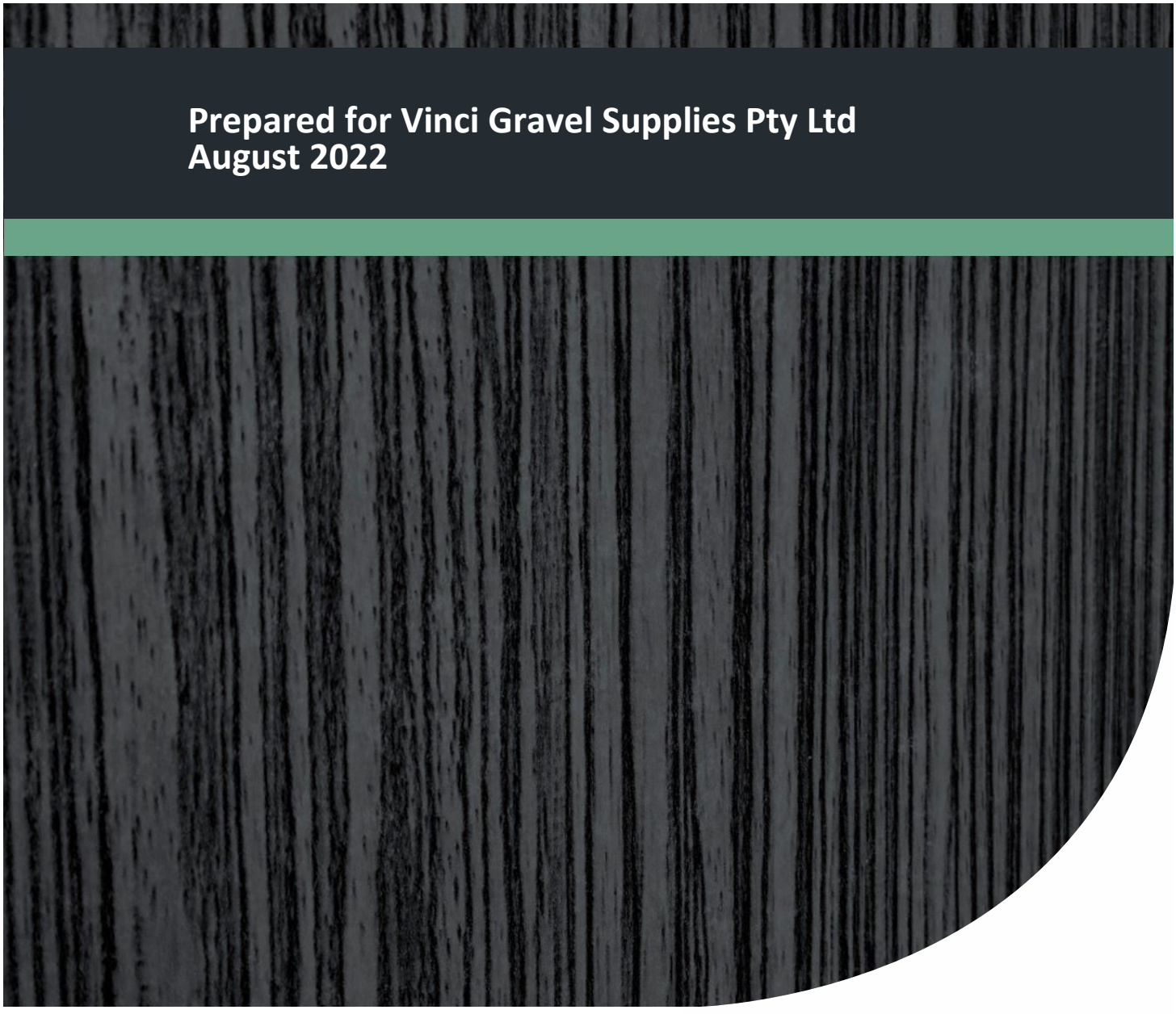
Environmental Management Plan

Lot 9 Brookton Highway, Karragullen

Project No: EP20-040(14)

Prepared for Vinci Gravel Supplies Pty Ltd
August 2022



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Executive Summary

This *Environmental Management Plan* (EMP) has been prepared on behalf of Vinci Gravel Supplies Pty Ltd (the proponent) for the proposed expansion of their existing gravel quarry at Lot 9 Brookton Highway, Karragullen (herein referred to as 'the site'). The site is 48.23 hectares in size and is located within the City of Armadale (CoA) municipality, 15 kilometres east of Armadale town centre (see **Figure 1**). The site is generally bound by broad acre rural landholdings zoned 'General Rural' to the north and south, Midgegooroo National Park to the north and east, and Brookton Highway and Canning Road to the south and west.

The CoA has previously granted approval for stages 1 to 4 of the gravel extraction and processing quarry, and the proponent is now seeking Development Approval (DA) and an Extractive Industry Licence (EIL) for a further expansion of the quarry referred to as 'stage 5'. The stage 5 extraction area is adjacent to the existing approved stage 4 extraction area, and is approximately 5 ha in size, and is subdivided into stage 5a (2.82 ha) and stage 5b (2.17 ha) in addition to a proposed internal access road (0.30 ha) and the vehicle compound (0.48 ha) (see **Figure 2**).

The stage 5 extraction area has been separated into two stages to mitigate visual amenity impacts by retaining staged screening vegetation, however the quarry will be excavated over several substages within each of these stages. The extraction activities will begin at the furthest eastern extent and gradually move in a westerly direction. The full extent of the historic quarry areas (stages 1 to 4) will be fully recontoured and either revegetated or ready for the first year of revegetation works to commence prior to gravel extraction commencing within Stage 5. The first year of revegetation works will have been completed within 12 months (i.e. within the first following revegetation season) of gravel extraction commencing within Stage 5.

Progressive rehabilitation works will occur within Stage 5 on a yearly basis following the completion of previously extracted areas of the quarry, with the easternmost backslope to be rehabilitated in the first instance so the quarry is less visually prominent. The staged approach also allows for the temporary retention of vegetation within the stage 5b area for screening purposes during the excavation of stage 5a, before quarrying moves in the westerly direction. The two stages of the stage 5 extraction area will also enable compliance management with the intended progressive rehabilitation approach proposed for this expansion area and as is detailed further in this EMP.

This EMP is the primary supporting environmental document for the DA and EIL applications to facilitate consideration of relevant environmental issues associated with the proposed quarry expansion. At the CoA's request this EMP also summarises and consolidates existing commitments from the previously approved extraction stages 1 to 4 of the quarry, and details new commitments for the proposed expansion to support the DA application.

The existing environmental assets and sensitive receptors within and adjacent to the site, that have the potential to be impacted by the quarry expansion are summarised as follows:

- Several sensitive land uses including residential landholdings and scenic walking tracks are located within a 450 m radius of the quarry expansion.

- The head of a tributary of the ephemeral Stinton Creek occurs in the centre of the site (with the Stinton Creek 400 m south of the proposed quarry expansion area) and flows in a south-westerly direction to a dam in the central southern portion of the site.
- The majority of the site comprises remnant native vegetation ranging from 'Excellent' to 'Good' condition, with the remainder comprising non-native vegetation and cleared areas (14.35 ha/30% of the site) largely associated with previously excavated areas within the site's western portion.
- The site was found to support native vegetation with high fauna habitat values associated with marri and jarrah forest, shrubland, granite outcrop, sedgeland and creek line. A total of 25 native and three introduced fauna species, including three species of conservation significant black cockatoos (Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo), were directly or indirectly recorded during the field survey.
- The site contains suitable roosting, breeding and foraging habitat for black cockatoos including approximately 23.41 ha of high value foraging habitat, 22.85 ha of moderate foraging habitat and 23.46 low value foraging habitat, along with a total of 468 habitat trees, of which two contain hollows suitable for breeding.
- The site is identified as bushfire prone in the WA *Map of Bush Fire Prone Areas* (OBRM 2019).
- No evidence of *phytophthora* dieback infestation is currently present within the site, however previous studies indicated some evidence of dieback presence.

The flora and vegetation and fauna habitat impacts associated with the stage 5 quarry-footprint has been determined from the baseline surveys and compared against the same values within the remainder of the site. This summary has been presented below within **Table E1**.

Table E1: Assessment of environmental conditions within the proposed stage 5 quarry footprint and the remainder of the site

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
Site Extent	Boundary		5.75	42.49
Flora and Vegetation	Vegetation Condition	Pristine	0	0
		Excellent	0	3.02
		Very Good	4.54	10.57
		Good – Very Good	0.006	6.98
		Good	0.16	6.27
		Degraded	0	2.19
		Completely Degraded	1.03	11.41
	Plant Community	AeGm	0	3.70
		Bs	0	3.02
		CcEmBa	4.71	21.47
		CcLI	0	0.06

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
		Cd	0	0.51
		LeH	0	0.22
		TIBr	0	0.05
		Revegetation	0.007	1.80
		Cleared and Non-native	1.03	11.40
		Water	0	0.11
	Community	Threatened Ecological Community	0	0
		Priority Ecological Community	0	0
Fauna	Fauna Habitat	Marri and Jarrah Forest	4.71	21.58
		Shrubland	0	4.44
		Sedgeland	0	0.05
		Revegetation	0.007	1.79
		Granite Outcrop	0	3.02
		Non-native Vegetation	0	0.15
		Predominantly Cleared Area	1.03	11.25
		Waterbody	0	0.11
		Creekline	0	0.08
Black Cockatoo	Carnaby's Cockatoo Foraging Habitat	High value	4.67	18.74
		Moderate value	0	0.26
		Low value	0.002	5.34
	Baudin's Cockatoo Foraging Habitat	High value	4.61	18.24
		Moderate value	0	0.30
		Low value	0.06	3.60
	Forest Red-Tailed Cockatoo Foraging Habitat	High value	4.67	18.79
		Moderate value	0	0.26
		Low value	0	1.25
	Black Cockatoo Breeding Trees (no.)	Confirmed Nest	0	0
		Potential Nest	0	0
		Suitable Hollow	0	2

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
		Potentially Suitable Hollow	0	0
		No Suitable Hollow	102	366

This EMP outlines the corresponding management strategies to mitigate and manage the identified risks to key environmental assets and sensitive receptors. The management actions to be implemented comprise eight categories with associated objectives as summarised below:

- **Stormwater soil and erosion:** Stormwater will be managed during the construction and operational phases of the gravel quarry such that no uncontrolled discharge of water from the extraction area will result in erosion or sedimentation into the Stinton Creek, which is outside of the site. A waterway 'avoidance area' has been identified either side of the Stinton Creek tributary within the site to a width of 30 meters (m) either side of the tributary channel. This area will be flagged within the site and no disturbance will occur within this area during the excavation and quarry operational activities in order to protect the waterway, avoid the trampling of riparian vegetation and minimise weed and pest encroachment. Diversion banks and catch drains will ensure avoidance of sediment-laden runoff and allow clean surface water to return to this natural ephemeral watercourse or to retained vegetation within the waterway avoidance area.
- **Native vegetation:** Native flora and vegetation will be managed so that biological diversity and ecological integrity are maintained within and adjacent to the site. A total 30.83 ha native vegetation will be retained and protected within the broader site (referred to as the 'Clearing Avoidance Footprint'). The extent of the clearing area will be clearly defined with flagging before any clearing activities commence to ensure there will be no encroachment of disturbance activities into adjacent vegetation. Clearing of native vegetation will occur progressively associated with extraction stages and rehabilitated in accordance with the *Rehabilitation and Decommissioning Programme*, detailed further below.
- **Weeds and *phytophthora* dieback:** A dieback survey will be undertaken prior to any commencement of works within the stage 5 quarry footprint. Based on the findings of this, hygiene procedures will be adopted during excavation activities to prevent the spread *Phytophthora* dieback within the site. Likewise, hygiene measures and materials control will be adopted to prevent the spread of weeds within the site.
- **Fauna:** The biological diversity and ecological integrity of terrestrial fauna within and adjacent to the site will be maintained. A pre-disturbance fauna inspection will be undertaken 1-2 days before clearing and progressive clearing in one direction undertaken enabling fauna species to move to adjacent vegetation.
- **Bushfire risks:** Part 10A Bushfire Risk Management 'deemed provisions' of City of Armadale TPS No.4 does not apply to the proposed expansion, because it does not include the construction or use of any habitable buildings. Notwithstanding, certain activities will not occur on site including construction of permanent or temporary habitable buildings on site, the storage of large quantities of fuel and the parking and servicing of trucks on site.
- **Dust:** Procedures to control dust will ensure dust levels meet statutory requirements and acceptable standards including watering haul roads and stockpiles, use of dust technologies

(crusher enclosures, wet drilling, automatic sprinklers) and speed restrictions on unsealed access roads.

- **Noise**: The results of the *Acoustic Assessment* (Lloyd George 2021) indicate noise levels associated with the stage 5a and 5b gravel extraction pits would comply with the daytime regulations at the surrounding noise sensitive receivers. With regard to night-time loading of trucks (between 6am and 7am), a marginal 1 dB exceedance is predicted at one receiver. To mitigate this exceedance, truck movements between 6am and 7am will be limited to a maximum of four trucks.
- **Visual amenity:** The results of the *Visual Impact Assessment* (Emerge Associates 2021) concluded the expansion would not cause a major visual impact on the landscape of this area with the proposed mitigation measures in place, namely, utilising a staged quarrying approach with retention of vegetation between stages, progressive revegetation and the retention of a 20 m vegetation buffer from the extraction area to the site boundary to the north to provide a visual screen. A rehabilitation schedule/program has been provided within this EMP to ensure this outcome.

This EMP provides a rehabilitation and decommissioning program consolidating previous rehabilitation commitments associated with historically approved stages of the existing quarry and proposes additional revegetation commitments. A summary of the quarry staging and rehabilitation requirements are summarised below in **Table E2**.

Table E2: Summary of quarry staging and rehabilitation requirements

Rehabilitation Zones	Staging of Rehabilitation Works and Delivery Commitments
Zone 1	Commencement of rehabilitation works: 2019 Duration of rehabilitation works: 5-year program (in accordance with Stage 4 approval) Rehabilitation rectification works: 2022 Rehabilitation completion (completion criteria satisfied): 2024 Formal monitoring completion: 2024
Zone 2	Commencement of rehabilitation works: 2019 Duration of rehabilitation works: 5-year program (in accordance with Stage 4 approval) Rehabilitation rectification works: 2022 Rehabilitation completion (completion criteria satisfied): 2024 Formal monitoring completion: 2024
Zone 3C	Maximum extent of 'active' quarry footprint (i.e. area not subject to progressive rehabilitation works and not including access): 2.2 ha Commencement of progressive rehabilitation works: 2022 Completion of active quarry works: 2022 Completion of 80% recontouring: 2022 Completion of 100% recontouring and initial revegetation installation works: 2023 (within 12 months of commencement of vegetation clearing within Zone 3A) 100% rehabilitation completion (incorporating 2 years monitoring and maintenance): 2025
Zone 3A	Pre-disturbance Dieback survey to satisfaction of CoA: prior to any vegetation clearing within Zone 3A Clearing: not to commence until completion of 80% recontouring and stabilisation of Zone 3C and acceptance of Dieback survey by CoA (clearing in Zone 3A trigger for 12-month timeframe for completion of 100% recontouring and initial revegetation installation works within Zone 3C) Completion of active quarry works: TBC Completion of 50% recontouring and initial revegetation installation works: at completion of active quarry works

Rehabilitation Zones	Staging of Rehabilitation Works and Delivery Commitments
	Completion of 100% recontouring and stabilisation and initial revegetation works: within 12 months of completion of active quarry works (and within 12 months of commencement of clearing within Zone 3B) Rehabilitation completion (2 years monitoring and maintenance): 2 years following initial revegetation installation works
Zone 3B	Pre-disturbance Dieback survey to satisfaction of CoA: prior to any access to or works within Zone 3B Clearing: not to commence until completion of 50% recontouring and stabilisation and initial revegetation installation works within Zone 3A and acceptance of Dieback survey by CoA (clearing in Zone 3B trigger for 12-month timeframe for completion of 100% recontouring and initial revegetation installation works within Zone 3A) Completion of active quarry works: TBC Completion of 50% recontouring and initial revegetation installation works: at completion of active quarry works Completion of 100% recontouring and stabilisation and initial revegetation works: within 12 months of completion of active quarry works Rehabilitation completion (2 years monitoring and maintenance): 2 years following initial revegetation installation works

A total 13.43 ha of native revegetation will be established through rehabilitation within the site which will ultimately establish potential breeding and foraging habitat for a number of conservation significant flora and fauna, including Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo. Based on the vegetation selected, it is expected that it would take between three and seven years from initial establishment for the revegetation to provide black cockatoo foraging habitat value, noting that abundance would increase with maturity.

Table E3 below provides a summary of the rehabilitation completion criteria to be applied to the quarry and the relevant timeframes for addressing these. The requirements and timeframes provided in **Table E2** and **Table E3** are proposed to be the key compliance benchmarks to provide CoA clarity and comfort that the necessary closure and rehabilitation requirements are being satisfactorily addressed. Any deviation from these would need to be resolved through the annual compliance reporting process (when identifying the program for future works) and agreement with CoA.

Overall, the revegetation within the site includes 5.01 ha of native revegetation previously conditioned under Clearing Permit 8273-1 for stage 4 of the quarry. The remaining 8.42 ha comprises additional revegetation areas (i.e. not already required as part of previous approvals), with 4.99 ha of the stage 5 expansion, and 3.43 ha across the stage 4 quarry and previously disturbed areas of the site, collectively to counterbalance the residual impact of the stage 5 expansion site. Maintenance and monitoring will be conducted until completion criteria are met for these areas. Compliance reporting and adaptive management measures are also specified in this EMP, to ensure the intended outcomes are achieved.

Overall, the environmental attributes and values of the site can be managed appropriately through the implementation of this EMP in line with the relevant state and local government legislation, policies and guidelines and best management practices.

Table E3: Summary of rehabilitation completion criteria

Rehabilitation Zone	Quarry Stage	Completion Criteria			Completion Date
		Landform reinstatement	Revegetation	Weeds	
Zone 1	4	Prior to 2022 planting works	Establish three tree rows, 5 m apart, with one tree per 10 m and three shrub rows, 5 m apart, with one shrub per 2 m	<10% coverage	In accordance with Stage 4 approval, 5 Year program. Commencement year: 2019 Completion year: 2024 Formal monitoring completion: 2024
Zone 2	4	Prior to 2022 planting works	A native density of approximately 0.8 plants/1m2 A species richness of no less than 15 species of tree, shrub and herbs	<10% coverage	In accordance with Stage 4 approval, 5 Year program. Commencement year: 2019 Completion year: 2024 Formal monitoring completion: 2024
Zone 3C	4	80% completion prior to commencement of clearing within Zone 3A	A native density of approximately 0.8 plants/1m2 A species richness of no less than 15 species of tree, shrub and herbs	<10% coverage	Completion of active quarry works: 2022 Completion of 100% recontouring and initial revegetation installation works: 2024 Completion year: 2026 Formal monitoring completion: 2026
Zone 3A	5	50% completion prior to commencement of clearing within Zone 3B	A native density of approximately 0.8 plants/1m2 A species richness of no less than 15 species of tree, shrub and herbs	<10% coverage	Three-year program to commence within 12 months of vegetation clearing commencing in Zone 3B. Year 1: Initial installation Year 2: Infill planting and weed control Year 3: Infill planting, weed control and completion
Zone 3B	5	Within 12 months of completion of quarry works	A native density of approximately 0.8 plants/1m2 A species richness of no less than 15 species of tree, shrub and herbs	<10% coverage	Three-year program to commence across 100% extent within 12 months of completion of quarry works. Year 1: Initial installation Year 2: Infill planting and weed control Year 3: Infill planting, weed control and completion
Operational Buffer	5	N/A	N/A	<5%	N/A

Table of Contents

List of Tables

Figures

Appendices

1 Introduction

1.1 Background

Vinci Gravel Supplies Pty Ltd (the proponent) is proposing to expand their existing gravel quarry located at Lot 9 Brookton Highway, Karragullen. Lot 9 (herein referred to as 'the site') is 48.23 hectares (ha) in size and is located within the City of Armadale (CoA) municipality, approximately 15 kilometres (km) east of Armadale town centre (see **Figure 1**).

The CoA has previously granted conditional approval for Stages 1 to 4 of the gravel extraction and processing at the quarry, and the proponent is now seeking Development Approval (DA) and an Extractive Industry Licence (EIL) for a further expansion of the quarry, hereafter referred to as 'stage 5' (comprising stage 5a and stage 5b, together with an internal access road and a separate vehicle compound to the south (see **Figure 2**).

1.2 Purpose of report

Emerge Associates (Emerge) was engaged by the proponent to prepare an EMP to outline the environmental management procedures to be implemented by the proponent for the proposed stage 5a and 5b expansion area, as well as detailing existing commitments held by the proponent in relation to the previous Stage 1 to 4 expansion areas.

Specifically, this EMP:

- Identifies the existing environmental values and attributes of the site (see **Section 2**)
- Discusses the proposed expansion and quarry operations (see **Section 3**)
- Discusses how the proposed expanded quarry design responds to the existing environmental features and values and provides an implementation framework for environmental management procedures to comply with identified environmental objectives (see **Section 5**).

1.3 Scope of report

This EMP is the primary supporting environmental document for the DA and EIL applications to facilitate consideration of relevant environmental issues associated with the proposed stage 5 quarry expansion. At the CoA's request this EMP also summarises and consolidates existing commitments from previously approved extraction stages 1 to 4 of the quarry, specifically contained in the following:

- *Site Environmental Management Plan* (Accendo Australia 2019)
- *Site Environmental Management Plan* (Accendo Australia 2017a)
- *Dust Management Plan* (Harley Dykstra 2017)
- *Phytophthora Dieback Management Plan* (Accendo Australia 2017b)
- *Acoustic Assessment* (Lloyd George Acoustics 2017).

In addition, Emerge have prepared or commissioned the following technical reports to support the DA and EIL applications for the site:

- *Detailed Flora and Vegetation Survey - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021a) (**Appendix A**)
- *Level 1 Fauna Assessment - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2020) (**Appendix B**)
- *Targeted Black Cockatoo Habitat Assessment - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021b) (**Appendix C)**
- Acoustic Assessment (Lloyd George Acoustics 2021) (**Appendix D**)
- Visual Impact Assessment – Lot 9 Brookton Highway, Karragullen Gravel Quarry Expansion (Emerge Associates 2021c) (**Appendix E**).

The outcomes of these site-specific investigations, as well as a comprehensive desktop review of available information on environmental conditions has provided context for the following within and adjacent to the site:

- Landforms, topography and soils
- Flora and vegetation
- Terrestrial fauna
- Surface and groundwater hydrology
- Aboriginal and non-indigenous heritage
- Historical and existing land uses within and surrounding the site
- Bushfire hazards.

1.4 Stakeholder consultation

As a component of the DA and EIL processes, the proposal has been advertised, and stakeholders have had the opportunity to comment on the proposal. The proponent has provided a response to all submissions received. In addition, the proponent has held four meetings with CoA between February 2020 and October 2021, to specifically address the proposed quarry expansion. Key topics which were discussed with the CoA were related to bushfire risk management, visual impact concerns, the status of compliance with existing approval requirements, and the status of historic rehabilitation outcomes for stages 1 to 4.

It was confirmed with the CoA that a separate Bushfire Management Plan or Risk Management Plan will not be required for the quarry expansion, however mitigation measures for the increased risk of bushfire ignition, such as fuel storage, would need to be addressed in the Environmental Management Plan to support the DA/EIL applications. On review of the proposed visual impact mitigation approach, the CoA raised no visual concerns for the quarry expansion given the implementation of proposed vegetative screening and rehabilitation works.

2 Statutory Context

2.1 City of Armadale development approval

Local and regional planning schemes provide guidance on what types of development and building activities require local government planning approval. Under the CoA's TPS No. 4, activities involving the extraction of raw materials are to be addressed as part of a formal DA application.

A summary of the planning approvals history for previous extraction phases within the site is provided in **Table 1**. It is noted that this EMP summarises and consolidates existing commitments from previously approved extraction stages 1 to 4 of the quarry (**Table 1**), and details new commitments for the proposed stages 5a and 5b to support the DA application.

Table 1: Planning approvals history

Extractive stage	Date of Approval	CoA Reference	Details
Stage 1	28 October 2003	A117566: PRR	DA granted for proposed extractive industry renewal subject to conditions.
Stage 2	29 July 2014	PR5514; 10.2013.355.1	DA granted for expansion of existing extractive industry (gravel quarry) subject to conditions.
Stage 3	5 April 2016	PR5514; 10.2015.379.1	DA granted for expansion of industry – extractive (gravel) subject to conditions.
Stage 4	24 May 2018	PR5514; 10.2017.154.1	DA granted for industry extractive (gravel) – stage four extraction area subject to conditions. Conditions 2 & 4 subsequently revised 26 February 2019 through State Administrative Tribunal (SAT) review (DR148/2018).

2.2 City of Armadale Extractive Industries Licence

The *City of Armadale Extractive Industries Local Law* (City of Armadale 2000) establishes the need for extractive industries to operate under a licence. The CoA has previously issued Extractive Industry Licences (EILs) for stages 2 to 4 of the existing gravel quarry, subject to specific conditions (incorporated in **Section 5** of this EMP).

The information provided in this EMP is intended to support the EIL application for the proposed stage 5 quarry expansion.

2.3 State planning policy 2.4 – basic raw materials

State Planning Policy 2.4 - Basic Raw Materials (SPP 2.4) (WAPC 2000) was prepared, in part, to assist local governments in the determination of applications for extractive industry proposals. This EMP has been prepared with regard to all the relevant considerations set out in SPP 2.4.

2.4 Environmental Protection Act 1986

2.4.1 Part IV *Environmental Protection Act 1986 (WA)*

Part IV of the EP Act provides for the consideration of proposals that could result in a significant adverse impact on the environment. The stage 5 expansion proposal will likely require referral to the Environmental Protection Authority (EPA) pursuant to Section 38 of the EP Act, on the basis that the proposal may impact on the following key environmental factors:

- Land – Flora and vegetation (the removal of intact native vegetation representative of the Yarragil Complex).
- Land – Terrestrial fauna (impacts to roosting, foraging and potential breeding habitat for the three species of threatened black cockatoo; CBC, FRTBC and BC (listed as endangered and vulnerable under the BC Act))
- Water – Inland waters (i.e. uncontrolled runoff into Stinton Creek tributary and waterway management requirements)
- People – Social surroundings (visual amenity, dust, and noise).

The proponent met with the EPA Services Unit on 9 April 2021 to discuss the proposal, specifically whether the proposal is likely to warrant referral to the EPA under Section 38 Part IV of the EP Act for a determination on whether it is a 'significant proposal'. The details discussed during this meeting included potential impacts, possible preliminary key environmental factors, stakeholder consultation, proposed management measures and possible assessment pathways, including possible level of assessment.

On review of the information provided, the EPA Services Unit did not raise any concerns with regards to the level of environmental investigations undertaken and the assessment of impacts to key environmental factors. It was considered it likely that the proposal can be adequately regulated through other state and federal environmental and planning approvals without the need for further regulation through Section 38 Part IV of the EP Act. The EPA Services Unit is interested in the outcome of the other environmental approvals including Native Vegetation Clearing Permit approval under Part V of the EP Act and approval under the EPBC Act given potential impacts on Matters of National Environmental Significance. The EPA Services Unit did not recommend that the proponent refer the proposal, particularly given that there has been no previous community interest in the existing gravel extraction activities.

2.4.2 Part V *Environmental Protection Act 1986 (WA)*

A Native Vegetation Clearing Permit pursuant to Part V of the EP Act will be sought from the Department of Water and Environmental Regulation (DWER). A clearing permit ref. CPS 8273/1 (area permit) was granted by DWER in June 2019 to facilitate the stage 4 quarry operations.

DWER regulates industrial emissions and discharges to the environment through a works approval, licensing, and registration process, under Part V of the EP Act. Industrial premises with potential to cause emissions and discharges to air, land or water are known as 'prescribed premises' and trigger regulation pursuant to the EP Act. Prescribed premises categories are outlined in Schedule 1 of the *Environmental Protection Regulations 1987*.

The relevant prescribed premise for the quarry operations is category 70 (Part 2, Schedule 1), defined as 'screening etc. of material: premises on which material extracted from the ground is screened, washed, crushed, ground, milled, sized or separated.' Category 70 applies to operations with a production or design capacity of 'more than 5,000 but less than 50,000 tonnes per year.' Should the annual extraction volumes of the proposed operations fall within this range a prescribed premises registration will be sought pursuant to Part V, Division 3 of the EP Act.

2.5 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Commonwealth Government's principal environmental legislation and provides for the protection and management of nationally and internationally important flora, fauna, ecological communities and heritage places, defined as 'Matters of National Environmental Significance' (MNES).

The relevant MNES which applies to this site are *'nationally threatened species and ecological communities.'* Any action that is likely to have a significant impact on listed threatened species and ecological community under the EPBC Act must be referred to the Minister and potentially undergo an environmental assessment and approval process.

The proposed stage 5a and 5b expansion of the quarry will impact on threatened black cockatoo habitat and is therefore being referred to the Department of Agriculture, Water and Environment (DAWE) pursuant to the EPBC Act. Should the proposed expansion be deemed to be a 'Controlled Action' requiring formal assessment and approval, consideration will be given to utilising the Native Vegetation Clearing Permit assessment process, as this is an 'accredited process' under the State and Commonwealth's assessment bilateral agreement.

3 Existing Environment

3.1 Climate

The climate of the site (which applies to the wider Perth region) is described as Mediterranean, with hot, dry summers and moderately wet, mild winters. An average of 1019.5 millimetres (mm) of rainfall is recorded annually from the Karragullen North weather station, which is the closest weather station, located approximately 800 m north-east of the site (BoM 2021). The majority of this rainfall is received between the months of May and September. Mean maximum temperatures at the Bickley weather station, which is the nearest temperature recording station approximately 10 km north of the site, range from 15.1 °C in July to 30.5 °C in January and February, while mean minimum temperatures range from 7.3 °C in July to 15.9 °C in February (BoM 2021).

3.2 Geomorphology

3.2.1 Topography

The topography of the site slopes in a south westerly direction, with elevation ranging from approximately 349 metres Australian height datum (AHD) in the north-eastern corner to 268 m AHD in the south western corner (**Figure 3**).

3.2.2 Landform, soils, and geology

The site is located on the western side of the Darling Plateau and broad scale soil mapping places the site within the Yarragil and the Dwellingup soil associations (Churchward and McArthur 1980). The Yarragil association occurs in the western portion of the site and is described as gentle valleys with sandy gravels on the slopes and orange earths on flat swampy floors (Churchward and McArthur 1980). The Dwellingup association occurs in the eastern portion of the site and is described as a 'gently undulating landscape with duricrust on ridges; sands and gravels in shallow depressions' (Churchward and McArthur 1980).

Finer scale mapping by DPIRD (2018) shows four soil landscape units as occurring within the site, as described in **Table** 2 and shown in **Figure 4**.

Table 2: Soil landscape mapping units within the site (DPIRD 2018)

Soil landscape unit	Location within site	Description
Yarragil 1 Phase	South-western portion and small area in south eastern portion	Very gentle to moderately inclined concave sideslopes (with) moderately well drained yellow duplex soils and yellow and brown massive earths and gravels.
Yarragil 4 Phase	Small area in the central southern portion	Valley floors with some poorly drained mottled yellow duplex soils and gentle lower slopes with moderately well to well drained loamy and sandy earths, gravels and duplex soils.
Dwellingup 2 Phase	North-western and south eastern portions	Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.

Table 2: Soil landscape mapping units within the site (DPIRD 2018) (continued)

Soil landscape unit	Location within site	Description
Cooke Subsystem	Eastern portion	Crests and upper slopes dominated by granite outcrop and very shallow yellow duplex soils, and yellow and brown massive earths.

Geotechnical surveys undertaken over the site to date generally found the soil conditions representative of the regional mapping with the dominant soils being brown lateritic sands containing abundant lateritic gravel throughout the profile, overlaying laterite and clays with weathered granite at depth. The surface was found to be 100 to 200mm of grey/black to brown sands which grade into the lateritic sands (Accendo Australia 2019).

Based on the location of the expansion area, the extent of the future quarry activities will suitably avoid the identified granite outcrop within the eastern portion of the site.

3.2.3 Acid sulfate soils

Acid sulfate soils (ASS) is the name commonly given to naturally occurring soils and sediment containing iron sulphide (iron pyrite) materials. In their natural state, ASS are generally present in waterlogged and/or anoxic conditions and do not present any risk to the environment. ASS can pose issues when oxidised, producing sulphuric acid, which can present a range of risks for the surrounding environment, infrastructure and human health.

The Department of Water and Environment Regulation (DWER) provides broad-scale mapping indicating areas of potential ASS risk (DWER 2021) however, the site does not fall within the extent of this mapping. ASS risk mapping does not extend over the Darling Scarp primarily due to the lack of ASS forming soil types characteristic of well drained sandy soils. The Yarragil (Yg1) and Dwellingup 2 Phase (DW2) soil units mapped as occurring within the site are free-draining sandy soils and are consequently unlikely to experience waterlogged conditions prone to forming ASS.

The tributary of the ephemeral Stinton Creek intersects with the southern portion of the site and disturbance of these seasonally waterlogged soils may present an ASS risk. However, the proposed expansion avoids the Stinton Creek tributary and will not cause any disturbance to the creek bed or its banks.

No further consideration of ASS is required as part of the management considerations for the proposed gravel quarry expansion.

3.3 Hydrology

3.3.1 Surface water

The head of a tributary of the ephemeral Stinton Creek occurs in the centre of the site (just south of the proposed stage 5 expansion area) and flows in a south-westerly direction to a dam in the central southern portion of the site (see **Figure 5**). The tributary remains dry for the majority of the year. No activities associated with the gravel extraction operation have previously disturbed or are likely to disturb the bed or banks of the tributary as a result of the proposed expansion.

Two non-perennial watercourses extend into the south of the site (DWER 2018); however, these are outside of the proposed stage 5 expansion area and will not be impacted by the gravel extraction operation.

Foreshore buffers provide for the protection of riparian vegetation communities along watercourses and provide a barrier to slow down or limit the passage, via surface runoff or groundwater, of contaminants resulting from chemical or wastewater spills from potentially polluting land uses and activities. The *Operational policy 4.3: Identifying and establishing waterways foreshore areas* (DWER 2012) recommends a foreshore area width of 30 metres for waterways and 50 metres for estuaries. To prevent the disturbance to riparian vegetation a waterway 'avoidance area' has been identified to a width of 30 m either side of the Stinton Creek tributary, as shown in **Figure 5.** This area will be flagged and no machinery or support vehicles will enter the waterway 'avoidance area'. This will ensure the environmental values of local conservation and buffer areas are maintained and ensure no disturbance activities will occur within this area during the excavation activities.

3.3.2 Groundwater

Groundwater within the site is expected to be in excess of 15 m below the natural ground levels and increases in depth in an easterly direction (Accendo Australia 2019). Groundwater has not been encountered during any of the excavation activities previously undertaken within the site.

3.3.3 Wetlands

Wetlands are areas which are permanently, seasonally, or intermittently waterlogged or inundated with water. Naturally occurring wetland features are common across the Swan Coastal Plain and can contain fresh or salty water, which may be flowing or still.

The Department of Biodiversity Conservation and Attractions (DBCA) maintains the *Geomorphic Wetlands of the Swan Coastal Plain* (DBCA 2021) database, which categorises geomorphic wetland features into specific management categories based on their attributes and management objectives. A review of this dataset confirms that no geomorphic wetlands are mapped within the site or in close proximity to the site.

3.4 Flora and vegetation

3.4.1 Regional context

The site is contained within the 'JF1' or northern jarrah forest subregion, as defined by the Interim Biogeographic Regionalisation of Australia (IBRA) (Environment Australia 2000). The subregion is characterised as *Eucalyptus marginata* (jarrah) – *Corymbia calophylla* (marri) forest on laterite gravels with Eucalyptus wandoo – marri woodlands in the eastern part (Beard 1990).

Regional vegetation complex mapping extending over the Darling Scarp undertaken by (Heddle et al. 1980) delineates the various vegetation complex types which would have occurred across the region prior to European settlement in Western Australia. Based on this mapping, two vegetation complexes have been mapped as occurring within the site, as summarised below:

- Dwellingup Complex (D2) – Open forest of E*ucalyptus marginata subsp marginata – Corymbia calophylla* on lateritic uplands in subhumid and semiarid zones; and
- Yarragil Complex (Yg1) - Open forest of *Eucalyptus marginata subsp. marginata- Corymbia calophylla* on slopes with mixtures of *Eucalyptus patens and E. megacarpa* on the valley floors in humid and subhumid zones.

The Dwellingup and Yarragil complexes have 82.50% and 80.95% of their pre-European extents respectively remaining (Government of Western Australia 2018), thus exceed the EPA's 30% minimum threshold for unconstrained areas of the Perth and Peel regions.

The native vegetation within the site in 'Good' or better condition is considered representative of the Dwellingup and Yarragil complexes, extending over 31.52 ha. This intact vegetation is also likely to occur within the Korung National Park and Midgegooroo National Parks which supports similar jarrah and marri bushland extending to the north and east of the site and protected through MRS 'Parks and Recreation' reserves.

3.4.2 Plant communities

A flora and vegetation assessment to the standard required of a 'detailed' survey in the Environmental Protection Authority's (EPA's) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016b) was undertaken by Emerge Associates on multiple dates between May and December 2020 (Emerge Associates 2021a) (see **Appendix A**). Vegetation within the site was determined to be representative of eight plant communities including cleared/planted vegetation, as described in **Table 3** and shown in **Figure 6**.

Approximately 70% of the site (33.88 ha) supports plant communities dominated by native vegetation. The remainder of the site comprises non-native vegetation, cleared areas and water bodies (14.35 ha/30% of the site).

Table 3: Description and extent of plant communities identified within the site.

Plant community	Description	Area (ha)
AeGm	Closed shrubland *Acacia ephedroides* and *Grevillea manglesii* subsp. *manglesii*	3.70
Bs	Granite outcrop comprising bare rock surfaces and bryophytes and herbland dominated by *Borya sphaerocephala*	3.02
Cd	Low shrubland *Calytrix depressa* over mixed open native herbland	0.51
CcEmBa	Open forest *Corymbia calophylla* and *Eucalyptus marginata* with *Allocasuarina fraseriana* over shrubland to tall shrubland *Banksia grandis* and *Bossiaea aquifolium* over shrubland *Xanthorrhoea preissii* over mixed native herbland *Platysace filiformis*, *Stylidium* spp. and *Scaevola* spp.	26.25
CcLl	*Corymbia calophylla* over scattered shrubs *Taxandria linearifolia* over closed sedgeland *Lepidosperma longitudinale*	0.12
LeH	Tall shrubland *Leptospermum erubescens* and *Hakea undulata* over shrubland *Xanthorrhoea preissii, Melaleuca trichophylla, Allocasuarina humilis* and *Hakea erinacea* over low shrubland *Gastrolobium villosum* over mixed open herbland *Stylidium* spp.	0.22
TlBr	Tall open shrubland *Taxandria linearifolia* over closed sedgeland *Baumea rubiginosa*	0.06
Revegetation	Planted vegetation - closed shrubland dominated by *Calothamnus quadrifidus*	1.81
Cleared and non-native	Cleared areas and predominantly scattered non-native plants including patches of non-native planted trees	12.43

3.4.3 Vegetation condition

The most intact vegetation in the site is located within plant community **Bs** which comprises granite rises with exposed rock, mosses and native shrubs and herbs. This vegetation was mapped as being in 'excellent' condition as it comprises a vegetation structure expected of granite outcrops and very low weed cover was recorded. Plant community **TlBr** was also mapped as being in 'excellent' condition as it supports an intact structure, high cover of native species and very low cover of weeds.

Plant communities **CcEmBa**, **LeH** and **Cd** in the north-eastern portion of the site comprise relatively intact native vegetation and were mapped as being in 'very good' condition. This vegetation shows some signs of disturbance such as patches of bare ground, altered structure and/or weeds but generally supports moderate to high cover of native species and low weed cover. One patch of plant community **CcEmBa** in the north-western portion of the site, and small areas of plant communities **CcLl** and **Bs** in the central southern portion of the site, were also mapped as being in 'very good' condition for the same reasons.

Most of the portion of plant community **CcEmBa** in the south-eastern portion of the site was mapped as being in 'very good – good' condition. This vegetation comprises a mosaic of small intact patches with moderately intact structure and native species diversity interspersed with small patches supporting an altered structure and reduced native understorey diversity. Parts of this plant community that were significantly altered and comprises scattered native plants only were mapped as being in 'degraded' condition.

Vegetation in the central portion of the site and southern portions of the site were mapped as being in 'good' condition as they have been subject to disturbance and comprise an altered structure with reduced native species diversity. Vegetation subject to higher levels of disturbance and with minimal native species diversity were mapped as being in 'degraded' condition.

The remainder of the site was mapped as being in 'completely degraded' condition as it mainly consists of bare ground including tracks and the current quarry, with scattered native and non-native plants. The 0.11 ha of open water and the 1.81 ha of revegetation in the site were not assigned a condition category.

The extent of vegetation by condition category is detailed in **Table 4** and shown in **Figure 7**.

Table 4: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	3.02
Very good	15.24
Good	6.99
Good – degraded	6.43
Degraded	2.19
Completely degraded	12.44

3.4.4 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate, and water availability (DAWE 2020). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

An ecological community under consideration for listing as a TEC in Western Australia, but which does not yet meet survey criteria or has not been adequately defined, or which is rare but not currently threatened, is referred to as a 'Priority Ecological Community' (PEC). Whilst PECs are not afforded statutory protection in Western Australia, they are also considered during other approval processes, such as those administered under Part IV and Part V of the EP Act.

No TECs or PECs were identified as occurring within the site.

3.4.5 Conservation significant flora

Certain flora species that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora species may be listed as 'threatened' pursuant to the EPBC Act. At a State level, plant species may also be classed as 'threatened' under the BC Act. Species which are potentially rare or threatened meet the criteria for near threatened; or have recently been removed from the threatened species list are classed as 'priority' flora species. However, priority flora species are not afforded statutory protection.

No threatened or priority flora have been recorded within the site.

3.4.6 National Parks

The Midgegooroo National Park, reserved as 'Parks and Recreation Regional' under the City of Armadale TPS No.4, is located immediately adjacent the north and east boundaries of the site (**Figure 8**).

3.4.7 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding values such as significant wetlands, threatened flora, threatened communities and *Bush Forever* sites. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, which includes any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

No ESAs occur within the site.

3.4.8 *Phytophthora* dieback

Phytophthora dieback is caused by the plant pathogen, *Phytophthora cinnamomi*, which kills susceptible plants, such as banksias, jarrah and grass trees, by attacking their root systems. Dieback is a symptom of a *Phytophthora* infection and affects more than 40 per cent of the native plant species and half of the endangered ones in the south-west of Western Australia.

An initial site investigation was undertaken in November 2014 by qualified interpreter Colin Walker from Geo and Hydro Management Pty Ltd on behalf of Berry Consultants. It was concluded that stages 1, 2 and 3 were 'uninfected'. A portion of stage 4 was identified as 'suspected as infected' due to the presence of a positive soil sample result for *Phytophthora* species. A 2016 investigation reported no observed evidence of *Phytophthora* infestation within the proposed stage 4 extraction area. However, evidence symptomatic of *Phytophthora* infestation such as *Xanthorrhoea pressii* and *Banksia grandis* deaths was observed downslope of the site in a southerly direction by Accendo Australia (2017b). Soil and plant tissue samples taken from this area were analysed and returned positive results for the presence of *Phytophthora* (Accendo Australia 2017b).

A recheck of the lines established in April 2016, conducted in March 2017 consisted of a visual site assessment in combination with soil and plant tissue samples and confirmed the presence of *Phytophthora* spp in the area outlined in 2016 and recorded no further spread of the disease (Accendo Australia 2017b). No evidence of the disease occurring within the stage 4 area was recorded.

A detailed flora and vegetation assessment within the proposed stage 5 area (Emerge Associates 2021a) was undertaken in 2020 and reported no visual evidence of *Phytophthora* dieback. Prior to the commencement of the proposed stage 5 quarrying works, a pre-disturbance dieback survey shall be undertaken specifically for the stage 5 expansion area.

3.4.9 Summary of proposed stage 5 footprint

Table 5 below provides a summary of the impact footprint within the proposed expansion area, based on the flora and vegetation values present within the impact footprint and the remainder of the site.

Table 5: Extent of flora and vegetation conditions within the proposed stage 5 quarry footprint and across the remainder of the site

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
Flora and Vegetation	Vegetation Condition	Pristine	0	0
		Excellent	0	3.02
		Very Good	4.54	10.57
		Good – Very Good	0.006	6.98
		Good	0.16	6.27
		Degraded	0	2.19
		Completely Degraded	1.03	11.41
	Plant Community	AeGm	0	3.70
		Bs	0	3.02
		CcEmBa	4.71	21.47
		CcLI	0	0.06
		Cd	0	0.51
		LeH	0	0.22
		TIBr	0	0.05
		Revegetation	0.007	1.80
		Cleared and Non-native	1.03	11.40
		Water	0	0.11
	Community	Threatened Ecological Community	0	0

Table 5: Extent of flora and vegetation conditions within the proposed stage 5 quarry footprint and across the remainder of the site (continued)

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
		Priority Ecological Community	0	0

3.5 Terrestrial fauna

3.5.1 Fauna habitat

A fauna assessment to the standard required of a 'level 1' survey in the Environmental Protection Authority's (EPA's) *Technical Guidance – Terrestrial Fauna Surveys* (EPA 2016a) was undertaken by Emerge Associates on 27 May and 2 June 2020 (Emerge Associates 2020) (**Appendix B**). The majority of the site (70.24%) was found to support native vegetation with high fauna habitat values, including marri and jarrah forest, shrubland, granite outcrop, sedgeland and creek line as described in **Table 6**: Fauna habitats identified within the site **a**nd shown in **Figure 9**.

Table 6: Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Marri and jarrah forest	Open forest *Corymbia calophylla* and *Eucalyptus marginata* over tall shrubland *Bossiaea aquifolium* and shrubland *Xanthorrhoea preissii* over assorted native shrubs and forbs.	26.29
Shrubland	Closed shrubland *Acacia oncinophylla* subsp. o*ncinophylla* (P3) and *Grevillea manglesii.*	4.44
Sedgeland	Tall open shrubland *Taxandria linearifolia* over closed sedgeland *Baumea rubiginosa.*	0.05
Granite outcrop	Granite outcrop comprising bare rock surfaces, bryophytes and herbland dominated by *Borya* sp.	3.02
Creekline	Shallow creeks running off granite outcrops through **marri and jarrah forest** and **sedgeland**.	0.08
Waterbody	Temporary or permanent waterbodies (dams) containing limited native and/or non-native (or absent) vegetation.	0.11
Revegetation	Shrubland *Calothamnus quadrifidus*, *Eucalyptus* sp. and other associated native species over non-native grassland or bare ground.	1.8
Non-native vegetation	Predominantly non-native vegetation, including *Eucalyptus botryoides* and *Eucalyptus camaldulensis* over non-native shrubs and/or bare ground with occasional native plant species.	0.15
Predominantly cleared area	Heavily disturbed areas containing primarily pasture and bare ground with isolated native and non-native trees and shrubs.	12.28

A total of 25 native and three introduced fauna species, including three species of conservation significance (Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo), were directly or indirectly recorded during the field survey. All these fauna species are generally common and widespread in the Jarrah Forest region, including the three species of black cockatoo.

3.5.2 Conservation significant fauna

3.5.2.1 Black Cockatoos

A targeted black cockatoo assessment has been undertaken by Emerge Associates with four ecologists visiting the site multiple times between September to December 2020 to conduct the field survey (Emerge Associates 2021b) (see **Appendix C**). The site occurs within the modelled distribution of all three black cockatoos and within the breeding range of Carnaby's cockatoo and forest red-tailed black cockatoo. Direct or indirect evidence of all three species was recorded in the site.

A total of 468 habitat trees have been recorded within the site, of which two contain hollows suitable for breeding by black cockatoos (see **Figure 10**). The site is therefore considered to provide suitable breeding habitat for Carnaby's cockatoo and forest red-tailed black cockatoo.

No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.

A total of 29.01 ha of foraging habitat for Carnaby's cockatoo, 26.82 ha for Baudin's cockatoo and 24.97 ha for Forest red-tailed black cockatoo were recorded within the site. Of this, 23.41 ha, 22.85 ha and 23.46 ha of the respective black cockatoo habitat is considered to possess a high value. Further extensive areas of remnant native vegetation that may provide foraging habitat for all three species of black cockatoo occur adjacent to the site within Midgegooroo National Park.

