recorded.

Due to the dry conditions in the project area, surveys were not conducted for Growling Grass Frogs or waterbirds. Surveys for Pale Sun Moth and Reddish-Orange Sun Moths were postponed.

3 Methods

Flora and fauna surveys were informed by the Desktop Assessment prepared in August 2018 (Ecology Australia 2018).

3.1 Flora

Field surveys were conducted from 19 to 23 November 2018 including:

- EVC description and mapping
- species inventories
- threatened species searches
- Vegetation Condition Assessments (Version 1.3 – October 2004)
- Preliminary identification of scattered trees;
- identification of EPBC Act 1999 and/or FFG Act communities and assessment against patch size and conditions thresholds outlined in the respective Listing Advice statements.

3.2 Fauna

Surveys for SLL and GSM followed survey guidelines (DEWHA 2009; DSEWPaC 2011a). Specific survey methods were outlined below.

3.2.1 Striped Legless Lizards

Striped Legless Lizards were surveyed using artificial shelter surveys. These are considered the most effective survey technique in areas without rocky habitat. The guidelines suggest that surveys should consist of grids of 50 roof tiles, arranged in a grid of ten tiles by five, with tiles spaced 5m apart and tiles preferably arranged on a northerly aspect. As a minimum, two tile grids should be used for sites less than 2 hectares in size, one grid per 3 hectares for sites up to 30 hectares, and 10 grids for sites greater than 30 hectares in size. Artificial shelter sites should be checked at least twice a month, and ideally once a week during spring to early summer (that is, between early September to December). Shelter sites should not be checked more than once a week as this may lead to Striped Legless Lizards abandoning the artificial shelters. Shelter sites should be checked when ambient temperatures do not exceed 28°C (DSEWPaC 2011a; b).

As there are approximately 24.7 ha of native vegetation in the project area of which 9.1 hectares is in the proposed mining footprint (Table 4), nine tile grids were required to meet the guidelines. Eight tile grids were established in the greater project area on 10th-11th September 2018. A ninth established tile grid was also found in Dooen Swamp (Figure 2, Table 3). Tile grids were established in areas with the relative highest quality and least disturbed habitat based on initial site assessments. Where possible, grids were laid out in a traditional array of five by ten tiles, however some sites were constrained (e.g. roadside verges between the road and fenceline) so at some sites arrays were modified but still contained at least 50 tiles (Table 3).

Tile grids were inspected seven times between 3rd October and 18th December, with inspections conducted every one to two weeks on days when conditions were suitable (generally cool to warm days

(<<28°C) with light to partial cloud, or clear skies). Surveys were conducted between 9:30 am and 1 pm before tiles were too hot to support sheltering SLL.

Table 3 Location, description and layout of Striped Legless Lizard tile grids.

Site	Tile Grid	Location	Within mining footprint	Within project area	Description
SLL1	5 x 10	Johns Road	No	Yes	Open grassy Buloke woodland dominated (~80%) by weeds
SLL2	5 x 10	Near Max Johns Road	Yes	Yes	Grassy Buloke woodland with almost 100% weed cover. Rabbit warrens present.
SLL3	3 x 17	Eastern end of Greenhills Road	Yes	Yes	Grassland, with approximately ~60% weed cover. On southern side of road.
SLL4	3 x 17	Middle of Greenhills Road	Yes	Yes	Grassland, with approximately ~90% weed cover. On southern side of road.
SLL5	4 x 13	Western end of Greenhills Road	No	Yes	Grassland with a few recently planted trees, with approximately ~90% weed cover. On northern side of road.
SLL6	5 x 10	Darlot Swamp	No	No	Black Box woodland, low weed cover (~10%). Lots of bare ground. West of Drung-Jung Road
SLL7	5 x 10	Dooen Swamp	No	No	Grassland in north-west corner of Dooen Swamp. Low (~30%) weed cover.
SLL8	3 x 17	Eastern end of Greenhills Road	No	No	Grassland with a few recently planted trees, with approximately ~40% weed cover. On northern side of road.
SLL9	5 x 10	Dooen Swamp	No	No	Established tile grid found in Dooen Swamp. Red Gum swamp, with a grassy understorey. Weed cover ~30%.

Between the first and second site visit, tiles were moved at site SLL3 on Greenhills Road so the grass could be slashed. During the second site visit, tiles were returned to their initial location.

3.2.2 Golden Sun Moth

Golden Sun Moths are surveyed by walking transects across areas of suitable habitat, looking for flying males, females and pupal casings. Survey guidelines for GSM (DEWHA 2009) state that surveys should be conducted:

- During the local flying season (based on known reference sites)
- Over four suitable days, at approximately weekly intervals.
- During the warmest part of the day (10 am to 2 pm)
- When conditions are as follows:
  - Warm to hot days (>20°C by 10 am)

- Clear or mostly cloudless days
- Still or relatively still wind conditions.
- At least two days since rain.