3.5.2.2 Chuditch

The chuditch was historically distributed across the majority of Australia and was known to utilise a range of habitats including woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Chuditch require adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to survive. Chuditch are rarely found in habitats fragmented by clearing, except as transient animals and may utilise these areas as part of a much larger home range.

A search of *NatureMap* (DBCA 2021) does not identify any previous records of the Chuditch occurring within the site, however a number of historical records (dated pre-1997) occur within 2 km of the site within the Korung National Park to the north and a private landholding 1.5 km to the west. The species was not directly or indirectly observed during the fauna assessment (Emerge Associates 2021c).

Given the species' wide habitat preference, the remnant native vegetation within the site may provide potential habitat for the species as part of a much larger home range. A total 35.55 ha of potentially suitable habitat for the chuditch was identified within the site, comprising a suitable microhabitat of dense understory and hollow logs**.** While it is possible that chuditch may occasionally utilise the habitat within the site, it would only form part of a much larger home range, if the species occurs at all.

3.5.3 Summary of proposed stage 5 footprint

Table 7 below provides a summary of the impact footprint within the proposed stage 5 expansion area, based on the flora and vegetation values present within the impact footprint and the remainder of the site.

Table 7: Extent of fauna habitat within the proposed stage 5 quarry footprint and across the remainder of the site

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
Level 1 Fauna	Fauna Habitat	Marri and Jarrah Forest	4.71	21.58
		Shrubland	0	4.44
		Sedgeland	0	0.05
		Revegetation	0.007	1.79
		Granite Outcrop	0	3.02
		Non-native Vegetation	0	0.15
		Predominantly Cleared Area	1.03	11.25
		Waterbody	0	0.11
		Creekline	0	0.08
Black Cockatoo	Carnaby's Cockatoo Foraging Habitat	High value	4.67	18.74
		Moderate value	0	0.26
		Low value	0.002	5.34
	Baudin's Cockatoo Foraging Habitat	High value	4.61	18.24
		Moderate value	0	0.30
		Low value	0.06	3.60
	Forest Red-Tailed Cockatoo Foraging Habitat	High value	4.67	18.79
		Moderate value	0	0.26
		Low value	0	1.25

Table 7: Extent of fauna habitat within the proposed stage 5 quarry footprint and across the remainder of the site (continued)

		Description	Clearing Footprint (ha)	Remainder of the site (ha)
	Black Cockatoo Breeding Trees (no.)	Confirmed Nest	0	0
		Potential Nest	0	0
		Suitable Hollow	0	2
		Potentially Suitable Hollow	0	0
		No Suitable Hollow	102	366

3.6 Heritage

3.6.1 Indigenous heritage

The Aboriginal Heritage Inquiry System (AHIS) is maintained pursuant to Section 38 of the *Aboriginal Heritage Act 1972* by the Department of Planning, Lands and Heritage, containing information on Registered Aboriginal Heritages Sites and Other Heritage Places throughout Western Australia.

In accordance with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the AHIS online database (DPLH 2020) was undertaken. No Registered Aboriginal Heritage Sites or Other Heritage Places have been identified within the site.

3.6.2 Non-Indigenous heritage

A desktop search of the Australian Heritage Database (Department of the Environment 2020), the State Heritage Office database (Heritage Council 2020) and the City of Armadale Local Government Inventory (City of Armadale 2020) indicated there are no registered heritage sites within or in close proximity to the site.

3.7 Bushfire hazards

The Map of Bush Fire Prone Areas published by the Office of Bushfire Risk Management (OBRM, 2019) identifies the site and surrounding area as a 'bushfire prone area.' Development within an area identified as bushfire prone is subject to consideration under the *Planning and Development Act 2005*, and in turn *State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP 3.7)* and its Guidelines.

For the stage 5 expansion, the City of Armadale's consideration of the requirements of SPP 3.7 will be consistent with the approach taken to the Development Approval for Stage 4, as detailed in the following extract from the Council's report, namely that a Bushfire Attack Level assessment, and associate Bushfire Management Plan, are not required:

> *"State Planning Policy SPP3.7 Planning in Bushfire Prone Areas (SPP3.7) is applicable to certain development proposals in designated Bushfire Prone Areas. The intent of the policy is to "preserve life and reduce the impact of bushfire on property and infrastructure". The Part 10A Bushfire Risk Management 'deemed provisions' of TPS No.4 do not apply to this proposal because it does not include the construction or use of any habitable buildings. The proposal does not include the bulk storage of hazardous materials or result in the intensification of land use, or increase numbers of residents or employees, therefore is unlikely to result in an increase to the threat of bushfire. SPP3.7 does not specifically exempt the proposal from assessment against the criteria contained in Guidelines for Planning in Bushfire Prone Areas however it is considered that there is little practicable reason to require a BAL Assessment given the absence of habitable buildings. It is recommended however that any approval should be subject to a condition requiring all areas in use by machinery and vehicles to be maintained in a state that minimises the risk of machinery and vehicles setting fire to vegetation" (City of Armadale 2018 Council Report).*

3.8 Other land use considerations

3.8.1 Historic and existing land uses

A review of historical aerial imagery from 1965 onwards indicates the majority of the site supported relatively undisturbed native vegetation until 1974, after which gravel quarry activities began within the western portion of the site. With the exception of scattered paddock trees, the southern portion of the site was cleared circa 1974 for agricultural purposes including livestock grazing.

Several small clearing events have occurred associated with the expansion of the quarry and construction of vehicle tracks through the northern patch of remanent vegetation between 1977 and 2001. There is evidence of vegetation regrowth within the south-eastern portion of the site from 1985 to 2020, however several bare ground areas are still evident due to historical clearing.

3.8.2 Potential site contamination

A review of the DWER Contaminated Sites Database (DWER 2021b) indicates that the site is not registered as a contaminated site pursuant to the Contaminated Sites Act 2003, nor are other registered sites located nearby.

Given the historic land uses within the site, the majority of the site is unlikely to pose significant contamination risks. Additionally, given there will be no intended change in land use (and particularly the sensitivity of the land use), contamination is unlikely to be an issue which would require any specific consideration.

3.8.3 Surrounding land uses

The site is surrounded by adjacent broad acre rural landholdings zoned ‘General Rural’ and Midgegooroo National Park zoned ‘Parks and Recreation’ under the MRS and ‘Parks and Recreation Regional’ under the City of Armadale Town Planning Scheme (TPS) No. 4 to the north and east. The site is also bound to the west by Brookton Highway zoned ‘Primary Regional Road’ under the MRS and broad acre agricultural landholdings to the south. Canning Road and Stinton Creek tributary are located to the west of the site.

Approximately 14 residential dwellings are located within a 500 m radius of the stage 5 quarry expansion and an additional 30 within a 1km radius as shown in **Figure 11.** EPA Guidance Statement no. 3 *Separation Distances Between Industrial and Sensitive Land Uses* specifically addresses generic separation distances between industrial and sensitive land uses to avoid conflicts between these land uses. The generic separation distances are based on the consideration of typical emissions that may affect the amenity of nearby sensitive land uses. The guidance’s recommended buffer distance for ‘Extractive Industries - hard rock, sand, limestone’ ranges from 300 m to 1 km.

If the distance from the industrial land use to the sensitive land use is less than the generic separation distance, a scientific study based on site- and industry-specific information must be presented to demonstrate that a lesser distance will not result in unacceptable impact.

3.9 Noise impacts

Several residential dwellings are located between 300 m and 1 km from the site, with the closest dwelling located 350 m to the south-east which is considered as a sensitive land-use under the *Environmental Protection (Noise) Regulations 1997.*

The proposed stage 5 expansion has been subject to a Noise Assessment (Lloyd George Acoustics 2021) (see **Appendix D**), which compares the predicted noise levels from front-end loaders, dozers, excavators, truck movements and rock breakers, against the "assigned levels" contained within the regulations.

The assessment assumes one front-end loader will be used to load product into trucks, operating from behind a 4 m high stockpile within the confines of the stage 5 quarry. It is assumed that a 4 m high quarry face will be maintained at all times and will provide a noise barrier to the houses located to the south and west. An average of 3.3 truck movements per day are expected in accordance with current quarry operations. Up to five trucks per hour could access the site between 6am and 7am.

Works generating excessive noise and rock breaking are not permitted outside the hours of 7am to 7pm or on a Sunday or Public Holiday, however the loading of materials is permissible between 6am and 7am. During this time, the excavation operation noise emissions are considered against the night time assigned noise levels.

The results of the assessment indicate noise levels associated with the operation of stage 5a and 5b are predicted to comply with the daytime assigned levels at the surrounding noise sensitive receivers. A marginal 1 dB exceedance is predicted at one receiver during night-time assigned levels (between 6am and 7am), associated with the loading of trucks.

In order to reduce noise levels to compliance under worst-case meteorological conditions, the number of trucks accessing the site for loading purposes between 6am and 7am (night-time) will be limited to no more than four trucks. No further noise mitigation measures are required to comply with the *Environmental Protection (Noise) Regulations 1997.*

3.10 Dust impacts

Dust is a generic term used to describe 'solid airborne particles generated and dispersed into the air by processes such as handling, crushing and grinding of organic or inorganic materials such as rock, ore, metal, wood or grain and stockpiling of materials and wind-blown dust' (DEC 2011).

There are several activities within the proposed stage 5a and 5b quarries that have potential to generate dust, including:

- Removal of topsoil and overburden, and stockpiling of topsoil on site (lifting onto vehicles, movement of vehicles and placement of soils in stockpiles)
- Extraction of gravel resource
- Crushing of extracted material
- Transfer/relocation of stockpiled soils
- Vehicular movement within the site on unsealed roads, as well as entering and exiting the site. It is noted that access to the site is via a sealed driveway that traverses over a right-of carriageway extending from Brookton Highway. The access way has been sealed from Brookton Highway to within 50m of the current extraction area (stage 4), thereby reducing dust associated with its operations.

Specific dust management actions for the site are detailed in **Section 5.6**.

3.11 Visual amenity

Due to the proximity of the proposed quarry expansion to existing sensitive uses, as well as sight lines from Brookton Highway, a Visual Impact Assessment (VIA) has been undertaken to support the stage 5a and 5b expansion DA and EIL applications (Emerge Associates 2021c) (see **Appendix E**).

The VIA identified that the proposed quarry expansion may be visible at times by users driving along Brookton Highway in an easterly direction (depending on location), when climbing a soft ridgeline in front of the site. Due to a valley landform and the height and form of existing vegetation, the existing and proposed quarry expansion area will not be visible from the scenic Munda Biddi Cycle Track to the east of the site, Springdale Road walking trail and vehicle access track to the north-west of the site, or the majority of Canning Road within a 1 km radius to the north of the site.

The VIA considers that the existing quarry is not easily discernible within the contextual landscape and found that the existing quarry was visible at three viewpoints, with existing vegetation at the boundary of the site and within the broader area shielding most views of the quarry. The VIA concludes that the proposed stage 5a and 5b excavations would not cause a major visual impact on the landscape of this area with vegetation screening measures in place, see **Section 6.1**.

4 Stage 5 Works and Excavation Program

4.1 Overview

With the gravel resource in the stage 4 extraction area soon to be exhausted, the proponent is seeking approval to continue gravel extraction within the site. Specifically, the proposed stage 5 extraction area located adjacent to the existing approved stage 4 extraction area, together with an internal access road and a separate vehicle compound proposed to the south.

The proposed stage 5 extraction area is approximately 5 ha in size and divided into stage 5a (approximately 2.82 ha) and stage 5b (approximately 2.17 ha) (**Figure 2**). It is projected that the gravel will be extracted at a rate of approximately 16,000 m³ a year (dependent on market demand) to a maximum depth of 10 m from the existing ground surface, or less as determined by the actual depth of the gravel resource encountered. This is consistent with the previously approved stages 1 to 4 of the existing quarry.

The proposed quarrying process and operations within the expanded gravel quarry will continue in accordance with existing operations. The following section is structured to specifically respond to the operational descriptions required by the *City of Armadale Extractive Industries Local Law* (City of Armadale 2000). Descriptions of environmental considerations and corresponding management are covered within **Sections 3** and **5** of this EMP.

4.2 Nature and duration of proposed excavation

Stage 5 works will begin at the furthest eastern extent, gradually expand the quarry in a westerly direction. Progressive rehabilitation works will occur on a yearly basis following the closure of previously extracted areas with the majority of stage 5a to be completed prior to the commencement of excavation within stage 5b. All quarrying operations will be confined within the site.

Hours of operation for the proposed expansion will remain the same, occurring between 6am to 7pm Monday to Friday. Operations permissible prior to 7.00am will be limited to the loading of no more than four trucks which can also traverse in and out of premises prior to this time, in accordance with the Acoustic Assessment, as detailed in **Section 0**. This includes the operation of front-end loaders, used inside the quarry to load gravel into the trucks. Operations prohibited prior to 7.00am include, but are not limited to, the operation of bulldozers, water trucks, fuel trucks and rock breaking machines.

4.3 Excavation stages and timing

The resource within stage 5a is equivalent to approximately three years of supply, and Stage 5b is equivalent to approximately two years of supply. Therefore, if there is maximum demand, quarrying could be completed within five years; however, more typical demand forecasts indicate that quarrying could continue or up to 10 years.

Following completion of quarrying in stage 5a, operations will move to stage 5b with revegetation to be completed in stage 5a. The staged approach allows for the temporary retention of vegetation within stage 5b during the stage 5a quarrying activities for screening purposes before the quarrying moves in a westerly direction.

Quarrying in stages, moving in a westerly direction ensures that the quarry face provides a noise barrier to the houses located to the south and west of the pit. It is assumed that a quarry face of 4 m high or greater would be always maintained and the front-end loader used to load product into trucks, operates from behind a 4 m high stockpile during activities.

4.4 Extraction methods and on-site processing works

Extraction is to be undertaken on the following basis:

- Topsoil will be removed (approximately 50 mm thick) and stockpiled in windrows.
- Overburden will be removed (approximately 250-300 mm thick).
- A bulldozer will rip the gravel and then blade it into a raw material stockpile. No over-excavation will be undertaken below pit finished floor levels.
- The raw gravel material will subsequently be crushed by way of a mobile (tracked) impact crusher.
- Trucks cart material from the quarry throughout the extraction period.
- Upon completion of extraction, the quarry floor will be ripped prior to topsoil replacement. The area will be rehabilitated in accordance with this EMP.
- The approximate annual gravel removal will be 16,000 m^3 however, this will be dependent on demand.
- The removal of gravel from the quarry will include the use of a bulldozer, a rock breaker, excavators, a loader and a crusher.

4.5 Depth and extent of the existing and proposed excavation

The ultimate depth of excavation will be to a maximum of 10 m below the natural surface and batters of 1:3 (vertical:horizontal) will be maintained throughout the operation.

4.6 Depth and description of topsoil to be removed

Topsoil will consist of 50 mm depth across the extraction area.

4.7 Removal of vegetation, topsoil, and overburden

Vegetation, overburden, and topsoil will be removed in sections and stockpiled as detailed in **Section 6.3**. All stockpiles associated with the stage 5 expansion will be located within the stage 5 quarry working area, and not within other areas of the site.

4.8 Site access

Site access for vehicles (i.e. 6 x 4 trucks and semi-trucks) entering and exiting the site will continue to occur via a sealed driveway crossing over a right-of-carriageway easement extending from Brookton Highway. A maximum speed limit of 25 km per hour will be applied to all internal roads, driveways and vehicle access ways and signs in this regard displayed at the entrances to the site.

4.9 Truck usage

The number of vehicular movements (employee and truck movements) will remain the same as existing operations. An average of 3.3 truck movements between 7am and 7pm are expected in accordance with current quarry operations. Between 6am and 7am, the number of trucks accessing the site will be restricted to four trucks to achieve compliance with night-time noise levels. The maximum number of employees on site at any one time will remain the same. A small extension of the current access road may be required to gain access into the stage 5 quarry area.

4.10 Proposed structures

No structures are proposed.

4.11 Drainage conditions

Surface water protection is an important part of the management of quarries. The extraction of gravel and hard rock is a clean operation as no chemicals are used apart from machinery lubricants.

Detailed management measures for stormwater, soil and erosion control are provided in **Section 5.1**. It is anticipated that any stormwater not diverted away from the extraction area will be easily contained within the confines of the quarry excavation area and will infiltrate through the soil profile and/or evaporate.

4.12 Specific exclusions

Given some of the issues raised during previous applications, it is important to note that the following activities will not be occurring on site:

- Mass storing of fuel. The only fuel that is stored on site comprises small amounts, no greater than three 20 Litre jerry cans at any time.
- The parking of trucks at the site. Trucks are not parked at the premises given that they are parked at the landowner's premises in Pickering Brook.
- The servicing of vehicles at the site. Only minor greasing of vehicles will occur occasionally onsite. All other vehicle maintenance and servicing will occur elsewhere.
- The undertaking of extraction activities on Sunday and Public Holidays. Operational hours have been stated above, and the operators will strictly adhere to these.
- Dewatering or blasting. No dewatering or blasting activities are proposed within the stage 5 expansion area, nor are currently undertaken as part of the existing quarry operations.
- Importation of any bulk materials to the site to be mixed/blended with gravel for sale
- Importation of any bulk materials to the site for backfilling quarry voids, unless suitable material is required (beyond that sourced within the site) for rehabilitation where granite is encountered and a suitable growing profile is required to be re-established.

4.12.1 Clearing and disturbance exclusion areas

A waterway 'avoidance area' has been identified either side of the Stinton Creek tributary to a width of 30 m, as shown in **Figure 5.** This area will be flagged on the ground and no disturbance activities will occur within this area during the excavation or quarry operational activities in order to protect the natural flow of the waterway, avoid the trampling of riparian vegetation, and weed and pest encroachment.

A total 30.83 ha native vegetation will be retained and protected within the broader site (referred to as the 'Clearing Avoidance Footprint'), as shown in **Figure 13**. The extent of the clearing area will be clearly defined on the ground with flagging before any clearing activities commence to ensure there will be no inadvertent encroachment of disturbance into retained vegetation. The vegetation proposed to be retained comprises native vegetation with high fauna habitat values suitable for a number of conservation significant fauna including the three species of black cockatoo and the chuditch, and includes:

- A total 366 black cockatoo habitat trees, two with suitable breeding hollows.
- At least 24.34 ha of Carnaby's cockatoo (CC) foraging habitat, 22.14 ha of Baudin's cockatoo (BC) foraging habitat and 20.30 ha of Forest red-tailed black cockatoo (FRTBC) foraging habitat will be retained within the broader site. Both BC and CC are listed as 'Endangered' under the EPBC Act, whilst the FRTBC is listed as 'vulnerable'.
- A total 26.18 ha of good quality consolidated habitat for the Chuditch, listed as 'Vulnerable' under the EPBC Act, will be retained within the broader site, contiguous with the similar jarrah/marri forest habitat within protected conservation reserves Korung National Park and Midgegooroo National Park to the north and east.

5 Environmental Management

The following section provides a summary of the potential environmental issues that may be encountered during the proposed extraction activities and the corresponding management strategies to avoid and/or minimise impacts. The management measures are consistent with existing commitments from the previously approved stages 1 to 4 of the quarry and include revegetation commitments for the proposed stage 5 expansion, which is referred to as rehabilitation zone 3A and 3B, and the area previously without native vegetation revegetation commitments referred to as rehabilitation zone 3C

The environmental impacts associated with the project and the management measures to be implemented at the site are summarised in **Section 9**, and addressed individually in the sections below.

5.1 Stormwater, soil, and erosion

5.1.1 Objective

To control the severity and extent of soil erosion and pollutant transport during the construction and operational phases of the gravel quarry. To maintain the quantity of surface water so that adjacent environmental values, including the Stinton Creek to the south of the site, are protected.

The site is elevated and is well drained with good potential for surface water management. There is an ephemeral watercourse (Stinton Creek) located approximately 400 m south of the existing and proposed operations which will not be directly impacted by the quarry activities. On this basis, erosion and sedimentation is not expected to be a significant issue..

Within the site, an ephemeral tributary to the Stinton Creek is present, located approximately 30 m south of the proposed stage 5 quarry extent. The tributary remains dry for the majority of the year. No activities associated with gravel extraction have been previously undertaken in this area, or are proposed to occur that would disturb the bed or banks of the tributary as a result of the proposed stage 5 expansion.

5.1.2 Target

No uncontrolled discharge of water from the extraction area that results in erosion or sedimentation into the Stinton Creek, the ephemeral tributary or areas of retained vegetation. No capture of significant volumes of overland flow to the extent that flows in Stinton Creek are materially impacted.

5.1.3 Management actions

Table 8: Management actions for stormwater, soil and erosion control

Parameter	No.	Action	Timing
Stormwater	S1	Construct diversion banks and contour drains upslope of disturbed areas to allow clean surface water to continue overland flow paths and return to the Stinton Creek and other natural watercourses (i.e. avoid external surface water flows into the quarry operational areas).	Prior to clearing and excavation.
	S2	Construct catch drains to capture runoff from disturbed areas and retain within the quarry area to enable infiltration/evaporation.	Prior to clearing and excavation.
	S3	Construct drainage works to utilise natural drainage patterns.	Prior to clearing and excavation.
	S4	Drains will discharge clean stormwater into existing vegetated natural drainage lines.	At all times
	S5	No machinery or support vehicles will enter the waterway 'avoidance area' either side of the Stinton Creek tributary to a width of 30 m and no clearing of this vegetation will be permitted, as shown in **Figure 5.** Ensure no disturbance activities will occur within the waterway buffer area during the excavation activities. Extent of avoidance area to be clearly flagged on the ground.	At all times.
	S6	Undertake visual assessment of water pooling within the quarry operational areas/pit. Standing water greater than 10 m x 10 m in extent that remains for longer than one week will be reported within the annual audit report.	Ongoing and reported annually
Erosion control	S6	Use existing access tracks or roads wherever possible rather than creating new ones.	At all times.
	S7	Clearing will only be undertaken as required for quarrying operations and will not be conducted in adverse and extreme weather conditions (e.g. excessive windy and dry conditions or during heavy rainfall).	Evaluate prior to clearing
	S8	Stabilise disturbed land as soon as possible and no later than the winter wet season, to minimise erosion.	After quarry completion
	S9	Level or gently sloping areas will be selected as stockpile sites to minimise erosion and potential soil loss.	During topsoil removal
	S10	Appropriate sediment controls will be installed upslope of stockpiles to divert water around and downslope of the stockpiles to prevent soil loss.	Prior to clearing and excavation.
	S11	Provide adequate erosion control structures on sloping ground such as spur drains or contour banks at suitable intervals.	Prior to clearing and excavation.
Stinton Creek tributary	S12	Undertake visual monitoring within the 30 m waterway avoidance area to identify any signs of erosion or sedimentation to supported with photographic evidence of site conditions.	Ongoing and reported annually

5.2 Native vegetation

5.2.1 Objective

To protect native flora and vegetation as far as practicable so that biological diversity and ecological integrity are maintained within and adjacent to the site.

5.2.2 Target

Clearing of native vegetation within the site is limited to the access road extension and proposed stage 5a and 5b extraction area.

5.2.3 Management actions

Table 9: Management actions for native vegetation management

Parameter	No.	Action	Timing
Native vegetation	V1	Native vegetation to be retained will be visibly delineated on site using flagging, in accordance with the clearing avoidance areas as shown on **Figure 13**. Clearing of any vegetation outside of the stage 5 area or propose compound is not permitted, and off-road vehicle and personnel access into the clearing avoidance area will be controlled, to reduce the spread of weeds and dieback.	During clearing activities
	V2	Clearing of native vegetation within the excavation area will occur progressively associated with extraction stages and rehabilitated in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**).	During clearing activities
	V3	No quarry excavation or operational activities are undertaken within the 'clearing avoidance footprint'.	At all times
	V4	The extent of the disturbance footprint will be monitored onsite and via aerial imagery.	At all times
	V5	Fencing established along the perimeter of the site will be maintained to control unauthorised external access into the site.	At all times

5.3 Weeds and *Phytophthora* dieback

5.3.1 Objective

To prevent spread of weed species and *Phytophthora* dieback within the site. The implementation of measures to limit or control weed infestation and pathogen spread is necessary to protect the surrounding vegetated areas within the site and the adjacent Midgegooroo National Park.

5.3.2 Target

Controlled management of weeds, particularly those listed as a Weed of National Significance (WoNS), and *Phytophthora* dieback within the site and enhanced outcomes from the proposed rehabilitation works. No weed or disease encroachment into the native vegetation proposed to be retained within the 'clearing avoidance footprint', including the Stinton Creek tributary 30 m buffer area. Ensure no disturbance activities occur within these areas during the excavation activities. Within rehabilitation zones 1 – 3, the target weed coverage is to be 10%.

A 50 m 'interface management area' will be established immediately surrounding the operational areas of the quarry, which will be monitored and managed for weeds and dieback. The extent of the interface area has been illustrated in **Figure 14**. Within this area, the target weed coverage is 5%.

5.3.3 Management actions

The primary objective of a weed control program is to prevent weed species competing with the native plants for light, nutrients and moisture. Two methods of weed control are to be utilised within the site: chemical and non-chemical.

- Chemical controls can be applied by water spraying (from small backpacks to large machinery operated systems), wiping and pasting (used in conjunction with manual cutting of woody weeds).
- Methods of nonchemical weed control include using steam, manual removal (mainly for woody weeds using either machinery or hand implements), soil scalping, soil cultivation and mulching.

Herbicides will be selected for the target species, taking into account the surrounding environment and the constraints this may present. Amongst remnant native vegetation, selective herbicides (i.e. grass or broadleaf-specific) will be favoured over general knockdown herbicides to keep off-target damage to a minimum. In consideration of the identified weed species, primarily introduced grasses and daisy species (*Asteraceae* spp.), the most suitable method for weed control is chemical spraying. It is recommended that spot spraying with a backpack spray unit is utilised to reduce impacts to non-target species. Some large woody weeds may require mechanical removal using on site machinery.

Based on the location and species of weeds present, the recommended weed treatments are detailed in **Table 10**.

Table 10: Weed control treatment

Treatment	Suggested Constituents	Target species
Glyphosate spray	2% Glyphosate including Pulse®, wetting agent and Chlorsulfuron	Broadleaf species e.g. *Sonchus oleraceus* Woody weeds e.g. *Gomphocarpus fruticosus*, *Ricinus communis*
Selective grass spray	Fusilade and approved adjuvant (e.g. Pulse®)	Grass species e.g. *Ehrharta longifolia*

While no evidence of *phytophthora* dieback infection is currently present within the site, it has historically been present within the stage 4 extraction area and therefore could be dormant within material on the site. Prior to the commencement of the stage 5 quarrying works, a pre-disturbance dieback survey will be undertaken by a DBCA certified *Phytophthora* interpreter. This will be undertaken to guide the adoption of dieback management measures within the quarry. A copy of the pre-disturbance dieback survey report will be submitted to the City of Armadale prior to undertaking any ground disturbing works within Stage 5. In the instance that *Phytophthora* is identified, the following management actions will be adopted, to prevent the spread of *Phytophthora* dieback within the subject site, as outlined in **Table 11**.

Table 11: Management actions for dieback infected areas/soil

Parameter	No.	Action	Timing
Positive result for *Phytophthora*	P1	The suspected infected area will be delineated with flagging	At all times
	P2	The suspected infected area shall be bunded to ensure that stormwater is managed and contained.	Prior to and during excavation works

Parameter	No.	Action	Timing
	P3	Appropriate signage will be erected at the entry to the subject site and at the border of the suspected infected area.	Prior to and during excavation works
	P4	Fencing and lockable gates at the entry of the property will be maintained and used to control unauthorised access to the site.	Prior to and during excavation works
	P5	Access to the subject site during operation will be restricted to the established roads. No other access points should be established. The access location and clean on exit point (CoE) should be clearly signposted.	Prior to and during excavation works
	P6	As far as reasonable and practicable all vehicles and machinery are to be cleaned of all mud and plant material prior to exit from the suspected infected area at the CoE point.	Prior to and during excavation works
	P7	Non-essential vehicle and plant movement into and within the suspected infected area will be restricted as far as possible.	At all times
	P8	All topsoil, plant material and excavated material from the suspected infected area will remain within the area and be contained in a separate stockpile from *Phytophthora* dieback free material.	At all times
	P9	Once gravel material from the suspected infected area has been processed and stockpiled, it will be tested for *Phytophthora* dieback. Any positive test results will be reported to potential customers prior to the purchase of gravel.	Prior to sale of product
	P10	All staff shall be inducted and made aware of the suspected presence and impact of the *Phytophthora* dieback pathogen and the management measures outlined in this plan.	Prior to commencement of excavation activities

Regardless of the result of the dieback survey, hygiene procedures will be adopted during excavation in stage 5a and 5b to ensure that the incidence of dieback is not increased. Specific management actions for weed and dieback control are provided in **Table 12**.

Table 12: Management actions for weed and dieback control

Parameter	No.	Action	Timing
Surface Material	W1	Assess weed and dieback potential within topsoil material prior to removal and separate topsoil for treatment or disposal if required.	Prior to and during topsoil removal
	W2	Stockpile all surface materials in the general vicinity of its origin	Surface material removal
Hygiene Measures	W3	Avoid moving surface material or fill material from weed infected areas to non-infested areas.	Surface material removal
	W4	As far as reasonable and practicable all vehicles and machinery will be cleaned of plant material, mud and soil prior to entry and exit of the site.	At all times
	W5	No soil and/or vegetation should be brought to the site, unless this is specifically required for rehabilitation works and the material has been evaluated in terms of any weed or dieback risk. Any materials bought onto the site will be specifically reported in the annual compliance report.	At all times
Access	W6	Control access within the quarry area and clearing avoidance footprint to reduce the spread of weeds and dieback, especially off-road vehicle access and personnel. This will prevent disturbance to vegetation and weed/dieback invasion.	At all times

Parameter	No.	Action	Timing
	W7	Restrict access to areas outside the quarry operations to reduce the spread of weeds and dieback into or out of the site.	At all times
Weed Control	W8	Chemical spot-spraying is to be undertaken, as necessary within the revegetation areas, operational area and the interface area, as per **Table 10**.	At all times
	W9	An interface management area extending out 50 m will be established immediately surrounding the operational areas (see **Figure 13**), which will be the target area for ongoing weed monitoring and management works.. A 5% weed cover management target will be adopted within this interface management area.	Annually
	W10	Within the revegetation area, a weed cover completion criteria of 10% will be utilised.	At all times.
	W11	Weeds observed within the quarry or clearing interface area will be addressed through an annual weed control program.	At all times
Weeds of National Significance and Priority Weeds	W9	Any identified WoNS will be given priority and removed promptly, to mitigate negative impacts on rehabilitated areas and nearby native vegetation. All WoNS have an individual strategic management plan, which will be adhered to.	At all times
Water	W10	The site will be managed to ensure water runoff is contained within the quarry and does not exit the area.	At all times
Stockpile	W11	Excavated materials that require stockpiling (topsoil and overburden) from the Stage 5 quarry area shall not be removed from the quarry. This material will be stockpiled within the vicinity of excavation and will prevent the potential spread of dieback out of the quarry.	At all times
	W12	Suspected dieback infested material, vegetation and topsoil will be contained in a separate stockpile and within the quarry boundary away from native vegetation.	At all times
Survey	W13	Pre-disturbance dieback survey shall be undertaken within the stage 5 quarry region.	Prior to stage 5 works commencing

5.4 Fauna

5.4.1 Objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained within the native vegetation proposed to be retained and adjacent conservation areas.

5.4.2 Target

Fauna habitat disturbance within the site is limited to the access road extension and proposed stage 5 extraction area.

5.4.3 Management actions

Table 13: Management actions for local fauna

Parameter	No.	Action	Timing
Native Fauna	F1	The extraction stages with be progressively cleared and rehabilitated following completion of works to minimise impacts on native fauna.	At all times.
	F2	To minimise the risk of disturbing active bird nests, clearing is to be undertaken outside of the main bird breeding season (spring).	Prior to clearing.
	F3	A pre-disturbance fauna inspection will be undertaken 1-2 days before clearing	Prior to clearing.
	F4	As far as practical, clearing will be completed in a single direction without creating islands of vegetation, ensuring that fauna do not become trapped during works.	During clearing.
	F5	An experienced fauna specialist will be present as a fauna spotter during clearing of vegetation searching for fauna in areas to be cleared and areas just cleared to identify the presence of bird or marsupial species in trees and more common ground dwelling fauna species, such as small mammals, lizards and snakes. If encountered, these animals will be assisted to disperse to nearby vegetation, if appropriate, or translocated.	During clearing.
	F6	Fauna must not be intentionally harmed and any feeding of or contact with native fauna is not permitted.	At all times.
	F7	Any instances of native fauna mortality will be reported immediately to the Site Manager and fauna habitats identified for protection not disturbed.	As required.
	F8	Native fauna habitat to be retained which comprises high fauna habitat values suitable for a number of conservation significant fauna, including the three species of black cockatoo and the Chuditch, will be visibly delineated on site with flagging according to the clearing avoidance areas as shown on **Figure 13**. No clearing of this vegetation is permitted.	During clearing.
Pest Fauna	F9	Feral fauna species identified within the operational area, revegetation area and interface management area shall be recorded, reported to the Site Manager, and control measures will be undertaken as appropriate.	Monthly
	F10	1.8 m high fence composed of steel star pickets with rammed in corner assemblies will be installed around the perimeter of revegetation areas. The fencing surrounding active rehabilitation areas shall be maintained and used to control herbivorous fauna (i.e. kangaroos and rabbits) entering these zones.	As required.
	F11	The interface management area will be monitored for the presence of feral animals.	At all times

5.5 Bushfire

The proposed quarry expansion does not meet the SPP 3.7 definition of a 'high-risk' development. There is no threshold for what constitutes a proposal as high-risk, but decision-makers may consider the quantity of hazardous materials stored such as explosives. As part of the extraction activities, the quantities of fuel storage on site will not necessitate the requirement to obtain a Dangerous Goods Licence under the *Dangerous Goods Safety (Storage and Handling of Non-explosives) Regulations 2007.* The only fuel that is currently stored on site comprises approximately three 20 Litre jerry cans at any time. The removal of gravel from the quarry will occur through ripping by bulldozers and excavators and will not require blasting activities.

The following activities will not occur on site:

- Construction of permanent or temporary habitable buildings on site
- Mass storing of fuel
- Parking of trucks at the site
- Servicing of vehicles at the site.

Further consideration of bushfire will be required if any future building construction, that requires Development Approval, is proposed within the 'bushfire prone areas' (within the Map of Bush Fire Prone Areas, as published).

The CoA releases a Firebreak Notice on an annual basis to provide a framework for bushfire management within the municipality. The CoA can enforce this notice in accordance with Section 33 of the *Bush Fires Act 1954*. In addition, Section 33 1(b) also provides the CoA with additional power to direct landowners to undertake works to remedy conditions conducive to the outbreak or spread of bushfire.

The proponent will be required to comply with the Firebreak Notice, including the maintenance of minimum 3 m-wide perimeter firebreaks to accommodate for the width of emergency vehicles and have a minimum height clearance of 4 m to allow for the height of emergency vehicles.

5.6 Dust

5.6.1 Objective

To control the severity and extent of dust impacts off site during the construction and operational phases of the gravel quarry.

5.6.2 Target

No substantiated complaints received from the community, neighbours, other stakeholders, or regulatory authorities in relation to off-site dust impacts from the extractive operations.

5.6.3 Management actions

Table 14: Management actions for dust control

Parameter	No.	Action	Timing
Dust control	D1	Monitor weather forecasts to determine ground moisture level, wind strength (especially prevailing winds) or direction or other seasonal conditions applicable to the extractive operations.	At all times
	D2	In the event that weather conditions are unfavourable, especially in the case of adverse ground moisture level or wind strength or direction, operations will be rescheduled or ceased to minimise excessive dust emissions.	When required by unfavourable weather conditions

Table 14: Management actions for dust control (continued)

Parameter	No.	Action	Timing
	D3	A water truck (6 x 4 in size) with hydraulic water pumps is to be used to wet the access/driveways and stockpiles when hot, dry and windy conditions are anticipated to occur during operations.	When required by unfavourable weather conditions
	D4	A 25 km/hr speed limit will be applied to all internal roads, driveways and vehicle access ways, supported by appropriate signage.	At all times

5.7 Noise

5.7.1 Objective

To control the severity and extent of noise impacts off site during the construction and operational phases of the gravel quarry.

5.7.2 Target

No substantiated complaints received from the community, neighbours, other stakeholders, or regulatory authorities in relation to off-site noise impacts from the extractive operations.

5.7.3 Management actions

An acoustic report was prepared by Lloyd George Acoustics (2021) to reflect the new stage 5 extraction area. The findings of the acoustic report have confirmed that the impact of excavation in the stage 5 area will continue to comply with the relevant noise regulations, with the restrictions of truck movements in place, as outlined in **Table 15**.

The results of the assessment indicate that the night-time loading of trucks (between 6am and 7am), causes a marginal 1 dB exceedance at one receiver. Therefore, the number of truck loadings will be reduced to four trucks during this time. The acoustic report indicates that the predicted noise levels will comply with the required levels, and as such, no additional noise reducing measures are required.

Table 15: Management actions for noise

Parameter	No.	Action	Timing
Noise control	N1	Works generating excessive noise and rock breaking will not occur outside the hours of 7am to 7pm or on a Sunday or Public Holiday.	Between 7am to 7pm or on a Sunday or Public Holiday.
	N2	Prior to 7am Monday to Friday, works are limited to loading of a maximum of four trucks per hour.	Prior to 7am Monday to Friday.
	N3	The crusher and front-end loaders will operate from behind stockpiles of at least 4 m height	During excavation activities.
	N4	Rock breaker and dozer will operate behind the 4 m high pit face within the confines of the approved expansion area.	During excavation activities

Table 15: Management actions for noise (continued)

Parameter	No.	Action	Timing
	N5	Undertake regular maintenance of plant and ensuring acoustic enclosures or covers fitted to plant are used at all times.	During excavation activities as required
	N6	A limit of two items of plant will be in operation at any one time due to the number of personnel of site.	At all times.

5.8 Visual amenity

5.8.1 Objective

To reduce adverse visual impacts on the surrounding environment as low as reasonably practicable.

5.8.2 Target

Works in visually prominent places are minimised and disturbed natural areas rehabilitated to maintain the existing landscape character.

5.8.3 Management actions

The Visual Impact Assessment (Emerge Associates 2021) concluded that with the proposed vegetation screening measures, outlined in **Table 16** below, the expansion would not cause a major visual impact or alteration to the landscape of this area.

Table 16: Management actions for visual amenity

Parameter	No.	Action	Timing
Visual	V1	Retain temporary strip of vegetation over stage 5b during the stage 5a excavation activities for screening purposes.	During stage 5a extraction activities
	V2	Respread topsoil and progressively rehabilitate post-quarried areas in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**), so the exposed areas are less visually prominent.	At the completion of each quarry
	V3	Revegetate visual screening strip (Zone 1) with planting dieback resistant tubestock in a linear arrangement and undertake weed control in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**) so the exposed gravel quarry areas are less visually prominent.	During revegetation activities
	V4	Retain of a 20 m vegetation buffer from the extraction area to the site boundary to the north to provide a physical separation barrier.	At all times.
	V5	Ensure barriers, fences and gates are compatible with the semi-rural style of the surround land areas and natural landscape.	At all times
	V6	Locate stockpiles within confines of the gravel quarry footprint.	During excavation activities
	V7	To ensure exposed areas are less visually prominent, the respread of topsoil will be darker in colour than the orange-coloured post-mined pits.	At all times.

6 Rehabilitation and Decommissioning Program

The following section is structured to provide a rehabilitation and decommissioning program in accordance with the requirements of the *City of Armadale Extractive Industries Local Law* (CoA 2000). The rehabilitation program proposed for stage 5a and 5b also takes into account previous rehabilitation commitments associated with historically approved stages of the existing quarry, as well as new revegetation commitments for the proposed expansion area.

A total 13.43 ha of native revegetation will be established within the site which will ultimately establish potential breeding and foraging habitat for a number of conservation significant fauna, including Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo.

This incorporates the 5.01 ha of native revegetation using a mixture of tube stock and direct seeding previously conditioned under Clearing Permit 8273/1 for stage 4 of the quarry. The remaining 8.42 ha comprises additional revegetation areas (i.e. not already required as part of previous approvals), with 4.99 ha of the stage 5 expansion, and 3.43 ha across the stage 4 quarry and previously disturbed areas of the site, collectively to counterbalance the residual impact of the stage 5 expansion clearing.

Maintenance and monitoring will be conducted until completion criteria are met for these areas. Compliance reporting and adaptive management measures are also specified in this EMP to ensure the intended outcomes are achieved, further detailed in **Section 6.1** to **Section 9**.

Completion criteria for species diversity, species density, topsoil management and reinstatement of the site has been determined in accordance with specific advice sought and received from Tranen Revegetation Systems, a specialist revegetation contractor. All advice has been accommodated within this EMP.

6.1 Program objectives

The site is classified into post-quarrying land uses, with specific objectives for each land use. The planned post-quarrying land uses, their relevant objectives and the measurable goals for each zone to achieve the objectives are described below. The planned post-quarrying land uses, and the relevant objectives are illustrated in **Figure 12**.

6.1.1 Land use – screening (zone 1)

The objective is to reduce any visual impacts associated with the excavation area via vegetative screening. This will involve planting dieback resistant tubestock in a linear arrangement and undertaking weed control.

The completion criteria for zone 1 is as follows:

- Establish three tree rows, 5 m apart, with one tree per 10 m and three shrub rows, 5 m apart, with one shrub per 2 m
- Reduce weed cover to less than 10%.

6.1.2 Land use – native revegetation (zones 2 and 3)

Zone 2 incorporates the 4.35 ha of native revegetation previously conditioned under Clearing Permit 8273/1. The objective is to further revegetate a previously stabilised area (i.e. existing rehabilitation area) with native vegetation to create a diverse, self-sustaining vegetation community. This will include additional direct seeding with dieback resistant species and the implementation of a weed control program.

Zone 3 extends over 8.42 ha including the stage 4 quarry and previously disturbed areas of the site, which covers 3.43 ha, in addition to the revegetation of 4.99 ha encompassing the proposed stage 5a and 5b quarries. The objective is to revegetate a historically disturbed and future stabilised area with native vegetation to create a diverse, self-sustaining vegetation community. This will include direct seeding of over 15 dieback resistant species of tree, shrub and herbs and the implementation of a weed control program.

The completion criteria for zones 2 and 3 are as follows:

- A native density of approximately 0.8 plants/1m^2
- A species richness of no less than 15 species of tree, shrub and herbs
- Reduce weed cover to less than 10%.

6.2 Restoration and reinstatement of excavation site

In areas where excavation is completed, and prior to the ultimate re-forming of the area for subsequent revegetation, slopes around the perimeter of the excavation area will be re-contoured to achieve stable gradients (less than 1:4 vertical to horizontal) and the quarry floor will have at least a 1:100 fall. The post-quarried stage 5 will be recontoured to the above dimensions, this is depicted based on existing topographic contours, in **Figure 14**. The final landform is anticipated to be a gently sloping surface created by the gravel extraction 'scalping' the existing upland topography. The floor of the excavated areas, which generally bottoms out in clayey material, will be deep ripped parallel to contours to minimise or eliminate erosion and seed loss and provide a base for native revegetation, as discussed below.

Restoration and reinstatement of the excavation site will be undertaken progressively upon the completion of each extraction stage.

6.3 Topsoil and overburden replacement and revegetation

Topsoil is an integral part of rehabilitation as it contains organic matter and seed bank which assists in establishing vegetation when respread on disturbed areas.

Topsoil at the site will be stripped and stockpiled prior to commencing quarrying. If possible, progressive rehabilitation will be undertaken whereby topsoil will be directly replaced onto a previously excavated stage. The soils will be stripped in a dry state to preserve soil structure and stripping will be undertaken in relatively still weather conditions. Management of the topsoil will involve the following:

- Stockpiles will be located sufficiently distant from quarrying operations so that they will not be disturbed prior to being used in rehabilitation (if progressive rehabilitation is not possible).
- Topsoils should be stripped to a depth of approximately 50 mm, respread separately. In some areas, topsoil depth may differ due to the topography of the site.
- Soil stripping should be avoided during wet conditions.
- The dimensions of the topsoil stockpiles will not exceed 2 m in height. This is to prevent topsoil becoming anaerobic and deteriorating in soil structure, organic matter, nutrients, seed resource and populations of beneficial soil micro-organisms.
- All topsoil and overburden stockpiles will be located within the general vicinity of its origin, and stockpiles associated with the stage 5 expansion will remain in the stage 5 extraction footprint. This is to prevent the potential spread of weeds and *Phytophthora* dieback.

Furthermore, to maximise the reuse of valuable materials from clearing events, large logs will be salvaged from clearing areas and then utilised within rehabilitation areas to provide fauna habitat. The location of large trees in the clearing footprint that will be targeted for salvage for revegetation use in zones 2 and 3 is shown in **Figure 15**.

6.4 Revegetation details

In consideration of the post-quarried land use and the site's environmental values and distinct rehabilitation zones have been identified. These are depicted on **Figure 12** and described as follows:

- Zone 1 – Visual Screening
- Zones 2 and 3 – Native Revegetation

Revegetation activities have commenced within previously disturbed portions of the site. Informal visual investigations of rehabilitation success within these areas and a formal audit undertaken in 2021 covering the 2020 and 2021 operational years have indicated some vegetation has established, however the native plant percentage cover targets in most survey locations have not been met. Therefore, the rehabilitation programme will utilise infill planting and direct seeding with species of local province at the densities required to reach the completion criteria as outlined in **Section 6.1**.

A species list for revegetation with native species is provided in **Table 17**.

A key objective of the revegetation is to re-establish black cockatoo habitat, and particularly foraging habitat within the site. Based on the species selected, it is expected that shrubs would mature (flower and fruit) and provide foraging habitat for black cockatoos within approximately three to five years, and trees would be expected to provide a foraging resource for black cockatoos from around five to seven years. Noting that these timeframes would be the initial flowering and fruiting and abundance would increase with maturity.

Table 17: Revegetation plant species list

Form	Species	
Groundcovers	*Hardenbergia comptoniana* *Kennedia coccinea* *Orthrosanthus laxus* *Dampiera linearis*	*Burchardia congesta* *Clematis pubescens* *Kennedia prostrata* *Conostylis aculeata*
Shrubs	*Allocasuarina humilis* *Calothamnus quadrifidus* *Hakea amplexicaulis* *Hakea lissocarpha* *Mirbelia dilatata* *Hakea petiolaris*	*Acacia drummondii* *Acacia huegelii* *Acacia preissiana* *Hemiandra pungens* *Hibbertia racemosa* *Acacia lateriticola* *Acacia pulchella*
Trees	*Eucalyptus patens* *Eucalyptus lane-poolei* *Eucalyptus laeliae*	*Eucalyptus wandoo* *Corymbia calophylla*

Direct seeding is a key component of the revegetation approach. This is considered acceptable and will ensure appropriate outcomes on the basis that adequate and appropriate site preparation is undertaken, and the specified (and higher) seed application rates (i.e. kg/ha) are adopted.

6.4.1 Zone 1 – visual screening

It is proposed to continue to improve the vegetative screen associated with the existing stage 4, to the west of the internal haul road. Revegetation activities have previously commenced for visual screening purposes however the native plant percentage cover targets have not been met.

Where necessary, soil in this area will be ripped (excluding areas that contain native vegetation) prior to additional planting to loosen soil aggregate and provide a softer soil surface for the establishment of plant roots.

Tubestock will be used in this zone in consideration of the small planting area and layout requirements. The maximum stock size will be limited to tubestock size as larger stock is likely to require supplementary watering to ensure survival. All revegetation stock will be sourced from (preferably) local nurseries with NIASA accreditation to ensure that tubestock soil is disease free. Provenance stock will be used to revegetate this zone.

Planting will be undertaken by ripping to loosen the soil. The planting hole will be excavated vertically to accommodate the root ball of the plant, such that the top of the plant root ball finishes below the existing ground surface and creates a watering saucer suitable for the size of the plant. Seedlings will be watered before delivery to site on the day of planting to reduce the potential for transplant shock.

The planting of seedlings will occur between the months of May to July after substantial rain has saturated the soil profile. Prior to planting the seedling, any tangled roots will be loosened and good soil to plant contact will be made. Seedlings will not be staked for support as free standing plants have increased durability and strength as opposed to staked plants.

6.4.2 Zone 2 – native revegetation

Zone 2 consists of the previous stage 4 rehabilitation areas, also required as a condition of the clearing permit, and was largely undertaken in the 2019 revegetation season. Zone 2 will continue to be revegetated with native species via infill planting to improve the overall success.

An informal assessment was undertaken on 8 March 2021 combined with formal monitoring in July 2021 to measure progress towards the EMP revegetation targets and quantify the requirements to meet the commitments. The assessment found some vegetation had established within zone 2 as part of previous revegetation activities, however, native stem density met the target in only two of the 20 survey points, both in the northwest of the site. Weed cover met the target in just three of 20 survey locations, two of those being the areas where the native stem density target was also met and averaged over 30% across the site.

Two revegetation methodologies will be utilised within zone 2; infill planting for areas semi established but plant density is below target, and direct seeding for areas where establishment has not met the completion criteria.

Areas where revegetation has not met the completion criteria will undergo new site preparation and seeding. Seed will be broadcast uniformly within the marked areas in overlapping passes using portable hand-held equipment to allow for complete and even seed coverage of the pre-prepared area. Seed will be mixed with a bulking agent such as vermiculite, clean sand or sawdust in a ratio of two parts bulking agent to one part seed. If deemed necessary, seed will be covered by very light harrowing, scarifying, bagging, dragging or light raking of the seeded area as soon as practical and within the same day of seeding. Recommended sowing rates to ensure successful revegetation are based on up to 4kg of seed per hectare.

6.4.3 Zone 3 – native revegetation

Zone 3 consists of the previous stage 4 extraction area (3C) and the proposed stage 5a and 5b extraction areas (Zone 3A and 3B) as shown on **Figure 12**. Zone 3 will be revegetated with native species via direct seeding.

Seed will be broadcast uniformly within the marked areas in overlapping passes using portable hand-held equipment to allow for complete and even seed coverage of the pre-prepared area. Seed will be mixed with a bulking agent such as vermiculite, clean sand or sawdust in a ratio of two parts bulking agent to one part seed. If deemed necessary, seed will be covered by very light harrowing, scarifying, bagging, dragging or light raking of the seeded area as soon as practical and within the same day of seeding.

Recommended sowing rates to ensure successful revegetation are based on up to 3 to 6 kg of seed per hectare.

6.5 Maintenance of rehabilitation areas

Maintenance will be undertaken following planting/seeding with all activities to be conducted in response to the maintenance inspections and monitoring (as discussed below). The key elements associated with maintenance works will include suppression of smothering weeds and infill planting.

The requirement to implement revegetation maintenance and infill planting measures will be determined following each monitoring event.

To reduce the risk of mortality, watering will occur if required during the first summer after tubestock have been planted (i.e. only within zone 1). This will entail periodic watering from December to April using a mobile watering vehicle. It is expected that two watering events per month is sufficient to establish the revegetation planting, however if plants are suffering drought stress, additional water may be required. Watering will be undertaken at an approximate rate of two litres per plant.

Maintenance will continue to be undertaken as required until the criteria have been achieved or as otherwise agreed with the CoA. Following the successful completion of the revegetation program, and the submission of a final report, the CoA will, upon application from the owner, refund the bond lodged against the implementation of the EMP for these areas.

6.6 Program of rehabilitation works

6.6.1 Schedule for zone 1 and 2

The site has historically been revegetated via direct seeding within zone 1 and zone 2. This technique, however, has not met the completion criteria in many areas and as such, it is recommended that this be rectified with infill planting of tubestock to ensure that the completion criteria can be met. Whilst direct seeding could be reapplied in these areas, it would require extensive site preparation works, which would impact on those plants already established, and take several years for any vegetation cover to form. Tubestock/seedling planting is likely to lead to quicker establishment in the short term and therefore has been selected as the most appropriate revegetation technique for zone 1 and zone 2. Based on an assessment undertaken on 30th July 2021, the infill planting and direct seeding required to achieve the target density has been specified for zone 1 and zone 2, as outlined in **Table 18** below. Zone 2 has been further categorised into four areas (2A – 2D), in accordance with the revegetation requirements (whether infill planting or direct seeding is required) and the plants/seed needed to fulfil the specified target within **Section 6.1**.

Table 18: Revegetation schedule for zones 1 and 2

Revegetation area	Method of revegetation	Infill density required (plants required)	Seed @ 3 kg/ha (kg)	Comments
Zone 1	Infill planting	381	N/A	Very few plants have established so this area will be replanted at 100% of the target density, with the screening lines reinstated
Zone 2A		7,273	N/A	Some established plants but density below target
Zone 2B		2,043	N/A	
Zone 2C		3,332	N/A	
Zone 2D	Direct seeding	N/A	1.32	Recontour and seed rather than infill plant. This is because preparatory earthworks in this area would not result in many plant losses due to very low establishment densities

The ongoing and proposed maintenance schedule for decommissioned pre-disturbed portions of the site, incorporating zone 1 and zone 2 is provided in **Table 19**. The timing provided is indicative only as the specified actions will be undertaken at times appropriate to the activity and conditions (i.e. soil conditions, weather, growth of weeds).

Table 19: Maintenance schedule for zone 1 and zone 2

Timing	Action	Purpose/Frequency
Site preparation		
2021 September – November	Herbicide application	To target spring weeds before seeds set.
2021 September – November	Woody weed removal	Are to be initially treated with herbicide. Some may require mechanical removal using onsite machinery. Undertaken on an as needs basis between the specified months, and prior to planting or seeding in weed affected areas
2022	Fence installation – 1.2 m star picket ringlock	Upon completion of quarry activities. Post quarry closure
2021/2022 December – February	Order seeds on species list for zone 2E Order local endemic plants on species list for zone 1 and zone 2A – 2D	In preparation of infill/seeding
2021/2022 December – February	Herbicide application	To target late summer weeds
2021/2022	Plastic tree guard removal and disposal	Prior to ripping and re-contouring
2022 March – May	Herbicide application	To target new autumn weeds
Revegetation		
2022 March – May	Ripping and re-contouring	Prior to planting
2022 April – June	Seed pre-treatment and batching Seed hand broadcasting (zone 2E) Tree guard supply and installation in zone 2B	Prior to direct seeding and may include aerosol smoke treatment, mechanical scarification and hot water treatment, depending on species Hand broadcasting ensures even dispersal of all seed types Once seedlings have been established, to reduce potential loss from herbivory fauna, and foot and vehicle traffic
2022 June – August	Tubestock installation (zone 1 and zone 2A – 2D)	
2022 September – November March – May	Visual inspection of plant numbers and species (infill). Monitoring for weed invasion, seedling survival, plant pests and other factors affecting seedling survival (seed)	Every two years.
2022 September – November	Herbicide application	To target spring weeds before seeds set.

Timing	Action	Purpose/Frequency
2022/2023 December – February	Herbicide application	To target late summer weeds.
2022/2023 December – April	Watering seedlings during the first summer	Every second week at an approximate rate of two litres per plant.
2023 March – May	Herbicide application	To target new autumn weeds.
2023 June – August	Infill planting – 30% required density Infill tree guards – 30% in zone 2B	Once seedlings have been established, tree guards to be established to reduce potential loss from herbivory fauna, and foot and vehicle traffic
2023 September – November	Herbicide application	To target spring weeds before seeds set.
2023/2024 December – February	Herbicide application	To target late summer weeds.
2024 March – May	Tree guard removal year 1 infill Herbicide application	To target new autumn weeds.
2024 June – August	Infill planting – 15% required density (no guards required for zone 2B)	N/A

6.6.2 Schedule for zone 3

The proposed program of works for rehabilitation zone 3C, which specifically relates to the historical stage 4 quarry, has been provided in **Table 20.** To reach the native vegetation density of 0.8 plants/m^2, 15.92 kg seeds at 4 kg/ha are required to be dispersed across the area.

Prior to the commencement of any vegetation clearing within zone 3A, zone 3C landform recontouring will be 80% completed ready for the first year of revegetation works. The initial revegetation works for 100% of the Zone 3C area needs to be completed within 12 months of vegetation clearing occurring within zone 3A.

Table 20: Rehabilitation of 3C within zone 3

Timing	Action	Purpose/Frequency
Site preparation		
March – May	Herbicide application pre-planting	To target new autumn weeds
March – May or post quarry closure.	Fence installation	Upon completion of quarry activities
December – February	Order seeds on species list for zone 3	
Revegetation		
March – May	Seed pre-treatment and batching Ripping and re-contouring	Prior to direct seeding and may include aerosol smoke treatment, mechanical scarification and hot water treatment, depending on species Prior to planting
April – June	Seed hand broadcasting	Hand broadcasting ensures even dispersal of all seed types
Maintenance		
September – November March – May	Monitoring for weed invasion, seedling survival, plant pests and other factors affecting seedling survival	Every two years
September – November	Herbicide application	To target spring weeds before seeds set
December – April	Watering seedlings during the first summer	Every second week at an approximate rate of two litres per plant
December – February	Herbicide application	To target late summer weeds.
March – May	Herbicide application	To target new autumn weeds.
June – August	Infill planting – 30% required density	N/A
September – November	Herbicide application	To target spring weeds before seeds set.
December – February	Herbicide application	To target late summer weeds.
March – May	Herbicide application	To target new autumn weeds.
June – August	Infill planting – 15% required density	N/A

The proposed program of works for rehabilitation areas 3A and 3B, which specifically relates to the stage 5 quarry, has been provided in **Table 21**. To reach the native vegetation density of 0.8 plants/m^2, 19.98 kg seeds at 4 kg/ha are required to be dispersed across the area.

Zone 3A will be progressively recontoured as quarrying progresses within the area. Clearing within zone 3B will not commence until topsoil placement has occurred across the eastern (rear) pit slopes of zone 3A, and recontouring has been completed for 50% of the zone 3A area.

The first year of revegetation works will be undertaken and completed across the entirety of zone 3A, within 12 months after vegetation clearing commencing in zone 3B. As quarrying progresses within zone 3B, the land will be progressively recontoured. The first year of revegetation works will be completed across the entirety of Zone 3B in the first revegetation season after gravel extraction has concluded from Zone 3B.

Table 21: Rehabilitation of 3A and 3B within zone 3

Timing	Action	Purpose/Frequency
Site preparation		
March – May	Herbicide application pre-planting	To target new autumn weeds
March – May or post quarry closure.	Fence installation	Upon completion of quarry activities
December – February	Order seeds on species list for zone 3	
Revegetation		
March – May	Seed pre-treatment and batching Ripping and re-contouring	Prior to direct seeding and may include aerosol smoke treatment, mechanical scarification and hot water treatment, depending on species Prior to planting
April – June	Seed hand broadcasting	Hand broadcasting ensures even dispersal of all seed types
Maintenance		
September – November March – May	Monitoring for weed invasion, seedling survival, plant pests and other factors affecting seedling survival	Every two years
September – November	Herbicide application	To target spring weeds before seeds set
December – April	Watering seedlings during the first summer	Every second week at an approximate rate of two litres per plant
December – February	Herbicide application	To target late summer weeds.
March – May	Herbicide application	To target new autumn weeds.
June – August	Infill planting – 30% required density	N/A
September – November	Herbicide application	To target spring weeds before seeds set.
December – February	Herbicide application	To target late summer weeds.
March – May	Herbicide application	To target new autumn weeds.
June – August	Infill planting – 15% required density	N/A

6.7 Monitoring and reporting

A program of monitoring of the revegetation works and the broader EMP compliance is required to ensure that the objectives and management requirements are achieved.

Two maintenance inspections will be undertaken each year during the key growth periods of spring and autumn by the proponent to determine the requirement for maintenance measures. Annual maintenance reports will outline the current status of the revegetation program and establish trends with respect to previous assessments, as well as determine whether remedial actions such as weed control and infill planting are required to meet the completion criteria.

Formal monitoring for native species establishment, invasive species, and erosion will be undertaken in spring, every two years, by a qualified botanist. The frequency of formal monitoring has been developed in consideration of the variable germination rates between species and the typically long establishment times associated with direct seeding. Given that half-yearly maintenance inspections will be undertaken to determine the requirement for maintenance measures (i.e. weed management), the formal monitoring schedule is considered suitable.

Formal monitoring within zone 1 will involve a visual inspection of plant numbers and species within each row. This will include specific counts and percentage cover of native species, and a list of weed species with estimates of percentage cover.

Formal monitoring for zones 2 and 3 will involve an assessment of randomly selected quadrats within both zones. This will include photo monitoring points at each quadrat. The dimensions of the monitoring quadrats will be approximately five metres by five metres and will be pegged on each corner. An average of the revegetation success will be determined based on the results from the monitoring quadrats. The following characteristics will be assessed:

- Stem density and health
- Weed cover
- Plant pests
- Herbivory
- Other factors affecting seedling survival, such as water stress and disease
- Species richness.

A report will be prepared on the results from each formal monitoring event, addressing the criteria provided above. A copy will be provided to the CoA by way of reporting on the success of the program by 29th July each year, with the reporting period being from 30th June to 1st July the following year.

Whilst weed suppression will primarily be required in those areas that have been disturbed, as these have a greater susceptibility to weed invasion compared to those areas with intact vegetation, weed monitoring shall extend to the wider regions of the site and primarily into the interface management area. This will involve annual visual inspections to monitor the presence and introduction of weeds beyond each of the zones. On the identification of weed invasion, weeds will either be removed, buried or sprayed with herbicide. Weeds identified as a Weed of National Significance or a declared and priority weed will take precedence and will be promptly removed from site.

Audit reports will continue to be submitted to the City of Armadale by 29th July each year to illustrate the applicant's compliance with the relevant management requirements and criteria. This currently includes the following:

- Emissions, discharges and wastes associated with the extraction of gravel
- Dust emissions
- Noise emissions
- Groundwater separation
- Potential contamination of the surrounding environment
- Management of complaints
- Rehabilitation of disturbed areas

Additional information arising from this EMP to be provided within the annual audit report has been summarised in **Table 22.**

Table 22: Items to be reported within the annual audit compliance report

Parameter	Item to be reported
Mine Closure Planning	The volume of gravel extracted and removed from the site over the reporting period
	Summary of the proposed closure works for the next 12 month reporting period
	The extraction progress of the reporting period and the provision of an annual contour survey
Landform stability	Evaluation of landform stability, including assessment of and comment on areas of on-site erosion, scouring, or potential offsite sedimentation
	Provision of a map demonstrating areas where contour stabilisation is complete
Soils	Provide details of topsoils stripping, stockpile locations and proposed re-use schedule of topsoil
Clearing avoidance footprint	Photographic evidence of the onsite delineation of the clearance avoidance footprint
Weed management	Weed management will be undertaken within the revegetation areas, the clearing area and interface management area
Dieback management	Dieback management will be undertaken within the revegetation areas, the clearing area and interface management area
Pest animal management	Pest animal management will be undertaken within the revegetation areas, the clearing area and interface management area
Stinton Creek tributary	Environmental assessment/evaluation of the Stinton Creek tributary including 2 photo monitoring points
Documentation	Provision of a copy of induction records, inspections, and compliance register
	Map of areas ripped
	Map of areas of vegetation cleared
	Report on progress of clearing and an annual progress report on revegetation activities and progress of implementation
Non-compliance	Any non-compliances with the planning approval, extractive industry licence and/or the EMP will be noted within the audit and will be rectified as soon as possible

Zone 3 incorporates all future rehabilitative work, specifically the historically disturbed stage 4 (rehabilitation zone 3C) and the proposed stage 5 quarry (rehabilitation zones 3A and 3B), as illustrated in **Figure 12**. Historically, it was the objective of the applicant to return the stage 4 gravel extraction land to a condition capable of supporting agricultural activities, using a variety of dryland pasture species. It is now the intent to revegetate the land with native species. Future audit reports shall include the audit and monitoring results within zone 3. The purpose of the audit report is to assess conformance with the EMP.

6.8 Management actions

Table 23: Management actions for revegetation

Parameter	No.	Action	Timing
Landform	R1	All slopes will be contoured to achieve a maximum slope of 1:4 vertical to horizontal.	Prior to revegetation
	R2	Deep rip (approximately 0.5 m) on contours to reduce erosion, reduce flow velocities, promote water capture/infiltration, and promote soil binding. Carry out shallow ripping as required.	Prior to revegetation
	R3	Stockpiled topsoil will be re-spread to create a land surface that is safe and stable.	Prior to revegetation
Revegetation	R4	Undertake revegetation within each zone as per **Section 6.4**.	During revegetation activities
Maintenance	R5	Undertake maintenance measures as per **Section 6.5**.	During revegetation activities
Monitoring	R6	Monitoring and reporting work are required to ensure that the revegetation objectives are achieved. Undertake monitoring as per **Section 6.7**.	Refer to **Section 6.7**.

7 Quarry closure

The proposed rehabilitation and decommissioning commitments are outlined within **Table 24**.

Table 24: Rehabilitation and decommissioning commitments

Task	Description	Frequency and duration
Rehabilitation monitoring	Assessment of success of rehabilitation areas and identification of additional works required to progress site towards completion criteria.	Formal monitoring undertaken in spring, every two years.
Decommissioning of infrastructure	Removal of non-natural infrastructure.	Upon completion of site rehabilitation.
Weed control	Chemical weed spraying, mechanical removal of large weeds as necessary.	To be identified during rehabilitation monitoring
General maintenance	Fence maintenance, rubbish removal, infill planting.	As required.

The closure planning will be updated on an as needs basis as the excavation progresses towards completion. This will include anticipated costs and procedures.

Table 25 provides the methods to be used to achieve the closure and rehabilitation objectives. The following procedures will be used for final closure and rehabilitation of the quarry.

- The closure of completed areas of the operations will be progressive with closure of all remaining ground at the end of operations.
- Maintenance and monitoring will be conducted until completion criteria are met (refer to **Section 6.5**).
- Unexpected or early closure will be completed in the same way as permanent closure.

Table 25: Closure measures

Closure objective	Completion criteria	Measurement tool	Performance indicator	Remediation
All non-natural structures will be removed.	Non-natural materials associated with quarrying will be removed. All hardstands and roads will be removed.	Visual audit of site.	No non-natural structures will be retained on site.	Remove any non-natural materials.
All wastes will be removed from site.	No waste material on site	Visual audit of site.	No waste material on site.	Remove any non-natural materials.
Provide a safe and stable landform	All slopes will be contoured to achieve a maximum slope of 1:4 vertical to horizontal.	Feature survey of the site.	Feature survey confirms gradients within rehabilitated areas.	Undertake further earthworks to create a safe and stable landform.
The land surface and soils are to be capable of supporting native vegetation.	Soil properties and the landform will be appropriate for the future land use.	Formal monitoring as per **Section 6.7**.	Visually observe the land surface and compliance with completion criteria (refer to **Section 6.1**).	Undertake further earthworks to provide the required land surface.

Closure objective	Completion criteria	Measurement tool	Performance indicator	Remediation
Soils and landforms exhibit erosion rates consistent with surrounding areas and do not compromise post-mining land uses.	No active gully erosion or sedimentation.	Visual audit of the site.	Stable soils and landforms.	Undertake additional drainage works to control erosion.

8 Implementation

8.1 Roles and responsibilities

Key roles and responsibilities for the implementation of this EMP are presented in **Table 26.** These will be clearly communicated to personnel via site induction. It is essential that all personnel associated with the quarrying comply with the requirements of applicable environmental legislation, regulations and standards.

Table 26: Roles and responsibilities for EMP implementation

Roles	Responsibilities
Site Manager	• Ensure that all personnel are inducted in the requirements of this EMP, and the system used for reporting of environmental incidents. • In the event of a non-compliance, take corrective action to prevent repeat offences. • Ensure that the site remains tidy and safe for personnel.
All personnel (including subcontractors)	• Attend environmental induction or any other training as required. • Report all environmental non-compliances or risks as they occur to the Site Manager.

8.2 Inspections and reporting

8.2.1 Induction records

All personnel will be provided with a site induction covering the requirements of this EMP prior to commencing work on the site. Records of site induction training attendance will be kept on-site.

8.2.2 Inspections

The Site Manager will undertake regular inspections to ensure management measures contained in this EMP are being followed. All non-compliances during inspections will be documented and details provided to the CoA regarding how these were handled.

8.2.3 Compliance register and consultation

The Site Manager is responsible for dealing with any complaints received by the community, neighbours, other stakeholders or regulatory authorities in relation to the extractive operations. The Site Manager will also be responsible for informing neighbours or other relevant parties of clearing, overburden removal or crushing operations as planned to minimise any complaints which are specifically related to dust emissions.

A compliance register should be established, and appropriate consultation should be undertaken with the relevant parties immediately to address their concerns in relation to reducing dust emissions associated with the operations.

9 Summary of Management Actions

Table 27 below provides a summary of the management commitments to be implemented by Vinci Gravel Supplies Pty Ltd in order to reduce the impact of quarrying activities on the environment. The following actions outline how environmental impacts will be avoided, minimised, and managed. The items within Table 25 will also provide the audit template/framework for annual compliance reports.

Table 27: Summary of Management Commitments

Parameter	No.	Action	Timing
Stormwater and erosion			
Stormwater	S1	Construct diversion banks and contour drains upslope of disturbed areas to allow clean surface water to return to the Stinton Creek and other natural watercourses.	Prior to clearing and excavation.
	S2	Construct catch drains to capture runoff from disturbed areas and direct into the quarry area to enable infiltration.	Prior to clearing and excavation.
	S3	Construct drainage works to mimic natural drainage patterns.	Prior to clearing and excavation.
	S4	Drains will discharge clean stormwater into vegetated natural drainage lines.	At all times
	S5	No machinery or support vehicles will enter the waterway 'avoidance area' either side of the Stinton Creek tributary to a width of 30 m and no clearing of this vegetation will be permitted, as shown in **Figure 5.** Ensure no disturbance activities will occur within the waterway buffer area during the excavation activities.	At all times.
Erosion control	S6	Use existing access tracks or roads wherever possible rather than creating new ones.	At all times.
	S7	Clearing will only be undertaken as required for quarry operations and will not be conducted in adverse and extreme weather conditions (e.g. excessive windy and dry conditions).	Evaluate prior to clearing
	S8	Stabilise disturbed land as soon as possible and no later than the winter wet season, to minimise erosion.	After pit completion
	S9	Level or gently sloping areas will be selected as stockpile sites to minimise erosion and potential soil loss.	During topsoil removal
	S10	Appropriate sediment controls will be installed upslope of stockpiles to divert water around and downslope of the stockpiles to prevent soil loss.	Prior to clearing and excavation.

Table 27: Summary of Management Commitments (continued)

Parameter	No.	Action	Timing
	S11	Provide adequate erosion control structures on sloping ground such as spur drains or contour banks at suitable intervals.	Prior to clearing and excavation.
Native vegetation			
Native vegetation	V1	Native vegetation to be retained will be visibly delineated on site according to the clearing avoidance areas as shown on **Figure 13**. No clearing of this vegetation is permitted.	During clearing activities
	V2	Clearing of native vegetation within the excavation area will occur progressively associated with extraction stages and rehabilitated in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**).	During clearing activities
Weed and dieback			
Surface material	W1	Assess weed and dieback potential within topsoil material prior to removal and separate topsoil for treatment or disposal if required.	Prior to and during topsoil removal
	W2	Stockpile all surface materials in the general vicinity of its origin.	Surface material removal
Hygiene measures	W3	Avoid moving surface material or fill material from weed infected areas to non-infested areas.	Surface material removal
	W4	As far as reasonable and practicable all vehicles and machinery will be cleaned of plant material, mud and soil prior to entry and exit of the site.	At all times
	W5	No soil and/or vegetation should be brought to the site apart from that to be used in rehabilitation. Those used in rehabilitation should be free from weeds and dieback.	At all times
Access	W6	Control access within the quarry area to reduce the spread of weeds and dieback, especially off-road vehicle access. This will prevent disturbance to vegetation and weed/dieback invasion.	At all times
	W7	Restrict access to areas outside the quarry operations to reduce the spread of weeds and dieback into or out of the site.	At all times
Weed Control	W8	Chemical spot-spraying is to be undertaken, as necessary, as per Table 10.	At all times
Weeds of National Significance and Priority Weeds	W9	Any identified WoNS will be given priority and removed promptly, to mitigate negative impacts on rehabilitated areas and nearby native vegetation. All WoNS have an individual strategic management plan, which will be adhered to.	At all times
Water	W10	The site will be managed to ensure water runoff is contained within the quarry and does not exit the area.	At all times

Table 27: Summary of Management Commitments (continued)

Parameter	No.	Action	Timing
Stockpile	W11	Excavated materials that require stockpiling (topsoil and overburden) from the Stage 5 quarry area shall not be removed from the quarry. This material will be stockpiled within the vicinity of excavation and will prevent the potential spread of dieback out of the quarry.	At all times
	W12	Suspected dieback infested material, vegetation and topsoil will be contained in a separate stockpile and within the quarry boundary away from native vegetation.	At all times
Survey	W13	Pre-disturbance dieback survey shall be undertaken within the stage 5 quarry region.	Prior to stage 5 works commencing
Fauna			
Native Fauna	F1	The extraction stages with be progressively cleared and rehabilitated following completion of works to minimise impacts on native fauna.	At all times
	F2	To minimise the risk of disturbing active bird nests, clearing is to be undertaken outside of the main bird breeding season (spring)	Prior to clearing
	F3	A pre-disturbance fauna inspection will be undertaken 1-2 days before clearing.	Prior to clearing
	F4	As far as practical, clearing will be completed in a single direction without creating islands of vegetation, ensuring that fauna do not become trapped during works.	During clearing
	F5	An experienced fauna specialist will be present as a fauna spotter during clearing of vegetation searching for fauna in areas to be cleared and areas just cleared to identify the presence of bird or marsupial species in trees and more common ground dwelling fauna species, such as small mammals, lizards and snakes. If encountered, these animals will be assisted to disperse to nearby vegetation, if appropriate, or translocated.	During clearing
	F6	Fauna must not be intentionally harmed and any feeding of or contact with native fauna is not permitted.	At all times
	F7	Any instances of native fauna mortality will be reported immediately to the Site Manager and fauna habitats identified for protection not disturbed.	As required
	F8	Native fauna habitat to be retained which comprises high fauna habitat values suitable for a number of conservation significant fauna, including the three species of black cockatoo and the Chuditch, will be visibly delineated on site according to the clearing avoidance areas as shown on **Figure 13**. No clearing of this vegetation is permitted.	During clearing

Table 27: Summary of Management Commitments (continued)

Parameter	No.	Action	Timing
Pest Fauna	F9	Feral fauna species identified within the quarry or surrounding site shall be recorded, reported to the Site Manager, and control measures will be undertaken where necessary.	As required
	F10	1.8 m high fence composed of steel star pickets with rammed in corner assemblies along the perimeter of revegetation areas. The fencing surrounding active rehabilitation areas shall be maintained and used to control herbivorous fauna (i.e. kangaroos and rabbits) entering these zones.	As required
Dust			
Dust control	D1	Monitor weather forecasts to determine ground moisture level, wind strength (especially prevailing winds) or direction or other seasonal conditions applicable to the extractive operations.	At all times
	D2	In the event that weather conditions are unfavourable, especially in the case of adverse ground moisture level or wind strength or direction, operations will be rescheduled or ceased to minimise excessive dust emissions.	When required by unfavourable weather conditions
	D3	A water truck (6 x 4 in size) with hydraulic water pumps is to be used to wet the access/driveways and stockpiles when hot, dry and windy conditions are anticipated to occur during operations.	When required by unfavourable weather conditions
	D4	A 25 km/hr speed limit will be applied to all internal roads, driveways and vehicle access ways, supported by appropriate signage.	At all times
Noise			
Noise Control	N1	Works generating excessive noise and rock breaking will not occur outside the hours of 7am to 7pm or on a Sunday or Public Holiday.	Between 7am to 7pm or on a Sunday or Public Holiday
	N2	Prior to 7am from Monday to Friday, works are limited to loading of a maximum of four trucks per hour.	Prior to 7am from Monday to Friday
	N3	The crusher and front-end loader will operate from behind stockpiles of at least 4 m height	During excavation activities
	N4	Rock breaker and dozer will operate behind the 4 m high pit face within the confines of the approved expansion area.	During excavation activities
	N5	Undertake regular maintenance of plant and ensuring acoustic enclosures or covers fitted to plant are used at all times.	As required
	N6	A limit of two items of plant will be in operation at any one time due to the number of personnel of site.	At all times

Table 27: Summary of Management Commitments (continued)

Parameter	No.	Action	Timing
Visual amenity			
Visual impacts	V1	Retain temporary strip of vegetation over stage 5b during the stage 5a excavation activities for screening purposes.	During stage 5a extraction activities
	V2	Respread topsoil and progressively rehabilitate post-quarried areas in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**), so the exposed gravel pits are less visually prominent.	Rehabilitation activities
	V3	Revegetate visual screening strip (Zone 1) with planting dieback resistant tubestock in a linear arrangement and undertake weed control in accordance with the Rehabilitation and Decommissioning Programme (**Section 6**).	Rehabilitation activities
	V4	Retain of a 20 m vegetation buffer from the extraction area to the site boundary to the north to provide a physical separation barrier.	At all times
	V5	Ensure barriers, fences and gates are compatible with the semi-rural style of the surround land areas and natural landscape	At all times
	V6	Locate stockpiles within confines of gravel quarry.	During excavation activities
	V7	To ensure exposed areas are less visually prominent, the respread of topsoil will be darker in colour than the orange-coloured post-mined pits.	At all times.
Revegetation			
Landform	R1	All slopes will be contoured to achieve a maximum slope of 1:4 vertical to horizontal.	Prior to revegetation
	R2	Deep rip (approximately 0.5 m) on contours to reduce erosion, reduce flow velocities, promote water capture/infiltration, and promote soil binding. Carry out shallow ripping as required.	Prior to revegetation
	R3	Stockpiled topsoil will be re-spread to create a land surface that is safe and stable.	During excavation activities
Revegetation	R4	Undertake revegetation within each zone as per **Section 6.4**.	During excavation activities
Maintenance	R5	Undertake maintenance measures as per **Section 6.5**.	During excavation activities
Monitoring	R6	Monitoring and reporting work are required to ensure that the revegetation objectives are achieved. Undertake monitoring as per **Section 6.7**.	Refer to **Section 6.7**.

10 References

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Figures

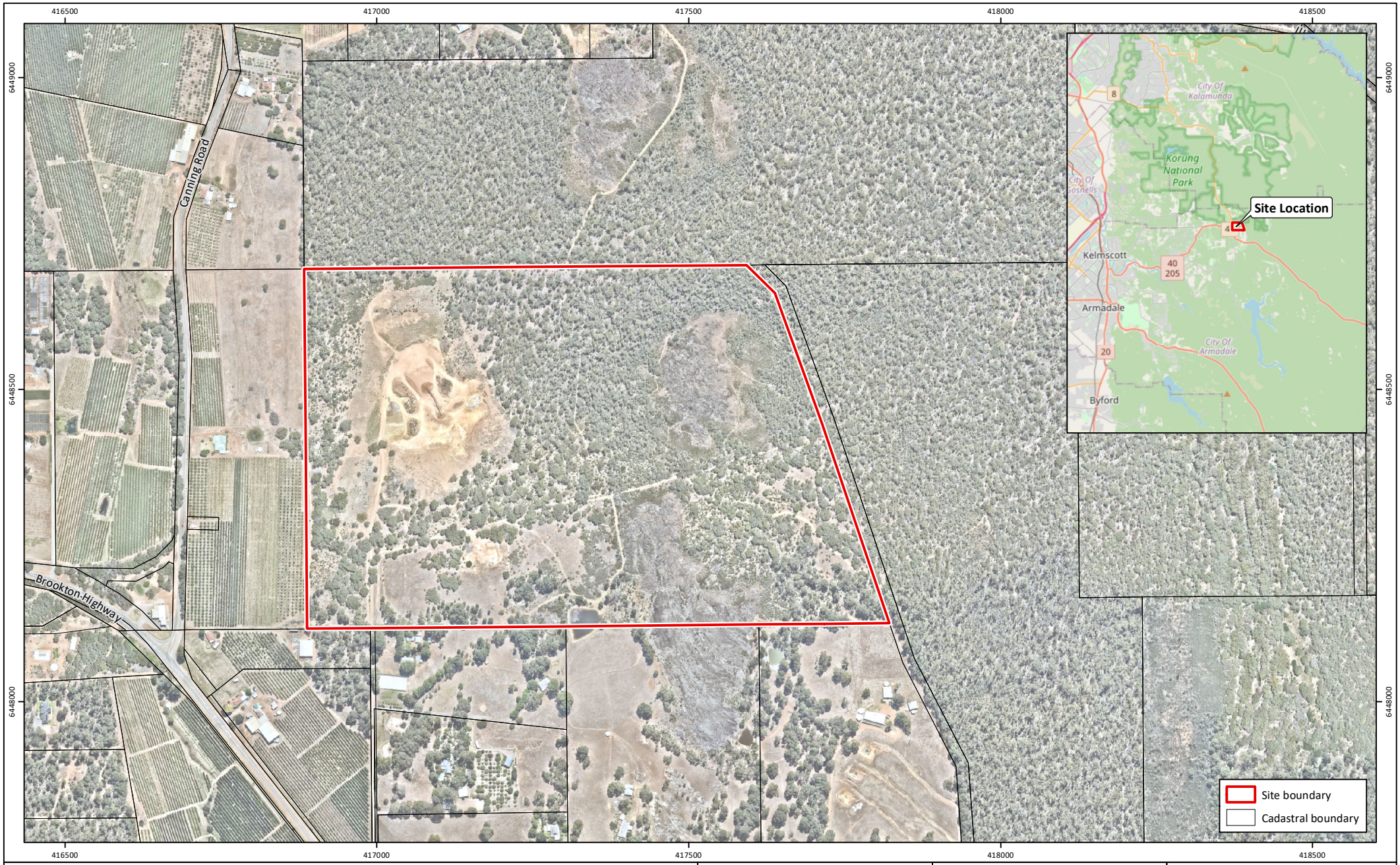

Figure 1: Site Locality

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F49

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

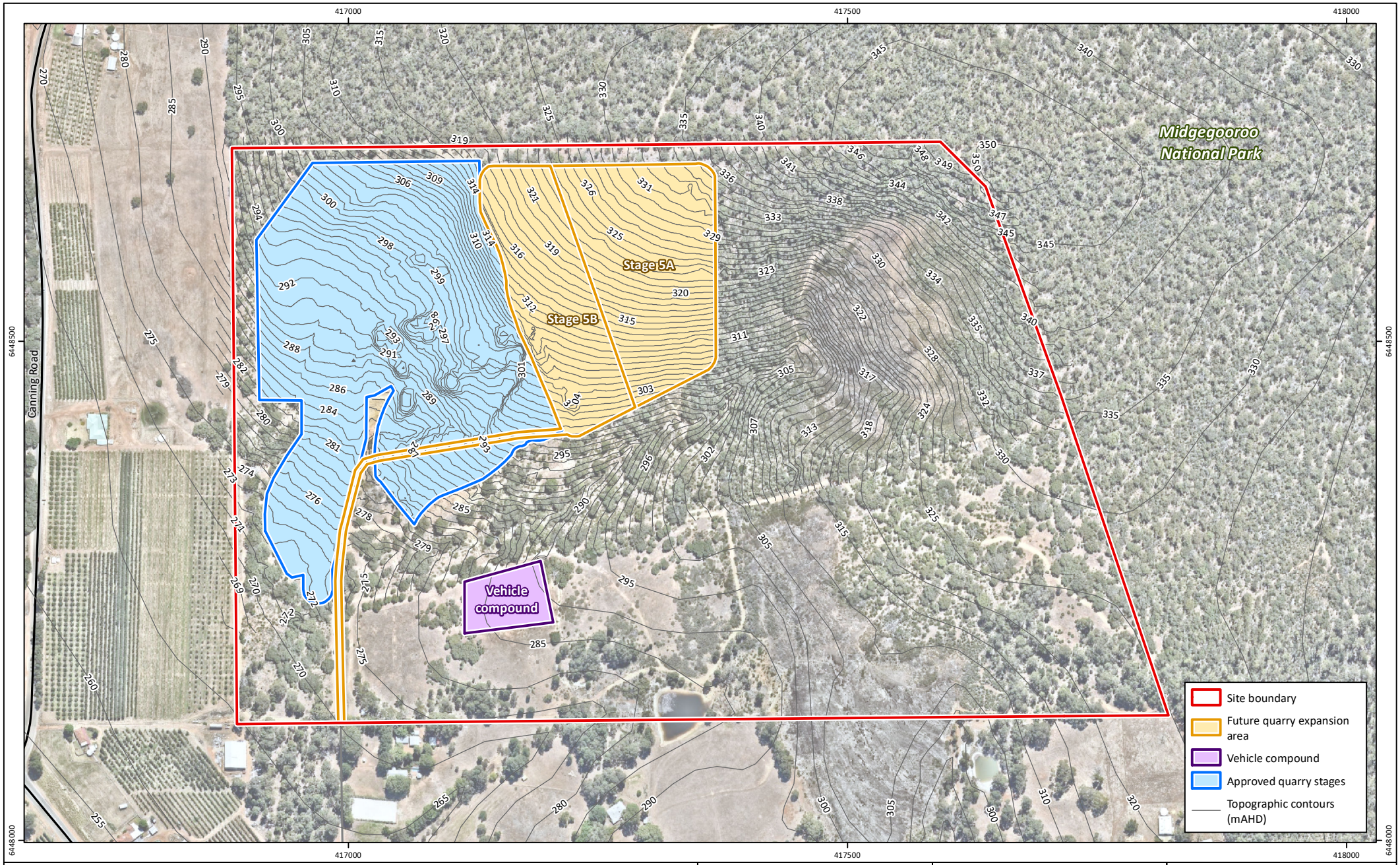

Figure 2: Quarry Staging Plan

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F50a

Drawn:	GAR
Date:	26/05/2021
Checked:	ALB
Approved:	ALB
Date:	26/05/2021

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GDA 1994 MGA Zone 50

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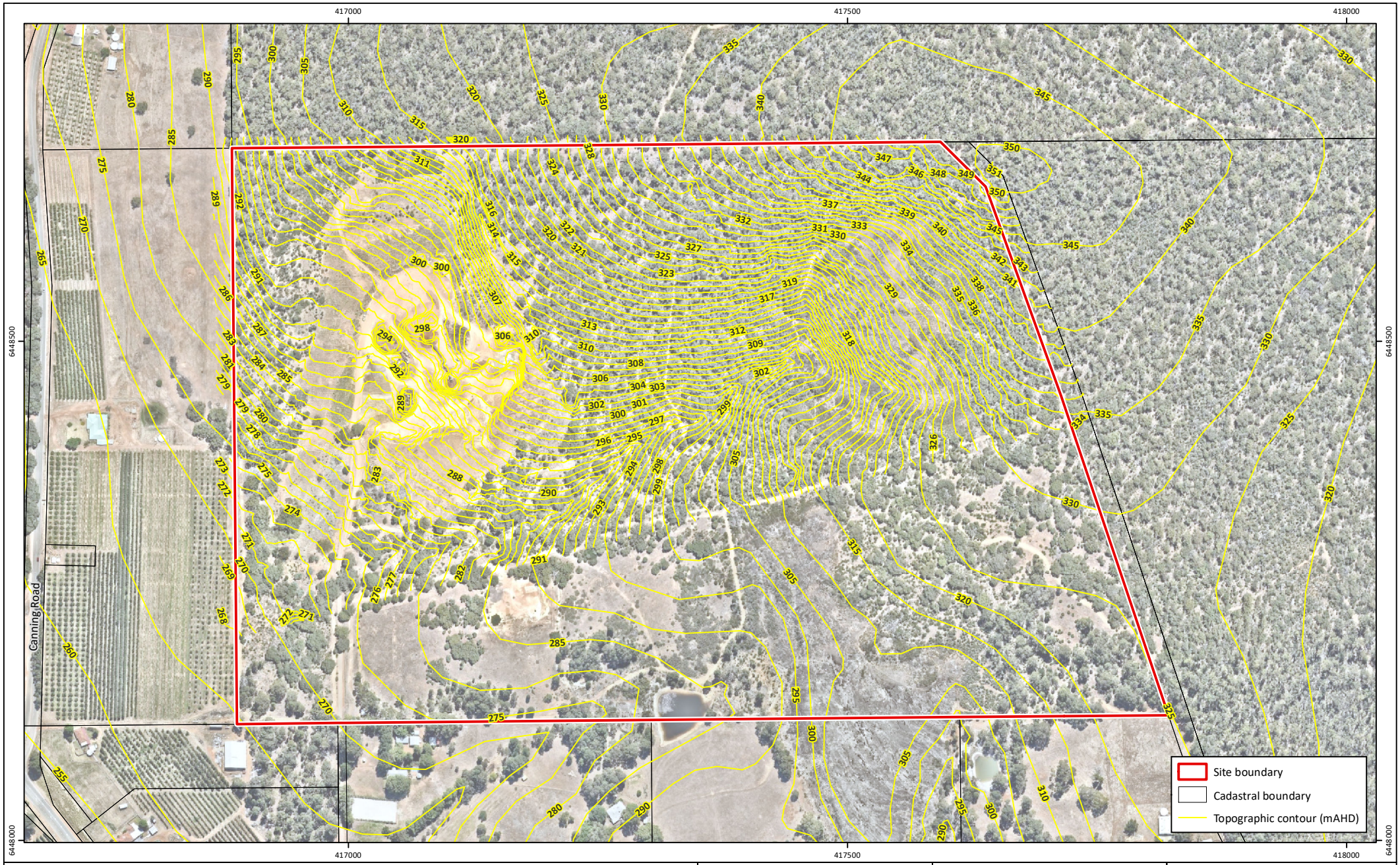

Figure 3: Topography

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F51a

Drawn:	GAR
Date:	21/05/2021
Checked:	ALB
Approved:	ALB
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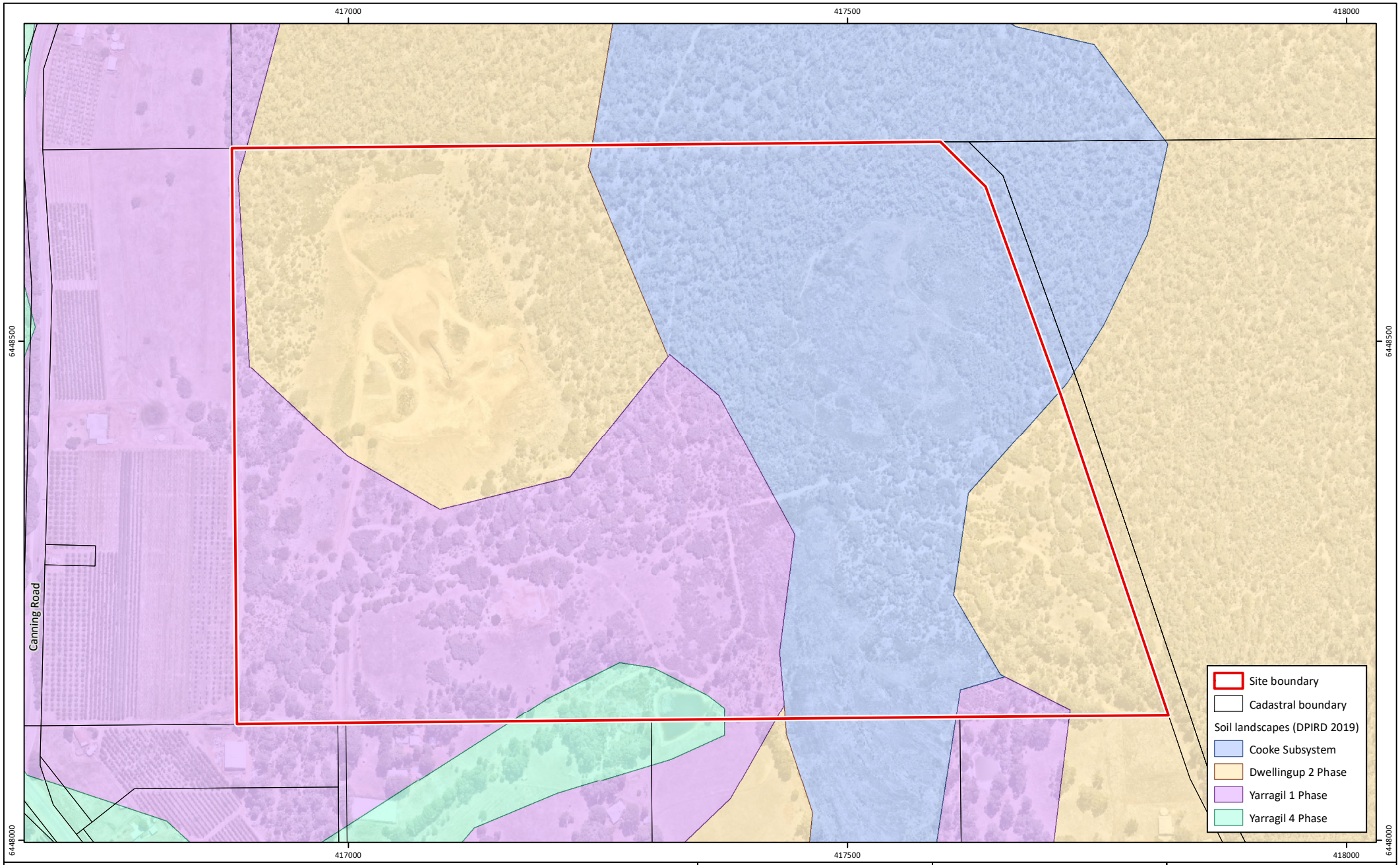

Figure 4: Geology

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen

Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F52

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

Figure 5: Hydrology

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F53
Drawn: AFF
Date: 25/02/2021
Checked: JMM
Approved: JMM
Date: 5/03/2021

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GDA 1994 MGA Zone 50

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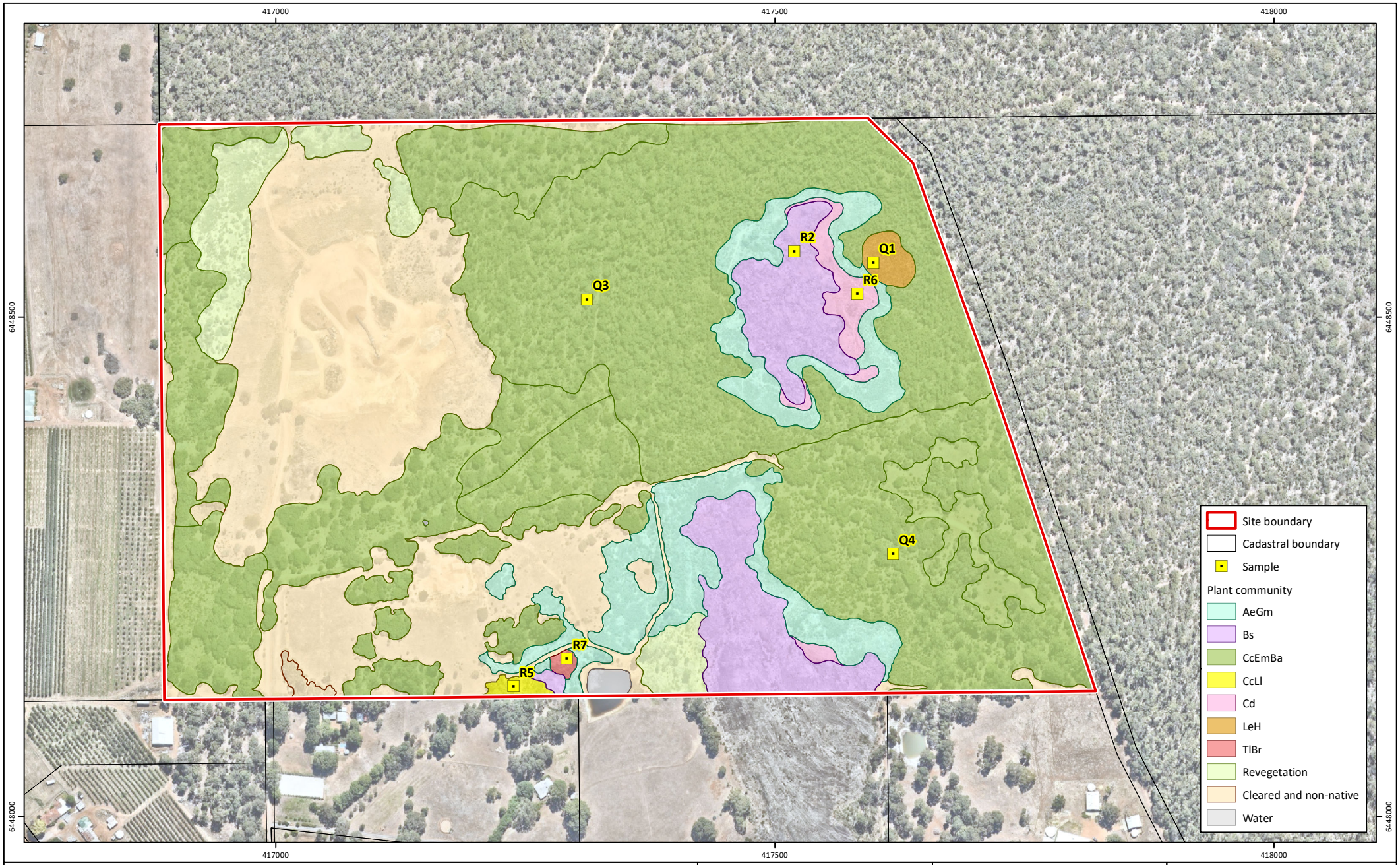