Surveys were conducted over four days between 12th November and 17th December 2018 when conditions were appropriate. Surveys were conducted between 10am and 2:30 pm. As a point of reference, Golden Sun Moths were recorded at sites regionally within four days of all surveys in the project area (Ecological Consultants Association of Victoria 2018). Five sites that contained habitat that may support GSM were surveyed on foot. These five sites were (Figure 2):

- Grassland on southern side of Greenhills Road between Jung Wheat Road and Max Johns Road, mostly within the mining footprint. The survey consisted of a single 3.9 km long transect along the 20 m wide roadside verge.
- Open woodland with a grassy understorey at the western end of Darlot Swamp. This area is in the greater project area. The survey consisted of a series of transects spaced by approximately 30 m across the 11 ha site.
- Grassland on private property at the corner of Tuckers and Molyneaux Roads within project area. The survey consisted of a series of transects spaced by approximately 30 m across the 12 ha site.
- Grassland at the north western corner of Dooen Swamp. The survey consisted of a series of transects spaced by approximately 30 m across the 3.1 ha site.
- Grassland on northern side of Longerenong Road between the Henty Highway and Field Days Road. The survey consisted of a single 4.2 km long transect along the 20 m - 40 m wide roadside verge.

3.2.3 Incidental fauna

Any other fauna species encountered on site were recorded. The dam at the Viterra facility just north of Dooen (outside the proposed mining footprint), was visited during each site visit, as it regularly contained a large number of waterbirds.

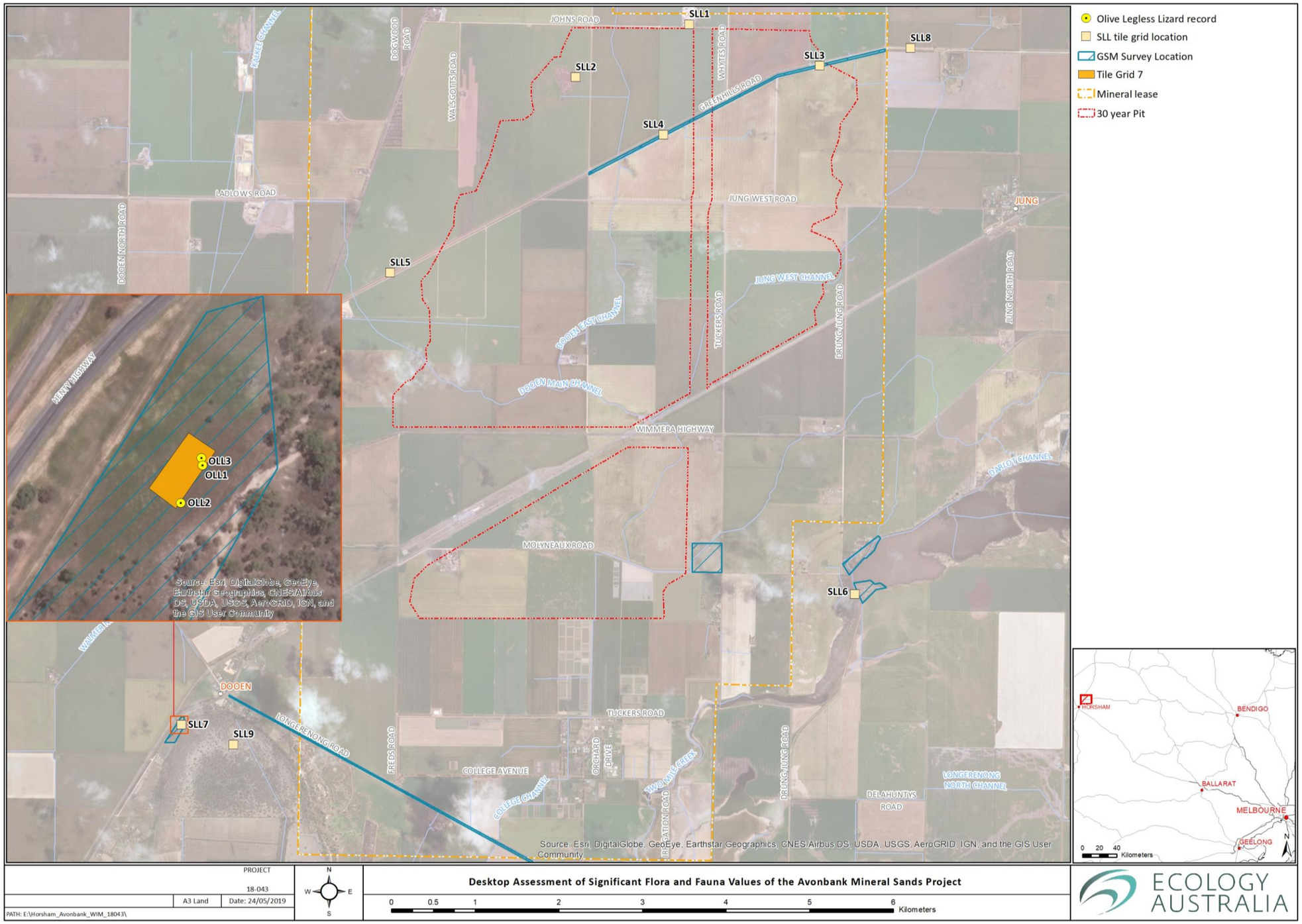

Figure 2 Location of Striped Legless Lizard tile grids, Golden Sun Moth survey areas and Olive Legless Lizard records during the Avonbank Mineral Sands Project Targeted Surveys.

4 Key Findings

4.1 Flora

4.1.1 Retention Lease

The following Ecological Vegetation Classes were identified within the Retention Lease either within or closely proximate to the proposed mining footprint (Table 4, Figure 3).

Table 4 Ecological Vegetation Classes associated with the Retention Lease. Shaded EVCs are within the proposed mining footprint.