Figure 6: Plant Communities

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F54
Drawn: AFF
Date: 25/02/2021
Checked: JMM
Approved: JMM
Date: 5/03/2021

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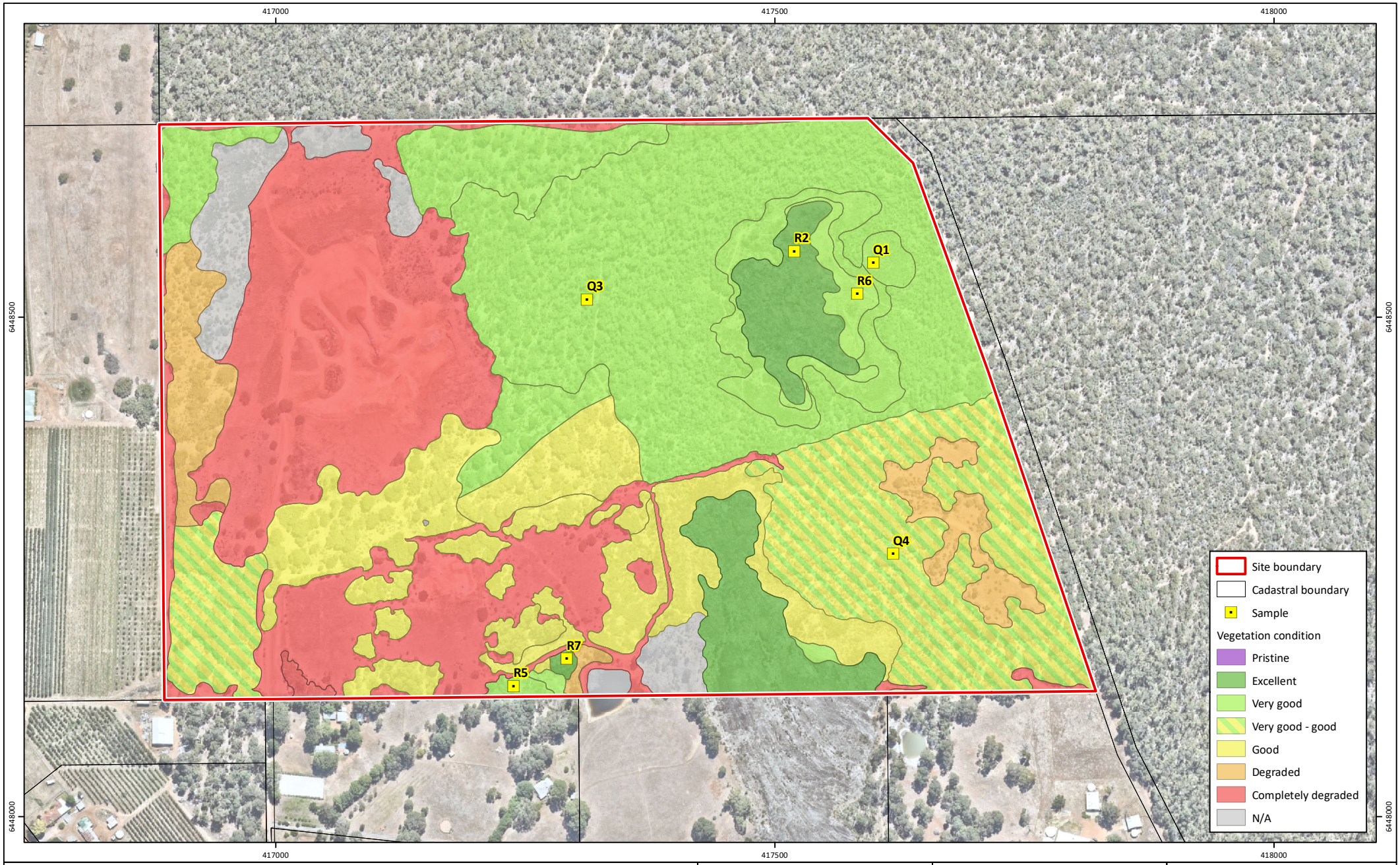

Figure 7: Vegetation Condition

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F55
Drawn: AFF
Date: 25/02/2021
Checked: JMM
Approved: JMM
Date: 5/03/2021

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GDA 1994 MGA Zone 50

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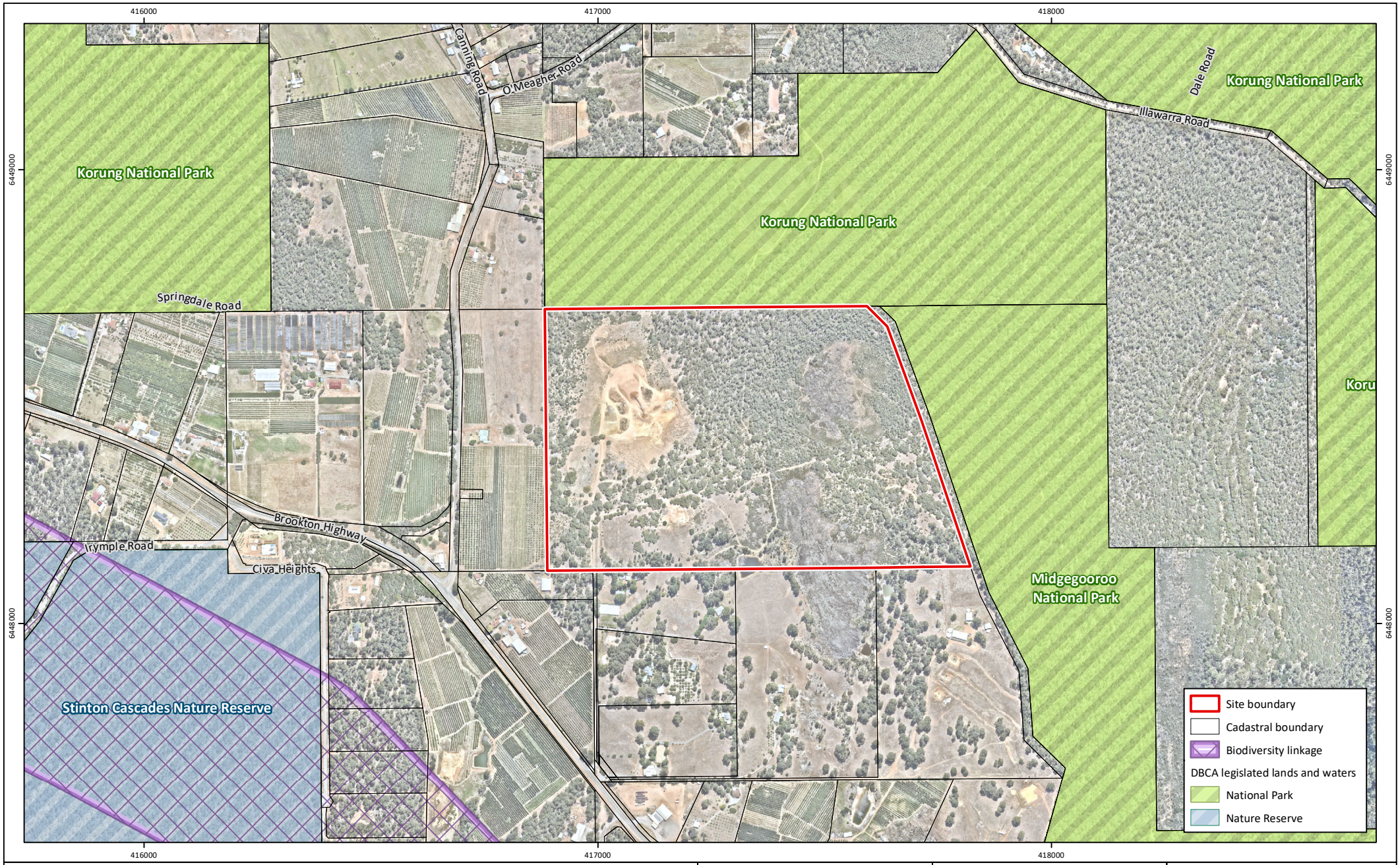

Figure 8: Conservation Reserves

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F56

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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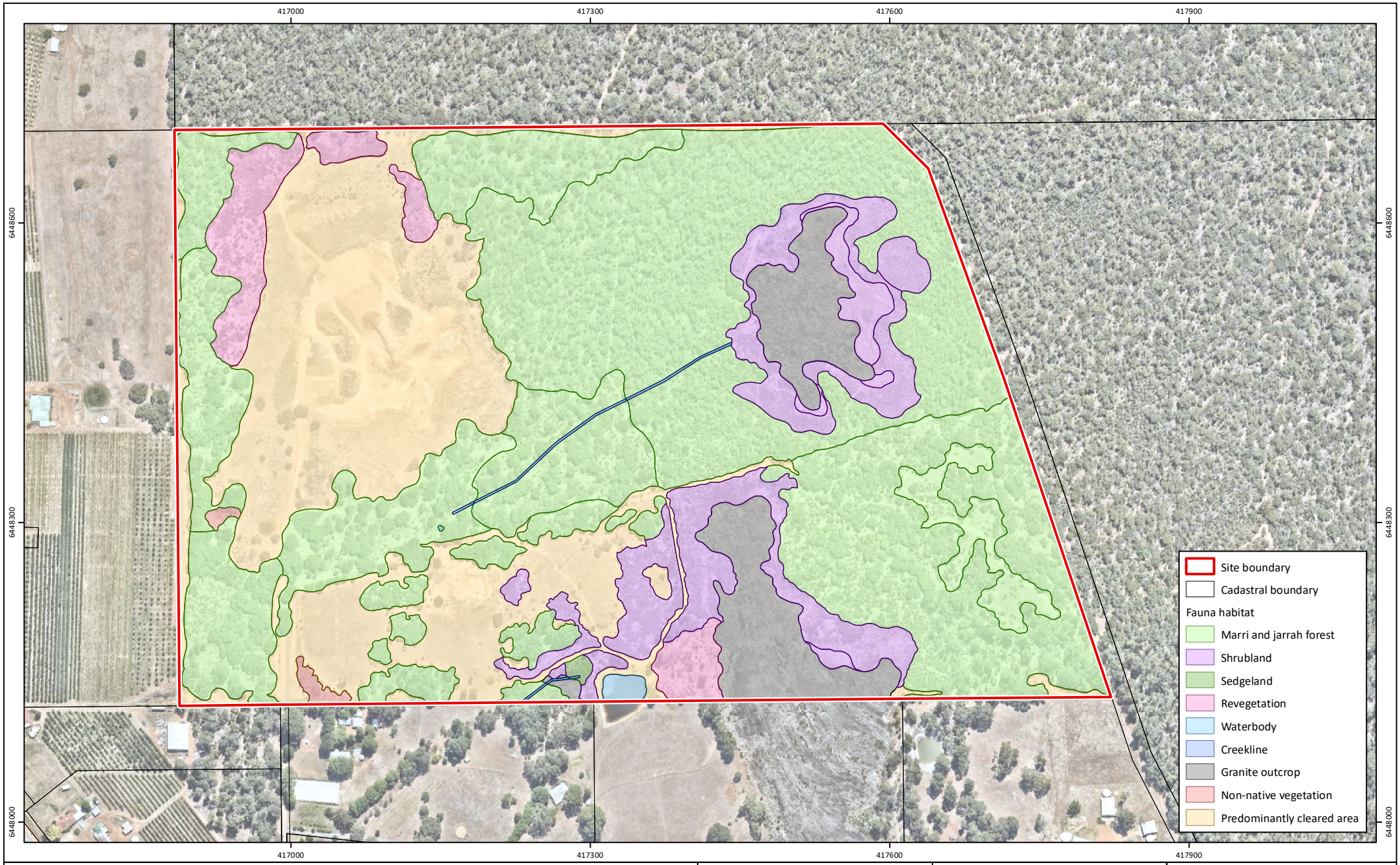

Figure 9: Fauna Habitat

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F57

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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GDA 1994 MGA Zone 50

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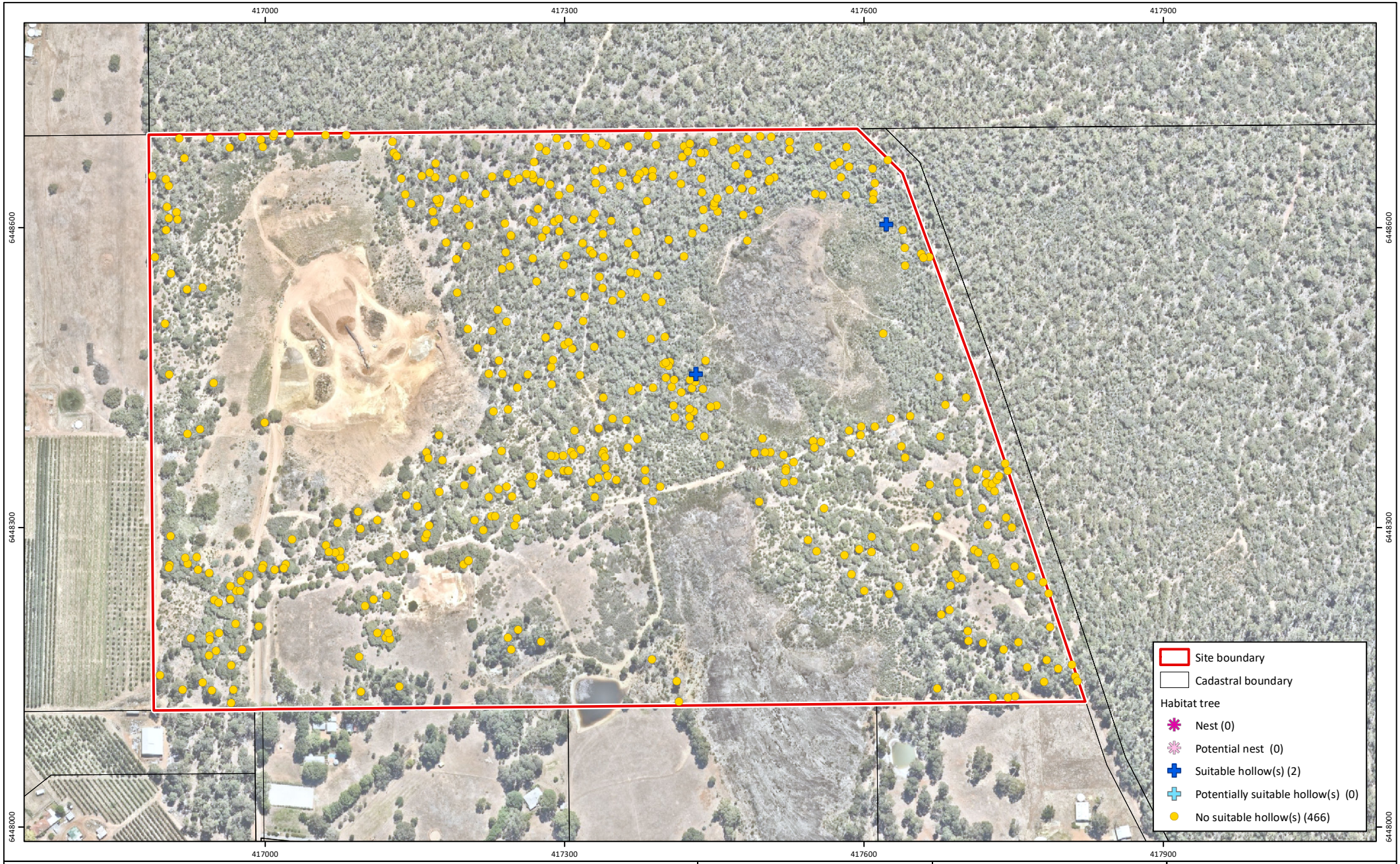

Figure 10: Black Cockatoo Habitat Trees

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F58

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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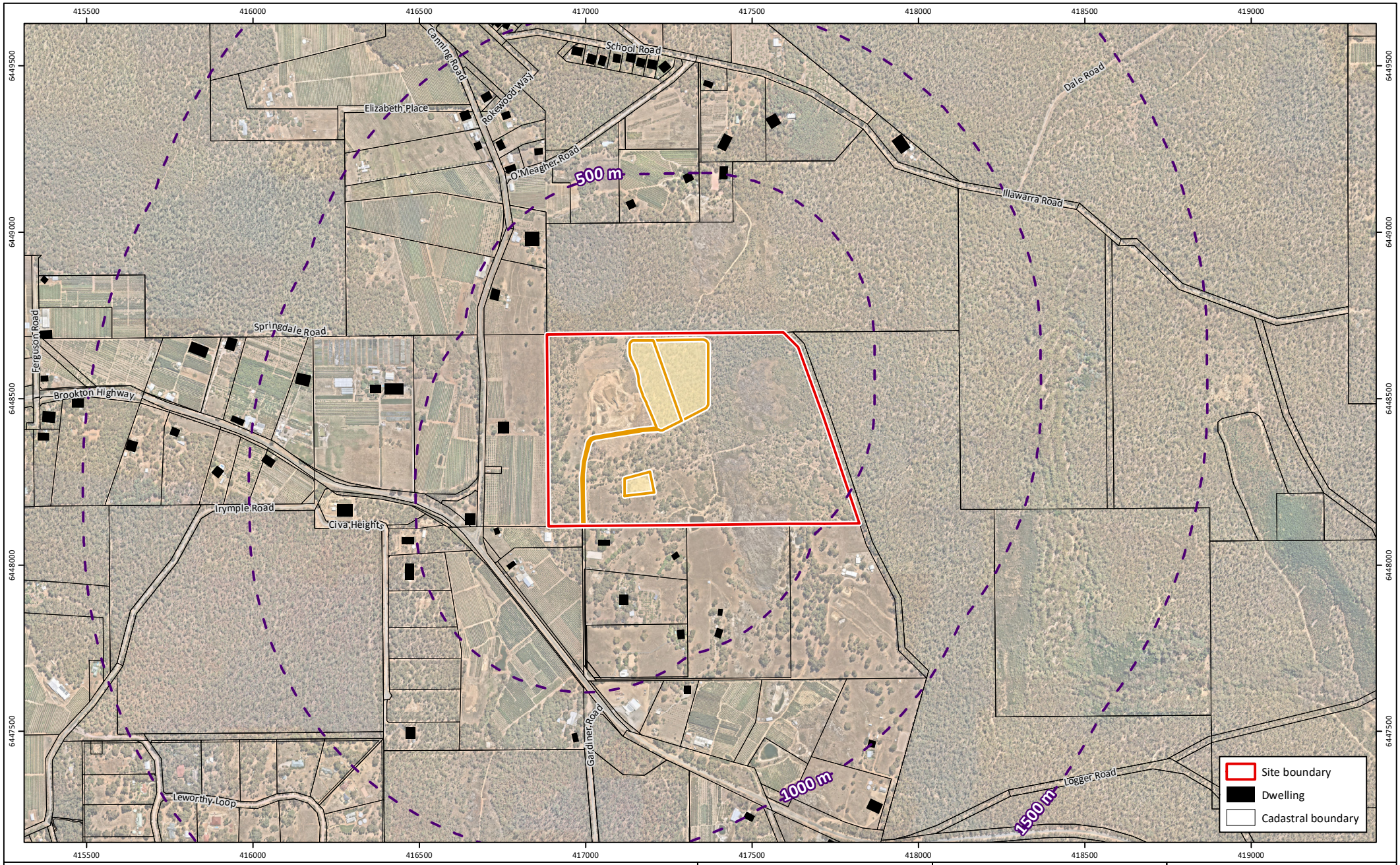

Figure 12: Proximity of Sensitive Land Uses

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F60

Drawn:	AFF
Date:	25/02/2021
Checked:	JMM
Approved:	JMM
Date:	5/03/2021

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GDA 1994 MGA Zone 50

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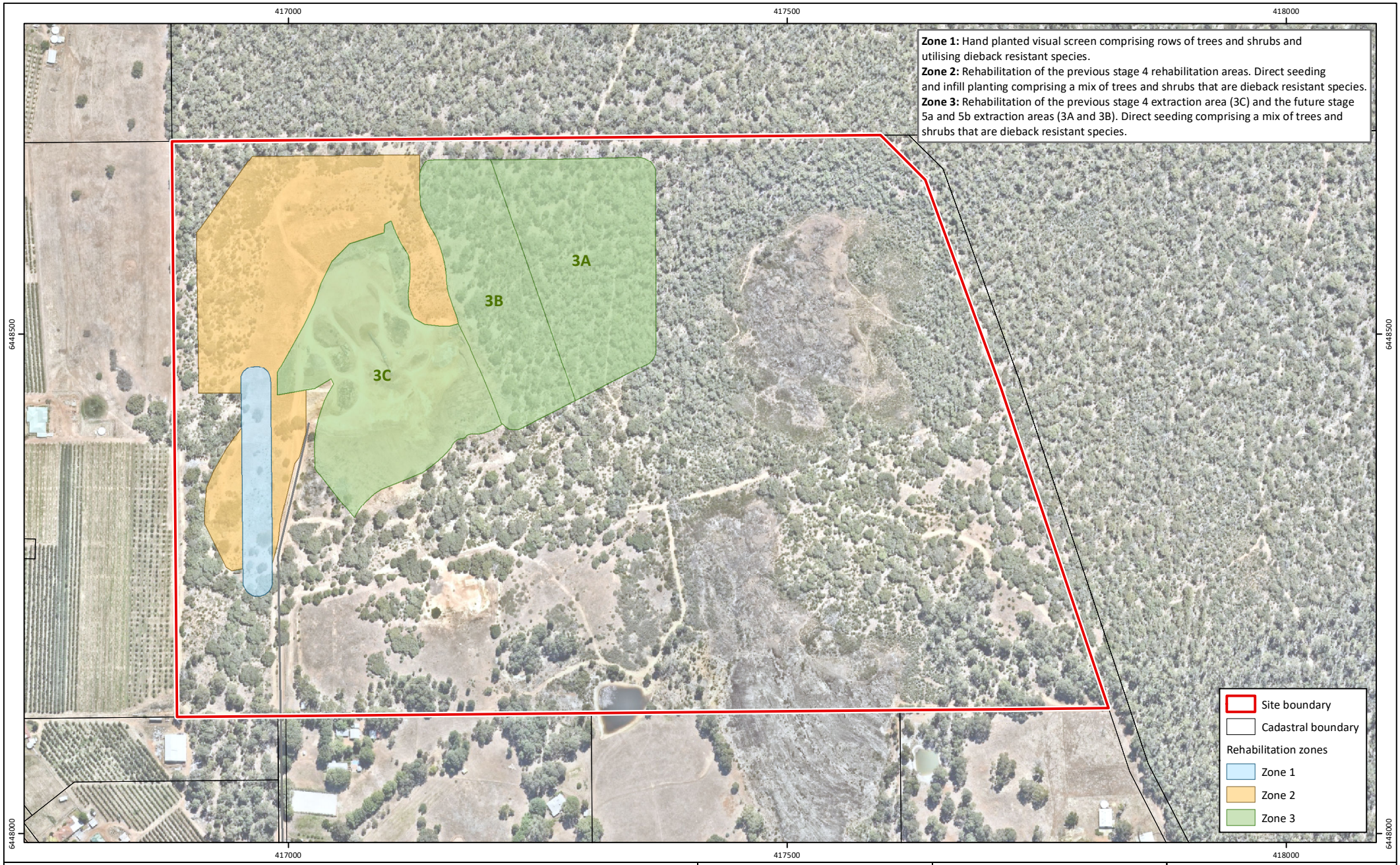

Figure 12: Rehabilitation Zones

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F61c

Drawn:	GAR
Date:	14/01/2022
Checked:	JDH
Approved:	JDH
Date:	14/01/2022

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

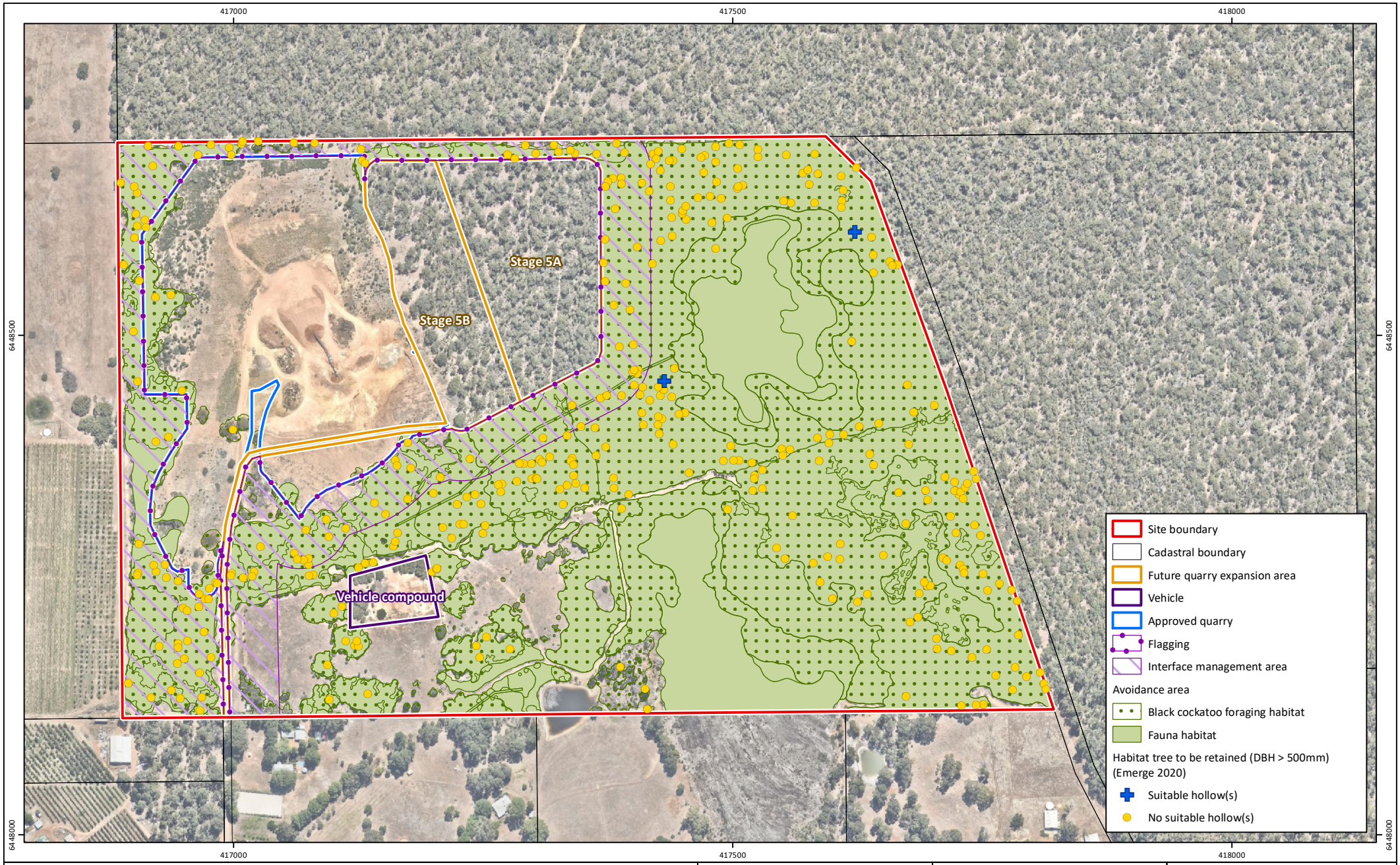

Figure 13: Clearing Avoidance Area and Interface Management Area

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F62a

Drawn:	GAR
Date:	19/10/2021
Checked:	SJP
Approved:	JDH
Date:	27/10/2021

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

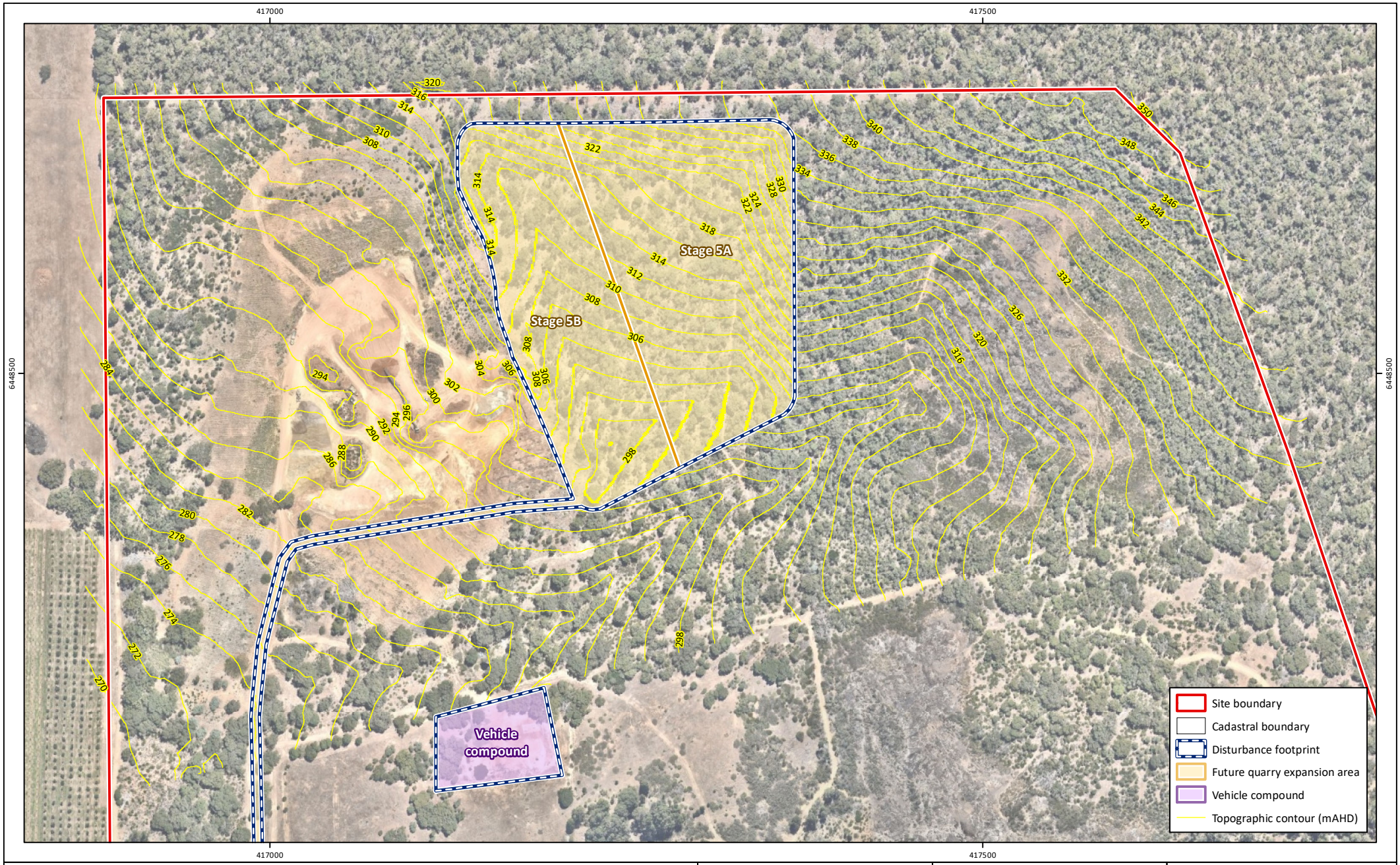

Figure 14: Quarry Closure Contours

Project:	Environmental Management Plan Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F63a

Drawn:	GAR
Date:	06/04/2021
Checked:	SJP
Approved:	JDH
Date:	27/10/2021

N

0 50 100 150
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

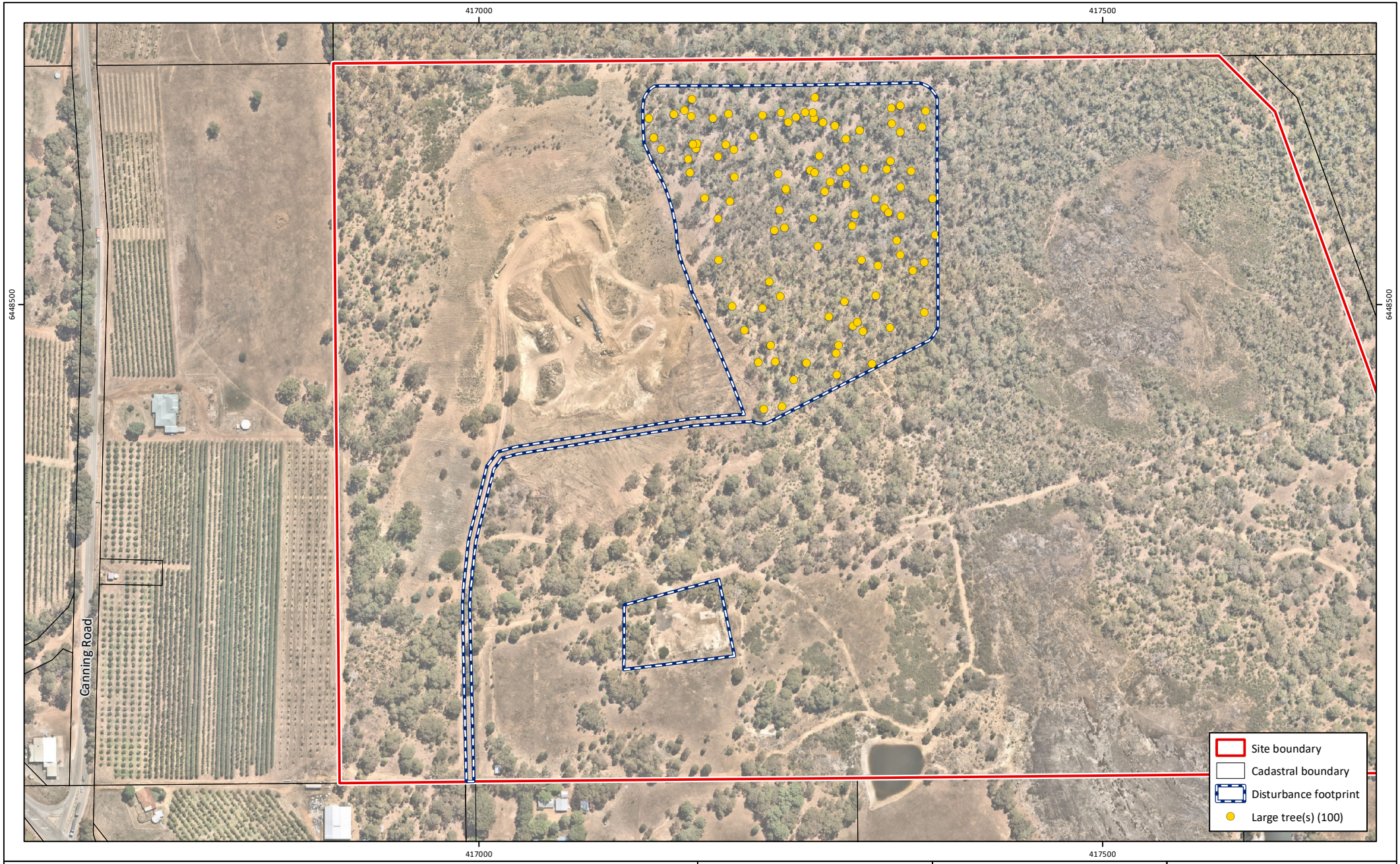

Figure 15: Large Trees for Salvage

Project: Environmental Management Plan
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(14)--F80
Drawn: GAR
Date: 19/10/2021
Checked: SJP
Approved: JDH
Date: 27/10/2021

N

0 50 100 150
Metres
Scale: 1:4,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Detailed Flora and Vegetation Survey – Lot 9 Brookton Highway, Karragullen (Emerge Associates 2021a)

Detailed Flora and Vegetation Assessment

Lot 9 Brookton Highway Karragullen

Project No: EP20-040(04)

Prepared for Vinci Gravel Supplies Pty Ltd
February 2021

Document Control

Doc name:	Detailed Flora and Vegetation Assessment Lot 9 Brookton Highway Karragullen				
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	Report prepared for client review				

Executive Summary

Vinci Gravel Supplies Pty Ltd (Vinci Gravel) engaged Emerge Associates (Emerge) to undertake a detailed flora and vegetation survey within Lot 9 Brookton Highway in Karragullen (referred to herein as 'the site').

As part of the assessment a desktop review of relevant background information was completed and a field survey was undertaken on multiple dates between May and December 2020. During the field survey an assessment was made on the type, condition and values of vegetation across the site.

Outcomes of the survey include the following:

- A total of 140 native and 19 non-native (weed) species were recorded in the site.
- No threatened or priority flora species were recorded within the site.
- The survey timing was not appropriate to confirm the presence or absence of two priority flora species: *Eriochilus* sp. Roleystone (G. Brockman 1140) (P1) and *Paracaleana ferricola* (P2) but they are considered unlikely to occur. No other threatened or priority flora are considered likely to occur in the site.
- Eight plant communities were identified within the site. Approximately 70% of the site supports plant communities dominated by native vegetation (33.88 ha). The remainder of the site comprises non-native vegetation, cleared areas and water bodies (14.35 ha/30% of the site).
- Vegetation in 'excellent', very good', 'very good – good' and 'good' condition occurs across 31.68 ha (66% of the site). Vegetation in 'degraded' and 'completely degraded' condition occurs across 14.63 ha (30% of the site). A total of 1.92 ha (4% of the site) was not assigned to a vegetation condition category.
- No threatened or priority ecological communities occur within the site.
- Trees within the site, particularly in the eastern portion, may provide potential foraging, roosting and/or nesting habitat for threatened species of black cockatoos which occur in the local area. The native vegetation, particularly that in the northern and eastern portions of the site contributes to ecological linkages in the area.

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Table of Contents

List of Tables

List of Plates

Figures

Appendices

Appendix A

Additional Information

Appendix B

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Appendix D

Species List

Appendix E

Species x Plant Community Matrix

Appendix F

Sample Data

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
DPaW	Department of Parks and Wildlife (now DBCA)
WALGA	Western Australia Local Government Association

Table A2: Abbreviations – General terms

General terms	
ESA	Environmentally sensitive area
IBRA	Interim Biogeographic Regionalisation of Australia
NVIS	National Vegetation Inventory System (ESCAVI 2003)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PEC	Priority ecological community
T	Threatened
TEC	Threatened ecological community

Table A3: Abbreviations –Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
BC Act	*Biodiversity Conservation Act 2016*
BC Regs	*Biodiversity Conservation Regulations 2018*

Table A4: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

Vinci Gravel Supplies Pty Ltd (Vinci Gravel) intends to expand an existing gravel quarry within part of Lot 9 Brookton Highway in Karragullen (referred to herein as 'the site'). The site is located approximately 29 kilometres (km) south-east of the Perth Central Business District within the City of Armadale and is zoned 'rural' under the Metropolitan Region Scheme and 'general rural' under the City of Armadale *Town Planning Scheme No 4.*

The site is approximately 48.23 hectares (ha) in size and is bound by rural residential properties and orchards to the west and south and native vegetation to the north and east. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by Vinci Gravel to provide environmental consultancy services to support the planning process associated with the expansion of the quarry in the site. The purpose of this survey is to provide sufficient information on the flora and vegetation values within the site to inform this process.

The scope of work was specifically to undertake a flora and vegetation assessment to the standard required of a detailed survey in accordance with the Environmental Protection Authority's (EPA's) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for threatened flora species and ecological communities.
- Compilation of a comprehensive list of flora species recorded as part of the field survey.
- Mapping of plant communities and vegetation condition.
- Identification of conservation significant flora and vegetation.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Environmental Context

2.1 Climate

Climate has a strong influence on the types of vegetation that grow in a region and the life cycles of the flora present. It is therefore critical for a flora and vegetation survey to respond appropriately to climatic conditions to ensure that surveys are conducted during times when flora species are easiest to detect and identify.

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. In Mediterranean type climates some flora species will typically spend part of their lifecycle as either underground storage organs or as seed. This is an adaptation to unfavourable environmental conditions such as excessive heat and drought that occur over the summer period. These species, known as 'geophytes' or 'annuals', tend to re-emerge during winter when favourable conditions return and are most visible during spring, which is the flowering period for a majority of plant species. Therefore, spring is the optimal time to complete flora and vegetation surveys in the south west of WA.

An average of 1019.5 millimetres (mm) of rainfall is recorded annually from the Karragullen North weather station, which is the closest weather station, located approximately 800 m north east of the site. The majority of this rainfall is received between the months of May and September. Mean maximum temperatures at the Bickley weather station, which is the nearest temperature recording station approximately 10 km north of the site, range from 15.1 °C in July to 30.5°C in January and February, while mean minimum temperatures range from 7.3°C in July to 15.9°C in February (BoM 2021).

A total of 885 mm of rain was recorded from April to December 2020 prior to and during the survey, which is approximately 92% of the mean of 964.3 mm for this period (BOM 2021). This indicates that the amount of rainfall was considered to have been sufficient to promote the flowering and emergence of flora.

2.2 Geomorphology and soils

Landform and soils influence vegetation types at regional and local scales. The site occurs on the Darling Plateau which lies directly east of the Darling Scarp. The Darling Plateau is an ancient erosion surface capped with laterite and dissected by drainage channels (Beard 1990). The eastern part of the Plateau is characterised by flat-topped hills bound by breakaways and more prominent hills (monadnocks) which protrude above the general level of the plateau (Gozzard 2011). The western part comprises valleys with steep, rocky slopes and narrow, flat floors (Gozzard 2011).

The site is located on the western side of the Darling Plateau and broad scale soil mapping places the site within the Yarragil and the Dwellingup soil associations (Churchward and McArthur 1980). The Yarragil association occurs in the western portion of the site and is described as gentle valleys with sandy gravels on the slopes and orange earths on flat swampy floors (Churchward and McArthur 1980). The Dwellingup association occurs in the eastern portion of the site and is described as a

'gently undulating landscape with duricrust on ridges; sands and gravels in shallow depressions' (Churchward and McArthur 1980).

Finer scale mapping by DPIRD (2018) shows four soil landscape units as occurring within the site, as described in **Table 1** and shown in **Figure 2**.

Table 1: Soil landscape mapping units within the site (DPIRD 2018)

Soil landscape unit	Location within site	Description
Yarragil 1 Phase	South western portion and small area in south eastern portion	Very gentle to moderately inclined concave sideslopes (with) moderately well drained yellow duplex soils and yellow and brown massive earths and gravels.
Yarragil 4 Phase	Small area in the central southern portion	Valley floors with some poorly drained mottled yellow duplex soils and gentle lower slopes with moderately well to well drained loamy and sandy earths, gravels and duplex soils.
Dwellingup 2 Phase	North western and south eastern portions	Very gently to gently undulating terrain (<10%) with well drained, shallow to moderately deep gravelly brownish sands, pale brown sands and earthy sands overlying lateritic duricrust.
Cooke Subsystem	Eastern portion	Crests and upper slopes dominated by granite outcrop and very shallow yellow duplex soils, and yellow and brown massive earths.

2.3 Topography

The elevation of the site ranges from 265 m in relation to the Australian height datum (mAHD) in the south western part of the site to 350 mAHD in the north eastern part of the site (DoW 2008) (**Figure 2**).

2.4 Hydrology and wetlands

Wetlands include "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" (Wetlands Advisory Committee 1977). Wetlands can further be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al*. 1996).

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. The following lists of important wetlands were checked as part of this assessment:

- *Ramsar List of Wetlands of International Importance* (DBCA 2017c)
- *A Directory of Important Wetlands in Australia* (DBCA 2018).

No Ramsar or listed 'important wetlands' are located within or near the site.

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows one minor, non-perennial watercourse in the central portion of the site and part of two non-perennial watercourses in the central southern portion of the site. The locations of these watercourses are shown in **Figure 2**.

2.5 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides Australia into floristic subregions (Environment Australia 2000). The site is contained within the 'JF1' or northern jarrah forest subregion, which is characterised by *Eucalyptus marginata* (jarrah) – *Corymbia calophylla* (marri) forest on laterite gravels with *Eucalyptus wandoo* – marri woodlands in the eastern part (DEC 2002).

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Heddle *et al.* (1980) mapping shows the western portion of the site comprises the 'Yarragil Complex (maximum development swamps) in medium to high rainfall' which is described as 'open forest of *Eucalyptus marginata - Corymbia calophylla* with admixtures of *Eucalyptus patens*.' The eastern portion of the site comprises the 'Dwellingup complex in medium to high rainfall' which is described as 'open forest of *Eucalyptus marginata - Corymbia calophylla* on the uplands.'

More recent Beard *et al.* (2013) mapping shows the majority of the site comprises vegetation association 'West Darling 3'. This association is described as 'mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*' (Beard *et al.* 2013). A small area in the south western portion of the site comprises vegetation association "West Darling 4' which is described as 'jarrah, marri and wandoo *Eucalyptus marginata, Corymbia calophylla, E. wandoo*' (Beard *et al.* 2013).

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). The national objectives and targets for biodiversity conservation established an objective of retaining 30% of the original extent of each vegetation complex (Environment Australia 2001).

This 'Yarragil Complex (maximum development swamps) in medium to high rainfall' was determined to have 92.47% remaining in 2018, of which 10.58% is under formal protection (Government of Western Australia 2019a). The 'Dwellingup complex in medium to high rainfall' was determined to have 82.50% remaining in 2018, of which 19.31% is under formal protection (Government of Western Australia 2019a).

'West Darling 3' association has 67.10% of its pre-European extent remaining in 2018, with 16.11% protected for conservation purposes (Government of Western Australia 2019b).

The percentage protected for conservation of the above three complexes fall below the 30% retention objective.

2.6 Historic land use

Review of historical images from 1965 onwards indicates that the site supported relatively intact native vegetation from 1965 to sometime before 1974, with imagery from 1974 showing that all of the site except the north eastern portion has been cleared of native vegetation and appears to be used for grazing (WALIA 2020). A quarry is also visible in the central western portion of the site in images from 1974 onwards and gradually increases in size until 1995. Regrowth of native vegetation in the south eastern portion of the site is visible in imagery from 1985 to 2020.

2.7 Significant flora and vegetation

2.7.1 Threatened and priority flora

Certain flora taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Threatened flora species listed under the EPBC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia flora species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). Similarly, it is an offence to 'take' or 'disturb' threatened flora listed under the BC Act without Ministerial approval.

Flora species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA's *Priority Flora List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes. Further information on threatened and priority species and their categories is provided in **Appendix A**.

2.7.2 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DAWE 2020). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

Selected TECs are afforded statutory protection at a Commonwealth level under the EPBC Act. Similar to flora species, TECs listed under the EPBC Act are assigned a conservation status. Any action likely to have a significant impact on a community listed under the EPBC Act requires Ministerial approval.

TECs are also listed within Western Australia under the BC Act and the BC Regulations. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

A plant community that is under consideration for listing as a TEC in Western Australia, but does not yet meet survey criteria or has not been adequately defined, may be listed as a 'priority ecological community' (PEC). Listing as a PEC is similarly considered during State approval processes. Further information on categories of TECs and PECs is provided in **Appendix A**.

2.7.3 Local and regional significance

Flora species and ecological communities may be significant for a number of reasons irrespective of whether they have special protection under policy or legislation.

Three key reasons that vegetation within the site may be significant are listed below:

- The vegetation within the site is associated with wetlands/water courses.
- The vegetation is part of a larger patch that provides extensive habitat for flora and fauna and functions as an ecological linkage.
- The vegetation within the site has potential value as habitat for threatened or priority fauna species including, in particular, species of black cockatoo which are listed under the EPBC Act and the BC Act.

2.7.4 Weeds

The term 'weed' can refer to any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native flora species and some native species are considered to be weeds.

A particularly invasive or detrimental weed species may be listed as a 'declared pest' pursuant to Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. At a National level, the Australian government has compiled a list of 32 *Weeds of National Significance* (WoNS) (DAWE 2020c). Whilst the WoNS list is non-statuatory, many WoNS are also listed under the BAM Act. Further information on categories of declared pests is provided in **Appendix A**.

Due to historical disturbance weed species are expected to be present at the site.

2.8 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding values such as significant wetlands, threatened flora, threatened communities and *Bush Forever* sites. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, which includes any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

No ESAs occur over the site or in close proximity to the site.

2.9 DBCA managed or legislated lands

DBCA has tenure of or interests in numerous areas of land across the state for a range of purposes. Tenure categories include national parks, nature reserves, conservation parks, marine parks, marine nature reserves, marine management areas, section 5(1)(g) reserves, state forest and timber reserves. These areas are mapped within the *Legislated Lands and Waters* (DBCA 2017a) and *Lands of Interest* (DBCA 2017b) datasets. The *Legislated Lands and Waters* (DBCA 2017a) dataset includes lands subject to the following legislation; the *Conservation and Land Management Act 1984* (CALM Act 1984), Swan and Canning Rivers Management Act 2006 (SCRM Act) and lands identified under the Land Administration Act 1997 (LA Act). The *Lands of Interest* (DBCA 2017b) dataset includes all other lands of which DBCA is recognised as the manager but is not vested under any act. These lands

comprise of crown land and freehold land which DBCA has been acknowledged by the Department of Lands as the responsible agency.

No DBCA managed or legislated lands occur within the site. The Korung National Park, which is listed under the CALM Act, lies adjacent to the north and east of the site.

2.10 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. This exchange of genetic material between vegetation remnants improves the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004). This study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

There are no mapped ecological linkages within or adjacent to the site. One ecological linkage (No. 141) occurs approximately 500 m to the south west of the site but is not connected to the site.

2.11 Previous surveys

No previous relevant surveys are known to have been undertaken within the site.

3 Methods

3.1 Desktop assessment

3.1.1 Database searches

A search was conducted for threatened and priority flora that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020a), *NatureMap* (DBCA 2020) and DBCA's threatened and priority flora database (reference no. 31-0520FL).

A search was also conducted for TECs and PECs that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020a). A search of DBCA's threatened and priority ecological communities' database was also undertaken using a 5 km radius as recommended by DBCA (reference no. 13-0620EC).

3.1.2 Likelihood of occurrence

Prior to undertaking the field survey, information on the habitat preferences of threatened and priority flora species and communities identified from database searches was reviewed. This was compared to existing environmental information available for the site, such as geomorphology, soils, regional vegetation and historic land use.

An assessment of the likelihood of occurrence of threatened and priority flora species and communities within the site was undertaken and each species was assigned to one of the following categories:

- Recorded: the species has been previously recorded in the site or was recorded during the current field survey.
- Likely: suitable habitat for the species occurs in the site.
- Possible: suitable habitat for the species may occur in the site but is sub-optimal and no existing records occur close to the site.
- Unlikely: no suitable habitat for the species is present within the site.

3.2 Field survey

Botanists and ecologists from Emerge visited the site on the following days in 2020 to conduct the flora and vegetation field survey:

- 27 May
- 2 June
- 11 September
- 21 October
- 27 October
- 12 December.

The majority of the vegetation sampling was undertaken on 27 May, 2 June and 11 September. Targeted searches of particular areas were undertaken on the other survey dates.

3.2.1 Flora and vegetation

The site was traversed on foot and the composition and condition of vegetation was recorded.

Detailed sampling of the vegetation was undertaken using a combination of non-permanent 10 x 10 m quadrats and relevés. The quadrats were established using fence droppers bound by measuring tape. The relevés were completed over an equivalent 10 x 10 m area without the use of physical markers and were included to provide a more rapid sample of patches of vegetation in poorer condition and/or of smaller size.

A total of seven locations were sampled, comprised of three quadrats and four relevés. The position of each sample location was recorded with a hand-held GPS unit, as shown in **Figure 3**.

The data recorded within each sample included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping soil type and colour class, litter layer, topographical position, time since last fire event)
- biological information (vegetation structure and condition, 'foliage projective cover' (FPC), degree of disturbance and species present).

Additional plant taxa not observed within samples were recorded opportunistically as the botanist traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

Conservation significant species previously recorded within the site (refer **Section 3.1.2**) were searched for, where appropriate. The site was also assessed to determine whether suitable habitat was present for conservation significant species identified as potentially occurring within the site and (refer **Section 3.1.2**) whether the survey effort was appropriate to determine if they occur in the site.

All plant specimens collected during the field survey were dried, pressed and then named in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk ('*') in text and raw data.

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994).

Table 2: Vegetation condition scale applied during the field assessment

Condition category	Definition (Keighery 1994)
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

3.3 Mapping and data analysis

3.3.1 Plant community identification and description

The local plant communities within the site were identified from the sample data collected during the field survey. The vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant communities were mapped on aerial photography from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography based on the locations and notes recorded during the field survey to define areas with differing condition.

3.3.2 Threatened and priority ecological communities

Areas of native vegetation potentially representing a TEC or PEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds.

3.3.3 Species accumulation curve

A species accumulation curve was plotted from sample data by generating a trendline (log) in Microsoft Excel. The trendline was forecast to locate the asymptote of the curve (the point at which the curve flattens), which provides an indication of amount of sampling that would be required before it can be assumed few species remain undetected. PRIMER v6 also offers a range of estimators to predict minimum species richness (Clarke and Gorley 2006). Both the Jacknife1 and Chao2 non-parametric estimators are reported, as these are known to perform well in comparison to simulated and real data sets and are also recommended for small sample sizes (Gotelli and Colwell

2011). Comparison between actual and estimated species accumulation assists in evaluating the adequacy of sampling effort.

3.4 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) is provided in **Table 3**.

Table 3: Evaluation of survey methodology against standard constraints outlined in EPA (2016)

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in **Section 2** is adequate to place the site and vegetation in context.
		No previous survey information was available.
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanist with over ten years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with 18 years' experience in environmental science in Western Australia.
Suitability of timing	No limitation	The survey was conducted in the main flowering season. High rainfall was recorded in the months preceding the site visit. Therefore it is likely that many plant species would have been in flower and/or visible at the time of survey. The survey timing was considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	No limitation	Comprehensive flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited multiple times in 2020 including within and outside the main flowering period. Therefore, according to the EPA guidelines this survey is considered to meet the requirements of a 'detailed' survey.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Sampling intensity	No limitation	A total of 159 species were recorded, of which 87 were recorded from seven samples and 72 were recorded opportunistically. Minimum species richness within site is estimated at between 139 (Jacknife1) and 180 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 10**). This indicates that between 88 and 100% of the estimated 139-180 species in the site were recorded, demonstrating that survey effort was adequate to prepare a near-comprehensive species inventory for the site.
Influence of disturbance	Minor limitation	Time since fire is greater than 50 years as interpreted form aerial imagery and therefore short lived species more common after fire may not have been visible. Some evidence of fire was present on the trunks of trees within the site but it is unclear how recent this is.
	No limitation	Historical ground disturbance was evident in parts of the site. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 General site conditions

The western and southern portions of the site have been subject to intensive historical disturbance and support non-native vegetation and native regrowth vegetation. The north eastern portion of the site supports intact native vegetation that has been subject to lower levels of disturbance.

Soils are generally brown clay and sand with lateritic gravel. Two granitic outcrops occur in the eastern portion of the site. An active gravel quarry exists in the north western portion of the site and a dam is present in the central southern portion. A minor waterway which was dry during most of the surveys runs from the granite outcrop in the north east to a small dam in the centre of the site.

4.2 Flora

4.2.1 Desktop assessment

The database search results identified a total of one extinct, 18 threatened and 28 priority flora species occurring or potentially occurring within a 10 km radius of the site. Information on these species including their habitat preferences is provided in **Appendix B**.

Based on background information available for the site, suitable habitat was considered to potentially occur within the site for 12 threatened flora species and 28 priority flora species as shown in **Table 4**.

Table 4: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Lasiopetalum pterocarpum	CR	EN	P	Riparian community with species such as flooded gum, marri and swamp peppermint.	Aug-Nov
Darwinia apiculata	EN	EN	P	Open jarrah-marri woodland on shallow gravely soil over laterite, or open heathland over sandy loams with granite boulders.	Oct-Nov
Diplolaena andrewsii	EN	EN	P	Granite outcrops & hillsides.	Jul-Oct
Goodenia arthrotricha	EN	EN	P	Granite rocks, slopes	Oct-Nov
Thelymitra stellata	EN	EN	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov
Verticordia fimbrilepis subsp. *fimbrilepis*	VU	EN	P	Gravelly sandy or clayey soils. Flats, road verges.	Oct-Dec/Jan
Acacia anomala	VU	VU	P	Shallow sand,loam,clay or gravel	Aug-Sep
Anthocercis gracilis	VU	VU	P	Steep granite slopes along the Darling Scarp in shallow, humis-rich sandy or loamy soils.	Sep-Oct, Apr

Table 4: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Eleocharis keigheryi	VU	VU	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec
Eriochilus sp. Roleystone (G. Brockman 1140)	P1	-	PG	Lateritic or black sandy gravel.	Jun-Jul (limited information)
Thelymitra magnifica	P1	-	PG	Gravelly soil on stony ridges.	Sep-Oct
Bossiaea modesta	P2	-	P	Soils derived from granite. Damp areas close to stream.	Oct-Dec
Paracaleana ferricola	P2	-	PG	Lateritic gravel in open areas of woodland	Jul
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2	-	P	Grey sand with lateritic gravel.	Dec
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	P2	-	P	Sandy clay with gravel.	Sep-Nov
Acacia horridula	P3	-	P	Gravelly soils over granite, sand, rocky hillsides.	May-Aug
Banksia kippistiana var. *paenepeccata*	P3	-	P	Lateritic gravelly soils.	Oct-Nov
Beaufortia purpurea	P3	-	P	Lateritic or granitic soils on rocky slopes.	Oct-Feb
Gonocarpus pycnostachyus	P3	-	A	Sand or clay soils. Wet depressions, granite rocks.	Oct
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec
Thysanotus anceps	P3	-	P	White or grey sand, lateritic gravel, laterite.	Oct-Dec
Acacia oncinophylla subsp. *oncinophylla*	P3	-	P	Granitic soils	Aug-Oct
Allocasuarina grevilleoides	P3	-	P	Sand over laterite, gravel.	Sep-Nov
Asteridea gracilis	P3	-	A	Sand, clay, gravelly soils.	Sep-Dec
Grevillea manglesii subsp. *dissectifolia*	P3	-	P	Gravelly loam, moist. Roadsides.	Jun, Sep/Nov
Halgania corymbosa	P3	-	P	Gravelly soils, soils over granite.	Aug-Nov
Lasiopetalum glutinosum subsp. *glutinosum*	P3	-	P	Brown clay loam on slopes	Sep-Dec

Table 4: Conservation significant flora species considered to have potential to occur in the site based on known habitat preferences (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period
	State	EPBC Act			
Stackhousia sp. Red-blotched corolla (A. Markey 911)	P3	-	P	Granitic soils on slopes.	Sep-Nov
Calothamnus graniticus subsp. *leptophyllus*	P4	-	P	Clay over granite, lateritic soils. Hillsides.	Jun-Aug
Pimelea rara	P4	-	P	Lateritic soils.	Dec-Jan
Stylidium striatum	P4	-	P	Brown clay over laterite on hill slopes.	Oct-Nov
Thysanotus glaucus	P4	-	P	White, grey or yellow sand, sandy gravel.	Oct-Mar
Acacia oncinophylla subsp. *patulifolia*	P4	-	P	Granitic soils, occasionally on laterite.	Aug-Nov/Nov-Dec
Boronia tenuis	P4	-	P	Laterite, stony soils, granite.	Aug-Nov
Calothamnus accedens	P4	-	P	Sandy soils over laterite.	Sep-Jan
Grevillea pimeleoides	P4	-	P	Gravelly soils over granite. Rocky hillsides.	May-Nov
Lasiopetalum bracteatum	P4	-	P	Sandy clay, clay, lateritic gravel along drainage lines, creeks, gullies, granite outcrops.	Aug-Nov

CR=critically endangered, E=endangered, V=vulnerable, P1-P4=Priority 1-Priority 4, P=perennial, PG=perennial geophyte.

4.2.2 Species inventory

A total of 140 native and 19 non-native (weed) species were recorded within the site during the field survey, representing 44 families and 111 genera. The dominant families containing native taxa were Asteraceae (11 native taxa and five weed taxa) and Myrtaceae (eleven native taxa and one weed taxa). The most common genera were *Stylidium, Acacia, Lepidosperma and Hibbertia* with seven, six, five and five taxa respectively. The family containing the most taxa was Asteraceae (16 a). Of the species recorded 87 were recorded in samples and 72 were recorded opportunistically.

A complete species list is provided in **Appendix D** and a species list by plant community matrix is provided in **Appendix E**.

4.2.3 Threatened and priority flora

No threatened or priority flora species were recorded in the site.

The majority of the threatened and priority flora species identified in the desktop assessment are not considered to occur in the site due to lack of suitable habitat and/or because they were not recorded during the field survey. The survey was unable to confirm the presence or absence of two priority flora species, *Eriochilus* sp. Roleystone (G. Brockman 1140) (P1) and *Paracaleana ferricola* (P2), but these species are considered unlikely to occur as discussed in **Section 5.1**.

4.2.4 Locally and regionally significant flora

No locally or regionally significant flora species were recorded within the site.

4.2.5 Declared pests

Two species listed as declared pests (C3) pursuant to the BAM Act, **Asparagus asparagoides* (bridal creeper) and **Moraea flaccida* (one-leaf cape tulip), were recorded within the site. A small number of these plants were recorded scattered throughout the site.

Bridal creeper is also listed as a weed of national significance (WoNS).

4.3 Vegetation

4.3.1 Desktop assessment

The database search results identified community listed as a TEC and a PEC, banksia woodlands of the Swan Coastal Plain, as potentially occurring within a 10 km radius of the site. The DBCA database search did not return any results. Information on this community is provided in **Appendix C**.

Since the site is not located on the Swan Coastal Plain (refer to **Section 2.2**), the above TEC is not considered to potentially occur in the site.

4.3.2 Plant communities

Eight plant communities were identified within the site. Plant community **CcEmBa** extends over approximately half of the site (26.25 ha/54%), particularly in the eastern portion. Plant communities **Bs**, **Cd**, **AeGm** and **LeH** are associated with granite outcrops in the eastern portion of the site. Plant communities CcLl and TlBr occur in the central southern portion of the site. The remainder of the site comprises revegetation (1.81 ha/4% of the site) and **cleared and non-native** areas (12.43 ha/26% of the site). Two water bodies which extend over 0.11 ha occur within the site and were not mapped as a plant community.

A description and the area of each plant community is provided in **Table 5** and representative photographs of each are provided in **Plate 1** to **Plate 9**. The location of each plant community is shown in **Figure 3**. A matrix of species recorded within each plant community is provided in **Appendix E** and raw sample data in **Appendix F**.

Table 5: Description and extent of plant communities identified within the site

Plant community	Description	Area (ha)
AeGm	Closed shrubland *Acacia ephedroides* and *Grevillea manglesii* subsp. *manglesii* (**Plate 1**).	3.70
Bs	Granite outcrop comprising bare rock surfaces and bryophytes and herbland dominated by *Borya sphaerocephala* (**Plate 2**).	3.02
Cd	Low shrubland *Calytrix depressa* over mixed open native herbland (**Plate 3**).	0.51
CcEmBa	Open forest *Corymbia calophylla* and *Eucalyptus marginata* with *Allocasuarina fraseriana* over shrubland to tall shrubland *Banksia grandis* and *Bossiaea aquifolium* over shrubland *Xanthorrhoea preissii* over mixed native herbland *Platysace filiformis*, *Stylidium* spp. and *Scaevola* spp. (**Plate 4**).	26.25
CcLl	*Corymbia calophylla* over scattered shrubs *Taxandria linearifolia* over closed sedgeland *Lepidosperma longitudinale* (**Plate 5**).	0.12
LeH	Tall shrubland *Leptospermum erubescens* and *Hakea undulata* over shrubland *Xanthorrhoea preissii, Melaleuca trichophylla, Allocasuarina humilis* and *Hakea erinacea* over low shrubland *Gastrolobium villosum* over mixed open herbland *Stylidium* spp. (**Plate 6**).	0.22
TlBr	Tall open shrubland *Taxandria linearifolia* over closed sedgeland *Baumea rubiginosa* (**Plate 7**).	0.06
Revegetation	Planted vegetation - closed shrubland dominated by *Calothamnus quadrifidus* (**Plate 8**).	1.81
Cleared and non-native	Cleared areas and predominantly scattered non-native plants including patches of non-native planted trees (**Plate 9**).	12.43

*Plate 1: Plant community **AeGm** in 'very good' condition*

*Plate 2: Plant community **Bs** in 'excellent' condition*

*Plate 3: Plant community **Cd** in 'very good' condition*

*Plate 4: Plant community **CcEmBa** in 'very good' condition*

*Plate 5: Plant community **CcLl** in 'very good' condition*

*Plate 6: Plant community **LeH** in 'very good' condition*

*Plate 7: Plant community **TlBr** in 'excellent' condition*

*Plate 8: Plant community **Revegetation** in 'degraded' condition*

*Plate 9: Plant community **Cleared** in 'completely degraded' condition*

4.3.3 Vegetation condition

The most intact vegetation in the site is located within plant community **Bs** which comprises granite rises with exposed rock, mosses and native shrubs and herbs. This vegetation was mapped as being in 'excellent' condition as it comprises a vegetation structure expected of granite outcrops and very low weed cover was recorded. Plant community **TlBr** was also mapped as being in 'excellent' condition as it supports an intact structure, high cover of native species and very low cover of weeds.

Plant communities **CcEmBa**, **LeH** and **Cd** in the north eastern portion of the site comprise relatively intact native vegetation and were mapped as being in 'very good' condition. This vegetation shows some signs of disturbance such as patches of bare ground, altered structure and/or weeds but generally supported moderate to high cover of native species and low weed cover. One patch of plant community **CcEmBa** in the north western portion of the site, and small areas of plant communities **CcLl** and **Bs** in the central southern portion of the site, were also mapped as being in 'very good' condition for the same reasons.

Most of the portion of plant community **CcEmBa** in the south eastern portion of the site was mapped as being in 'very good – good' condition. This vegetation comprises a mosaic of small intact patches with moderately intact structure and native species diversity interspersed with small patches supporting an altered structure and reduced native understorey diversity. Parts of this plant community that were significantly altered and comprises scattered native plants only were mapped as being in 'degraded' condition.

Vegetation in the central portion of the site and southern portions of the site were mapped as being in 'good' condition as they have been subject to disturbance and comprise an altered structure with reduced native species diversity. Vegetation subject to higher levels of disturbance and with minimal native species diversity were mapped as being in 'degraded' condition.

The remainder of the site was mapped as being in 'completely degraded' condition as it mainly consists of bare ground including tracks and the current quarry, with scattered native and non-native plants. The 0.11 ha of open water and the 1.81 ha of revegetation in the site were not assigned a condition category.

The extent of vegetation by condition category is detailed in **Table 6** and shown in **Figure 4**.

Table 6: Extent of vegetation condition categories within the site

Condition category (Keighery 1994)	Size (ha)
Pristine	0
Excellent	3.02
Very good	15.24
Good	6.99
Good – degraded	6.43
Degraded	2.19
Completely degraded	12.44

4.3.4 Threatened and priority ecological communities

The vegetation within the site is not considered to represent a TEC or PEC.

4.3.5 Locally and regionally significant vegetation

Mature eucalypt trees (diameter at breast height larger than 500 mm) including *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah) occur in the site and may provide foraging, roosting and nesting habitat for threatened species of black cockatoos, along with other ecological services. Opportunistic sightings of threatened black cockatoos (Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo) were recorded within and adjacent to the site during the field survey.

Vegetation, particularly that in the northern and eastern portions of the site, is adjacent to extensive areas of intact native vegetation and would contribute to ecological linkages in the area.

4.4 Species richness and sampling adequacy

A total of 87 species were recorded from seven samples. A species accumulation curve derived from sample data is presented in **Plate 10**. After seven samples the curve is still increasing and has not reached its asymptote. This indicates that a proportion of species likely remain undetected by sampling.

Species richness was estimated in PRIMER v6 to be between 139 (Jacknife1) and 180 (Chao2). Based on the trend of the species accumulation curve 70 to 80 samples would be required to capture that many species. Including the 72 additional species recorded opportunistically, a total of 159 species was recorded in the site. This indicates that between 88 and 100% of the estimated 139-180 species in the site were recorded. The survey effort was therefore considered to be adequate to prepare a comprehensive species inventory.

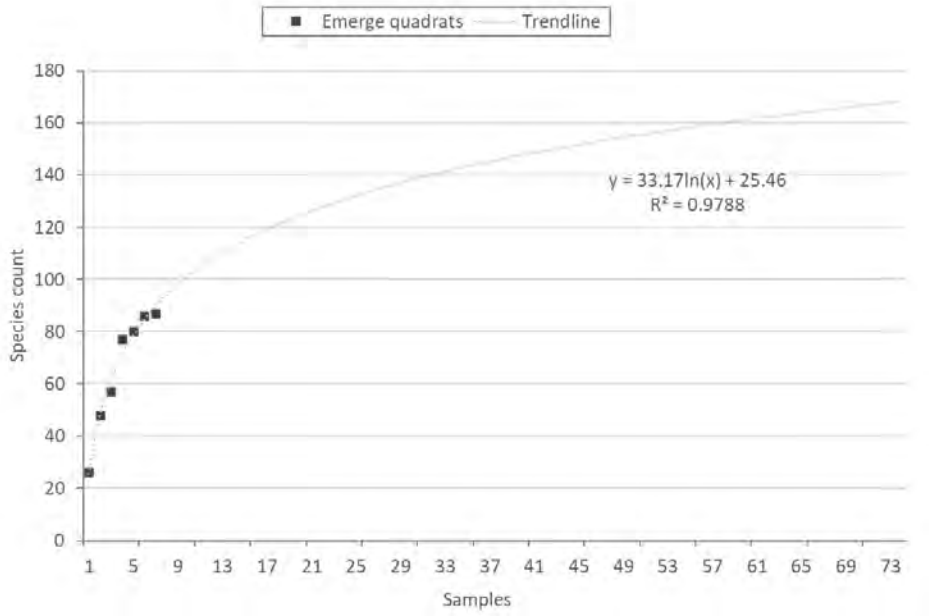

Plate 10: Species accumulation curve derived from sample data (y = 33.17ln(x) + 25.46 R^2 = 0.9788)

5 Discussion

The eastern, and particularly the north eastern, portion of the site supports intact native vegetation. The western portion of the site has been subject to intensive historical and ongoing disturbance and comprises patches of native vegetation and cleared areas.

5.1 Threatened and priority flora

No threatened or priority flora species were recorded within the site. Prior to the survey, based on background information, multiple threatened and priority flora species were considered to potentially occur within the site. The field surveys between May and December were considered sufficient to determine that all but two priority species are unlikely to occur. This is because the timing of the surveys coincided with the main flowering period of the majority of the conservation significant flora identified in the desktop assessment and those with dissimilar flowering periods were mostly perennials. Since no unidentified specimens which had potential to comprise conservation significant species were collected, the survey effort is considered sufficient to confirm the absence of these species on the basis that either suitable habitat does not occur or the species were not recorded during traverses within potentially suitable habitat during periods when they should have been detectable.

However, the field survey was outside of the flowering period of two priority flora species: *Eriochilus* sp. Roleystone (G. Brockman 1140) (P1) and *Paracaleana ferricola* (P2). These species are both perennial geophytic orchids, occurring underground for most of the year and developing leaves and flowers above-ground only during a few months in order to reproduce. *Eriochilus* sp. Roleystone (G. Brockman 1140) is known to flower between June and July but limited information is available on this species as only three records exist on DBCA's *Florabase* website (Western Australian Herbarium 2021). These three records occur close together, approximately 7 km west of the site in Banyowla Regional Park. Similarly, *Paracaleana ferricola* (P2) flowers in July and five records occur on *Florabase* (Western Australian Herbarium 2021). These records also occur close together and lie approximately five km north west of the site in Korung National Park. Although suitable habitat for these species is present in the site, they are considered unlikely to occur as the extent of the nearby recorded populations is localised and does not suggest that these taxa are distributed along the scarp such that they would occur in the site.

5.2 Vegetation condition

Assigning a condition category to most of the patches of vegetation within the site was relatively straightforward.

Plant community **Bs**, mapped as being in 'excellent' condition, includes large portions of unvegetated granite areas but this is a natural part of granite outcrop landforms and not considered a sign of disturbance or an indication it should be assigned to a lower condition category.

A compound condition category of 'very good – good' was included for part of plant community **CcEmBa** which comprises a mosaic of patches of vegetation in each category. At the scale of mapping

undertaken within the site it was not appropriate to separate these patches and the compound condition category was considered sufficient to portray the values within this area.

5.3 Threatened and priority ecological communities

The desktop assessment indicated that no TECs or PECs associated with the jarrah forest bioregion occur within 10 km of the site. Therefore, the vegetation within the site is not considered to represent a TEC or a PEC.

5.4 Local and regional significance

Trees within the site, particularly in the eastern portion, may provide potential foraging, roosting and/or nesting habitat for threatened species of black cockatoos which occur in the local area. The native vegetation, particularly that in the northern and eastern portions of the site contributes to ecological linkages in the area.

6 Conclusions

The south west of the site has been subject to intensive historical disturbance and primarily supports non-native vegetation or native regrowth. The north east of the site supports intact native vegetation that has been subject to lower levels of disturbance.

A total of 140 native and 19 non-native (weed) species were recorded in the site.

No threatened or priority flora were recorded in the site.

The survey timing was not appropriate to confirm the presence or absence of two priority flora species: *Eriochilus* sp. Roleystone (G. Brockman 1140) (P1) and *Paracaleana ferricola* (P2) but they are considered unlikely to occur. No other threatened or priority flora are considered likely to occur in the site.

Eight plant communities were identified within the site. Approximately 70% of the site supports plant communities dominated by native vegetation (33.88 ha). The remainder of the site comprises non-native vegetation, cleared areas and water bodies (14.35 ha/30% of the site).

Vegetation in 'excellent', very good', 'very good – good' and 'good' condition occurs across 31.68 ha (66% of the site). Vegetation in 'degraded' and 'completely degraded' condition occurs across 14.63 ha (30% of the site). A total of 1.92 ha (4% of the site) was not assigned to a vegetation condition category.

No TECs or PECs occur within the site.

Vegetation within the site, particularly in the eastern portion, may provide potential foraging, roosting and/or nesting habitat for threatened species of black cockatoos which occur in the local area. The native vegetation, particularly that in the northern and eastern portions of the site contributes to ecological linkages in the area.

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Figures

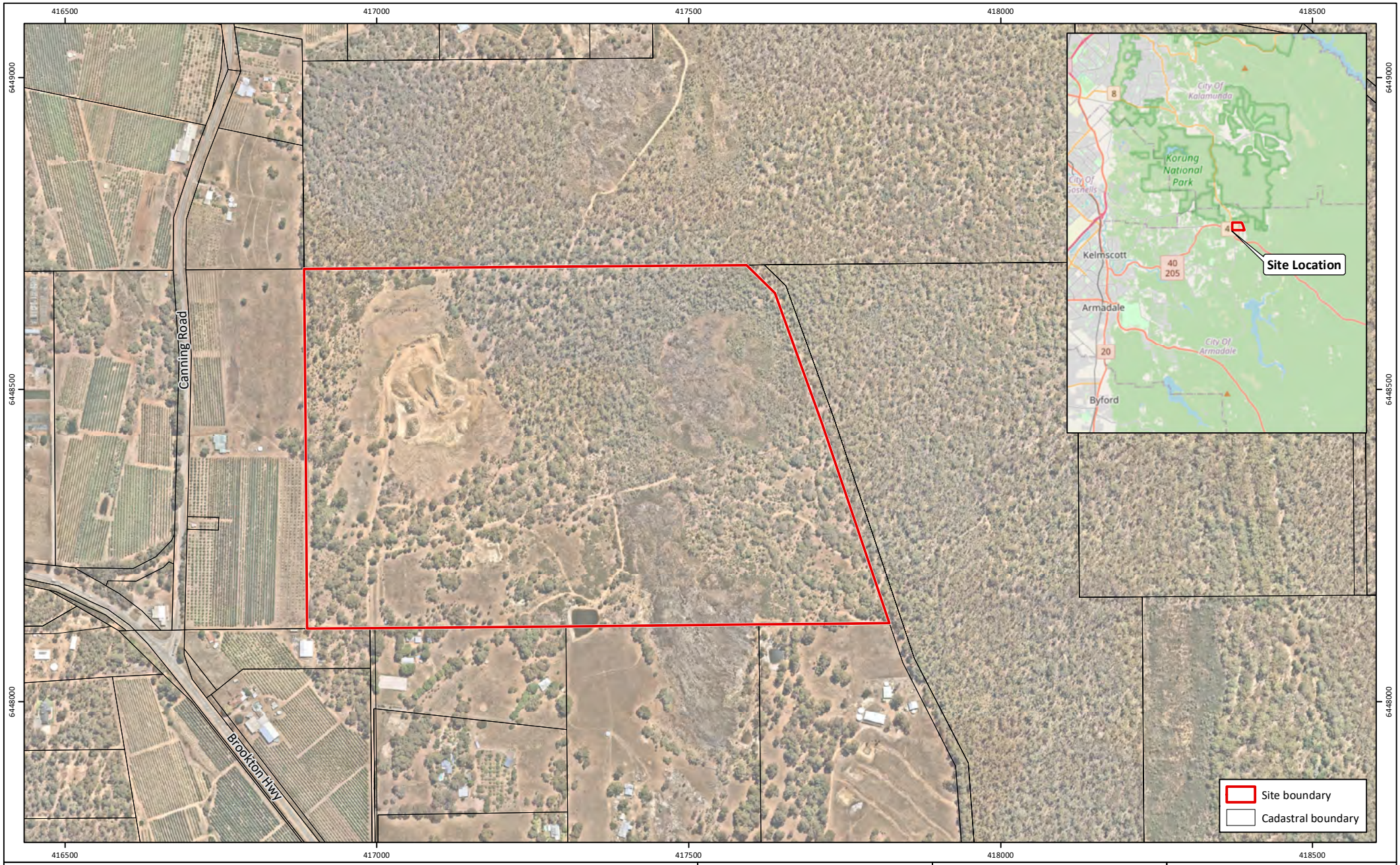

Figure 1: Site Location

Project: Detailed Flora and Vegetation Assessment
Lot 9 Brookton Highway Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F20
Drawn: GAR
Date: 04/02/2021
Checked: RAW
Approved: TAA
Date: 05/02/2021

N

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Metres
Scale: 1:8,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

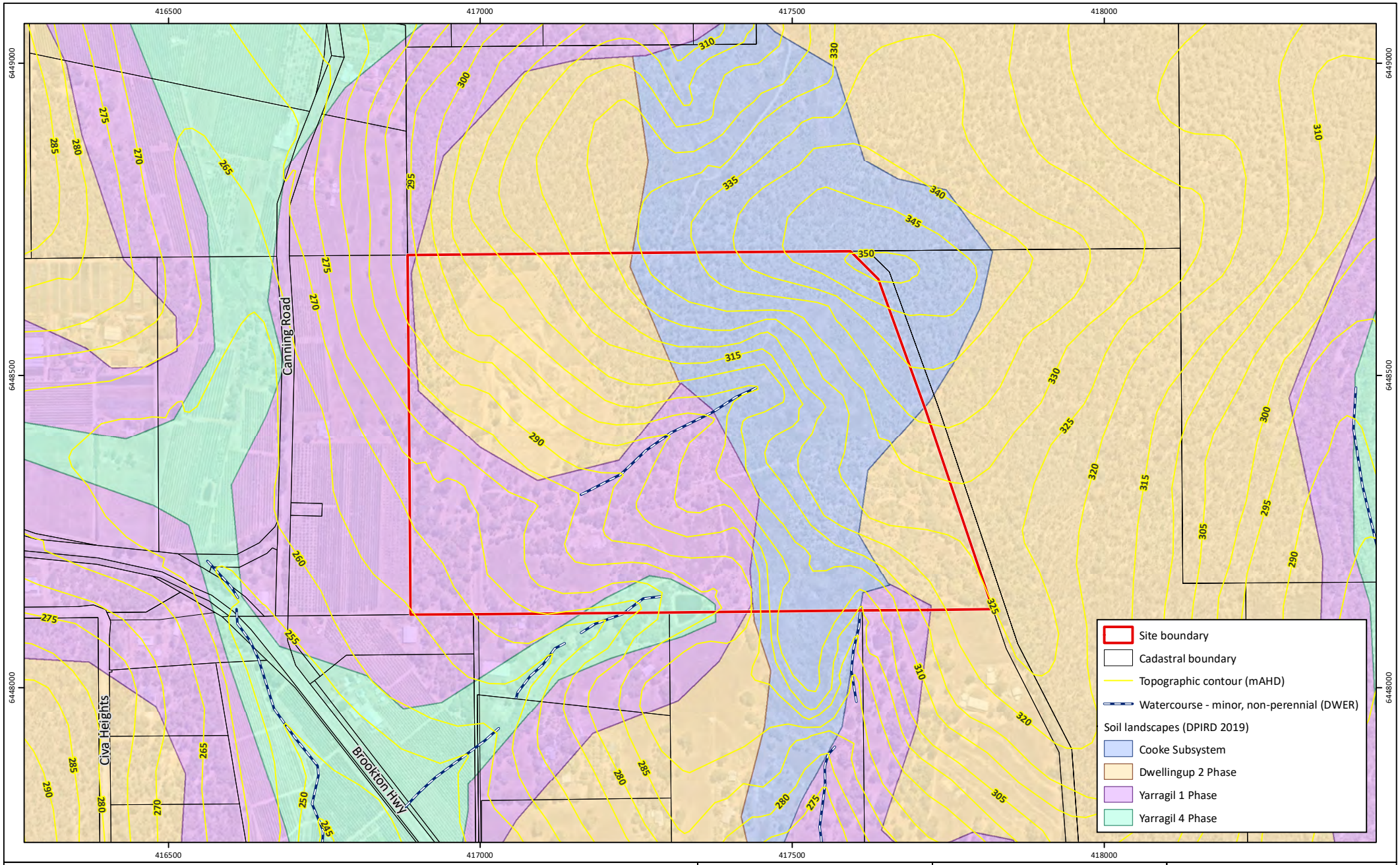

Figure 2: Environmental Features

Project:	Detailed Flora and Vegetation Assessment Lot 9 Brookton Highway Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F21

Drawn:	GAR
Date:	04/02/2021
Checked:	RAW
Approved:	TAA
Date:	05/02/2021

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Metres

Scale: 1:8,000@A4

GDA 1994 MGA Zone 50

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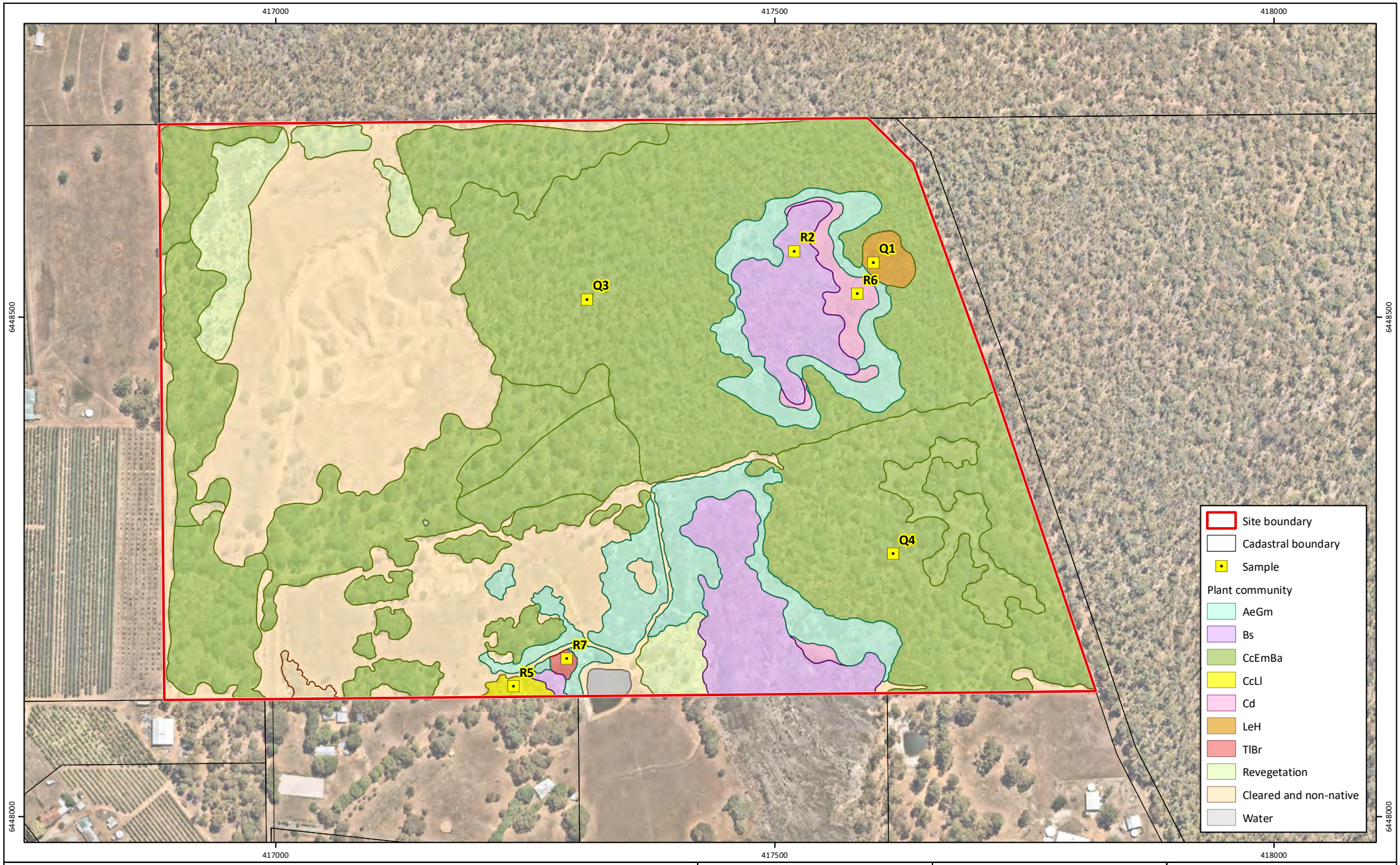

Figure 3: Plant Communities

Project: Detailed Flora and Vegetation Assessment
Lot 9 Brookton Highway Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F22

Drawn:	GAR
Date:	04/02/2021
Checked:	RAW
Approved:	TAA
Date:	05/02/2021

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Metres

Scale: 1:5,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

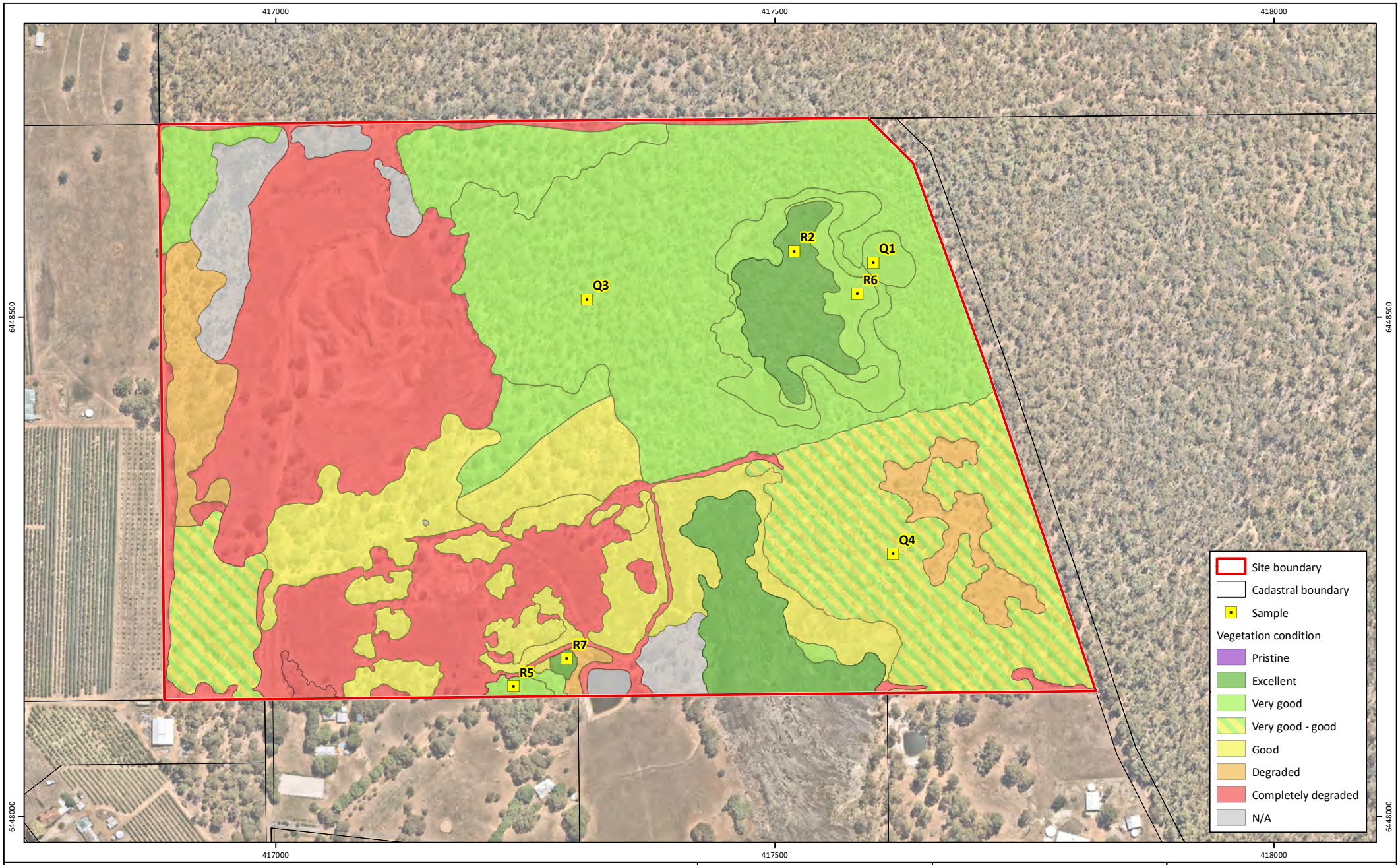

Figure 4: Vegetation Condition

Project: Detailed Flora and Vegetation Assessment
Lot 9 Brookton Highway Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F23
Drawn: GAR
Date: 04/02/2021
Checked: RAW
Approved: TAA
Date: 05/02/2021

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Additional Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Flora species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories according to their conservation status, as outlined in **Table 1**.

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done. The definition of threatened flora under the BC Act is provided in **Table 1**.

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018c). Priority flora species are considered during State approval processes. Priority flora categories and definitions are listed in **Table 1**.

Table 1: Definitions of conservation significant flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2018c)

Conservation code	Description
EX†	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T^†	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR^	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN^	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU^	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

^pursuant to the EPBC Act, †pursuant to the BC Act, on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are recognised as ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment.

Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs endorsed by the State Minister are published by DBCA (DBCA 2018b).

TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). TECs are afforded direct statutory protection at a State level under the BC Act and BC Regulations. Ecological communities are listed under Section 27(1) and 33 of the BC Act. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009)

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). PECs are categorised as priority category 1, 2 or 3 as described in **Table 3**. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for 'near threatened', or that have been recently removed from the threatened list, are placed in 'priority 4'. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in 'priority 5' (DEC 2013). Listed PECs are published by DBCA (DBCA 2017b).

Table 3: Categories of priority ecological communities (DEC 2013)

Priority code	Description
P1	Priority One: Poorly known ecological communities Ecological communities that are known from very few occurrences with a very restricted distribution (generally ≤5 occurrences or a total area of ≤ 100ha). Occurrences are believed to be under threat either due to limited extent, or being on lands under immediate threat (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) or for which current threats exist. May include communities with occurrences on protected lands. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2	Priority Two: Poorly known ecological communities Communities that are known from few occurrences with a restricted distribution (generally ≤10 occurrences or a total area of ≤200ha). At least some occurrences are not believed to be under immediate threat (within approximately 10 years) of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3	Priority Three: Poorly known ecological communities (i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) communities known from a few widespread occurrences, which are either large or with significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat (within approximately 10 years), or; (iii) communities made up of large, and/or widespread occurrences, that may or may not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, inappropriate fire regimes, clearing, hydrological change etc. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four: Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (i) Rare. Ecological communities known from few occurrences 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 communities are usually represented on conservation lands. (ii) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for a higher threat category. (iii) Ecological communities that have been removed from the list of threatened communities during the past five years.
P5	Priority Five: Conservation Dependent ecological communities Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Weeds

A number of legislative and policy documents exist in relation to weed management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding weed management in Western Australia and lists declared pest species. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018), of which many are also listed under the BAM Act.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 7**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in **Table 8**.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 9**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DPIRD 2020).