Ecological Vegetation Class	Figure 3 ref.	Area (ha)	EVC Conservation Status	EPBC Act	FFG Act
Plains Savannah 826	1	4.77	Endangered	✓	✓
Black Box Lignum Woodland 663	6	0.34	Endangered		
Plains Savannah 826	3	4.62	Endangered	✓	✓
Plains Grassland 132	2	1.27	Endangered	✓	✓
Plains Grassland 132	2	2.48	Endangered	✓	✓
Plains Savannah 826	4	2.07	Endangered	✓	✓
Plains Grassland 132	5	8.94	Endangered	✓	✓
Plains Grassland 132	7	0.11	Endangered	✓	✓
Plains Grassland 132	7	0.10	Endangered	✓	✓

These results indicate the following:

- Vegetation remnants occupy a relatively small proportion of the Retention Lease (approx. 24.6 ha) and the mine footprint (9.1 ha). The vast majority of the Retention Lease has a long-term association with cropping;
- The majority of remnants are Plain Grassland and Plains Savannah EVCs, which reflect these as the former dominants of the landscape;
- Plains Grassland EVC forms part of an EPBC Act and FFG Act-listed community (Table 4). However, no surveyed remnants satisfied the condition thresholds for the EPBC Act-listed community (Approved Conservation Advice 28 August 2012)(Plates 1 and 2). This relatively poor condition is also reflected in the low Vegetation Condition Scores (16-18, Table 5) and is consistent with the practice of apparently regular cultivation of roadsides, resulting in species-poor weedy remnants.
- Plains Savannah EVC similarly forms part of an EPBC Act and FFG Act-listed community (Table 4). The three patches identified in the Retention Lease consist predominantly of stands of Buloke *Allocasuarina luehmanni* with few other native species (Plates 3 and 4). While these patches conform to the diagnostic characteristics for the community, the key legislative instrument – the National Recovery Plan – does not address condition or patch size thresholds for the community (Cheal *et al.* 2011). Further correspondence with DoEE

confirmed that well defined thresholds for the community are not available. A brief examination of the criteria to prioritise actions for the recovery of the community, including size, connectivity, intactness and structural complexity (Cheal *et al.* 2011) suggest that the identified remnants may be at the lower end of the scale for prioritisation. The simplified composition of these remnants is also reflected in the Vegetation Condition Scores (14-26, Table 5). At present it would appear that the remnants represent the listed community, but at the degraded end of the spectrum.

- Although Plains Grassland and Plains Savannah clearly dominated the former landscape, it would have been punctuated with various seasonal wetland communities, particularly those characterised by Tangled Lignum *Duma florulenta*. These have been effectively eliminated from the Retention Lease. We identified a single very modified patch of Black Box Lignum Woodland (0.34 ha) and reasonably frequent but isolated individuals or clumps of Lignum, invariably in road reserves.
- There was little to no evidence of the EPBC Act -listed Seasonal Herbaceous Wetlands. Although gilgai was evident on the heavier clays and the landscape once typical of this community, its persistence is at odds with decades of intensive agriculture.

4.1.2 Darlot and Dooen Swamps

These wetland systems support substantial and much less modified vegetation. The vegetation is yet to be accurately mapped, but the extent of further work will also depend on whether they are likely to be impacted by potential changes to groundwater and/or surface hydrology following the studies by AECOM and GHD.

Our preliminary surveys of these swamps have resulted in the following:

Darlot Swamp

The broad vegetation composition is as follows:

- Black Box Lignum Wetland EVC is extensive on the fringes and in moderate condition (Habitat Score 54, Table 5, Plate 6).
- Lignum Swamp EVC dominates the western and central cells of the wetland and is in similar condition (Habitat Scores 40-50, Plate 7).
- Cane Grass Wetland EVC, indicative of wetter conditions occupies the eastern cell and is in very good condition (Habitat Score 70, Plate 8).

Dooen Swamp

Dooen Swamp appears to be a much larger system, with a catchment runoff presumably augmented by overbank flows from the Wimmera River. The dominant EVC is Red Gum Swamp, which at least in a dry phase is quite uniform throughout. A key feature is the representation of old growth Red Gum *Eucalyptus camaldulensis* which are widely distributed and massive in structure (Plates 9 and 10). There is also abundant Red Gum recruitment, roughly estimated at around 20 years.

The two Vegetation Condition Scores (swamp margins and centre) produced similar results (Habitat Score 55 and 57, Table 5) indicating vegetation is moderately good condition, particularly considering the dry conditions.