Table 4: Legal status of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management

Category	Description
	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 which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DPIRD 2020)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

References

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Appendix B

Conservation Significant Flora Species and Likelihood of Occurrence Assessment

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Acacia anomala	VU	VU	P	Shallow sand,loam,clay or gravel	Aug-Sep	Unlikely
Anthocercis gracilis	VU	VU	P	Steep granite slopes along the Darling Scarp in shallow, humis-rich sandy or loamy soils.	Sep-Oct, Apr	Unlikely
Eleocharis keigheryi	VU	VU	P	Clay or sandy loam in freshwater creeks and transient waterbodies such as seasonally wet clay pans.	Aug-Dec	Unlikely
Diuris drummondii	VU	V	PG	In low-lying depressions in peaty and sandy clay swamps.	Nov-Jan	Unlikely
Conospermum undulatum	VU	V	P	Sand and sandy clay soils, on flat or gently sloping sites between the Swan and Canning Rivers	May-Oct	Unlikely
Diuris micrantha	VU	V	PG	Dark grey-black sandy clay-loam in winter wet depressions or swamps. Often in shallow standing water.	Aug/Sep-early Oct	Unlikely
Drakaea micrantha	EN	V	PG	Open sandy patches often adjacent to winter-wet swamps.	Sept- early Oct	Unlikely
Darwinia apiculata	EN	EN	P	Open jarrah-marri woodland on shallow gravely soil over laterite, or open heathland over sandy loams with granite boulders.	Oct-Nov	Unlikely
Verticordia fimbrilepis subsp. fimbrilepis	VU	EN	P	Gravelly sandy or clayey soils. Flats, road verges.	Oct-Dec/Jan	Unlikely
Diplolaena andrewsii	EN	EN	P	Granite outcrops & hillsides.	Jul-Oct	Unlikely
Lasiopetalum pterocarpum	CR	EN	P	Riparian community with species such as flooded gum, marri and swamp peppermint.	Aug-Nov	Unlikely
Thelymitra stellata	EN	EN	PG	Sandy loam, clay or gravel over laterite or gravel.	Sep-Nov	Unlikely
Goodenia arthrotricha	EN	EN	P	Granite rocks, slopes	Oct-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Diuris purdiei	EN	E	PG	Sand to sandy clay soils in areas subject to winter inundation.	late September to mid-October, but only after a summer or early autumn fire (Brown et al., 1998)	Unlikely
Thelymitra dedmaniarum	CR	E	PG	Red brown sandy loam with dolerite and granite outcrops.	Oct-Nov	Unlikely
Eucalyptus x balanites	CR	E	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland (Population 2) or heathland with emergent mallees (population 1)	Oct - Feb	Unlikely
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CR	CR	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Unlikely
Grevillea thelemanniana	CR	CR	P	Sand, sandy clay. Winter-wet low-lying flats.	May-Nov	Unlikely
Scholtzia sp. Bickley (W.H. Loaring s.n. PERTH 06165184)	EX	-	P	Unknown. One record in Bickley	Unknown	Unlikely
Eriochilus sp. Roleystone (G. Brockman 1140)	P1	-	PG	Lateritic or black sandy gravel.	Jun-Jul (limited information)	Unlikely
Thelymitra magnifica	P1	-	PG	Gravelly soil on stony ridges.	Sep-Oct	Unlikely
Bossiaea modesta	P2	-	P	Soils derived from granite. Damp areas close to stream.	Oct-Dec	Unlikely
Paracaleana ferricola	P2	-	PG	Lateritic gravel in open areas of woodland	Jul	Unlikely
Thysanotus sp. Badgingarra (E.A. Griffin 2511)	P2	-	P	Grey sand with lateritic gravel.	Dec	Unlikely
Andersonia sp. Blepharifolia (F. & J. Hort 1919)	P2	-	P	Sandy clay with gravel.	Sep-Nov	Unlikely

Species name	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	WA	EPBC Act				
Acacia horridula	P3	-	P	Gravelly soils over granite, sand, rocky hillsides.	May-Aug	Unlikely
Banksia kippistiana var. paenepeccata	P3	-	P	Lateritic gravelly soils.	Oct-Nov	Unlikely
Beaufortia purpurea	P3	-	P	Lateritic or granitic soils on rocky slopes.	Oct-Feb	Unlikely
Gonocarpus pycnostachyus	P3	-	A	Sand or clay soils. Wet depressions, granite rocks.	Oct	Unlikely
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec	Unlikely
Thysanotus anceps	P3	-	P	White or grey sand, lateritic gravel, laterite.	Oct-Dec	Unlikely
Acacia oncinophylla subsp. oncinophylla	P3	-	P	Granitic soils	Aug-Oct	Unlikely
Allocasuarina grevilleoides	P3	-	P	Sand over laterite, gravel.	Sep-Nov	Unlikely
Asteridea gracilis	P3	-	A	Sand, clay, gravelly soils.	Sep-Dec	Unlikely
Grevillea manglesii subsp. dissectifolia	P3	-	P	Gravelly loam, moist. Roadsides.	Jun, Sep/Nov	Unlikely
Halgania corymbosa	P3	-	P	Gravelly soils, soils over granite.	Aug-Nov	Unlikely
Lasiopetalum glutinosum subsp. glutinosum	P3	-	P	Brown clay loam on slopes	Sep-Dec	Unlikely
Stackhousia sp. Red-blotched corolla (A. Markey 911)	P3	-	P	Granitic soils on slopes.	Sep-Nov	Unlikely
Calothamnus graniticus subsp. leptophyllus	P4	-	P	Clay over granite, lateritic soils. Hillsides.	Jun-Aug	Unlikely
Pimelea rara	P4	-	P	Lateritic soils.	Dec-Jan	Unlikely
Stylidium striatum	P4	-	P	Brown clay over laterite on hill	Oct-Nov	Unlikely
Thysanotus glaucus	P4	-	P	White, grey or yellow sand,	Oct-Mar	Unlikely
Acacia oncinophylla	P4	-	P	Granitic soils, occasionally on	Aug-	Unlikely
Boronia tenuis	P4	-	P	Laterite, stony soils, granite.	Aug-Nov	Unlikely
Calothamnus accedens	P4	-	P	Sandy soils over laterite.	Sep-Jan	Unlikely
Grevillea pimeleoides	P4	-	P	Gravelly soils over granite. Rocky hillsides.	May-Nov	Unlikely
Lasiopetalum	P4	-	P	Sandy clay, clay, lateritic gravel	Aug-Nov	Unlikely

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green

Appendix C

Conservation Significant Communities and Likelihood of Occurrence Assessment

Code	Community name	TEC/PEC	Level of significance		Likelihood of occurrence
			State	EPBC Act	
-	Banksia woodlands of the Swan Coastal Plain	**TEC/PEC**	EN	P3	Does not occur
Note: TEC=threatened ecological community, PEC=priority ecological community, EN=endangered, P3=priority 3					

Appendix D

Species List

Family	Status	*Species*
Apiaceae		*Actinotus leucocephalus*
	*	*Foeniculum vulgare*
		Pentapeltis peltigera
		Platysace filiformis
		Xanthosia candida
Apocynaceae		
	*DP	*Gomphocarpus fruticosus*
Asparagaceae		
	*DP,WoNS	*Asparagus asparagoides*
		Lomandra purpurea
		Lomandra sericea
		Sowerbaea laxiflora
		Thysanotus manglesianus
Asteraceae		
		Craspedia variabilis
	*	*Erigeron sumatrensis*
		Hyalosperma cotula
	*	*Hypochaeris glabra*
		Lagenophora huegelii
		Millotia myosotidifolia
		Olearia paucidentata
	*	*Osteospermum ecklonis*
		Pithocarpa pulchella var. pulchella
		Quinetia urvillei
		Siloxerus filifolius
	*	*Sonchus oleraceus*
		Trichocline spathulata
	*	*Ursinia anthemoides*
		Waitzia sp.
		Xerochrysum macranthum
Boryaceae		
		Borya ?laciniata
		Borya sphaerocephala
Casuarinaceae		
		Allocasuarina fraseriana
		Allocasuarina humilis
Celastraceae		
		Stackhousia pubescens
Centrolepidaceae		
		Aphelia cyperoides
		Centrolepis aristata
Colchicaceae		
		Burchardia congesta
		Burchardia multiflora
		Wurmbea dioica
Crassulaceae		
		Crassula ?extrorsa
Cyperaceae		

Family	Status	*Species*
		Baumea rubiginosa
		Cyathochaeta avenacea
		Lepidosperma apricola
		Lepidosperma longitudinale
		Lepidosperma pubisquameum
		Lepidosperma sp.
		Lepidosperma ?scabrum
		Schoenus clandestinus
Dilleniaceae		
		Hibbertia amplexicaulis
		Hibbertia aurea
		Hibbertia commutata
		Hibbertia hypericoides
		Hibbertia ?huegelii
Droseraceae		
		Drosera bulbosa subsp. bulbosa
		Drosera gigantea
		Drosera macrantha
Ericaceae		
		Andersonia lehmanniana
		Leucopogon capitellatus
		Leucopogon tenuis
		Leucopogon verticillatus
		Styphelia tenuiflora
Euphorbiaceae		
	*	*Ricinus communis*
Fabaceae		
		Acacia alata var. alata
		Acacia barbinervis
	*	*Acacia dealbata*
		Acacia ephedroides
		Acacia pulchella var. pulchella
		Acacia urophylla
		Bossiaea aquifolium
		Daviesia decurrens
		Daviesia horrida
		Gastrolobium villosum
		Gompholobium polymorphum
		Gompholobium ?polymorphum
		Gompholobium tomentosum
		Hovea sp.
		Kennedia coccinea
Geraniaceae		
	*	*Erodium botrys*
Goodeniaceae		
		Dampiera coronata
		Goodenia trinervis
		Lechenaultia floribunda

Family	Status	*Species*
		Scaevola pilosa
		Scaevola platyphylla
Haemodoraceae		
		Conostylis setosa
		Conostylis sp.
		Haemodorum sp.
		Tribonanthes longipetala
Hemerocallidaceae		
		Arnocrinum preissii
		Dianella revoluta
		Stypandra glauca
		Tricoryne humilis
Iridaceae		
	*DP	*Moraea flaccida*
		Patersonia babianoides
		Patersonia umbrosa var. xanthina
Juncaginaceae		
		Triglochin minutissima
Lentibulariaceae		
		Utricularia multifida
Malvaceae		
		Thomasia foliosa
Moraceae		
	*	*Ficus carica*
Myrtaceae		
		Astartea scoparia
		Babingtonia camphorosmae
		Calothamnus quadrifidus
		Calytrix depressa
		Corymbia calophylla
	*Pl	*Eucalyptus botryoides*
		Eucalyptus marginata
		Hypocalymma sp.
		Leptospermum erubescens
		Melaleuca trichophylla
		Taxandria linearifolia
		Verticordia huegelii var. decumbens
		Verticordia plumosa
Orchidaceae		
		Caladenia macrostylis
		Diuris corymbosa
		Eriochilus helonomos
		Pterostylis recurva
		Pterostylis vittata
		Thelymitra antennifera
		Thelymitra crinita
		Thelymitra macrophylla
Philydraceae		

Family	Status	*Species*
		Philydrella pygmaea subsp. pygmaea
Phyllanthaceae		
		Phyllanthus calycinus
Phytolaccaceae		
	*	*Phytolacca octandra*
Pittosporaceae		
		Billardiera fusiformis
Poaceae		
		Amphipogon amphipogonoides
	*	*Arundo donax*
	*	*Briza maxima*
	*	*Eragrostis curvula*
		Microlaena stipoides var. stipoides
Polygalaceae		
		Comesperma calymega
Proteaceae		
		Adenanthos barbiger
		Banksia grandis
		Banksia nivea
		Conospermum huegelii
		Grevillea bipinnatifida
		Grevillea manglesii subsp. manglesii
		Grevillea pilulifera
		Grevillea synapheae
		Hakea erinacea
		Hakea undulata
		Isopogon dubius
		Persoonia elliptica
		Persoonia longifolia
Pteridaceae		
		Cheilanthes austrotenuifolia
Ranunculaceae		
		Clematis pubescens
Restionaceae		
		Leptocarpus sp.
Rhamnaceae		
		Cryptandra arbutiflora var. arbutiflora
		Trymalium ledifolium var. rosmarinifolium
Sapindaceae		
		Dodonaea ceratocarpa
Solanaceae		
	*	*Solanum nigrum*
Stylidiaceae		
		Stylidium amoenum
		Stylidium androsaceum
		Stylidium brunonianum
		Stylidium eriopodum
		Stylidium repens

Family	Status	*Species*
		Stylidium ?ciliatum
		Stylidium ?perpusillum
Thymelaeaceae		
		Pimelea brevistyla subsp. brevistyla
		Pimelea ?ciliata
Xanthorrhoeaceae		
		Xanthorrhoea gracilis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia fraseri

*=non-native, Pl=planted, DP=declared pest under the BAM Act, WoNS=weed of national significance

Appendix E

Species x Plant Community Matrix

	Plant community								
Species	**AeGm**	**Bs**	**CcEmBa**	**CcLl**	**Cd**	**Cleared and non-native**	**LeH**	**Reveg-etation**	**TlBr**
Acacia alata var. alata			**X**						
Acacia barbinervis			**X**						
Acacia dealbata			**X**						
Acacia ephedroides		X		X	X				
Acacia pulchella var. pulchella			X				X		
Acacia urophylla			X						
Actinotus leucocephalus		X							
Adenanthos barbiger			X						
Allocasuarina fraseriana			X						
Allocasuarina humilis							X		
Amphipogon amphipogonoides							X		
Andersonia lehmanniana			X				X		
Aphelia cyperoides		X							
Arnocrinum preissii			X						
Arundo donax						X			
Asparagus asparagoides			X						
Astartea scoparia				X					
Babingtonia camphorosmae					X		X		
Banksia grandis			X						
Banksia nivea			X						
Baumea rubiginosa									X
Billardiera fusiformis			X						
Borya ?laciniata	X								
Borya sphaerocephala		X			X				
Bossiaea aquifolium			X						
Briza maxima			X						
Burchardia congesta			X						
Burchardia multiflora		X							
Caladenia macrostylis			X						
Calothamnus quadrifidus								X	
Calytrix depressa		X			X				
Centrolepis aristata		X							
Cheilanthes austrotenuifolia		X							
Clematis pubescens			X						
Comesperma calymega			X						
Conospermum huegelii					X				
Conostylis setosa			X						
Conostylis sp.							X		
Corymbia calophylla			X	X					
Craspedia variabilis			X						
Crassula ?extrorsa		X							
Cryptandra arbutiflora var. arbutiflora	X								
Cyathochaeta avenacea			X						
Dampiera coronata			X						
Daviesia decurrens			X						
Daviesia horrida					X				

	Plant community								
Species	**AeGm**	**Bs**	**CcEmBa**	**CcLl**	**Cd**	**Cleared and non-native**	**LeH**	**Reveg-etation**	**TlBr**
Dianella revoluta			X						
Diuris corymbosa					X				
Dodonaea ceratocarpa	X								
Drosera bulbosa subsp. bulbosa		X			X				
Drosera gigantea		X							
Drosera macrantha		X	X				X		
Eragrostis curvula						X			
Erigeron sumatrensis			X			X			
Eriochilus helonomos		X							
Erodium botrys						X			
Eucalyptus botryoides			X						
Eucalyptus marginata			X						
Ficus carica			X	X					
Foeniculum vulgare						X			
Gastrolobium villosum							X		
Gomphocarpus fruticosus						X			
Gompholobium ?polymorphum			X						
Gompholobium polymorphum			X						
Gompholobium tomentosum							X		
Goodenia trinervis		X							
Grevillea bipinnatifida					X		X		
Grevillea manglesii subsp. manglesii	X		X		X				
Grevillea pilulifera			X						
Grevillea synapheae			X						
Haemodorum sp.			X						
Hakea erinacea							X		
Hakea undulata							X		
Hibbertia ?huegelii			X						
Hibbertia aurea			X						
Hibbertia commutata			X						
Hibbertia hypericoides			X				X		
Hibbertia amplexicaulis			X						
Hovea sp.			X						
Hyalosperma cotula			X						
Hypocalymma sp.							X		
Hypochaeris glabra			X						
Isopogon dubius							X		
Kennedia coccinea			X						
Lagenophora huegelii			X						
Lechenaultia floribunda			X						
Lepidosperma ?scabrum		X							
Lepidosperma apricola			X				X		
Lepidosperma longitudinale				X					X
Lepidosperma pubisquameum			X						
Lepidosperma sp.				X			X		
Leptocarpus sp.									X

	Plant community									
Species	**AeGm**	**Bs**	**CcEmBa**	**CcLl**	**Cd**	**Cleared and non-native**	**LeH**	**Reveg-etation**	**TlBr**
Leptospermum erubescens							X		
Leucopogon capitellatus			X						
Leucopogon tenuis			X						
Leucopogon verticillatus			X						
Lomandra purpurea			X						
Lomandra sericea			X						
Macrozamia fraseri			X						
Melaleuca trichophylla							X		
Microlaena stipoides subsp. stipoides			X						
Millotia myosotidifolia		X							
Moraea flaccida			X						
Olearia paucidentata			X						
Osteospermum ecklonis						X			
Patersonia babianoides			X						
Patersonia umbrosa var. xanthina			X						
Pentapeltis peltigera			X						
Persoonia elliptica			X						
Persoonia longifolia			X						
Philydrella pygmaea subsp. pygmaea		X							
Phyllanthus calycinus			X						
Phytolacca octandra						X			
Pimelea ?ciliata							X		
Pimelea brevistyla subsp. brevistyla			X						
Pithocarpa pulchella var. pulchella			X						
Platysace filiformis			X				X		
Pterostylis recurva			X						
Pterostylis vittata			X						
Quinetia urvillei					X				
Ricinus communis						X			
Scaevola pilosa			X						
Scaevola platyphylla			X						
Schoenus clandestinus					X		X		
Siloxerus filifolius					X				
Solanum nigrum			X						
Sonchus oleraceus		X							
Sowerbaea laxiflora		X							
Stackhousia pubescens		X							
Stylidium ?ciliatum			X						
Stylidium ?perpusillum					X				
Stylidium amoenum			X						
Stylidium androsaceum					X				
Stylidium brunonianum			X				X		
Stylidium eriopodum					X				
Stylidium repens							X		
Stypandra glauca		X							
Styphelia tenuiflora			X				X		

	Plant community									
Species	**AeGm**	**Bs**	**CcEmBa**	**CcLl**	**Cd**	**Cleared and non-native**	**LeH**	**Reveg-etation**	**TlBr**
Taxandria linearifolia			X	X					X
Thelymitra antennifera					X				
Thelymitra crinita			X						
Thelymitra macrophylla			X						
Thomasia foliosa			X						
Thysanotus manglesianus			X						
Tribonanthes longipetala					X				
Trichocline spathulata			X						
Tricoryne humilis			X						
Triglochin minutissima		X							
Trymalium ledifolium var. rosmarinifolium			X				X		
Ursinia anthemoides			X						
Utricularia multifida		X							
Verticordia huegelii var. decumbens					X				
Verticordia plumosa	X				X				
Waitzia sp.			X						
Wurmbea dioica					X				
Xanthorrhoea gracilis			X						
Xanthorrhoea preissii			X				X		
Xanthosia candida			X						
Xerochrysum macranthum			X						

Appendix F

Sample Data

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q1

Project no.: EP20-040

Date: 27/05/2020, 02/06/2020, 11/09/2020

Status Non-permanent

Author: RAW,other

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	417598.6033	NW corner northing:	6448554.641
Altitude (m):	340	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	near saturated	Landform:	hilltop
Time since fire:	3-5 yrs	Disturbance:	low - native fauna, fire
Soil type/texture	clay/sand	Bare ground (%):	15
Rocks (%) and type:	15%, laterite	Soil colour:	brown/
Litter:	5% (leaves,twigs,)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q1

Project no.: EP20-040
Date: 27/05/2020, 02/06/2020, 11/09/ **Status** Non-permanent
Author: RAW,other Q1: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella var. pulchella	<1
	Allocasuarina humilis	5
	Amphipogon amphipogonoides	<1
	Andersonia lehmanniana	<1
	Babingtonia camphorosmae	1
	Conostylis sp.	<1
	Drosera macrantha	opp
	Gastrolobium villosum	10
	Gompholobium tomentosum	1
	Grevillea bipinnatifida	5
	Hakea erinacea	10
	Hakea undulata	10
	Hibbertia hypericoides	10
	Hypocalymma sp.	<1
	Lepidosperma apricola	opp
	Lepidosperma sp.	1
	Leptospermum erubescens	15
	Melaleuca trichophylla	5
	Pimelea ?ciliata	1
	Platysace filiformis	<1
	Schoenus clandestinus	<1
	Stylidium brunonianum	<1
	Stylidium repens	1
	Styphelia tenuiflora	1
	Trymalium ledifolium var. rosmarinifolium	<1
	Xanthorrhoea preissii	20

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R2

Project no.: EP20-040

Date: 27/05/2020, 02/06/2020, 11/09/2020

Status Non-permanent

Author: RAW,other

Quadrat and landform details

Sample type:	releve	Size:	N/A
NW corner easting:	417519.7128	NW corner northing:	6448566.196
Altitude (m):	330	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	saturated	Landform:	hilltop
Time since fire:	0	Disturbance:	low -
Soil type/texture	clay/	Bare ground (%):	10
Rocks (%) and type:	40%, granite	Soil colour:	black/
Litter:	1% (leaves,twigs,)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R2

Project no.: EP20-040
Date: 27/05/2020, 02/06/2020, 11/09/ **Status** Non-permanent
Author: RAW,other R2: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia ephedroides	
	Actinotus leucocephalus	
	Aphelia cyperoides	
	Borya sphaerocephala	
	Calytrix depressa	
	Centrolepis aristata	
	Cheilanthes austrotenuifolia	
	Drosera bulbosa subsp. bulbosa	
	Drosera gigantea	
	Drosera macrantha	
	Eriochilus helonomos	
	Goodenia trinervis	
	Lepidosperma ?scabrum	
	Millotia myosotidifolia	
	Philydrella pygmaea subsp. pygmaea	
*	*Sonchus oleraceus*	
	Sowerbaea laxiflora	
	Stackhousia pubescens	
	Stypandra glauca	
	Triglochin minutissima	
	Utricularia multifida	

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q3

Project no.: EP20-040

Date: 27/05/2020, 02/06/2020, 11/09/2020

Status Non-permanent

Author: RAW,other

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	417311.6459	NW corner northing:	6448518.058
Altitude (m):	316	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	upper slope
Time since fire:	> 5 yrs	Disturbance:	low - fauna tracks
Soil type/texture	clay/sand	Bare ground (%):	1
Rocks (%) and type:	10%, laterite	Soil colour:	brown/orange
Litter:	90% (leaves,branches,twigs)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q3

Project no.: EP20-040
Date: 27/05/2020, 02/06/2020, 11/09/ **Status** Non-permanent
Author: RAW,other Q3: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia barbinervis	<1
	Acacia urophylla	<1
	Adenanthos barbiger	<1
	Allocasuarina fraseriana	20
	Banksia grandis	2
	Bossiaea aquifolium	25
	Clematis pubescens	<1
	Corymbia calophylla	2
	Daviesia decurrens	<1
	Drosera macrantha	<1
	Eucalyptus marginata	30
	Haemodorum sp.	<1
	Hibbertia commutata	opp
	Lagenophora huegelii	<1
	Lepidosperma apricola	<1
	Lomandra purpurea	<1
	Macrozamia fraseri	<1
	Microlaena stipoides subsp. stipoides	<1
	Patersonia umbrosa var. xanthina	<1
	Pentapeltis peltigera	<1
	Platysace filiformis	2
	Pterostylis vittata	<1
	Scaevola pilosa	<1
	Stylidium ?ciliatum	<1
	Stylidium amoenum	<1
	Styphelia tenuiflora	<1
	Trymalium ledifolium var. rosmarinifolium	<1
	Xanthorrhoea preissii	10

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q4

Project no.: EP20-040

Date: 27/05/2020, 02/06/2020, 11/09/2020

Status Non-permanent

Author: RAW,other

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	417618.704	NW corner northing:	6448263.249
Altitude (m):	322	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	lower slope
Time since fire:	> 5 yrs	Disturbance:	moderate - tracks, historical clearing
Soil type/texture	sand/loam with organic layer	Bare ground (%):	20
Rocks (%) and type:	2%, laterite	Soil colour:	grey/
Litter:	80% (leaves,twigs,branches)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: Q4

Project no.: EP20-040
Date: 27/05/2020, 02/06/2020, 11/09/ **Status** Non-permanent
Author: RAW,other Q4: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia pulchella var. pulchella	1
	Bossiaea aquifolium	5
*	*Briza maxima*	<1
	Corymbia calophylla	40
	Drosera macrantha	<1
	Eucalyptus marginata	1
*	*Ficus carica*	<1
	Gompholobium polymorphum	<1
	Hibbertia commutata	<1
	Hibbertia hypericoides	5
	Kennedia coccinea	opp
	Lagenophora huegelii	<1
	Lepidosperma apricola	10
	Lepidosperma pubisquameum	1
	Leucopogon tenuis	opp
	Patersonia umbrosa var. xanthina	<1
	Phyllanthus calycinus	opp
	Scaevola pilosa	opp
	Thomasia foliosa	opp
	Trymalium ledifolium var. rosmarinifolium	5
	Xanthorrhoea gracilis	10
	Xanthorrhoea preissii	30

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R5

Project no.: EP20-040

Date: 2/06/2020, 11/09/2020 **Status** Non-permanent

Author: RAW,other R5: Page 2 of 2

Quadrat and landform details

Sample type:	releve	Size:	N/A
NW corner easting:	417238.2957	NW corner northing:	6448130.535
Altitude (m):	N/A	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	waterway
Time since fire:	3-5 yrs	Disturbance:	low -
Soil type/texture	clay/sand	Bare ground (%):	1
Rocks (%) and type:	10%, granite	Soil colour:	brown/
Litter:	20% (leaves,,)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R5

Project no.: EP20-040
Date: 2/06/2020, 11/09/2020 **Status** Non-permanent
Author: RAW,other

Species Data

* denotes non-native species

Status	Confirmed name
	Acacia ephedroides
	Astartea scoparia
	Corymbia calophylla
*	*Ficus carica*
	Lepidosperma longitudinale
	Lepidosperma sp.
	Taxandria linearifolia

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R6

Project no.: EP20-040

Date: 27/05/2020, 02/06/2020, 11/09/2020

Status Non-permanent

Author: RAW,other

Quadrat and landform details

Sample type:	releve	Size:	N/A
NW corner easting:	417582.5071	NW corner northing:	6448523.403
Altitude (m):	N/A	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	near saturated	Landform:	hilltop
Time since fire:	no evidence	Disturbance:	low -
Soil type/texture	clay/sand	Bare ground (%):	20
Rocks (%) and type:	10%, laterite	Soil colour:	brown/
Litter:	5% (leaves,twigs,)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R6

Project no.: EP20-040
Date: 27/05/2020, 02/06/2020, 11/09/ **Status** Non-permanent
Author: RAW,other

Species Data

* denotes non-native species

Status	Confirmed name
	Acacia ephedroides
	Babingtonia camphorosmae
	Borya sphaerocephala
	Calytrix depressa
	Conospermum huegelii
	Daviesia horrida
	Diuris corymbosa
	Drosera bulbosa subsp. bulbosa
	Grevillea bipinnatifida
	Grevillea manglesii subsp. manglesii
	Schoenus clandestinus
	Verticordia huegelii var. decumbens
	Verticordia plumosa

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R7

Project no.: EP20-040

Date: 2/06/2020, 11/09/2020 **Status** Non-permanent

Author: RAW,other R7: Page 2 of 2

Quadrat and landform details

Sample type:	releve	Size:	N/A
NW corner easting:	417291.4039	NW corner northing:	6448158.248
Altitude (m):	N/A	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	near saturated	Landform:	depression
Time since fire:	no evidence	Disturbance:	low -
Soil type/texture	clay/sand	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,,)	Vegetation condition:	very good

Vegetation Sample Data

Lot 9 Brookton Highway Karragullen

Sample Name: R7

Project no.: EP20-040

Date: 2/06/2020, 11/09/2020 **Status** Non-permanent

Author: RAW,other

Species Data

* denotes non-native species

Status	Confirmed name
	Baumea rubiginosa
	Lepidosperma longitudinale
	Taxandria linearifolia

Appendix B

Level 1 Fauna Survey – Lot 9 Brookton Highway, Karragullen (Emerge Associates 2020)

Level 1 Fauna Assessment

Lot 9 Brookton Highway, Karragullen

Project No: EP20-040(04)

Prepared for Vinci Gravel Supplies Pty Ltd
June 2020

Document Control

Doc name:	Level 1 Fauna Assessment Lot 9 Brookton Highway, Karragullen				
Doc no.:	**EP20-040(04)--003**				
Version	**Date**	**Author**		**Reviewer**	
1	June 2020	Melanie Schubert	MS	Tom Atkinson	TAA
	Submitted for client review				

Executive Summary

Vinci Gravel Supplies Pty Ltd (Vinci) intends to expand an existing gravel quarry within part of Lot 9 Brookton Highway in Karragullen (referred to as the 'site'). Emerge were engaged to conduct a 'level 1' fauna assessment to provide information on the fauna values within the site to inform the development.

As part of the assessment a desktop review of relevant background information was completed and a field survey was undertaken on 27 May and 2 June 2020. During the survey targeted searches for fauna species were conducted with a particular reference for conservation significant fauna species and an assessment was made on the type and conservation significance of fauna habitat across the site.

Outcomes of the survey include the following:

- The majority of the site (70.24%) contains remnant native vegetation with high fauna habitat values.
- A total of 25 native and three introduced fauna species were positively identified to occur within the site, including threatened (endangered) Baudin's cockatoo, (endangered) Carnaby's cockatoo and (vulnerable) forest red-tailed black cockatoo.
- The site contains foraging habitat for all three species of black cockatoo that occur in the south-west of Western Australia and may contain trees suitable as breeding and/or roosting habitat. A targeted black cockatoo assessment would be required to confirm the extent and suitability of potential black cockatoo habitat within the site.
- Additionally, 14 species of conservation significance not recorded during the field survey are also considered to have potential to occur within the site, including six bird, one insect, two reptile and five mammal species. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

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Table of Contents

List of Tables

List of Plates

Figures

Appendices

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DAWE	Department of Agriculture, Water and the Environment
WA Museum	Western Australian Museum

Table A2: Abbreviations – General terms

General terms	
EN	Endangered
EX	Extinct
VU	Vulnerable
MI	Migratory
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5

Table A3: Abbreviations –Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
BC Act	*Biodiversity Conservation Act 2016*

Table A4: Abbreviations – planning

Planning terms	
MRS	Metropolitan Region Scheme
TPS	Town Planning Scheme

Table A5: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
km	Kilometre
m	Metre

1 Introduction

1.1 Project background

Vinci Gravel Supplies Pty Ltd (Vinci) intends to expand an existing gravel quarry within part of Lot 9 Brookton Highway in Karragullen. This lot (referred to herein as the 'site') is located approximately 29 kilometres (km) south- east of the Perth Central Business District within the City of Armadale and is zoned 'rural' under the Metropolitan Region Scheme and 'general rural' under the City of Armadale *Town Planning Scheme No 4.*

The site is approximately 48.23 hectares (ha) in size and is bound by Midgegooroo National Park to the east, Korung National Park to the north and rural lots to the west and south. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by Vinci Gravel Supplies Pty Ltd to provide environmental consultancy services to support the planning process for the site. The purpose of this assessment is to provide sufficient information on the fauna values within the site to inform this process.

The scope of work was specifically to conduct a fauna assessment to the standard required of a 'level 1' fauna survey in accordance with the Environmental Protection Authority's (EPA's) *Technical Guidance – Terrestrial fauna Surveys* (EPA 2016).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of background information regarding fauna species relevant to the site and surrounds.
- Compilation of a list of fauna species opportunistically recorded as part of the field survey.
- Identification of potential habitat for conservation significant fauna species and likelihood of occurrence.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Environmental Context

2.1 Significant fauna

2.1.1 Threatened fauna species

Certain fauna taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, fauna taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment and Energy.

In Western Australia fauna species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). It is an offence to 'take' or 'disturb' threatened fauna without Ministerial approval.

Threatened fauna species listed under the EPBC Act and/or BC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Further information on threatened species and their categories is provided in **Appendix A**.

2.1.2 Priority fauna species

Fauna species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the Department of Biodiversity, Conservation and Attractions (DBCA) *Priority Fauna List*. These species are classified into 'priority' levels based on threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes. Further information on priority species and their categories is provided in **Appendix A**.

2.1.3 Migratory fauna species

Migratory fauna species that migrate to Australia and its external territories, or pass though or over Australian waters during their annual migrations warrant special protection under Commonwealth and State legislation. At a Commonwealth level, migratory fauna taxa may be listed as 'migratory' under *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment and Energy.

In Western Australia migratory fauna taxa may be listed as 'specially protected species' and classed as 'migratory' under the *Biodiversity Conservation Act 2016* (BC Act). Further information on migratory species is provided in **Appendix A**.

2.1.4 Specially protected fauna species

In Western Australia, fauna species that are of special conservation interest, including migratory species, cetaceans, species subject to international agreement or species otherwise in need of special protection may be listed as 'specially protected' under the BC Act. Further information on specially protected species and their categories is provided in **Appendix A**.

2.1.5 Pest fauna species

The term 'pest fauna' can refer to any animal that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native fauna species and some fauna species native to Australia but not Western Australia are considered to be pest fauna.

A particularly invasive or detrimental pest species may be listed as a 'declared pest' pursuant to Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. Further information on categories of declared pests is provided in **Appendix A.**

2.2 Bush Forever

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

No *Bush Forever* sites occur within 10 km of the site.

2.3 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004). This study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

There are no mapped ecological linkages within the site. One regional ecological linkage (No. 141) occurs to the west of the site and extends beyond the site to the north and south. Multiple additional ecological linkages are located within the wider area of the site. The location of ecological linkages near the site is shown in **Figure 2.**

2.4 DBCA managed or legislated lands

DBCA has tenure of or interests in numerous areas of land across the state for a range of purposes. Tenure categories include national parks, nature reserves, conservation parks, marine parks, marine nature reserves, marine management areas, section 5(1)(g) reserves, state forest and timber reserves. These areas are mapped within the *Legislated Lands and Waters* (DBCA 2017a) and *Lands of Interest* (DBCA 2017b) datasets. The *Legislated Lands and Waters* (DBCA 2017a) dataset includes lands subject to the following legislation; the *Conservation and Land Management Act 1984* (CALM Act 1984), Swan and Canning Rivers Management Act 2006 (SCRM Act) and lands identified under the Land Administration Act 1997 (LA Act). The *Lands of Interest* (DBCA 2017b) dataset includes all other lands of which DBCA is recognised as the manager but is not vested under any act. These lands comprise of crown land and freehold land which DBCA has been acknowledged by the Department of Lands as the responsible agency.

No DBCA legislated lands are mapped over the site but two are located adjacent to the site (DBCA 2017a). Korung National Park is located adjacent to the northern boundary of the site and extends to the north and west of the site. Midgegooroo National Park is located adjacent to the eastern boundary of the site and extends to the east and south of the site. Multiple additional DBCA legislated lands are located within the wider area of the site. The location of DBCA legislated lands near the site is shown in **Figure 2**.

2.5 Previous surveys

No previous fauna surveys are known to have been undertaken over the site.

3 Methods

3.1 Desktop assessment

3.1.1 Database searches

A search was conducted for conservation significant fauna that may occur or have been recorded within a 10 km radius of the site using the *Protected Matters Search Tool* (DAWE 2020), *NatureMap* (DBCA 2020) and DBCA's threatened and priority fauna database (reference no. FAUNA#6347).

A total number of species with potential to occur within the site was calculated by adding the total count of non-conservation significant species provided by *NatureMap* to the combined number of conservation significant species provided by *NatureMap* and *Protected Matters Search Tool*.

3.1.2 Likelihood of occurrence

Information on habitat preferences and distribution of conservation significant fauna species identified to potentially occur within the site or wider area was reviewed. This was assessed against the general site conditions and fauna habitat types recorded during the field survey.

An assessment of the likelihood of occurrence of conservation significant fauna species within the site was undertaken and each was assigned to one of the following categories:

- Recorded: The species in question was positively identified as being present within the site during the field survey or from recent literature records.
- Likely: Potentially suitable habitat for the species in question was identified during the field survey and the site lies within the known distribution of the species.
- Possible: Potentially suitable habitat for the species in question was identified but of marginal quality and/or extent. The site lies within or close to the known distribution of the species.
- Unlikely: The site lies outside of the known distribution of the species in question and/or no suitable habitat was identified within the site.

3.2 Field survey

Two ecologists from Emerge visited the site on the 27 May and 2 June 2020 during the day to conduct the level 1 fauna survey.

3.2.1 Level 1 fauna

Transects were traversed across the site, during the day, and the characteristics of fauna habitat and presence of fauna species was recorded. Microhabitats such as logs, rocks and leaf litter were investigated and secondary evidence of species presence such as tracks, scats, skeletal remains, foraging evidence or calls was also noted.

An opportunistic fauna species list was compiled, and fauna habitat values were described, with particular reference to 'threatened' and 'priority' fauna species with potential to occur within the site. Taxonomy and nomenclature for vertebrate fauna species was taken from the *Western*

Australian Museum Checklist of the Terrestrial Vertebrate Fauna of Western Australia (Western Australian Museum 2019). Literature listed in **Appendix A** represent the main publications used to identify fauna species and habitats within the site.

3.3 Data analysis, presentation mapping

3.3.1 Fauna habitat

Fauna habitats were described according to the dominant flora species and vegetation type present, as determined from observations made during the field survey and information provided in the '*Reconnaissance Flora and Vegetation Assessment*' (Emerge Associates 2020). The identified fauna habitats were mapped on aerial photography with the boundaries interpreted from aerial photography, previously identified plant communities (Emerge Associates 2020) and notes taken in the field.

Information on specific habitat requirements for conservation significant vertebrate fauna species with potential to occur within the site were compiled as part of the desktop assessment. This information was compared to the fauna habitats identified within the site to determine whether any conservation significant fauna species are considered to have potential to utilise the site.

3.4 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Terrestrial Fauna Surveys* (EPA 2016) is provided in **Table 1**.

Table 1: Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance - Terrestrial fauna Surveys

Constraint	Degree of limitation	Details
Level of survey	Minor limitation	A level 1 survey (desktop study and field survey) was considered adequate to determine whether conservation significant fauna species have the potential to occur within the site. Further targeted surveys would be required to confirm the status and habitat use of conservation significant specieswithin the site.
Scope	No limitation	The survey focused on fauna and habitat values, with particular reference to conservation significant taxa with potential to occur within the site.
Proportion of fauna identified, recorded and/or collected.	No limitation	All observed vertebrate fauna were identified. It is likely that the detectability of some fauna was lowered due to cold and intermittently rainy weather conditions, especially during the survey on the 27 May. Ectothermic fauna such as reptiles are typically less active during such conditions. However, it is not considered of great importance given the level of the survey.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	No limitation	Adequate information was available from database searches.

Table 2 (continued): Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance - Terrestrial fauna Surveys

Constraint	Degree of limitation	Details
The proportion of the task achieved and further work which might be needed.	No limitation	The task was achieved in its entirety.
Experience level of personnel	No limitation	This fauna assessment was undertaken by qualified ecologists with nine- and three-years' experience, respectively. Technical review was undertaken by a senior environmental consultant with 18 years' experience in environmental science in Western Australia.
Suitability of timing	Slight limitation	Survey timing is not considered to be of great importance for Level 1 assessments. Nonetheless, the cold seasonal conditions during the field survey likely reduced the detectability of some fauna classes such as reptiles.
Completeness	No limitation	The desktop assessment and field survey component of the survey were completed.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Survey intensity	No limitation	The intensity of the survey was adequate considering the level of the survey.
Influence of disturbance	No limitation	Some areas of the site are highly modified due to historical disturbance, particularly near the existing quarry. However, no recent disturbance was noted that may have affected outcomes of the survey.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 General site conditions

The site comprises a south-east to south-west facing slope with soils carrying from sandy and clay soils to granite outcrops. Two creeks and three waterbodies (dams) are located within the site. Both creeks and two of the waterbodies within the site were carrying water at the time of the field survey.

Native vegetation is located primarily within the central and eastern part of the site, with smaller areas nestled along the western boundary.

The site also comprises multiple disturbed areas, including an active gravel quarry, tracks and a farm shed, particularly within the western portion of the site.

4.2 Fauna habitat

The majority of the site comprises intact native vegetation. Approximately 14.36 ha of the site has been historically or recently disturbed and now supports cleared area, dominated by non-native and weed species with scattered or patches of native and non-native trees or planted native vegetation (revegetation).

A total of eight fauna habitats were identified within the site, including '**marri and jarrah forest**', '**shrubland**', '**sedgeland**', '**granite outcrop**', '**creekline**', '**waterbody**', '**revegetation**' and '**predominantly cleared area**'.

A description and the area of each habitat is provided in Table 2 and representative photographs of each are provided in **Plate 1** to **Plate 9**. The location of each habitat is shown on **Figure 3**.

The highest natural fauna habitat values within the site are associated with areas of remnant native vegetation and rocky outcrops, including **marri and jarrah forest**, **shrubland**, **sedgeland**, **granite outcrop** and **creekline**. In particular where this vegetation remains in good or better condition it supports a diverse canopy, shrub and ground cover layer and contains micro habitats such as rocky outcrops, rocks, logs and leaf litter.

Table 2: Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Marri and jarrah forest	Open forest *Corymbia calophylla* and *Eucalyptus marginata* over tall shrubland *Bossiaea aquifolium* and shrubland *Xanthorrhoea preissii* over assorted native shrubs and forbs (**Plate 1**).	26.29
Shrubland	Closed shrubland *Acacia oncinophylla* subsp. *oncinophylla* (P3) and *Grevillea manglesii* (**Plate 2**)**.**	4.44
Sedgeland	Tall open shrubland *Taxandria linearifolia* over closed sedgeland *Baumea rubiginosa* (**Plate 3**).	0.05
Granite outcrop	Granite outcrop comprising bare rock surfaces, bryophytes and herbland dominated by *Borya* sp. (**Plate 4**).	3.02

Table 2 (continued): Fauna habitats identified within the site

Fauna habitat classification	Description	Area (ha)
Creekline	Shallow creeks running off granite outcrops through **marri and jarrah forest** and **sedgeland** (**Plate** 5).	0.08
Waterbody	Temporary or permanent waterbodies (dams) containing limited native and/or non-native (or absent) vegetation (**Plate 6**).	0.11
Revegetation	Shrubland *Calothamnus quadrifidus*, *Eucalyptus* sp. and other associated native species over non-native grassland or bare ground (**Plate 7**).	1.8
Non-native vegetation	Predominantly non-native vegetation, including *Eucalyptus botryoides* and *Eucalyptus camaldulensis* over non-native shrubs and/or bare ground with occasional native plant species (**Plate 8**).	0.15
Predominantly cleared area	Heavily disturbed areas containing primarily pasture and bare ground with isolated native and non-native trees and shrubs (**Plate 9**).	12.28

Plate 1: ***Marri and jarrah forest***

Plate 2: ***Shrubland***

Plate 3: ***Sedgeland***

Plate 4: ***Granite outcrop***

Plate 5: ***Creekline***

Plate 6: ***Waterbody***

Plate 7: ***Revegetation***

Plate 8: ***Non-native vegetation***

Plate 9: ***Predominantly cleared area***

4.3 Fauna

4.3.1 Desktop assessment

A total number of 396 fauna species were identified from database searches as occurring or potentially occurring within 10 km of the site[1] as listed in **Appendix B**.

Of these species 34 are conservation significant, including 15 threatened, nine priority, eight migratory fauna and two other specially protected species as listed in **Appendix C**.

4.3.2 Species inventory

A total of 25 native and three introduced fauna species, including three species of conservation significance (Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo), were directly or indirectly recorded during the field survey. A complete species list is provided in **Appendix D**.

4.3.3 Conservation significant fauna

Forest red-tailed black cockatoos were observed foraging within the site and Baudin's cockatoos were observed adjacent to the site. Foraging evidence attributed to the two aforementioned species of black cockatoo and Carnaby's cockatoo was observed within the site. No signs of breeding or roosting were recorded during the field survey. The **jarrah and marri forest** and **shrubland** habitats support a range of food plants for these black cockatoo species. These habitats may also support trees suitable for breeding and roosting by black cockatoos.

Including the aforementioned species of black cockatoo, a total of 17 fauna species of conservation significance were considered to have potential to occur in the site, as shown in **Table 3**. This comprises the three recorded species of black cockatoo and 14 species that are considered 'possible' to occur.

The remainder of the conservation significant fauna species identified in the desktop assessment are not considered likely to occur in the site due to lack of suitable habitat or because the site lies outside of the species known distribution.

[1] Includes native and non-native species

Table 3: Summary of conservation significant fauna species with have potential to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		BC Act	EPBC Act		
Birds					
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Johnstone and Storr 1998).	**Possible**: May opportunistically forage in the air above the site or fly over on commute. This species does not breed in Australia.
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding Corymbia calophylla, Eucalyptus marginata, introduced Melia azedarach and Eucalyptus spp. trees (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding Corymbia calophylla, Banksia spp., Hakea spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of Pinus spp. Attracted to seeding Banksia spp., Dryandra spp., Hakea spp., Eucalyptus spp., Corymbia calophylla, Grevillea spp., and Allocasuarina spp. (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.
Falco peregrinus	Peregrine falcon	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible**: May opportunistically forage in or fly over the site on commute as part of a larger home range.

Table 3 (continued): Summary of conservation significant fauna species deemed possible or likely to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		WA	EPBC Act		
Birds					
Motacilla cinerea	Grey wagtail	MI	MI	Mainly banks and rocks in fast-running fresh water habitats: rivers, creeks, streams and around waterfalls, both in forest and open country; but occurs almost anywhere during migration.	**Possible**: Rarely occurs in south-western Australia but may occur opportunistically during migration.
Oxyura australis	Blue-billed duck	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998).	**Possible**: May opportunistically utilise waterbodies within the site.
Plegadis falcinellus	Glossy Ibis	MI	MI	Shallow and adjacent flats of freshwater lakes and swamps, also river pools, flooded samphire and sewage ponds (Pizzey and Knight 2012).	**Possible**: May opportunistically utilise waterbodies and adjacent areas within the site.
Tringa nebularia	Common greenshank	MI	MI	Shallow fresh waters (claypans, lagoons, swamps, river pools, dams and sewage ponds) and salt waters (estuaries, mangrove creeks, lakes, samphire flats, reef flats and saltwork ponds) (Pizzey and Knight 2012).	**Possible**: May opportunistically utilise waterbodies and adjacent areas within the site.
Mammals					
Dasyurus geoffroii	Chuditch	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along road sides in the wheatbelt (DEC 2012a).	**Possible**: May utilise remnant native vegetation within the site.
Hydromys chrysogaster	Rakali	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen et al. 1985).	**Possible**: May opportunistically utilise waterbodies and creeks within the site.
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012b).	**Possible**: May utilise remnant native vegetation within the site.

Table 3 (continued): Summary of conservation significant fauna species deemed possible or likely to occur within the site

Species	Common name	Level of significance		Habitat	Likelihood of occurrence within the site
		WA	EPBC Act		
Mammals					
Notamacropus irma	Western brush wallaby	P4	-	Dry sclerophyll forest, Banksia spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1984).	**Possible**: May utilise remnant native vegetation within the site.
Phascogale tapoatafa wambenger	South-western brush-tailed phascogale	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	**Possible**: May utilise remnant native vegetation within the site.
Reptiles					
Acanthophis antarcticus	Southern death adder	P3	-	Mostly in woodlands, grasslands and heaths. In the Darling Range this species is typically found within Eucalyptus marginata woodlands adjacent to granite outcrops and along densely vegetated creeks (Bush et al. 2007).	**Possible**: May utilise remnant native vegetation within the site.
Ctenotus delli	Dell's skink	P4	-	Jarrah and marri woodland with a shrub dominated understorey, sheltering in dense vegetation, inside grass trees and beneath rocks, sometimes in burrows (Nevill 2005).	**Possible**: May utilise remnant native vegetation within the site.
Invertebrates					
Kawaniphila pachomai	Grey vernal katydid	P1	-	Inhabits trees and shrubs and can be found mostly in heath or mixed woodland (Rentz 1993). The species occurs primarily in coastal SW Western Australia with records near Vasse, within the southern Perth metropolitan region and on the Darling scarp.	**Possible**: Species poorly understood. Potential habitat (heath) present within the site and historical record located approximately 7.5 km north-west of the site.

4.3.1 Declared pests

A total of two species, **Oryctolagus cuniculus* (rabbit) and *Vulpes vulpes* (fox) listed as a declared pests (C3) pursuant to the BAM Act, were identified from sightings and scats within the site.

5 Discussion

5.1 Fauna habitat values

The majority of the site (70.24%) supports native vegetation with high fauna habitat values, including **marri and jarrah forest**, **shrubland**, **granite outcrop**, **sedgeland** and **creek line**.

The **waterbody** habitats, although lacking native riparian vegetation and very limited in extent, also provide habitat for native fauna and make up 0.23% of the site. The **revegetation** and **non-native vegetation** habitats cover 4.06% of the site. These habitats provide varying value according to the plant species and density. However, the majority of the **revegetation** and **non-native vegetation** habitats lack understorey vegetation and would mainly provide habitat for common bird species. The remainder of the site (25.46%) provides **predominantly cleared area** including turf, bare ground, infrastructure and isolated trees and shrubs which provide low habitat values for native fauna.

The 25 native and three introduced fauna taxa recorded within the site are all generally common and widespread in the Jarrah Forest region, including the three species of black cockatoo.

5.2 Conservation significant fauna

All three species of black cockatoo were directly or indirectly (from foraging evidence) identified as occurring in the site. A record of these species within the site was anticipated as the wider local area contains extensive areas of habitat known to be utilized by the species.

The **marri and jarrah forest** and **shrubland** habitats contain multiple plant species known to be consumed by species of black cockatoo, including *Corymbia calophylla* (marri), *Eucalyptus marginata* (jarrah), *Banksia* spp. (banksia), *Grevillea* spp. (grevillea), *Hakea* spp. (hakea) and *Xanthorrhoea* spp. (grass tree). The site may also support trees suitable for breeding and roosting by black cockatoos, but a targeted assessment would need to be undertaken to confirm this.

An additional 14 species of conservation significance have potential to occur in the site. *Apus pacificus* (pacific swift) and *Falco peregrinus* (peregrine falcon) may opportunistically fly over or utlise habitat within the site as part of a much larger home range. The **creekline** and **water body** habitats provide potential habitat for *Motacilla cinerea* (grey wagtail), *Oxyura australis* (blue-billed duck), *Plegadis falcinellus* (glossy ibis) and *Tringa nebularia* (common greenshank). The **marri and jarrah forest** and shrubland habitats provide potential habitat for five mammal and two reptile and one insect species of conservation significance. Targeted surveys would need to be undertaken to confirm whether these fauna species occur within the site.

6 Conclusions

The majority of the site (70.24%) contains remnant native vegetation with high fauna habitat values.

A total of 25 native and three introduced fauna species were positively identified to occur within the site, including threatened (endangered) Baudin's cockatoo, (endangered) Carnaby's cockatoo and (vulnerable) forest red-tailed black cockatoo.

The site contains foraging habitat for all three species of black cockatoo that occur in the south-west of Western Australia and may contain trees suitable as breeding and/or roosting habitat. A targeted black cockatoo assessment would be required to confirm the extent and suitability of potential black cockatoo habitat within the site.

Additionally, 14 species of conservation significance not recorded during the field survey are also considered to have potential to occur within the site, including six bird, one insect, two reptile and five mammal species. Targeted surveys would need to be undertaken to confirm whether these species occur within the site.

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Figures

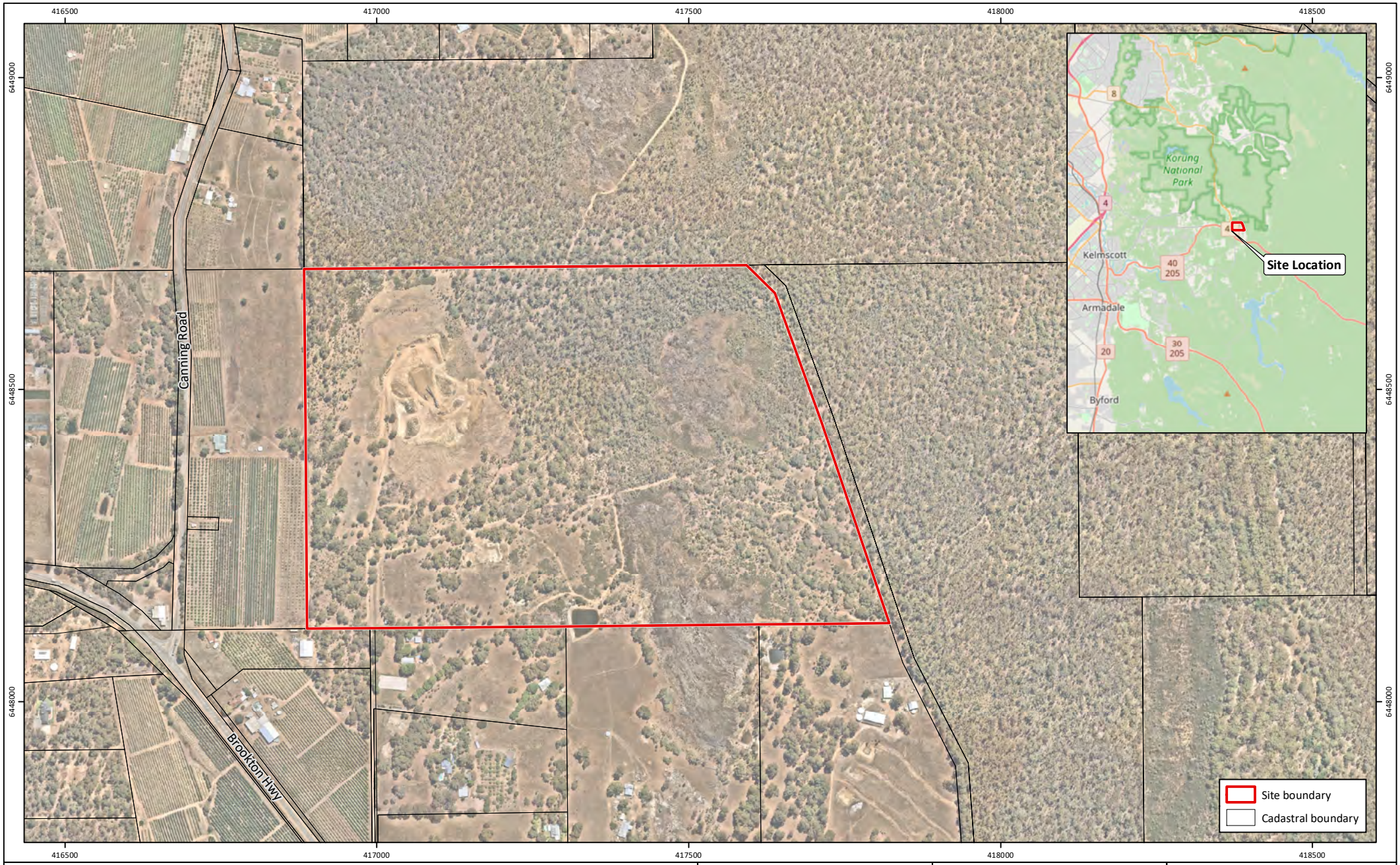

Figure 1: Site Location

Project: Level 1 Fauna Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F09
Drawn: GAR
Date: 12/06/2020
Checked: MS
Approved: TAA
Date: 19/06/2020

N

0 100 200 300
Metres
Scale: 1:8,000@A4
GDA 1994 MGA Zone 50

emerge ASSOCIATES

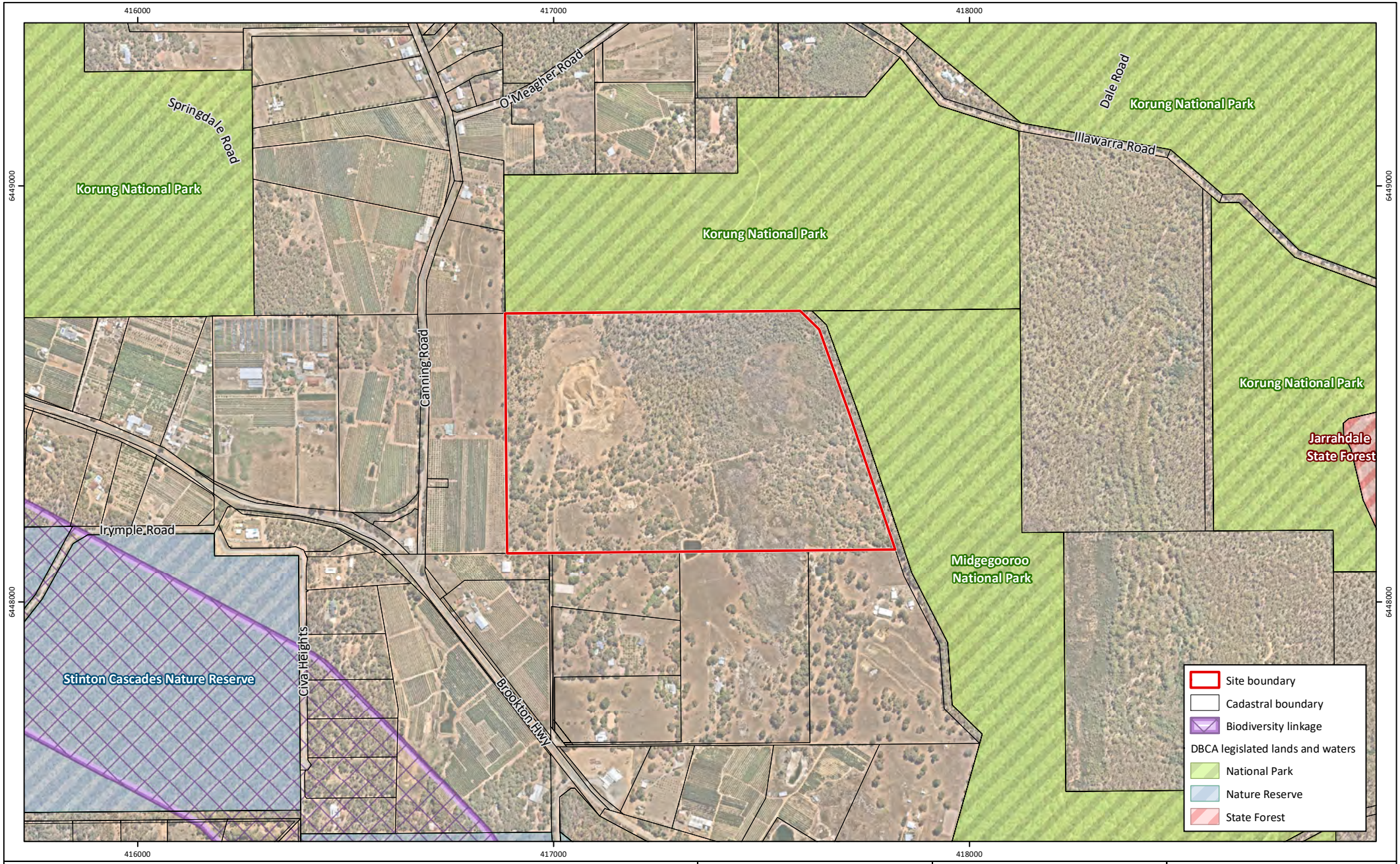

Figure 2: Environmental Features

Project:	Level 1 Fauna Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F10

Drawn:	GAR
Date:	12/06/2020
Checked:	MS
Approved:	TAA
Date:	19/06/2020

N

0 150 300 450
Metres

Scale: 1:12,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

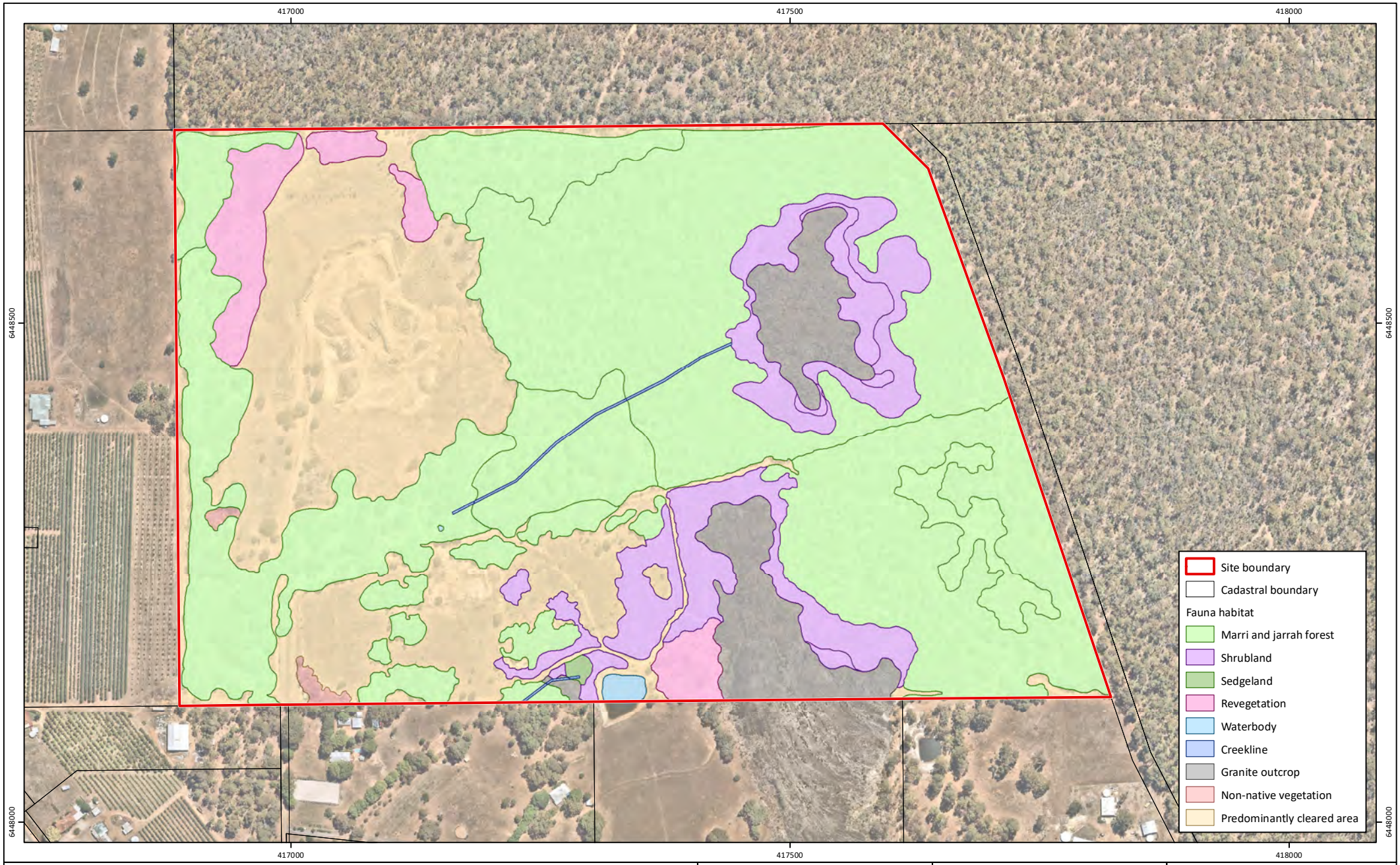

Figure 3: Fauna Habitat

Project: Level 1 Fauna Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(04)--F11
Drawn: GAR
Date: 12/06/2020
Checked: MS
Approved: TAA
Date: 19/06/2020

N

0 100 200
Metres
Scale: 1:5,000@A4
GDA 1994 MGA Zone 50

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Appendix A

Additional Information

Conservation Significant Fauna

Threatened and priority fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Migratory birds may be recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

All migratory bird species listed in the annexes to these bilateral agreements are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act. Fauna species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories as outlined in **Table 1**.

Table 1: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW[#]	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR[#]	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN[#]	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU[#]	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory[#]	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

[#]matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019). The definitions of these categories are provided in **Table 2**.

Table 2: Definitions of specially protected fauna schedules under the BC Act (DBCA 2019)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 3** (DBCA 2019).

Table 3: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019)

Conservation Code	Category
P1	Priority 1 – Poorly known 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.
P2	Priority 2 – Poorly known 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.
P3	Priority 3 – Poorly known 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.
P4	(a) Priority 4 – Rare species 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) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Pest fauna

A number of legislative and policy documents exist in relation to pest fauna management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding pest fauna management in Western Australia and lists declared pest species.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in

Table 5.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in **Table 6**.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Legal status of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management

Category	Description
	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 which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DAFWA 2016)

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

References

General references

Department of Biodiversity, Conservation and Attractions (DBCA) 2018, *Threatened and Priority Fauna List 15 February 2018*, Perth.

Department of Biodiversity Conservation and Attractions (DBCA) 2019, *Conservation Codes for Western Australian Flora and Fauna - last updated 3 January 2019*.

Literature

Table 1: Standard literature used for identifying fauna species and habitats.

Conservation Code	Category
Birds	Johnstone and Storr (1998b), Johnstone and Storr (1998a), Pizzey and Knight (2012), Slater *et al.* (2003)
Mammals	Menkhorst and Knight (2011), Triggs (2003)
Amphibia	Tyler and Doughty (2009), Bush *et al.* (2002)
Reptiles	Bush *et al.* (2002)

References

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. 2002, *Reptiles and Frogs of the Perth Region*, UWA Press, Crawley.

Johnstone, R. E. and Storr, G. M. 1998a, *Handbook of Western Australian Birds. Volume 2 - Passerines (Blue-Winged Pitta to Goldfinch)*, Western Australian Museum, Perth.

Johnstone, R. E. and Storr, T. 1998b, *Handbook of Western Australian Birds: Volume 1 - Non-passerines (Emu to Dollarbird)*, Western Australian Museum, Perth.

Menkhorst, P. and Knight, F. 2011, *Field guide to the mammals of Australia (Third edition)*, Oxford University Press Australia & New Zealand, Melbourne, VIC, Australia.

Pizzey, G. and Knight, F. 2012, *The Fieldguide to the Birds of Australia*, Harper Collins Publishers, Sydney, Australia.

Slater, P., Slater, P. and Slater, R. 2003, *The Slater Field Guide to Australian Birds*, Reed New Holland, Australia.

Triggs, B. 2003, *Tracks, Scats and Other Traces A Field Guide to Australian Mammals*, Oxford University Press Australia, Melbourne, Victoria.

Tyler, M. J. and Doughty, P. 2009, *Field Guide to Frogs of Western Australia*, Western Australian Museum, Perth, Western Australia.

Appendix B

Database Search Results

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 09/06/2020

Kingdom Animalia
Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 116° 07' 30" E,32° 05' 49" S
Buffer 10km

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1.	24559	*Acanthagenys rufogularis (Spiny-cheeked Honeyeater)*			
2.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
3.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
4.	24262	*Acanthiza inornata (Western Thornbill)*			
5.	25242	*Acanthophis antarcticus (Southern Death Adder)*		P3	
6.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
7.		*Acariformes sp.*			
8.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
9.	25536	*Accipiter fasciatus (Brown Goshawk)*			
10.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
11.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
12.		*Adversaeschna brevistyla*			
13.	25544	*Aegotheles cristatus (Australian Owlet-nightjar)*			
14.		*Akamptogonus novarae*			
15.		*Allotrochosina karri*			
16.		*Ambicodamus kochi*			
17.		*Amblyomma triguttatum*			
18.		*Aname mainae*			
19.	24312	*Anas gracilis (Grey Teal)*			
20.	24316	*Anas superciliosa (Pacific Black Duck)*			
21.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
22.		*Anisops sp.*			
23.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
24.	25449	*Antechinus flavipes (Yellow-footed Antechinus)*			
25.	24088	*Antechinus flavipes subsp. leucogaster (Yellow-footed Antechinus, Mardo)*			
26.	24561	*Anthochaera carunculata (Red Wattlebird)*			
27.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
28.		*Antiporus sp.*			
29.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
30.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
31.	24285	*Aquila audax (Wedge-tailed Eagle)*			
32.		*Araneus senicaudatus*			
33.		*Archaeosynthemis occidentalis*			
34.		*Archiargiolestes pusillus*			
35.	24340	*Ardea novaehollandiae (White-faced Heron)*			
36.	24341	*Ardea pacifica (White-necked Heron)*			
37.		*Arrenuridae sp.*			
38.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
39.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
40.		*Aturidae sp.*			
41.		*Austracantha minax*			
42.		*Australomimetus ovidi*			
43.		*Austroagrion coeruleum*			
44.		*Austrochthonius muchmorei*			
45.		*Austrogomphus collaris*			
46.		*Austrolestes analis*			
47.	47713	*Austronomus australis (White-striped Free-tailed Bat)*			
48.	24318	*Aythya australis (Hardhead)*			
49.		*Backobourkia brounii*			
50.		*Baetidae sp.*			
51.		*Barnardius zonarius*			
52.	24162	*Bettongia penicillata subsp. ogilbyi (Woylie, Brush-tailed Bettong)*		T	

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
53.		*Bibulmena kadjina*			
54.	24319	*Biziura lobata (Musk Duck)*			
55.	24345	*Botaurus poiciloptilus (Australasian Bittern)*		T	
56.	25715	*Cacatua roseicapilla (Galah)*			
57.	25716	*Cacatua sanguinea (Little Corella)*			
58.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
59.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
60.		*Calanoida sp.*			
61.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
62.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
63.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
64.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
65.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
66.		*Ceinidae sp.*			
67.		*Ceratopogonidae sp.*			
68.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
69.		*Cercophonius granulosus*			
70.		*Cercophonius sulcatus*			
71.		*Ceryerda cursitans*			
72.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
73.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
74.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
75.	33939	*Cherax cainii (Marron)*			
76.		*Cherax quinquecarinatus*			
77.		*Chironominae sp.*			
78.		*Chironomus aff. alternans (V24) (CB)*			
79.		*Chironomus tepperi*			
80.	24980	*Christinus marmoratus (Marbled Gecko)*			
81.	25601	*Chrysococcyx lucidus (Shining Bronze Cuckoo)*			
82.	24432	*Chrysococcyx lucidus subsp. plagosus (Shining Bronze Cuckoo)*			
83.	24288	*Circus approximans (Swamp Harrier)*			
84.		*Cladocera (unident.)*			
85.		*Cladopelma curtivalva*			
86.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
87.	24399	*Columba livia (Domestic Pigeon)*	Y		
88.		*Condocerus aptus*			
89.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
90.		*Corduliidae sp.*			
91.		*Cormocephalus aurantiipes*			
92.		*Cormocephalus turneri*			
93.	24416	*Corvus bennetti (Little Crow)*			
94.	25592	*Corvus coronoides (Australian Raven)*			
95.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
96.	25595	*Cracticus tibicen (Australian Magpie)*			
97.	25596	*Cracticus torquatus (Grey Butcherbird)*			
98.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
99.		*Cricotopus 'parbicinctus'*			
100.	25398	*Crinia georgiana (Quacking Frog)*			
101.	25399	*Crinia glauerti (Clicking Frog)*			
102.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
103.	30893	*Cryptoblepharus buchananii*			
104.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
105.	25027	*Ctenotus australis*			
106.	25035	*Ctenotus delli (Dell's skink, Darling Range southwest Ctenotus)*		P4	
107.	25039	*Ctenotus fallens*			
108.	25049	*Ctenotus labillardieri*			
109.		*Culicidae sp.*			
110.		*Curculionidae sp.*			
111.	24322	*Cygnus atratus (Black Swan)*			
112.		*Cyrtophora parnasia*			
113.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
114.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
115.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
116.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
117.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
118.		*Dicrotendipes sp. A (V47) (SAP)*			
119.		*Dinocambala ingens*			
120.	44654	*Diplodactylus lateroides (Speckled Stone Gecko)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
121.	24939	*Diplodactylus polyophthalmus*			
122.	24940	*Diplodactylus pulcher*			
123.	24470	*Dromaius novaehollandiae (Emu)*			
124.		*Dytiscidae sp.*			
125.	25096	*Egernia kingii (King's Skink)*			
126.	25100	*Egernia napoleonis*			
127.		*Egretta novaehollandiae*			
128.		*Elanus axillaris*			
129.		*Eolophus roseicapillus*			
130.	24651	*Eopsaltria australis subsp. griseogularis (Western Yellow Robin)*			
131.	24652	*Eopsaltria georgiana (White-breasted Robin)*			
132.		*Eriophora pustulosa*			
133.		*Eucyrtops latior*			
134.	24368	*Eurostopodus argus (Spotted Nightjar)*			
135.		*Exocelina ater*			
136.		*Eylaidae sp.*			
137.	25621	*Falco berigora (Brown Falcon)*			
138.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
139.	25623	*Falco longipennis (Australian Hobby)*			
140.	24474	*Falco longipennis subsp. longipennis (Australian Hobby)*			
141.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
142.	24041	*Felis catus (Cat)*	Y		
143.	25727	*Fulica atra (Eurasian Coot)*			
144.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
145.	34028	*Galaxias occidentalis (Western Minnow)*			
146.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
147.	24959	*Gehyra variegata*			
148.	25404	*Geocrinia leai (Ticking Frog)*			
149.	34030	*Geotria australis (Pouched Lamprey)*		P3	
150.	25530	*Gerygone fusca (Western Gerygone)*			
151.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
152.	24443	*Grallina cyanoleuca (Magpie-lark)*			
153.		*Gripopterygidae sp.*			
154.		*Gyrinidae sp.*			
155.	24295	*Haliastur sphenurus (Whistling Kite)*			
156.	24296	*Hamirostra isura (Square-tailed Kite)*			
157.		*Harrisius sp. A (SAP)*			
158.		*Harrisius sp. B (SFM)*			
159.	25409	*Heleioporus barycragus (Hooting Frog)*			
160.	25410	*Heleioporus eyrei (Moaning Frog)*			
161.	25411	*Heleioporus inornatus (Whooping Frog)*			
162.		*Hellyethira lituа*			
163.		*Hellyethira sp.*			
164.		*Hemicordulia tau*			
165.	25474	*Hemiergis initialis*			
166.	25115	*Hemiergis initialis subsp. initialis*			
167.	25117	*Hemiergis peronii subsp. peronii*			
168.	25119	*Hemiergis quadrilineata*			
169.	47965	*Hieraaetus morphnoides (Little Eagle)*			
170.	25734	*Himantopus himantopus (Black-winged Stilt)*			
171.	24491	*Hirundo neoxena (Welcome Swallow)*			
172.		*Hoggicosa storri*			
173.		*Hydrodromidae sp.*			
174.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
175.		*Hydrophilidae sp.*			
176.		*Hydryphantidae sp.*			
177.		*Idiommata blackwalli*			
178.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
179.		*Isopeda leishmanni*			
180.		*Kangarosa properipes*			
181.		*Karaops ellenae*			
182.	33980	*Kawaniphila pachomai (Grey Vernal Katydid (southwest), cricket)*		P1	
183.		*Kiefferulus intertinctus*			
184.		*Kiefferulus martini*			
185.		*Lampona brevipes*			
186.		*Lampona cylindrata*			
187.		*Lancetes lanceolatus*			
188.		*Lancetes sp.*			
189.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
190.		*Latrodectus hasseltii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
191.		*Leptoceridae sp.*			
192.		*Leptoperla australica*			
193.		*Leptophlebiidae sp.*			
194.	25131	*Lerista distinguenda*			
195.	25133	*Lerista elegans*			
196.	25147	*Lerista lineata (Perth Slider, Lined Skink)*		P3	
197.	25005	*Lialis burtonis*			
198.	25659	*Lichenostomus leucotis (White-eared Honeyeater)*			
199.	25661	*Lichmera indistincta (Brown Honeyeater)*			
200.		*Limbodessus inornatus*			
201.		*Limbodessus shuckhardi*			
202.		*Limnesiidae sp.*			
203.		*Limnoxenus sp.*			
204.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
205.		*Lophoictinia isura*			
206.		*Macrogyrus angustatus*			
207.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
208.	25650	*Malurus elegans (Red-winged Fairy-wren)*			
209.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
210.	25654	*Malurus splendens (Splendid Fairy-wren)*			
211.	24552	*Malurus splendens subsp. splendens (Splendid Fairy-wren)*			
212.		*Maratus pavonis*			
213.		*Marsupiopus leporilli*			
214.		*Megapodagrionidae sp.*			
215.		*Megaporus solidus*			
216.		*Megaporus sp.*			
217.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
218.	24587	*Melithreptus chloropsis (Western White-naped Honeyeater)*			
219.	24736	*Melopsittacus undulatus (Budgerigar)*			
220.	25184	*Menetia greyii*			
221.	24598	*Merops ornatus (Rainbow Bee-eater)*			
222.		*Microcarbo melanoleucos*			
223.		*Micronecta robusta*			
224.		*Micronecta sp.*			
225.		*Miniargiolestes minimus*			
226.		*Missulena granulosa*			
227.		*Missulena hoggi*			
228.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
229.	25191	*Morethia lineoocellata*			
230.	25192	*Morethia obscura*			
231.	24223	*Mus musculus (House Mouse)*	Y		
232.	25610	*Myiagra inquieta (Restless Flycatcher)*			
233.	24146	*Myrmecobius fasciatus (Numbat, Walpurti)*		T	
234.		*Naididae sp.*			
235.		*Nannoperca vittata*			
236.		*Necterosoma darwini*			
237.		*Necterosoma sp.*			
238.		*Nematoda sp.*			
239.	25686	*Neochmia temporalis (Red-browed Finch)*	Y		
240.	24738	*Neophema elegans (Elegant Parrot)*			
241.		*Nicodamus mainae*			
242.		*Notalina spira*			
243.	48022	*Notamacropus irma (Western Brush Wallaby)*		P4	
244.	25252	*Notechis scutatus (Tiger Snake)*			
245.		*Notonectidae sp.*			
246.		*Notoperata sp. AV1 (SFM)*			
247.		*Nousia sp. AV16*			
248.		*Nunciella aspera*			
249.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
250.	24194	*Nyctophilus geoffroyi (Lesser Long-eared Bat)*			
251.	24195	*Nyctophilus gouldi (Gould's Long-eared Bat)*			
252.	41424	*Nyctophilus major (Greater Long-eared Bat)*			
253.		*Occiperipatoides gilesii*			
254.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
255.		*Offadens soror (ex genus 1 WA sp. 1)*			
256.		*Oligochaeta sp.*			
257.		*Ommatoiulus moreleti*			
258.		*Opisthopora sp.*			
259.		*Oribatida sp.*			
260.		*Orthetrum caledonicum*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
261.		*Orthocladiinae 'woodminer' (SAP)*			
262.		*Orthocladiinae sp.*			
263.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
264.		*Ostracoda (unident.)*			
265.		*Oxidae sp.*			
266.		*Oxyethira sp.*			
267.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
268.		*Ozarchaea harveyi*			
269.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
270.		*Parachironomus sp. 1 (VSCL35) (SAP)*			
271.		*Paracladopelma M1 [SFM)*			
272.		*Parakiefferiella sp. S1*			
273.		*Paralimnophyes pullulus (V42)*			
274.		*Paramelitidae sp.*			
275.		*Paramerina levidensis*			
276.		*Parastacidae sp.*			
277.	25253	*Parasuta gouldii*			
278.	25255	*Parasuta nigriceps*			
279.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
280.	24625	*Pardalotus punctatus subsp. punctatus (Spotted Pardalote)*			
281.	25682	*Pardalotus striatus (Striated Pardalote)*			
282.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
283.		*Pentaneurini genus V20*			
284.		*Perthiidae sp.*			
285.	48061	*Petrochelidon nigricans (Tree Martin)*			
286.	48066	*Petroica boodang (Scarlet Robin)*			
287.	24659	*Petroica goodenovii (Red-capped Robin)*			
288.	25697	*Phalacrocorax carbo (Great Cormorant)*			
289.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
290.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
291.	25699	*Phalacrocorax varius (Pied Cormorant)*			
292.	24409	*Phaps chalcoptera (Common Bronzewing)*			
293.	25587	*Phaps elegans (Brush Bronzewing)*			
294.	48070	*Phascogale tapoatafa subsp. wambenger (South-western Brush-tailed Phascogale, Wambenger)*		S	
295.		*Philopotamidae sp.*			
296.		*Phreodrilidae sp.*			
297.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
298.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
299.		*Physidae sp.*			
300.		*Planorbidae sp.*			
301.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
302.	25720	*Platycercus icterotis (Western Rosella)*			
303.	24747	*Platycercus spurius (Red-capped Parrot)*			
304.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
305.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
306.		*Platynectes sp.*			
307.	25703	*Podargus strigoides (Tawny Frogmouth)*			
308.	25704	*Podiceps cristatus (Great Crested Grebe)*			
309.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
310.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
311.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
312.		*Polypedilum nr. convexum (SAP)*			
313.		*Polypedilum watsoni*			
314.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
315.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
316.	24767	*Porphyrio porphyrio subsp. bellus (Purple Swamphen)*			
317.	24771	*Porzana tabuensis (Spotless Crake)*			
318.		*Procladius paludicola*			
319.		*Procladius villosimanus*			
320.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
321.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
322.		*Purpureicephalus spurius*			
323.	24245	*Rattus rattus (Black Rat)*	Y		
324.		*Raveniella cirrata*			
325.		*Rhantus suturalis*			
326.		*Rheotanytarsus sp. (SFM)*			
327.	48096	*Rhipidura albiscapa (Grey Fantail)*			
328.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
329.		*Riethia v4*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
330.		*Scirtidae sp.*			
331.		*Scolopendra laeta*			
332.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
333.	24279	*Sericornis frontalis subsp. maculatus (White-browed Scrubwren)*			
334.	24145	*Setonix brachyurus (Quokka)*		T	
335.		*Simuliidae sp.*			
336.	30948	*Smicrornis brevirostris (Weebill)*			
337.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			
338.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
339.		*Sternopriscus browni*			
340.		*Sternopriscus marginatus*			
341.		*Sternopriscus sp.*			
342.		*Storena formosa*			
343.	25597	*Strepera versicolor (Grey Currawong)*			
344.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
345.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
346.	24943	*Strophurus spinigerus subsp. inornatus*			
347.		*Synsphyronus magnus*			
348.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
349.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
350.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
351.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
352.		*Tanypodinae sp.*			
353.		*Tanytarsus aff manleyensis*			
354.		*Tanytarsus fuscithorax/semibarbitarsus*			
355.		*Tanytarsus nr K5*			
356.		*Tanytarsus palmatus*			
357.		*Tasmanicosa leuckartii*			
358.		*Tasmanocoenis tillyardi*			
359.		*Thereuopoda lesueurii*			
360.		*Thienemanniella sp. (V19) (SAP)*			
361.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
362.	25519	*Tiliqua rugosa*			
363.	25207	*Tiliqua rugosa subsp. rugosa*			
364.		*Tipulidae sp.*			
365.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
366.	24309	*Todiramphus sanctus subsp. sanctus (Sacred Kingfisher)*			
367.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
368.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
369.	24158	*Trichosurus vulpecula subsp. vulpecula (Common Brushtail Possum)*			
370.		*Triplectides australis*			
371.		*Triplectides sp. AV21 (SFM)*			
372.	48147	*Turnix varius (Painted Button-quail)*			
373.	25764	*Tyto novaehollandiae (Masked Owl)*			
374.	24983	*Underwoodisaurus milii (Barking Gecko)*			
375.		*Urodacus novaehollandiae*			
376.		*Urodacus planimanus*			
377.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
378.	25526	*Varanus tristis (Racehorse Monitor)*			
379.	24206	*Vespadelus regulus (Southern Forest Bat)*			
380.	24040	*Vulpes vulpes (Red Fox)*	Y		
381.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
382.		*Zachria flavicoma*			
383.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

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.

Australian Government
Department of the Environment and Energy

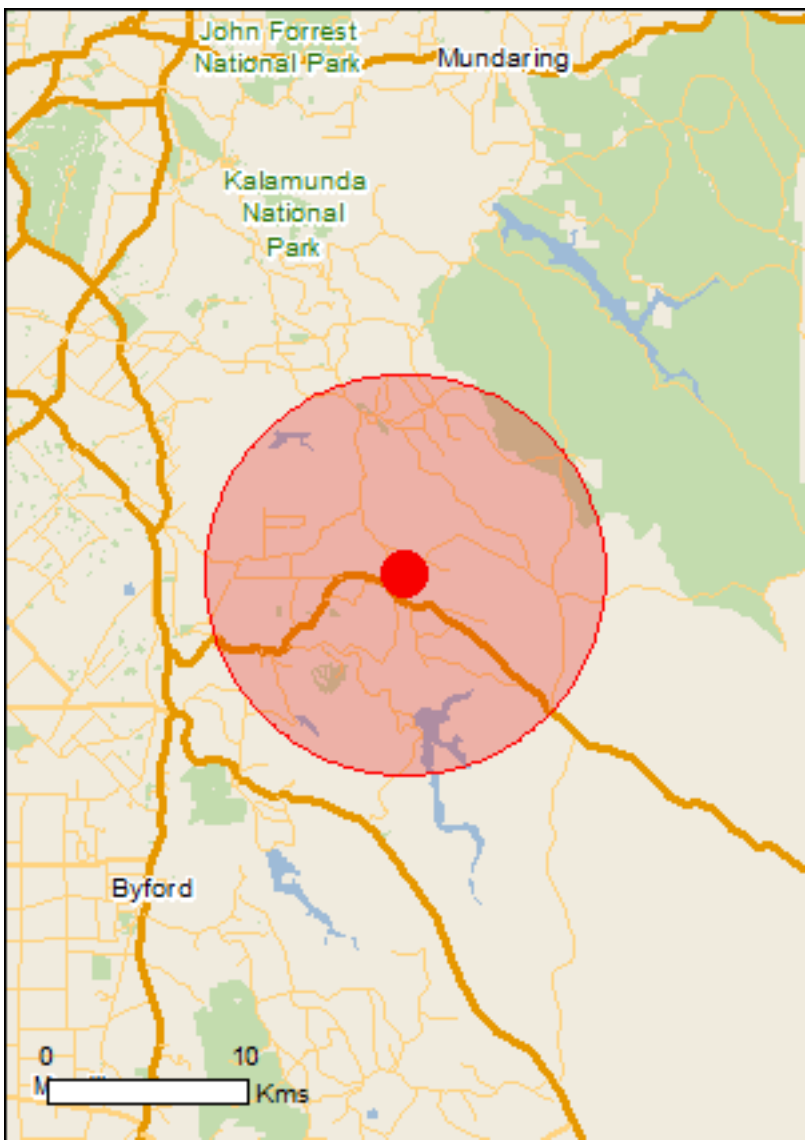
EPBC Act Protected Matters Report

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: 09/06/20 18:25:58



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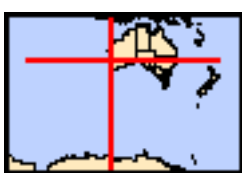

Summary

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:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	30
Listed Migratory Species:	9

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:	1
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:	5
Regional Forest Agreements:	1
Invasive Species:	30
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar)	[Resource Information]
Name	Proximity
Forrestdale and thomsons lakes	Within 10km of Ramsar

Listed Threatened Ecological Communities		[Resource Information]

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.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community may occur within area

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Breeding known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
[Pseudocheirus occidentalis](#) Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat may occur within area
[Setonix brachyurus](#) Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Other		
[Westralunio carteri](#) Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
[Acacia anomala](#) Grass Wattle, Chittering Grass Wattle [8153]	Vulnerable	Species or species habitat known to occur within area
[Anthocercis gracilis](#) Slender Tailflower [11103]	Vulnerable	Species or species habitat likely to occur within area
[Conospermum undulatum](#) Wavy-leaved Smokebush [24435]	Vulnerable	Species or species habitat may occur within area
[Darwinia apiculata](#) Scarp Darwinia [8763]	Endangered	Species or species habitat may occur within area
[Diplolaena andrewsii](#) [6601]	Endangered	Species or species habitat may occur within area
[Diuris drummondii](#) Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat known to occur within area
[Diuris micrantha](#) Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
[Diuris purdiei](#) Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat known to occur within area
[Drakaea micrantha](#) Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat may occur within area
[Eleocharis keigheryi](#) Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area
[Eucalyptus x balanites](#) Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
[Goodenia arthrotricha](#) [12448]	Endangered	Species or species habitat likely to occur within area
[Lasiopetalum pterocarpum](#) Wing-fruited Lasiopetalum [64922]	Endangered	Species or species habitat may occur within area
[Synaphea sp. Fairbridge Farm (D. Papenfus 696)](#) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
[Thelymitra dedmaniarum](#) Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Thelymitra stellata		
Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area
Verticordia fimbrilepis subsp. fimbrilepis		
Shy Featherflower [24631]	Endangered	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		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat likely to 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
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat likely to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -

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

Name	Threatened	Type of Presence
		habitat likely to 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
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to 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
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat likely to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Canning River	WA
Korung	WA
Midgegooroo	WA
Stinton Cascades	WA
Unnamed WA21569	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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
Birds		
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		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
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		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 within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		Species or species habitat likely to 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

-32.09689 116.12508

Acknowledgements

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

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

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

Please feel free to provide feedback via the Contact Us page.

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Appendix C

Conservation Significant Species and Likelihood of Occurrence Assessment

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Birds					
Actitis hypoleucos	Common sandpiper	MI	MI	Edge of sheltered waters salt or fresh, e.g. estuaries, mangrove creeks, rocky coasts, near-coastal saltlakes (including saltwork ponds), river pools, lagoons, claypans, drying swamps, flood waters, dams and sewage ponds. Preferring situations wherelow perches are available (Johnstone & Storr 1998).	**Unlikely**: No suitable habitat
Apus pacificus	Pacific swift	MI	MI	Aerial, migratory species that is most often seen over inland plains and sometimes above open areas, foothills or in coastal areas. Sometimes occurs over settled areas, including towns, urban areas and cities (Pizzey & Knight 2012).	**Possible**: May opportunistically forage in the air above the site or fly over on commute. This species does not breed in Australia.
Botaurus poiciloptilus	Australasian bittern	EN	EN	In or over water, in tall reedbeds, sedges, rushes, cumbungi, lignum. Also occurs in ricefields, drains in tussocky paddocks and occasionally in saltmarshes and brackish wetlands (Pizzey & Knight 2012).	**Unlikely**: No suitable habitat

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Calidris acuminata	Sharp-tailed sandpiper	MI	MI	Occurs in tidal mudflats, saltmarshes and mangroves, as well as, shallow fresh,brackish or saline inland wetlands. It is also known from floodwaters, irrigated pastures and crops, sewage ponds, saltfields (Pizzey & Knight 2012).	**Unlikely**: No suitable habitat
Calidris ferruginea	Curlew sandpiper	CR	CR (MI)	Mainly shallows of estuaries and near-coastal saltlakes (including saltwork ponds) and drying near-coastal freshwater lakes and swamps. Also beaches and near-coastal sewage ponds (Pizzey & Knight 2012).	**Unlikely**: No suitable habitat
Calidris melanotos	Pectoral sandpiper	MI	MI	Mainly fresh waters (swamps, lagoons, river pools, irrigation channels and sewage ponds); also samphire flats around estuaries and saltlakes (Johnstone & Storr 1998).	**Unlikely**: No suitable habitat
Calyptorhynchus banksii naso	Forest red-tailed black cockatoo	VU	VU	Eucalypt and Corymbia forests, often in hilly interior. More recently also observed in more open agricultural and suburban areas including Perth metropolitan area. Attracted to seeding Corymbia calophylla, Eucalyptus marginata, introduced Melia azdarach and Eucalyptus spp. trees (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Calyptorhynchus baudinii	Baudin's cockatoo	EN	EN	Mainly eucalypt forests. Attracted to seeding Corymbia calophylla, Banksia spp., Hakea spp., and to fruiting apples and pears (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.
Calyptorhynchus latirostris	Carnaby's cockatoo	EN	EN	Mainly proteaceous scrubs and heaths and adjacent eucalypt woodlands and forests; also plantations of Pinus spp. Attracted to seeding Banksia spp., Dryandra spp., Hakea spp., Eucalyptus spp., Corymbia calophylla, Grevillea spp., and Allocasuarina spp. (Johnstone and Storr 1998).	**Recorded**: Potential foraging, roosting and breeding habitat present.
Falco peregrinus	Peregrine falcon	OS	-	Mainly found around cliffs along coasts, rivers, ranges and around wooded watercourses and lakes (Johnstone and Storr 1998).	**Possible**: May opportunistically forage in or fly over the site on commute as part of a larger home range.
Leipoa ocellata	Mallefowl	VU	VU	Scrubs and thickets of Eucalyptus spp., Melaleuca lanceolata and Acacia linophylla; also other dense litter-forming shrublands. Attracted to fallen wheat in stubbles and along roads (Johnstone and Storr 1998).	**Unlikely**: Locally extinct

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Motacilla cinerea	Grey wagtail	MI	MI	In Australia mostly near running water in disused quarries,, sandy and rocky strams in escarpments and rainforests, sewage ponds, ploughed fields and airfields (Pizzey & Knight 2012).	**Possible**: Rarely occurs in south-western Australia but may occur opportunistically during migration.
Numenius madagascariensis	Eastern curlew	CR	CR (MI)	Mainly tidal mudflats; also reef flats, sandy beaches and rarely near-coastal lakes (including saltwork ponds) (Johnstone and Storr 1998).	**Unlikely**: No suitable habitat
Oxyura australis	Blue-billed duck	P4	-	Mainly deeper freshwater swamps and lakes; occasionally saltlakes and estuaries freshened by flood waters (Johnstone and Storr 1998)	**Possible**: May opportunistically utilise waterbodies within the site.
Pandion haliaetus	Osprey	MI	MI	Coasts, estuaries, bays, inlets, islands, and surrounding waters; coral atolls, reefs, lagoons, rock cliffs, stacks (Pizzey & Knight 2012).	**Unlikely**: No suitable habitat
Plegadis falcinellus	Glossy Ibis	MI	MI	Well-vegetated wetlands, wet pasture, ricefields, floodwaters, floodplains, brackish or occasionally saline wetlands, mangroves, mudflats and occasionally dry grassland (Pizzey & Knight 2012).	**Possible**: May opportunistically utilise waterbodies and adjacent areas within the site.

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Rostratula australis	Australian painted snipe	EN	EN	Mainly shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans (Marchant and Higgins 1993).	**Unlikely**: No suitable habitat
Rostratula benghalensis sensu lato	Painted snipe	-	EN	Well vegetated shallows and margins of wetlands, dams, sewerage ponds, wet pastures, marshy areas, irrigation systems, lignum, tea tree scrub, open timber. Requires dense low cover (Morcombe 2004).	**Unlikely**: No suitable habitat
Tringa nebularia	Common greenshank	MI	MI	Mudflats, estuaries, saltmarshes, margins of lakes, wetlands, claypans (fresh amd saline), commercial saltfields, sewage ponds (Pizzey & Knight 2012).	**Possible**: May opportunistically utilise waterbodies and adjacent areas within the site.
Fish					
Geotria australis	Pouched lamprey	P3	-	Marine, estuarine and coastal rivers and streams. Adults live in Southern Ocean and migrate upstream to spawn. Larvae live in muddy burrows in the upper reaches of streams (Bray and Gomon 2018).	**Unlikely**: No suitable habitat
Invertebrate					

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Kawaniphila pachomai	Grey vernal katydid	P1	-	Inhabits trees and shrubs and can be found mostly in heath or mixed woodland (Rentz 1993). The species occurs in coastal SW Western Australia with records near Vasse and within the southern Perth metropolitan region	**Possible**: Species poorly understood. Potential habitat (heath) present within the site and historical record located approximately 7.5 km north-west of the site.
Westralunio carteri	Carter's freshwater mussel	VU	VU	Occurs in greatest abundance in slower flowing streams with stable sediments that are soft enough for burrowing amongst woody debris and exposed tree roots. Salinity tolerance quite low (Morgan et al. 2011).	**Unlikely**: No suitable habitat
Mammals					
Bettongia penicillata ogilbyi	Woylie	CR	EN	Woodlands and adjacent heaths with a dense understorey of shrubs, particularly Gastrolobium spp. (TSSC 2018).	**Unlikely**: Locally extinct
Dasyurus geoffroii	Chuditch	VU	VU	Wide range of habitats from woodlands, dry sclerophyll forests, riparian vegetation, beaches and deserts. Appears to utilise native vegetation along road sides in the wheatbelt (DEC 2012b).	**Possible**: May utilise remnant native vegetation within the site.

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Hydromys chrysogaster	Rakali	P4	-	Areas with permanent water, fresh, brackish or marine. Likely to occur in all major rivers and most of the larger streams as well as bodies of permanent water in the lower south west (Christensen et al. 1985).	**Possible**: May utilise remnant native vegetation within the site.
Isoodon fusciventer	Quenda	P4	-	Dense scrubby, often swampy, vegetation with dense cover up to one metre high (DEC 2012)	**Possible**: May utilise remnant native vegetation within the site.
Myrmecobius fasciatus	Numbat	EN	EN	Generally dominated by Eucalyptus spp. that provide hollow logs and branches for shelter and termites for food (van Dyck & Strahan 2008).	**Unlikely**: Locally extinct
Notamacropus irma	Western brush wallaby	P4	-	Dry sclerophyll forest, Banksia spp. woodlands and shrublands, typically favouring dense low vegetation that provides dense cover (Christensen and Strahan 1983).	**Possible**: May utilise remnant native vegetation within the site.
Phascogale tapoatafa wambenger	South-western brush-tailed phascogale	CD	-	Dry sclerophyll forests and open woodlands that contain hollow-bearing trees but a sparse ground cover (Triggs 2003).	**Possible:** May opportunistically utilise waterbodies and creeks within the site.
Pseudocheirus occidentalis	Western ringtail possum	CR	CR	On the Swan Coastal Plain in Agonis flexuosa woodlands and Agonis flexuosa/ Eucalyptus gomphocephala forests. Also Eucalyptus marginata forests (DBCA 2017).	**Unlikely**: Locally extinct

Species	Common name	Level of significance		Habitat	Likelihood of occurrence
		WA	EPBC Act		
Setonix brachyurus	Quokka	VU	VU	On the mainland mostly dense streamside vegetation or shrubland and heath areas, particularly around swamps (Cronin 2007).	**Unlikely**: Locally extinct
Reptiles					
Acanthophis antarcticus	Southern death adder	P3	-	Mostly in woodlands, grasslands and heaths. In the Darling Range this species is typically found within Eucalyptus marginata woodlands adjacent to granite outcrops and along densely vegetated creeks (Bush et al. 2007).	**Possible**: May utilise remnant native vegetation within the site.
Ctenotus delli	Dell's skink	P4	-	Jarrah and marri woodland with a shrub dominated understorey, sheltering in dense vegetation, inside grass trees and beneath rocks, sometimes in burrows (Nevill 2005).	**Possible**: May utilise remnant native vegetation within the site.
Lerista lineata	Perth slider	P3	-	Sandy coastal heath and low scrubland. Banksia spp. woodland, Eucalyptus gomphocephala open woodland over deep sands, and coastal dunes immediately adjacent to the beach (Wilson and Swan 2017).	**Unlikely**: No suitable habitat
Note: CE=critically endangered, EN=endangered, VU=vulnerable, CD=conservation dependent, MI=migratory, OS=other specially protected, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4. Species recorded or considered to potentially occur within the site are shaded green.					