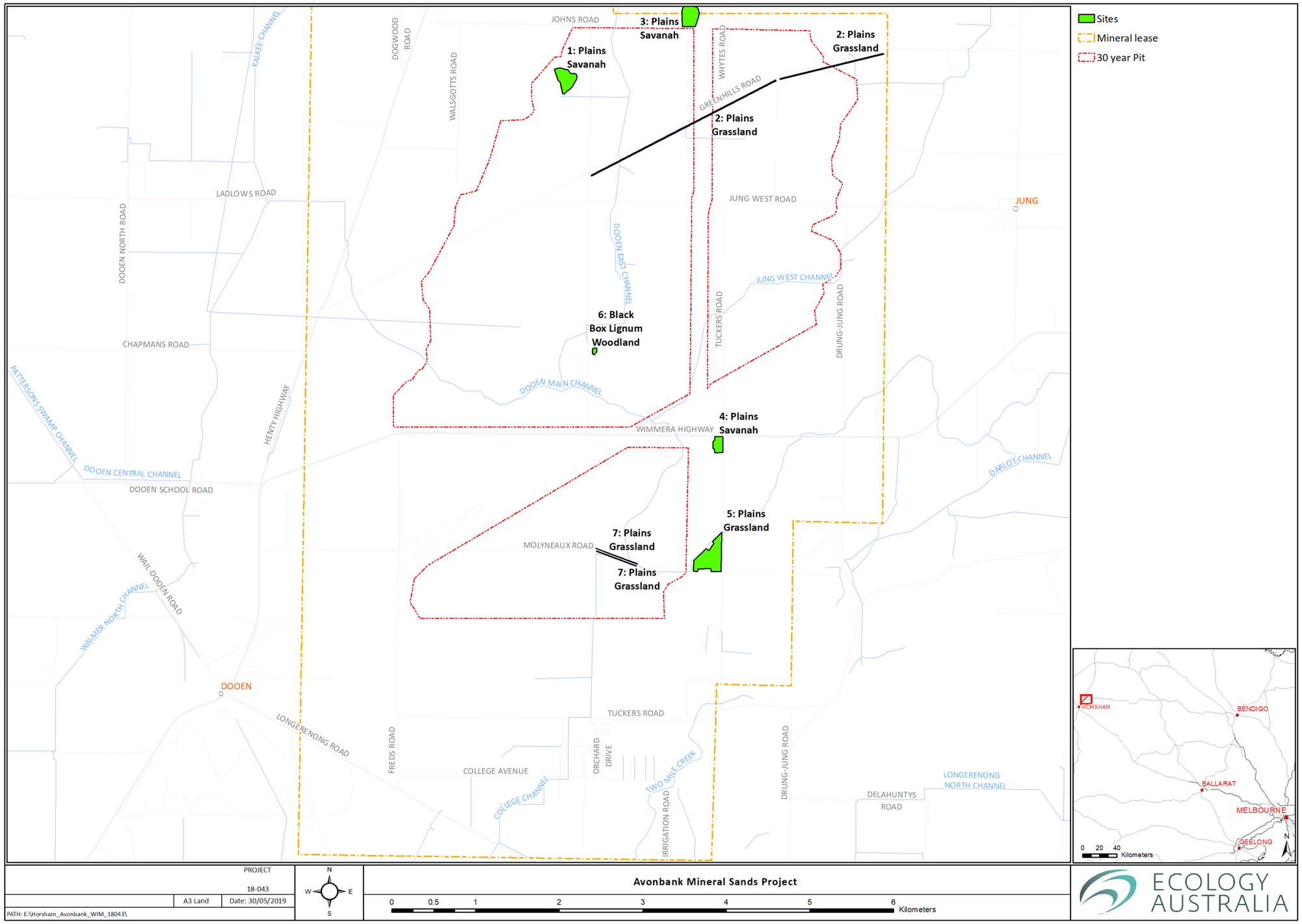

Figure 3 Ecological Vegetation Classes within the Retention Lease

A substantial portion of the swamp is private property, namely the central and south-eastern sections, and these have been cleared for agriculture.

4.1.3 Vegetation Condition Scores

Vegetation Condition scores for the mining footprint, Retention Lease and Darlot and Dooen Swamps are presented in Table 5. Overall, they reflect the generally poor condition of remnants within the mining footprint and Retention Lease (Habitat Score range 14 – 26) and the significantly better quality vegetation associated with Darlot and Dooen Swamps (Habitat Score range: 40-70).

At this preliminary stage, the key attribute in Table 5 is the Habitat Scores, rather than the Habitat hectare (hha) equivalents, as these will be determined when the project is more advanced.

4.1.4 Scattered trees

The total number of scattered trees within the Retention Lease is yet to be firmed. It is presently clear that the vast majority are Buloke (Plate 5), most of which would be classified as Large Old Trees (LOTs) (Benchmark DBH $\geq$ 40 cm), in addition to a few scattered Red Gum *Eucalyptus camaldulensis* and Black Box *E. largiflorens*.

Okologie Consulting (2017) recorded 76 scattered trees and our field observations suggest that it is a reasonable estimate – again mostly Buloke and mostly LOTs.

The Vegetation Condition Scores (Table 5) also indicate that there are some 107 LOTs in the remnant patches within the Retention Lease, suggesting that overall some 150 LOTs may be present. There would be fewer within the mine footprint but this is yet to be determined.

4.1.5 Rare and threatened plant species

Two threatened plant species have been recorded:

- Buloke *Allocasuarina luehmannii*, the ubiquitous tree species of the Retention Lease; Advisory List classification Endangered; and
- Grassland Bindweed *Convolvulus graminetinus,* recorded from Darlot Swamp, also with an Advisory List classification of Endangered.

No EPBC Act or FFG Act-listed species were recorded.

The record of so few threatened species from the Retention Lease is more or less expected considering the widespread practice of cultivating roadside Plains Grassland remnants and cultivation and grazing of Plains Savannah paddock remnants. As discussed previously, the modified state of these remnants is reflected in the Vegetation Condition / Habitat Scores of 14 – 26.

Further surveys, particularly when Darlot and Dooen swamps are inundated, may record additional threatened species.

Table 5 Avonbank Project - Vegetation Condition scores for the Retention Lease and Darlot and Dooen Swamps. Note that habitat zones 1, 6 and 7, and most of 2 are within the mining footprint.

			Retention Lease							Darlots Swamp				Dooen Swamp		Two Mile Creek
	Habitat Zone		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	EVC Name (Initials)		PS	PG	PS	PS	PG	BBLW	PG	BBLW	LS	LS	CGW	RGS	RGS	LS
	EVC Number		826	132	826	826	132	663	132	663	104	104	291	292	292	104
		Max Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score	Score
Site Condition	Large Old Trees	10	6	NA	10	6	NA	6	0	8	NA	NA	NA	8	8	NA
	Canopy Cover	5	5	NA	5	5	NA	5	0	5	NA	NA	NA	5	5	NA
	Understorey	25	0	5	0	0	5	0	5	10	10	15	25	10	5	5
	Lack of Weeds	15	0	0	0	0	2	0	0	6	2	6	9	6	9	2
	Recruitment	10	3	3	5	0	3	0	3	3	5	3	5	5	5	3
	Organic Matter	5	2	2	2	2	2	3	3	5	2	2	2	5	5	2
	Logs	5	2	NA	2	0	NA	2	NA	3	NA	NA	NA	3	3	NA
	Total Site Score	**75**	**18**	**14**	**24**	**13**	**16**	**16**	**15**	**40**	**26**	**36**	**56**	**42**	**40**	**17**
Landscape value	Patch Size	10	2	2	2	1	2	1	1	8	8	8	8	8	8	8
	Neighbourhood	10	0	0	0	0	0	0	0	2	2	2	4	4	4	0
	Distance to core	5	0	0	0	0	0	0	0	4	4	4	2	3	3	0
Habitat Score		**100**	**20**	**16**	**26**	**14**	**18**	**17**	**16**	**54**	**40**	**50**	**70**	**57**	**55**	**25**
Habitat Score		1	0.2	0.16	0.26	0.14	0.18	0.17	0.16	0.54	0.4	0.5	0.7	0.57	0.55	0.25
Habitat Zone area (ha)			4.8	3.8	4.6	2.1	0.3	0.3	0.2	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Habitat hectares			**0.96**	**0.608**	**1.196**	**0.294**	**0.054**	**0.051**	**0.032**							
Bioregion			W	W	W	W	W	W	W	W	W	W	W	W	W	W
EVC Conservation Status			E	E	E	E	E	E	E	E	E	E	V	V	V	E
Number of Large Old Trees			14	NA	65	26	NA	2	NA	TBD	NA	NA	NA	TBD	TBD	NA

EVC PG – Plains Grassland BBLW – Black Box Lignum Woodland CGW – Cane Grass Woodland PS – Plains Savannah LS – Lignum Swamp RGS – Red Gum Swamp
Conservation Status E – Endangered V – Vulnerable
Bioregion W – Wimmera
Habitat Zones 1-7 - see Figure 3
TBD - To be determined
NA - Not applicable

Plate 1 Plains Grassland EVC Greenhills Road: cultivation evident RHS – Site 2

Plate 2 Plains Grassland EVC - Site 5

Plate 3 Plains Savanna EVC - Site 1

Plate 4 Plains Savannah EVC – Site 3

Plate 5 Scattered Buloke (Large Old Tree) – Retention Lease

Plate 6 Black Box Lignum Woodland EVC – Darlot Swamp

Plate 7 Lignum Swamp EVC – Darlot Swamp

Plate 8 Cane Grass Wetland EVC – Darlot Swamp

Plate 9 Red Gum Swamp EVC – Dooen Swamp

Plate 10 Old Growth Red Gum– Dooen Swamp

4.3 Fauna

4.3.1 Striped Legless Lizard Surveys

No SLL were recorded during the artificial shelter surveys.

Olive Legless Lizards *Delma inornata* (Plates 11 and 12) were encountered on two occasions in grasslands on the western edge of Dooen Swamp (SLL7), with at least two individuals recorded (Figure 2). There are four previous records of Olive Legless Lizards at Dooen Swamp from the VBA, dating from between 2005 and 2008. There are a further nine records from Kings Swamp to the south-west of Darlot Swamp dating from between 2005-2010 (DELWP 2019).

Olive Legless Lizards have broader habitat requirements than SLL, with the former inhabiting grassy woodlands of dry sclerophyll, box-ironbark and red gum forests and occasionally grassland ecosystems, while the latter are grassland specialists that occasionally occur in grassy woodlands (Robertson and Coventry 2019). These two species rarely occur in sympatry (Osborne *et al.* 1993).

In addition, Eastern Brown Snakes *Pseudonaja textilis* were recorded at SLL1 and SLL3, skinks (most likely all Boulenger's Skink *Morethia boulengeri*, Plate 13) were recorded at all sites, and an introduced House Mouse *Mus musculus* was recorded at Dooen Swamp (SLL9).

Plate 11 Olive Legless Lizard (*Delma inornata*) recorded at Dooen Swamp (SLL 7)

Plate 12 Olive Legless Lizard (Delma inornata) recorded at Dooen Swamp (SLL 7).

Plate 13 Bloulenger's Skink *Morethia boulengeri* recorded during tile surveys.

4.3.2 Golden Sun Moth

No Golden Sun Moths were recorded during surveys, despite conditions being favourable and GSM being recorded at sites regionally over the same time period.

4.3.3 Incidental fauna

In addition to the species recorded during targeted surveys, an additional 79 species were recorded incidentally (Appendix 1). These included three species of mammal (two of which are introduced), three amphibians, and 73 bird species (6 of which are introduced).

Of these species, 12 species (all birds) are listed as either marine (2 species) or migratory (10 species) under the EPBC Act or are classified as vulnerable (1 species) or near threatened (2 species) in Victoria (Table 6) (DSE 2013).

Table 6 Species recorded during surveys that are listed under the Marine and Migratory Schedules of the EPBC Act or are classified in Victoria (DSE 2013)

Survey Type = type of survey during which each species was detected
I = incidental records
Migratory (Mi) = listed migratory species under the Commonwealth EPBC Act
Marine (M) = listed marine overfly species under the Commonwealth EPBC Act
VIC Advisory = conservation status on Victorian advisory list of threatened vertebrate fauna (DSE 2013)
vu = classified as vulnerable, nt = classified as near threatened.

Common Name	Scientific Name	Survey Type	Migratory	Marine	Vic Advisory
Australian Pipit	*Anthus novaeseelandiae*	I		M	
Australian White Ibis	*Threskiornis moluccus*	I		M	
Brown Treecreeper	*Climacteris picumnus*	I			NT
Glossy Ibis	*Plegadis falcinellus*	I	Mi	M	NT
Hardhead	*Aythya australis*	I			V
Magpie-lark	*Grallina cyanoleuca*	I		M	
Nankeen Kestrel	*Falco cenchroides*	I		M	
Pallid Cuckoo	*Cacomantis pallidus*	I		M	
Sharp-tailed Sandpiper	*Calidris acuminata*	I	Mi	M	
Stubble Quail	*Coturnix pectoralis*	I		M	
Welcome Swallow	*Hirundo neoxena*	I		M	
White-bellied Cuckoo-shrike	*Coracina papuensis*	I		M	

4.3.4 Summary

Striped Legless Lizards and Golden Sun Moth were not recorded during targeted surveys. Both GSM and SLL inhabit native temperate grasslands, and approximately 99.5% of native temperate grasslands have been destroyed or severely degraded due to agricultural and urban development. In particular, both species have been impacted through intense grazing, pasture improvement, ploughing or other heavy disturbance. In addition, weeds and inappropriate fire regimes have further reduced habitat quality for both of these species (DEWHA 2009; DoEE 2016).

Almost all habitat within the Retention Lease has been severely degraded as a result of decades of intensive agriculture. Removal of native vegetation and cultivation mean that the majority of habitat within the Retention Lease is most likely unsuitable for SLL and GSM. Following the targeted surveys, the likelihood of SLL and GSM being present within the Retention Lease has changed from moderate to low.

Incidental observations reveal that the general area supports a moderately diverse array of birds, with 73 species recorded. The large dam next to the Viterra loading facility located approximately 1 km north of Dooen township and partially within the Retention Lease supported several species of waterbird, including species listed under the EPBC Act Marine and Migratory Schedules as well as species classified in Victoria (Appendix 1, Table 6). This indicates that where water is present, the Retention Lease may support a range of waterbirds including some listed under Marine and Migratory Schedules of the EPBC Act and classified on the Victorian advisory list (DSE 2013), and has the potential to support species listed under the EPBC Act or FFG Act.

The Pale Sun Moth and Reddish-Orange Sun Moth may be present in more intact areas of habitat, particularly in the patches of Buloke and in woodlands and grasslands associated with Dooen and Darlots Swamp. The habitat requirements of these two species are poorly known, they are also associated with grasslands and open woodlands (Douglas 2008). Surveys should be conducted for these species.

Growling Grass Frog surveys were not conducted. However, following further time spent on site, there is little suitable habitat for Growling Grass Frogs within the Retention Lease. Aside from a small section of Dooen Swamp in the south west of the Retention Lease and a small drainage line in the south-east, there are no significant drainage lines or depressions across the Retention Lease. The drainage lines present on site are ephemeral and unlikely to hold water except following major rainfall. Since the region moved from open irrigation channels to pipeline in 2010 (the Wimmera Mallee Pipeline), the availability of artificial water across the landscape (dams and irrigation channels) is diminished. As a result, Growling Grass Frogs may only be present in the Retention Lease following major rainfall events, with activity likely restricted to the established drainage line in the south east of the Retention Lease, Dooen and Darlot Swamps, and the surrounding terrestrial habitat.

Dooen and Darlot Swamps and associated waterbodies support the highest quality fauna habitats. Following major rainfall events in particular these have the potential to support populations of listed species (e.g. waterbirds, Growling Grass Frogs). Survey efforts in these areas were preliminary compared to the extent of habitat available and only conducted when conditions were dry. If further studies show that these sites will be impacted due to the proposed development (e.g. via impacts to ground water and surface water flows), further fauna surveys should be conducted in these habitats to properly assess species present.

5 References

Cheal D, Lucas A, Macaulay L (2011) Recovery Plan for Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions. Department of Sustainability and Environment, (East Melbourne)

DELWP (2017) Guidelines for the removal, destruction or lopping of native vegetation. Department of Environment, Land, Water and Planning, (Melbourne)

DELWP (2019) Victorian Biodiversity Atlas Version 3.2.6. https://vba.dse.vic.gov.au/vba/#/.

DEWHA (2009) EPBC Act policy statement 3.14 – Nationally Threatened Species and Ecological Communities. Significant Impact Guidelines for the vulnerable Growling Grass Frog (*Litoria raniformis*). Department of Environment, Water, Heritage and the Arts, (Canberra)

DoEE (2016) Conservation Advice *Delma impar* striped legless lizard. Department of the Environment and Energy, (Canberra)

Douglas F (2008) The sun-moths (Lepidoptera: Castniidae) of Victoria, with a detailed study of the Pale Sun Moth (*Synemon selene* Klug, 1850). Masters Thesis, University of Ballarat, Ballarat.

DSE (2009) Advisory list of threatened invertebrate fauna in Victoria - 2009. Department of Sustainability and Environment, (East Melbourne)

DSE (2013) Advisory list of threatened vertebrate fauna in Victoria - 2013. Department of Sustainability and Environment, (East Melbourne)

DSEWPaC (2011a) Survey guidelines for Australia's threatened reptiles. Department of Sustainability, Environment, Water, Population and Communities, (Canberra) http://www.environment.gov.au/system/files/resources/eba674a5-b220-4ef1-9f3a-b9ff3f08a959/files/survey-guidelines-reptiles.pdf.

DSEWPaC (2011b) Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable striped legless lizard, *Delma impar*. Department of Sustainability, Environment, Water, Population and Communities, (Canberra)

Ecological Consultants Association of Victoria (2018) Golden Sun Moth flight diary. *ECA Vic.* https://ecavic.org.au/resources/gsm/.

Ecology Australia (2018) Desktop Assessment of Significant Flora and Fauna Values of the Avonbank Mineral Sands Project. Report prepared for WIM Resource by M Le Feuvre and A McMahon. Ecology Australia Pty Ltd, (Fairfield)

Osborne W, Kukolic K, Williams K (1993) Conservation of reptiles in lowland native grasslands in the Southern Tablelands of New South Wales and the Australian Capital Territory. 'Herpetol. Aust. Diverse Discip.' (Eds D Lunney, D Ayers) pp. 151–158. (Royal Zoological Society of New South Wales: P.O. Box 20, Mosman NSW 2088, Australia) doi:10.7882/HIA.1993.

Robertson P, Coventry AJ (2019) 'Reptiles of Victoria.' (CSIRO Publishing: Collingwood) https://www.publish.csiro.au/book/5260/.

6 Glossary

Biodiversity	The variety of all life-forms, plants, animals, fungi, protists (including algae) and bacteria, their encoded genes, and the ecosystems of which they form a part
Bioregion	Defined geographical regions of Australia with similar climatic and geophysical characteristics, and which generally contain a suite of distinct ecosystems and species
CaLP Act	Victorian *Catchment and Land Protection Act 1994*
Conservation status	Categorisation of the threat risk to biological assets (plant and animal species, EVCs or plant communities) at a defined scale (e.g. national, state), as determined by specific criteria
Ecological Vegetation Class (EVC)	A vegetation classification described through a combination of its floristic composition, life form and ecological characteristics, and its association with particular environmental attributes. EVCs may include one or more floristic communities that occur across a biogeographic range, and have similar habitat and ecological processes operating
Endemic	Naturally found only in a defined geographic area
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Exotic	Plants, animals, fungi and other organisms that have been introduced (deliberately or accidentally) to Australia or a given area after European settlement
Exotic vegetation	Vegetation comprised wholly or substantially of exotic species
FFG Act	Victorian *Flora and Fauna Guarantee Act 1988*
Floristic	Of or pertaining to plant species, i.e. flora
GIS	Geographic Information System. A digital platform for creating, analysing and viewing maps and other spatially referenced data
Habitat Hectares	A measure of the quality and extent of native vegetation, incorporating attributes including presence of large trees, tree canopy health, understorey structure and diversity, weed cover and landscape context
High threat weeds	Introduced species (including non-indigenous 'natives') which, as invading species have highly deleterious impacts on indigenous vegetation and faunal habitats
Indigenous	Plant and animal species found naturally in pre-European Australia
Indigenous vegetation	Vegetation native to Australia or native to a specific geographic region
Introduced	Deliberately or accidentally brought to Australia or part of Australia, usually by human agency

Life form	An abbreviated description of the habit, growth form and longevity of a plant species (e.g. tree, shrub, vine, annual, submerged aquatic)
Mining footprint	The proposed 1-30 years mining footprint, within the Retention Lease.
Native vegetation	Species occurring naturally in Australia as part of the pre-European flora or fauna
Retention Lease	Retention Licence 2014
Vegetation community	Term for interacting plant populations forming vegetation. A vegetation community in formal classifications may have characteristic plant species, composition and structure
VROTS	Victorian Rare or Threatened Species
WONS	Weeds of National Significance

Appendix 1 Fauna species recorded during surveys for the Avonbank Mineral Sands Project.

Survey Type = type of survey during which each species was detected
SLL = Striped Legless Lizard tile survey, I = incidental records
Migratory (Mi) = listed migratory species under the Commonwealth EPBC Act
Marine (M) = listed marine overfly species under the Commonwealth EPBC Act
VIC Advisory = conservation status on Victorian advisory list of threatened vertebrate fauna (DSE 2013)
vu = classified as vulnerable, nt = classified as near threatened,
* denotes introduced species

Common Name	Scientific Name	Survey Type	Migratory	Marine	Vic Advisory
Mammals					
European Hare*	*Lepus europaeus*	I			
European Rabbit*	*Oryctolagus cuniculus*	I			
Eastern Grey Kangaroo	*Macropus giganteus*	I			
House Mouse*	*Mus musculus*	SLL			
Reptiles					
Eastern Brown Snake	*Pseudonaja textilis*	SLL, I			
Bloulenger's Skink	*Morethia boulengeri*	SLL			
Olive Legless Lizard	*Delma inornata*	SLL			
Amphibians					
Common Eastern Froglet	*Crinia signifera*	I			
Spotted Marsh Frog	*Limnodynastes tasmaniensis*	I			
Pobblebonk	*Limnodynastes dumerilii*	I			
Birds					
Australasian Grebe	*Tachybaptus novaehollandiae*	I			
Australian Pipit	*Anthus novaeseelandiae*	I		M	
Australian Magpie	*Cracticus tibicen*	I			
Australian Raven	*Corvus coronoides*	I			
Australian Ringneck	*Barnardius zonarius*	I			

Common Name	Scientific Name	Survey Type	Migratory	Marine	Vic Advisory
Australian Shelduck	*Tadorna tadornoides*	I			
Australian White Ibis	*Threskiornis moluccus*	I		M	
Australian Wood Duck	*Chenonetta jubata*	I			
Barn Owl	*Tyto alba*	I			
Black-fronted Dotterel	*Elseyornis melanops*	I			
Black Honeyeater	*Sugomel nigrum*	I			
Black Kite	*Milvus migrans*	I			
Black-shouldered Kite	*Elanus axillaris*	I			
Brown Falcon	*Falco berigora*	I			
Brown Songlark	*Cincloramphus cruralis*	I			
Brown Treecreeper	*Climacteris picumnus*	I			NT
Common Blackbird*	*Turdus merula*	I			
Common Starling*	*Sturnus vulgaris*	I			
Crested Pigeon	*Ocyphaps lophotes*	I			
Crested Shrike-tit	*Falcunculus frontatus*	I			
Dusky Woodswallow	*Artamus cyanopterus*	I			
Eastern Rosella	*Platycercus eximius*	I			
Eurasian Coot	*Fulica atra*	I			
Eurasian Skylark*	*Alauda arvensis*	I			
European Goldfinch*	*Carduelis carduelis*	I			
Galah	*Eolophus roseicapilla*	I			
Glossy Ibis	*Plegadis falcinellus*	I	Mi	M	NT
Golden-headed Cisticola	*Cisticola exilis*	I			
Grey Currawong	*Strepera versicolor*	I			
Grey Fantail	*Rhipidura albiscapa*	I			
Grey Teal	*Anas gracilis*	I			
Hardhead	*Aythya australis*	I			V
House Sparrow*	*Passer domesticus*	I			

Common Name	Scientific Name	Survey Type	Migratory	Marine	Vic Advisory
Jacky Winter	*Microeca fascinans*	I			
Laughing Kookaburra	*Dacelo novaeguineae*	I			
Little Corella	*Cacatua sanguinea*	I			
Little Grassbird	*Megalurus gramineus*	I			
Little Lorikeet	*Glossopsitta pusilla*	I			
Magpie-lark	*Grallina cyanoleuca*	I		M	
Masked Lapwing	*Vanellus miles*	I			
Mistletoebird	*Dicaeum hirundinaceum*	I			
Nankeen Kestrel	*Falco cenchroides*	I		M	
Noisy Miner	*Manorina melanocephala*	I			
Pacific Black Duck	*Anas superciliosa*	I			
Pallid Cuckoo	*Cacomantis pallidus*	I		M	
Pink-eared Duck	*Malacorhynchus membranaceus*	I			
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	I			
Rainbow Lorikeet	*Trichoglossus moluccanus*	I			
Red-capped Robin	*Petroica goodenovii*	I			
Red Wattlebird	*Anthochaera carunculata*	I			
Red-kneed Dotterel	*Erythrogonys cinctus*	I			
Red-rumped Parrot	*Psephotus haematonotus*	I			
Rock Dove*	*Columba livia*	I			
Sharp-tailed Sandpiper	*Calidris acuminata*	I	Mi	M	
Silver Gull	*Chroicocephalus novaehollandiae*	I			
Singing Honeyeater	*Lichenostomus virescens*	I			
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	I			
Spotted Pardalote	*Pardalotus punctatus*	I			
Striated Pardalote	*Pardalotus striatus*	I			
Stubble Quail	*Coturnix pectoralis*	I		M	
Sulphur-crested Cockatoo	*Cacatua galerita*	I			

Common Name	Scientific Name	Survey Type	Migratory	Marine	Vic Advisory
Tree Martin	*Petrochelidon nigricans*	I			
Wedge-tailed Eagle	*Aquila audax*	I			
Weebil	*Smicrornis brevirostris*	I			
Welcome Swallow	*Hirundo neoxena*	I		M	
White-bellied Cuckoo-shrike	*Coracina papuensis*	I		M	
White-browed Woodswallow	*Artamus superciliosus*	I			
White-winged Chough	*Corcorax melanorhamphos*	I			
White-fronted Chat	*Epthianura albifrons*	I			
White-plumed Honeyeater	*Lichenostomus penicillatus*	I			
White-winged Triller	*Lalage sueurii*	I			
Willie Wagtail	*Rhipidura leucophrys*	I			
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	I			