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Appendix D

Species List

Opportunistic Fauna List -
Lots 504, 298 and 5 Toodyay Road and Lot 577 Brompton Heights, Gidgegannup

Class	Status	Species	Common name	Record type
Amphibia				
		Limnodynastes dorsalis	Western banjo frog	Call
		Squelching froglet	Crinia insignifera	Call
Birds				
		Acanthiza apicalis	Broad-tailed thornbill	Sight
		Cacatua roseicapilla	Galah	Sight
	VU	*Calyptorhynchus banksii naso*	Forest red-tailed black cockatoo	Sight, foraging evidence
	EN	*Calyptorhynchus Baudinii*	Baudin's cockatoo	Sight, call, foraging evidence
	EN	*Calyptorhynchus latirostris*	Carnaby's cockatoo	Foraging evidence
		Climacteris rufus	Rufous treecreeper	Sight
		Coracina novaehollandiae	Black-faced cucko shrike	Sight
		Corvus coronoides	Australian raven	Sight
		Cracticus tibicen	Australian magpie	Sight
	*	*Dacelo novaehollandiae*	Laughing kookaburra	Sight
		Dromaius novaehollandiae	Emu	Sight
		Malurus elegans	Red-winged fairy wren	Sight
		Malurus splendens	Splendid fairy-wren	Sight
		Pachycephala occidentalis	Western golden whistler	Sight
		Petroica boodang	Scarlet robin	Sight
		Platycercus spurius	Red-capped parrot	Sight
		Platycercus zonarius	Australian ringneck	Sight
		Rhipidura albiscapa	Grey fantail	Sight
		Smicrornis brevirostris	Weebill	Sight
		Zosterops citrinella	Grey-breasted white-eye (silvereye)	Sight
Mammals				
		Macropus fuliginosus melanops	Western grey kangaroo	Sight
	* DP	*Oryctolagus cuniculus*	Rabbit	Scats
		Trichosurus vulpecula	Common brush-tailed possum	Scull
	* DP	*Vulpes vulpes*	Red fox	Sight

Class	Status	Species	Common name	Record type
Reptiles				
		Egernia kingii	King's skink	Dead individual
		Pogona minor minor	Western bearded dragon	Sight

Note: * denotes introduced fauna species, DP=declared pest under the BAM Act, EN = Endangered under the EPBC and BC Act, VU=Vulnerable under the EPBC Act and BC Act

Appendix C

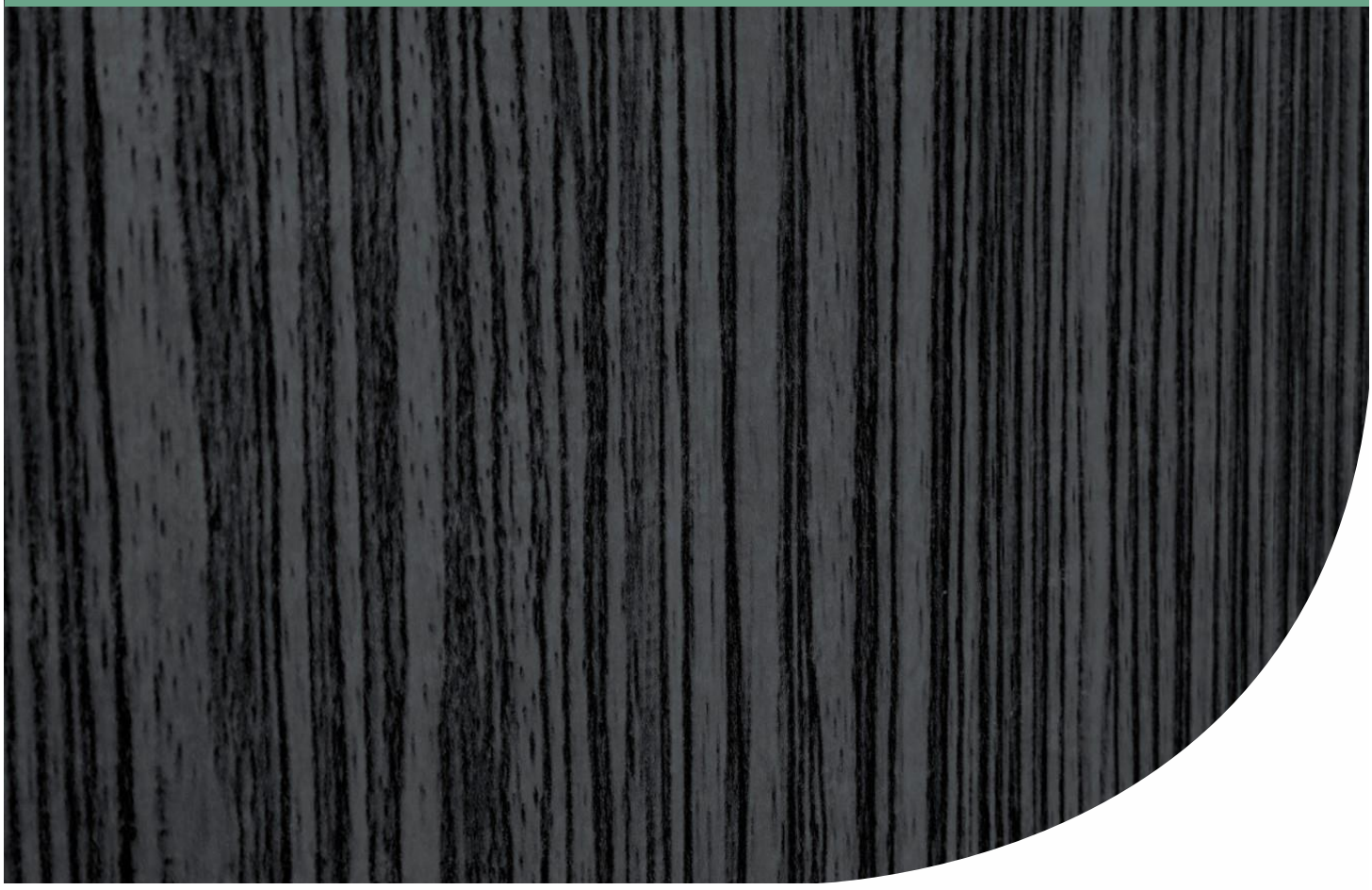
Targeted Black Cockatoo Habitat Assessment – Lot 9 Brookton Highway, Karragullen (Emerge Associates 2021b)

Targeted Black Cockatoo Assessment

Lot 9 Brookton Highway, Karragullen

Project No: EP20-040(05)

Prepared for Vinci Gravel Supplies Pty Ltd
July 2021



Document Control

Doc name:	Targeted Black Cockatoo Assessment Lot 9 Brookton Highway, Karragullen				
Doc no.:	**EP20-040(05)--009A SCM**				
Version	**Date**	**Author**		**Reviewer**	
1	February 2021	Sean Moylan	SCM	Rachel Weber	RAW
	Submitted for client review				
A	July 2021	Sean Moylan	SCM	Tom Atkinson	TAA
	Update following internal review				

Executive Summary

Vinci Gravel Supplies Pty Ltd intends to expand an existing gravel quarry within part of Lot 9 Brookton Highway in Karragullen (referred to herein as the 'site'). Emerge were engaged to conduct a 'targeted' assessment of habitat values for threatened species of black cockatoo within the site to inform future planning approvals.

As part of the assessment a desktop assessment of relevant background information was completed and a field survey was undertaken across several dates between September and December 2020.

Outcomes of the survey include the following:

- The site occurs within the modelled distribution of Carnaby's cockatoo, Baudin's cockatoos and forest red-tailed black cockatoo and within the breeding range of Carnaby's cockatoo and forest red-tailed black cockatoo.
- Remnant native jarrah/marri forest vegetation within the site provides habitat for all three species of black cockatoo.
- Forest red-tailed black cockatoos were recorded within the site and Baudin's cockatoos were observed adjacent to the site.
- Foraging evidence attributed to all three species was recorded and forest red-tailed black cockatoos were observed foraging within the site.
- A total of 468 habitat trees were recorded within the site of which two contained hollows that were considered suitable for use by black cockatoos for breeding. These hollows did not exhibit any signs of use.
- No evidence of black cockatoo roosting activity was recorded within the site. Roosting habitat for all three species of black cockatoo occurs within the site in the form of tall trees.
- A total of 29.01 ha of foraging habitat for Carnaby's cockatoo was mapped in the site of which 23.41 ha (81%) provides a high value resource, 0.26 ha (1%) provides a moderate value resource and 5.34 ha (18%) provides a low value resource.
- A total of 26.82 ha of foraging habitat for Baudin's cockatoo was mapped in the site, of which 22.85 ha (85%) provides a high value resource, 0.30 ha (1%) provides a moderate value resource and 3.65 ha (14%) provides a low value resource.
- A total of 24.97 ha of foraging habitat for forest red-tailed black cockatoo was mapped in the site, of which 23.46 ha (94%) provides a high value resource, 0.26 ha (1%) provides a moderate value resource and 1.25 ha (5%) provides a low value resource.
- Extensive areas of remnant native vegetation that provides foraging habitat for black cockatoo species occurs adjacent to the site and in the wider area.

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Table of Contents

List of Tables

Figures

Appendices

Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DPaW	Department of Parks and Wildlife (now DBCA)
DAWE	Department of Agriculture, Water and the Environment
WA Museum	Western Australian Museum

Table A2: Abbreviations – General terms

General terms	
EN	Endangered
VU	Vulnerable

Table A3: Abbreviations – Legislation

Legislation	
BC Act	*Biodiversity Conservation Act 2016*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

Table A4: Abbreviations – units of measurement

Units of measurement	
DBH	Diameter at breast height
cm	Centimetre
ha	Hectare
km	Kilometre
m	Metre

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1 Introduction

1.1 Project background

Vinci Gravel Supplies Pty Ltd (Vinci) intends to expand an existing gravel quarry within part of Lot 9 Brookton Highway in Karragullen. This lot (referred to herein as the 'site') is located approximately 29 kilometres (km) south-east of the Perth Central Business District within the City of Armadale and is zoned 'rural' under the Metropolitan Region Scheme and 'general rural' under the City of Armadale *Town Planning Scheme No 4.*

The site is approximately 48.23 hectares (ha) in size and is bound by Midgegooroo National Park to the east, Korung National Park to the north and rural lots to the west and south. The location and extent of the site is shown in **Figure 1**.

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by Vinci Gravel Supplies Pty Ltd to provide environmental consultancy services to support the planning process for the site. The purpose of this assessment is to provide sufficient information on the habitat values for threatened species of black cockatoo within the site to inform this process.

The scope of work was specifically to conduct a terrestrial vertebrate fauna assessment to the standard required of a 'targeted' black cockatoo survey in accordance with the Environmental Protection Authority's (EPA's) technical guidance (EPA 2020) and the *Environment Protection and Biodiversity Conservation Act* black cockatoo referral guidelines (DSEWPaC 2012).

As part of this scope of work, the following tasks were undertaken:

- Desktop assessment of relevant background information pertaining to the site and surrounds, including database and literature searches for black cockatoos.
- Field survey to identify potential habitat for species of black cockatoo.
- An assessment of the quality of black cockatoo habitat within the site.
- Mapping of black cockatoo habitat.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Background

2.1 Environmental Context

The site occurs within the northern jarrah forest subregion, as defined by the *Interim Biogeographic Regionalisation of Australia* (IBRA) (Environment Australia 2000).

The northern jarrah forest occurs in the south west of Western Australia and approximately extends from Dardanup in the south to Mogumber/ New Norcia in the north on its western side and then down to Williams / Darkan on its eastern side. This region comprises the northern part of the Darling Plateau and generally contains of acidic yellow-mottled soils with ironstone gravel (Beard 1990).

Finer-scale mapping by Beard *et al.* (2013) shows the majority of the site comprises vegetation association 'West Darling 3'. This association is described as 'mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*' (Beard *et al.* 2013). A small area in the south western portion of the site comprises vegetation association "West Darling 4' which is described as 'jarrah, marri and wandoo *Eucalyptus marginata, Corymbia calophylla, E. wandoo*' (Beard *et al.* 2013).

2.2 Threatened fauna

Certain fauna taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, fauna taxa may be listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires Ministerial approval.

In Western Australia fauna species may also be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act). It is an offence to 'take' or 'disturb' threatened fauna without Ministerial approval.

Threatened fauna species listed under the EPBC Act and/or BC Act are assigned a conservation status according to attributes such as population size and geographic distribution. Further information on threatened species and their categories is provided in **Appendix A**.

2.3 Black cockatoos

Three threatened species of black cockatoo occur in the south-west of WA (referred to herein collectively as 'black cockatoos'):

- *Calyptorhynchus latirostris* (Carnaby's cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus baudinii* (Baudin's cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) which is listed as 'vulnerable' under the EPBC Act and the BC Act.

Broad-scale maps are available for the modelled distribution of Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo (DSEWPaC 2011; DoEE 2016a, c). The modelled distribution maps also include 'known breeding areas' and 'predicted breeding range' for Baudin's cockatoo and 'breeding range' and 'non-breeding range' for Carnaby's cockatoo. No breeding range modelling is available for forest red-tailed black cockatoo but the species is known to breed mainly in the jarrah forest region (DBCA 2017) and in small populations on the Swan Coastal Plain within the Baldivis, Stake Hill, Lake McLarty and Capel area and increasingly in the Perth metropolitan area (DAWE 2020).

Each black cockatoo species has a defined breeding season, with Baudin's cockatoo breeding from August/September to February/March and Carnaby's cockatoo breeding from July/August to January/February (DSEWPaC 2012). Forest red-tailed black cockatoo breeds in October/November but may breed in March/April if there is good autumn rainfall (DSEWPaC 2012). There is also evidence that forest red-tail black cockatoos breed throughout the year, with peaks in April – June and August – October (Johnstone *et al.* 2013).

Black cockatoo habitat is conventionally separated into breeding, roosting and foraging categories.

2.4 Black cockatoo habitat

2.4.1 Breeding habitat

Black cockatoos nest in hollows that form in large trees and so 'breeding habitat' is typically assessed as 'habitat' trees. Generally, habitat trees are native eucalypts with a hollow that is suitable for a black cockatoo to nest within or that are of sufficient size that a suitable nest hollow could develop in time (DSEWPaC 2012). Any tree that has a suitable hollow may provide breeding habitat for black cockatoos. However, as a tree may need to be more than 200 years old before it develops a suitable hollow, remnant native eucalypts are most likely to be recorded as habitat trees.

The suitability of a tree hollow for use by black cockatoos is principally contingent on its physical dimensions and orientation. Local studies indicate that to be suitable a hollow must generally:

- have an entrance opening of at least 10 cm but preferably 20-30 cm (Saunders *et al.* 1982; Groom 2010; Johnstone *et al.* 2013) (Groom 2010; Saunders et al. 1982; Johnstone et al 2013)
- be located at least 3 m from the ground (Saunders 1979b; Johnstone and Storr 1998; Groom 2010; Saunders 2014)
- be located in a trunk or branch that is generally large enough to contain a hollow that has a floor diameter of at least 40 cm and depth of 50-200 cm such that it could house an adult black cockatoo and nestlings (Saunders 1979a; Johnstone and Storr 1998; Saunders 2014; DPaW 2015)
- have vertical or near vertical orientation (Johnstone and Kirkby 2008; Johnstone *et al.* 2013).

The minimum size for a habitat tree is typically determined through measurement of trunk 'diameter at breast height' (DBH). For most native eucalypts minimum DBH is defined as ≥50 centimetres (cm). However, for some eucalypts such as *Eucalyptus wandoo* (wandoo) and *Eucalyptus salmonophloia* (salmon gum) that are known to form suitable hollows at smaller size a DBH of ≥30 cm is applied (DSEWPaC 2012).

Breeding habitat is also generally expected to be located within 7 km of food and water resources (Saunders 1990).

Department of Environment and Conservation (DEC, now Department of Biodiversity, Conservation and Attractions (DBCA)) and fauna experts, have identified and mapped breeding habitat used by Carnaby's cockatoo in the Swan Coastal Plain and Jarrah Forest regions (Glossop *et al.* 2011). This dataset includes point records of breeding from a range of sources. Breeding sites were classified as 'confirmed' where eggs or chicks were recorded and 'possible' where observations relating to Carnaby's cockatoo breeding that did not include actual records of eggs or chicks (e.g. chewed hollows or records of breeding or nesting behaviour by an expert observer).

A 12 km buffer applies to each site to 'reflect the flexible use of these areas by cockatoos and to indicate the important zone for access to potential feeding habitat' (Glossop *et al.* 2011). Glossop *et al.* (2011) state that the areas mapped in the dataset are not a comprehensive record of Carnaby's cockatoo breeding and that many nesting sites remain unknown.

While this dataset only applies to Carnaby's cockatoo, the information it contains is also applicable for Baudin's cockatoo and forest red-tailed black cockatoo as they have similar breeding habitat requirements. That is, breeding habitat that is suitable for Carnaby's cockatoo is likely to also be suitable for Baudin's cockatoo and forest red-tailed black cockatoo, if located within the latter species respective breeding range.

BirdLife Australia also maintain a database of confirmed black cockatoo breeding sites which is accessible via a paid search system. BirdLife Australia have advised that their database is comprised of data collected during surveys by staff and volunteers of which most (>99%) surveys are of Carnaby's cockatoo. BirdLife Australia further advises that their dataset is not comprehensive and that an absence of nest records does not necessarily indicate a lack of breeding activity.

The Carnaby's cockatoo recovery plan also identifies 13 'important bird areas' for Carnaby's cockatoo, which are identified as 'sites of global bird conservation importance' (DPaW 2013b). These 'important bird areas' comprise sites supporting at least 20 breeding pairs or 1% of the population regularly utilising an area in the non-breeding part of the range.

2.4.2 Roosting habitat

Roosts are trees that black cockatoos reside and rest within during the day and overnight. Generally, roosting habitat comprises taller trees which may be native or non-native species (DSEWPaC 2012). Roosts are often located near a water source and within 6 km to 12 km of foraging resources (Shah 2006; DSEWPaC 2012; Le Roux 2017). The use of a particular roost site may vary over time depending on the local availability of water and food.

BirdLife Australia undertakes annual monitoring of black cockatoo overnight roost sites as part of the annual 'Great Cocky Count' community-based survey. Information gathered from these monitoring events provides roost locations and records of black cockatoo numbers (Peck *et al.* 2019).

2.4.3 Foraging habitat

Black cockatoos feed on the fruit and seeds of a range of native and non-native plants species. 'Foraging habitat' is therefore vegetation that contains plant species known to be foraged on by black cockatoos.

Glossop et al. (2011) mapped 'areas requiring investigation as Carnaby's cockatoo feeding habitat' for the Swan Coastal Plain and Jarrah Forest regions, based on regional vegetation mapping that may contain plant species known to be foraged upon by Carnaby's cockatoo. Note that this dataset does not include observations or point records of Carnaby's cockatoo feeding. This dataset represents areas of vegetation that may potentially provide foraging habitat for Carnaby's cockatoo.

Given this dataset was created in 2011 and in order to account for clearing of native vegetation that has occurred since this time, Emerge have updated this dataset using the current native vegetation extent as provided by DPIRD (2019a) to only show potential foraging habitat that currently exists (Emerge Associates 2020b).

Pine plantations also provide an important food source for Carnaby's cockatoo, but were not included in the Glossop et al. (2011) dataset. Mapping of pine plantations is available from the Forest Products Commission (Forest Products Commission 2020).

The Glossop et al. (2011) dataset is broadly applicable to other black cockatoos as many plant species that are foraged upon by Carnaby's cockatoo are also consumed by Baudins' cockatoo (e.g. fruit of *Banksia* spp., *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah)) and forest red-tailed black cockatoo (e.g. jarrah and marri fruit). However, using the Glossop et al. (2011) potential foraging habitat dataset for forest red-tailed cockatoos likely overestimates available foraging habitat as it includes multiple plant species that are not consumed by this species (e.g. *Banksia* spp.), and to a lesser extent the foraging value is also over-estimated for Baudin's cockatoo.

Emerge Associates (2020c) have used a similar methodology to Glossop et al. (2011) to define potential foraging habitat for forest-red tailed cockatoos. Specifically, DBCA (2019) regional vegetation complex mapping has been used to determine which areas of remnant vegetation support plant species known to be foraged upon by forest red-tailed cockatoos, including *Allocasuarina fraseriana* (sheoak), *Corymbia calophylla* (marri), *Eucalyptus gomphocephala* (tuart) and *Eucalyptus marginata* (jarrah). Where these vegetation complexes intersect remnant vegetation mapped by DPIRD (2019b) they were considered to represent potential foraging habitat for forest red-tailed cockatoos.

2.5 Previous surveys

No previous targeted black cockatoo surveys are known to have been undertaken over the site. Numerous studies have been completed over the south west of Western Australia in relation to the status of black cockatoo species (refer **Section 2.3** and **Section 7.1**).

Emerge have previously completed a basic fauna assessment within the site, which was undertaken at the same time as the targeted black cockatoo assessment. During this survey broad scale mapping of fauna habitat was completed (Emerge Associates 2020a).

3 Methods

3.1 Desktop assessment

A search was conducted of publicly available regional studies and spatial datasets that provide information on black cockatoo records and potential habitat mapping (Glossop *et al.* 2011; DPaW 2013a; DoEE 2016a, c, b; Emerge Associates 2020b, c).

3.2 Field survey

Four ecologists from Emerge visited the site on 11 September, 21 October, 27 November and 8 and 21 December 2020 during the day to conduct the targeted black cockatoo field survey.

The weather conditions prior to and during the survey were cool during the September - November surveys with minimum temperatures ranging between 6.3° and 11.5° to a maximum of 16.5° to 22.6°. The December surveys were hot, with minimum temperatures ranging between 12.2° and 14.3° to a maximum between 30.2° and 37.2° according to the Bickley weather station (no. 009240) (BoM 2021).

Transects were traversed across the site and potential black cockatoo breeding, night roosting and foraging habitat was recorded. If observed, the presence of black cockatoos within or near the site was noted. Active searches for secondary evidence of breeding, roosting and foraging activity such as chew marks, branch clippings, droppings, moulted feathers and chewed fruit were conducted.

3.2.1 Breeding habitat

Habitat trees were individually identified and the attributes outlined in **Table 1** were recorded for each tree.

Table 1: Attributes recorded for each habitat tree in the site

Attribute	Description
Image	Each habitat tree was individually photographed
GPS location	The location of each habitat tree was recorded using a handheld GPS unit
Tree species	Species and common name were identified
Diameter at breast height (DBH) (cm)	DBH was measured at breast height (1.3 metres) using a diameter tape
Hollows potentially suitable for breeding by a black cockatoo	Number of hollows potentially suitable for breeding by a black cockatoo (assessed from ground level only)

Habitat trees that appeared to have hollows potentially suitable for use by a black cockatoo from the ground were also tagged with a unique identifier on a metal tag. Hollows that appeared potentially suitable for use by a black cockatoo from the ground were further inspected using a drone and/or a pole-mounted camera. During the hollow inspection the internal dimensions of the hollow were confirmed, if possible, and an assessment was made for signs of use such as chew marks around the hollow entrance, nesting material, feathers or the presence of birds within the hollow.

Occasionally, native eucalypts were encountered that met DBH requirements but did not contain a trunk/branch of a sufficient size to support a hollow suitable for use by black cockatoos. For example, the tree may have been less than 3 m tall or had a trunk that forked between 1.3 m and 3 m in height and after the fork no limbs had a diameter such that they could contain a suitable hollow. These trees were not recorded as habitat trees as the likelihood they would ever form a suitable hollow was low. All recorded habitat trees were assigned to a category listed in **Table 2**.

Table 2: Habitat tree categories

Category	Specifications
Nest	The tree contains a hollow used by black cockatoos for breeding as confirmed by records of black cockatoos, their eggs or fledglings or other evidence of recent nesting activity by black cockatoos
Suitable hollow(s) with signs of use	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^ and evidence of use by an unidentified bird such as feathers, chew marks or nest material has been recorded within a hollow
Suitable hollow(s)	The tree contains one or more hollows that are suitable for use by black cockatoos as breeding habitat as confirmed by internal hollow inspection^
Potentially suitable hollow(s)	The tree contains or is suspected to contain one or more hollows that have the potential to be suitable for use by black cockatoos when either viewed from the ground or following an internal hollow inspection that was inconclusive^
No suitable hollow(s)	The tree does not contain hollow(s) that have the potential to be suitable for use by black cockatoos when viewed from the ground or contains hollows that were determined to be unsuitable for use by black cockatoos by internal inspection^

^Hollow determined to be suitable for use as breeding habitat by black cockatoos as listed above in **Section 3.1.1**.

3.2.2 Roosting habitat

The site was assessed for the presence of active or historical roosts and its potential to provide roosting habitat for black cockatoos. However, no dusk roost survey was undertaken. Groups of tall native and non-native trees, if present, were assumed to provide potential roosting habitat.

3.2.3 Foraging habitat

Foraging habitat was identified by comparing the literature on plant species known to be foraged upon by black cockatoos (Davies 1966; Saunders 1980; Johnstone and Storr 1998; Johnstone and Kirkby 1999; Groom 2011; Johnstone *et al.* 2011; DSEWPaC 2012).

The value of foraging habitat was then further classified as ‘high’, ‘moderate’ or ‘low’ value based on the proportion of ‘primary’ or ‘secondary’ food plants it contained as outlined in **Table 3**.

Table 3: Foraging habitat values

Value	Definition
High	Greater than 50% primary food plants
Moderate	Greater than 10% to 50% primary food plants
Low	10% or less primary foodplants^
Nil	No primary or secondary food plants

^includes areas with 1-100% secondary food plants where no primary food plants are available

Primary food plants were defined as those with historical and contemporary records of regular consumption by a black cockatoo species. Secondary food plants were defined as plants that black cockatoo species have been recorded consuming occasionally or that, based on their limited extent or agricultural origin, should not be considered a sustaining resource. A list of plant species classified as primary or secondary food plants is provided as **Appendix B.**

Each patch of foraging habitat was assigned a foraging value for each species of black cockatoo likely to occur within the site. As it is not always possible to separate out food plants from non-food plants, mapped foraging habitat may also include vegetation comprising non-food plants. The proportion of non-food plants in mapped foraging habitat was minimised as far as practicable.

Evidence of black cockatoo foraging, such as chewed fruits, was searched for within the site and allocated to a species where possible. The locations of black cockatoo foraging evidence within the site were recorded using a hand-held GPS unit.

3.3 Data analysis, presentation and mapping

Habitat trees were classified according to the scheme outlined in **Table 2** and mapped on aerial imagery. A complete summary of the recorded attributes of habitat trees was compiled in a tabular format. Foraging habitat was mapped on aerial photography with the boundaries interpreted from aerial photography and notes taken in the field.

Foraging habitat was described according to the dominant flora species or vegetation type present and mapped using boundaries interpreted from aerial photography and notes taken in the field. The foraging value of each patch of foraging habitat was attributed separately for each species of black cockatoo likely to occur in the site. Foraging value was assigned as outlined in **Table 3**. The proportions of high, moderate and low value foraging habitat mapped within the site were calculated for each species of black cockatoo.

3.4 Nomenclature and sources of information

Taxonomy and nomenclature of scientific and common names for fauna species follow the *Western Australian Museum* (WAM) *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020). Where common names were not provided by Western Australian Museum (2019); (WAM 2020), these have been derived from other sources. Literature listed in **Appendix A** represent the main publications used to identify fauna species and habitats within the site.

3.5 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA's document *Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment* (EPA 2020) is provided in **Table 4**.

Table 4: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020)

Constraint	Degree of limitation	Details
Level of survey	No limitation	A targeted black cockatoo habitat survey was undertaken. The level of survey and survey effort are considered adequate to assess the black cockatoo habitat values within the site.
Scope	No limitation	The survey focused on black cockatoo habitat within the site.
Proportion of fauna identified, recorded and/or collected.	No limitation	The survey primarily focused on identifying black cockatoo habitat. Nonetheless, all three species of black cockatoos were positively identified as occurring within the site through the presence of foraging evidence. The extent of foraging habitat was resolved such that the proportion of non-food plants within mapped habitat was less than 25%.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Minor limitation	Adequate information was available from database searches and previous surveys to place habitat in context. Taxonomy and nomenclature of scientific and common names for fauna species follow the *Western Australian Museum* (WAM) *Checklist of the Terrestrial Vertebrate Fauna of Western Australia* (WAM 2020). This is contrary to the recent EPA (2020) advice to follow the Australian Faunal Directory (DAWE 2020b) nomenclature for birds.
The proportion of the task achieved and further work which might be needed.	No limitation	The targeted black cockatoo assessment was achieved in its entirety.
Experience level of personnel	No limitation	This fauna assessment was undertaken by qualified and experienced ecologists with between two and 18 years-experience in black cockatoo assessment in Western Australia.
Suitability of timing, weather and season	No limitation	Survey timing is not of great importance for a black cockatoo habitat assessment (with exception of detecting active nests). Nevertheless, the survey was undertaken within the main breeding season for all three species of black cockatoo (refer to **Section 2.4.1**).
Completeness	No limitation	The desktop assessment, field survey and targeted black cockatoo habitat assessment was completed comprehensively.
Spatial coverage and access	No limitation	Site coverage was comprehensive (track logged).
	No limitation	All parts of the site could be accessed as required.
Survey intensity	No limitation	The intensity of the survey was adequate given the size of the site.
Influence of disturbance	No limitation	The western portion of the site is modified due to historical disturbance associated with quarrying activities. However, no recent disturbance was noted that may have affected outcomes of the survey.

Table 4: Evaluation of survey methodology against standard constraints outlined in the EPA's Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA 2020) (continued)

Constraint	Degree of limitation	Details
Adequacy of resources	No limitation	All resources required to perform the survey were available. The guidance currently available from Commonwealth and State agencies on the assessment of black cockatoo habitat is limited and relies heavily on technical experts preparing their own methodology. In response this assessment applies an internally developed methodology that is considered to provide a systematic and balanced characterisation of black cockatoo habitat.

4 Results

4.1 Desktop information

Publicly available regional datasets relating to black cockatoo distribution, records and extent of habitat types were reviewed in relation to the site and surrounding area, as summarised in **Table 5**, **Table 6** and **Table 7**, and shown in **Figure 2.** Detailed information on each dataset considered as part of the desktop review is provided in **Appendix A**.

Table 5: Summary of black cockatoo background review

Category		Site context	Source
Species distribution		• Site is within the modelled distribution of Baudin's cockatoo, but not within its known or predicted breeding range. • Site is within the modelled distribution of Carnaby's cockatoo and within its breeding range. • Site is within the modelled distribution for forest red-tailed black cockatoo and within its known breeding range.	(DoEE 2016a, c, b)
Breeding sites		• No nesting records occur within the site. • Breeding of forest red-tailed black cockatoo and white tailed^ black cockatoos has been reported in Bungendore Park approximately 12 km from the site#.	BirdLife Australia database search (2021)
Carnaby's cockatoo breeding areas (12 km radius surrounding breeding sites)		• One confirmed breeding area intersect the site. • Two possible breeding areas intersect the site.	(Glossop *et al.* 2011)
Important bird areas for Carnaby's cockatoo		• None within the site. • None within 12 km of the site	DPaW (2013a)
Roost site		• None within the site. • 21 roost sites within 12 km of the site (see **Table 6** and **Table 7**): o three associated with white-tailed^ black cockatoos o five associated with forest red-tailed black cockatoos o 13 associated with white^ and red-tailed black cockatoos	BirdLife Australia database search (2021)
Foraging habitat	White-tailed black cockatoo^	• Potential native foraging habitat mapped within the northern and portion of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, to the north and east of the site within Korung and Midgegooroo National Parks.	(Emerge Associates 2020b)
	White-tailed black cockatoo^	• Several pine plantations are mapped within 12 km of the site, to the east and north-east.	(Forest Products Commission 2020)
	Forest red-tailed black cockatoo	• Potential native foraging habitat primarily mapped within the northern portion of the site. • Extensive areas of potential native foraging habitat mapped within the wider local area of the site, to the north and east of the site within Korung and Midgegooroo National Parks.	(Emerge Associates 2020c)

^Carnaby's and/or Baudin's cockatoo

#Data provided by Birdlife Australia includes information provided by Tony Kirkby, who has reported breeding within Bungendore Park, approximately 12 km from the site. However, exact coordinates have not been provided.

Table 6: White-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year and number of individuals									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
ARMBEDR001	57	0	NS	0	0	0	0	6	0	98
ARMBEDR002	70	22	NS	3	0	NS	0	0	0	0
ARMBEDR003	385	NS	NS	0	0	60	6	3	12	5
ARMBEDR005	NS	NS	NS	NS	NS	NS	NS	0	36	0
ARMKELR001	14	0	0	0	0	NS	NS	NS	0	0
ARMKELR002	0	10	NS	0	0	0	0	0	0	NS
ARMROLR001	108	13	140	40	0	0	157	70	0	0
ARMROLR003	NS	0	0	50	0	0	0	0	0	0
ARMROLR004	NS	NS	NS	NS	0	NS	28	0	0	0
ARMROLR005	NS	NS	NS	NS	NS	NS	0	0	0	35
GOSMARR001	NS	NS	NS	NS	NS	NS	NS	0	120	36
KALCANR001	NS	NS	NS	NS	NS	NS	NS	NS	NS	1
KALCARR002	NS	NS	NS	NS	NS	NS	NS	90	NS	8
KALCARR003	NS	NS	NS	NS	NS	NS	NS	NS	NS	0
KALPICR001	NS	NS	NS	NS	NS	NS	NS	5	0	NS
KALPICR002	NS	NS	NS	NS	2	NS	0	0	NS	NS
KALWALR001	0	5	0	0	0	0	NS	0	0	NS

NS = not surveyed

Table 7: Forest red-tailed black cockatoos recorded in roosts within 12 km of the site (Birdlife Australia 2021)

Roost ID	Year and number of individuals					
	2014	2015	2016	2017	2018	2019
ARMBEDR001	21	0	0	0	0	13
ARMBEDR002	0	NS	0	22	0	0
ARMBEDR003	0	0	0	0	3	21
ARMBEDR004	NS	NS	18	6	0	7
ARMBEDR005	NS	NS	NS	0	4	18
ARMBEDR006	NS	NS	NS	14	14	15
ARMKELR004	NS	NS	NS	NS	NS	6
ARMROLR001	0	0	0	9	0	3
ARMROLR003	0	0	0	4	0	0
ARMROLR004	0	NS	35	0	0	50
ARMROLR005	NS	NS	0	36	40	12
GOSMARR001	NS	NS	NS	75	37	18
KALCANR001	NS	NS	NS	NS	NS	5
KALCARR001	NS	NS	0	12	0	NS
KALCARR002	NS	NS	NS	0	NS	24
KALCARR003	NS	NS	NS	NS	NS	76
KALPICR002	42	NS	0	7	NS	NS
KALWALR001	43	1	NS	0	0	NS

NS = not surveyed

4.2 General site conditions

The site slopes from north to south and supports sandy and clay soils with granite outcrops. Two creeks and three waterbodies (dams) are located within the site. Both creeks and two of the waterbodies within the site contained water at the time of the field survey.

Native vegetation is located primarily within the central and eastern part of the site, with smaller areas along the western boundary.

The western portion of the site has been heavily disturbed and supports an active gravel quarry.

4.3 Species inventory

Forest red-tailed black cockatoos were observed foraging within the site and Baudin's cockatoos were observed adjacent to the site. Foraging evidence attributed to all three species of black cockatoo was observed within the site.

4.4 Breeding habitat

A total of 468 black cockatoo habitat trees were recorded within the site as shown in **Figure 3**.

The habitat trees comprised 311 *Corymbia calophylla* (marri), 120 *Eucalyptus marginata* (jarrah) and 37 stags (dead trees).

An internal hollow inspection was undertaken for 20 habitat trees, which were originally assessed to potentially contain suitable hollows based on the initial inspection from ground level. Of the 20 trees inspected, two were determined to contain one suitable hollow (Tree IDs 206 and 208). The remaining trees were determined to not contain hollows suitable for black cockatoos.

The hollows within Tree IDs 206 and 208 were determined to be suitably sized for black cockatoos but no evidence of use by black cockatoos was observed.

A summary of the habitat trees recorded within the site is provided in **Table 8** and an inventory in **Appendix C.** Details of habitat trees with suitable hollows is provided in **Appendix D**.

Table 8: Habitat trees recorded within the site

Category	No. trees	No. suitable hollows
Confirmed nest	0	-
Potential nest	0	-
Suitable hollow(s)	2	2
Potentially suitable hollow(s)	0	-
No suitable hollow(s)	466	0
Total	**468**	**2**

4.5 Roosting habitat

No roosts or secondary evidence of roosting were observed within the site during the survey.

Native and non-native trees within the site have the potential to provide roosting habitat for black cockatoos.

4.6 Foraging habitat

A total of 29.01 ha of foraging habitat for Carnaby's cockatoo, 26.82 ha for Baudin's cockatoo and 24.97 ha for forest red-tailed black cockatoo was recorded in the site as shown in **Figure 4** to **Figure 6**.

Primary food plants within the site include marri, jarrah and *Banksia grandis* (bull banksia). Secondary foraging habitat comprises primarily *Xanthorrhoea preissii* (grass trees) and *Grevillea manglesii* subsp. *manglesii,* as well as, scattered individuals of *Eucalyptus camaldulensis* (river gum). Foraging habitat within the eastern and central portions of the site comprise forest with a continuous overstorey and intact understorey. Foraging habitat within the western portion of the site is fragmented by historical disturbance.

A summary of the food plant preferences for each species of black cockatoo is provided in **Table 9**.

Table 9: Dominant primary and secondary black cockatoo food plants recorded within the site

Food plant	Black cockatoo species		
	Carnaby's	Baudin's	Forest red-tailed
Marri	Primary	Primary	Primary
Jarrah	Primary	Secondary	Primary
Bull banksia	Primary	Secondary	-
Grass tree	Secondary	Secondary	-
River gum	-	-	Secondary

The extent of foraging habitat by value category is detailed in **Table 10**.

Table 10: Foraging habitat value

Foraging value	Black cockatoo species and foraging habitat area (ha)		
	Carnaby's	Baudin's	Forest red-tailed
High	23.41 (81%)	22.85 (85%)	23.46 (94%)
Moderate	0.26 (1%)	0.30 (1%)	0.26 (1%)
Low	5.34 (18%)	3.65 (14%)	1.25 (5%)
Total	29.01	26.82	24.97

5 Discussion

The three species of black cockatoo recorded are frequently sighted in the jarrah forest subregion, and so recording them within the site was not unexpected. However, while the site contains habitat trees and high value foraging habitat, extensive areas of similar habitat occur adjacent to the site and in the local area.

5.1 Breeding habitat

The two habitat trees classified as having 'suitable hollows' were inspected using a pole camera and have internal dimensions that match the requirements of black cockatoos for breeding. However, no evidence of use by black cockatoos or any other fauna was recorded. These habitat trees therefore represent breeding habitat that has the potential to be used by black cockatoos. As the site is located within the breeding range of Carnaby's cockatoo and forest red-tailed black cockatoo the hollows are most relevant to these species.

The remainder of the habitat trees within the site either contained no hollows or had hollows that are not suitable for use by black cockatoos for breeding. The reasons a hollow may have been considered unsuitable include that it had a shallow depth, an uneven base or, most commonly, an internal cavity size that would be too small for a black cockatoo to nest within. These habitat trees have the potential to form suitable hollows in the future, but it will likely take many years for hollows to form that are large enough to be of use to black cockatoos.

5.2 Roosting habitat

The field survey did not include an evening (sunset) visit to check for roosts. However, there was no indication from the current or previous surveys or other sources that roosting may occur within the site (such as local anecdotal information). Therefore, an evening survey was not considered crucial to confirming the absence of roosts within the site.

The tall stands of native and non-native trees within the site do have the potential to be used by black cockatoos for roosting. However, this is does not mean the site would ever be used for roosting. It is difficult to predict where black cockatoos may roost given that the (ostensibly unknowable) availability and suitability of nearby resources such as food and water would influence roosting behaviour. The best indicator of roosting is therefore roosting. As there are no BirdLife Australia (2021) roosts nearby, the importance of the site as roosting habitat is likely to be low.

5.3 Foraging habitat

The foraging habit in the site was classified as high value as it is dominated by primary food plants like jarrah and marri. Jarrah and marri trees are important sustaining resources for all three species of black cockatoo. While being of high value, the foraging habitat in the site is a relatively very small portion of the jarrah forest adjacent to that site and which contains foraging habit of similarly high value.

Extensive areas of foraging habitat of similar or higher value are located adjacent to the site and in the wider area. Therefore, while the extent of foraging habitat in the site is not insignificant, it is still a smaller part of extensive food resources available to black cockatoos in this part of the jarrah forest.

6 Conclusions

The site occurs within the modelled distribution of all three black cockatoos and within the breeding range of Carnaby's cockatoo and forest red-tailed black cockatoo. Direct or indirect evidence of all three species was recorded in the site.

A total of 468 habitat trees were recorded in the site of which two trees contain a hollow suitable for breeding by black cockatoos. The site therefore currently provides breeding habitat which is most relevant to Carnaby's cockatoo and forest red-tailed black cockatoo. However, no evidence of breeding by any species of black cockatoo was observed within the site.

No evidence of black cockatoo roosting activity was observed within the site. Potential roosting habitat that is suitable for all three species of black cockatoo occurs within the site in the form of tall native and non-native trees.

A total of 29.01 ha of foraging habitat for Carnaby's cockatoo was mapped in the site of which 23.41 ha (81%) provides a high value resource, 0.26 ha (1%) provides a moderate value resource and 5.34 ha (18%) provides a low value resource.

A total of 26.82 ha of foraging habitat for Baudin's cockatoo was mapped in the site, of which 22.85 ha (85%) provides a high value resource, 0.30 ha (1%) provides a moderate value resource and 3.65 ha (14%) provides a low value resource.

A total of 24.97 ha of foraging habitat for forest red-tailed black cockatoo was mapped in the site, of which 23.46 ha (94%) provides a high value resource, 0.26 ha (1%) provides a moderate value resource and 1.25 ha (5%) provides a low value resource.

Extensive areas of native vegetation that provides high value foraging habitat for all three species of black cockatoo occurs adjacent to the site and in the wider area.

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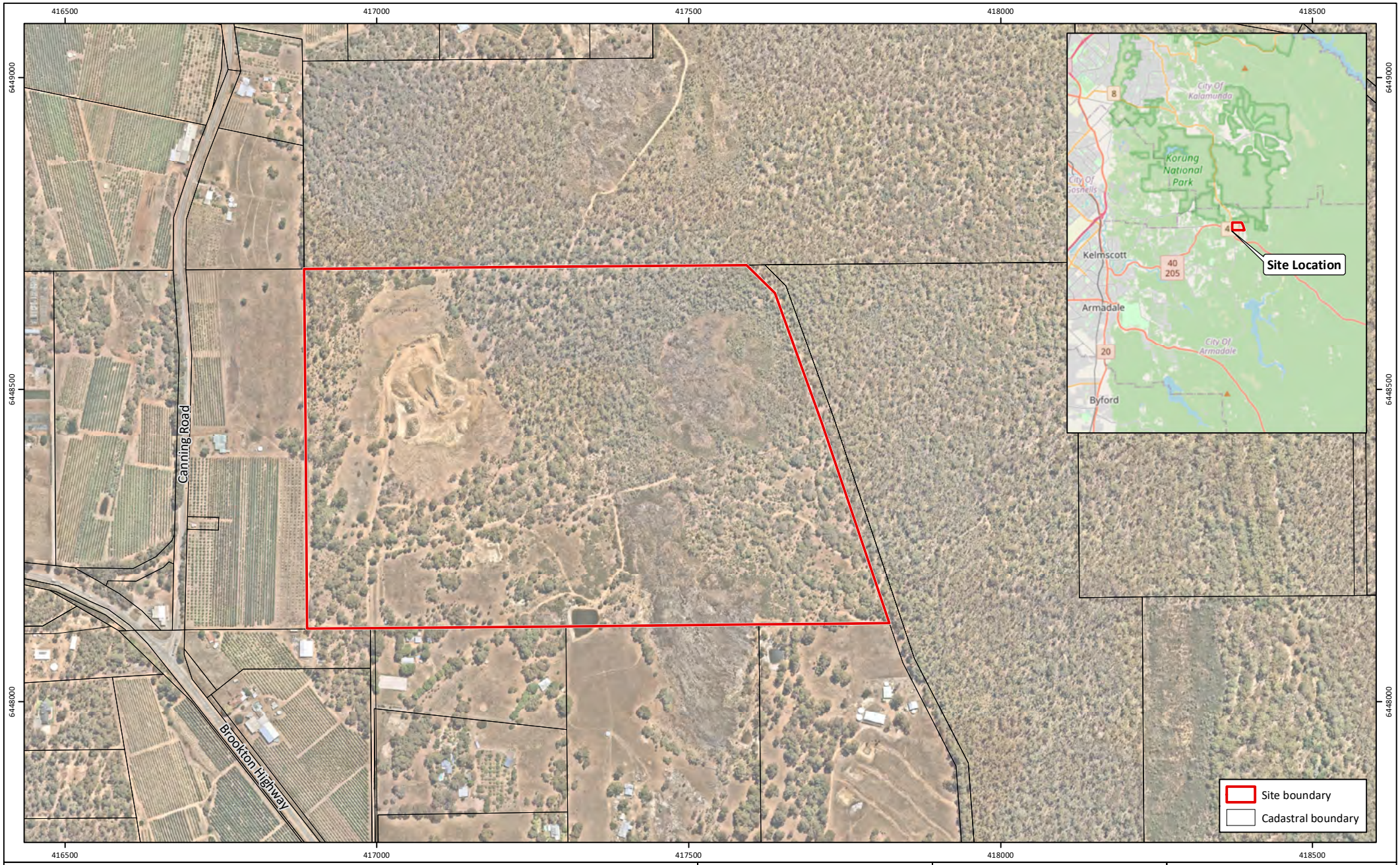

Figure 1: Site Location

Project:	Targeted Black Cockatoo Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(05)--F42

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Checked:	SCM
Approved:	RAW
Date:	19/02/2021

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emerge ASSOCIATES

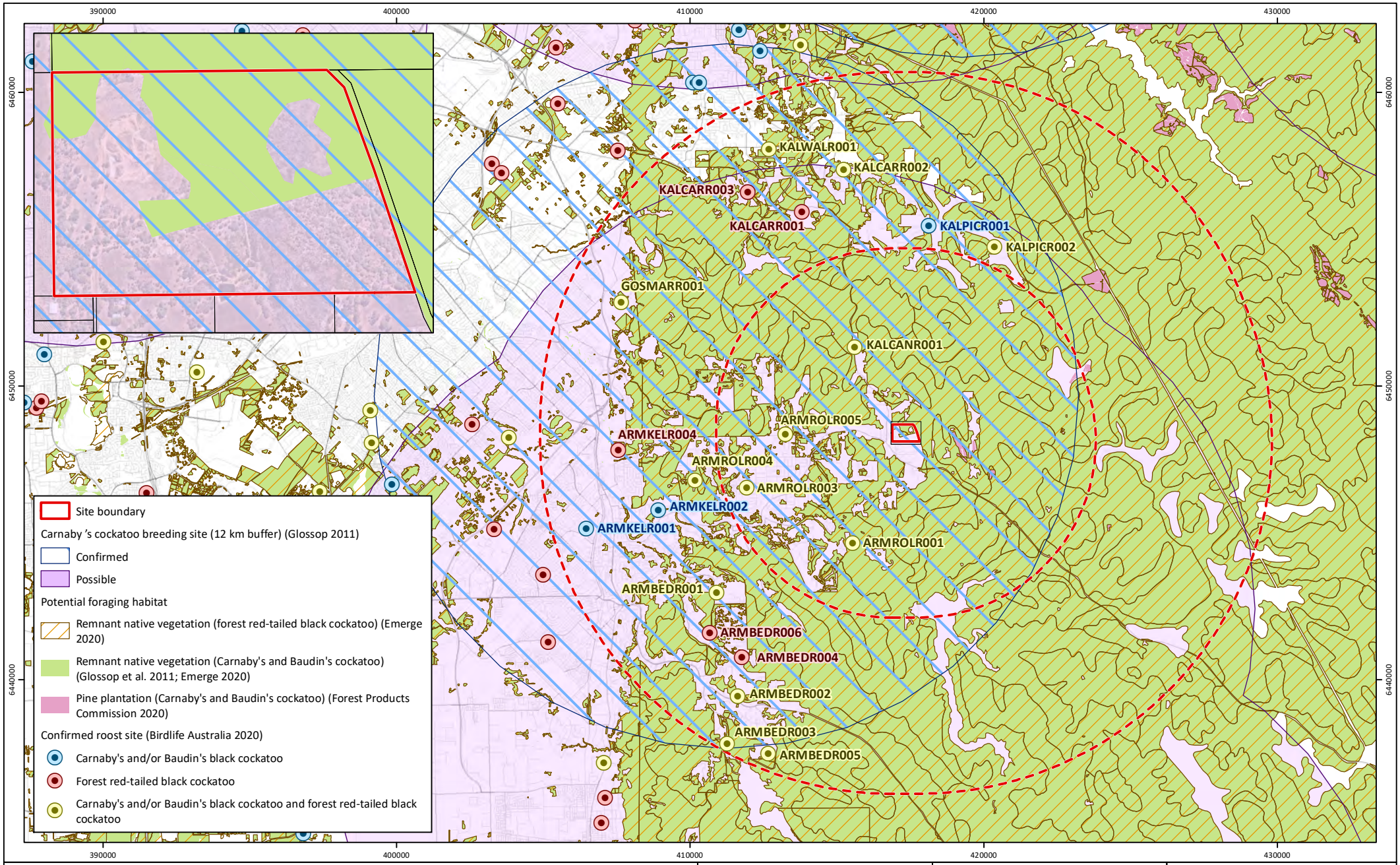

Figure 2: Black Cockatoo Habitat Context

Project:	Targeted Black Cockatoo Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(05)--F43

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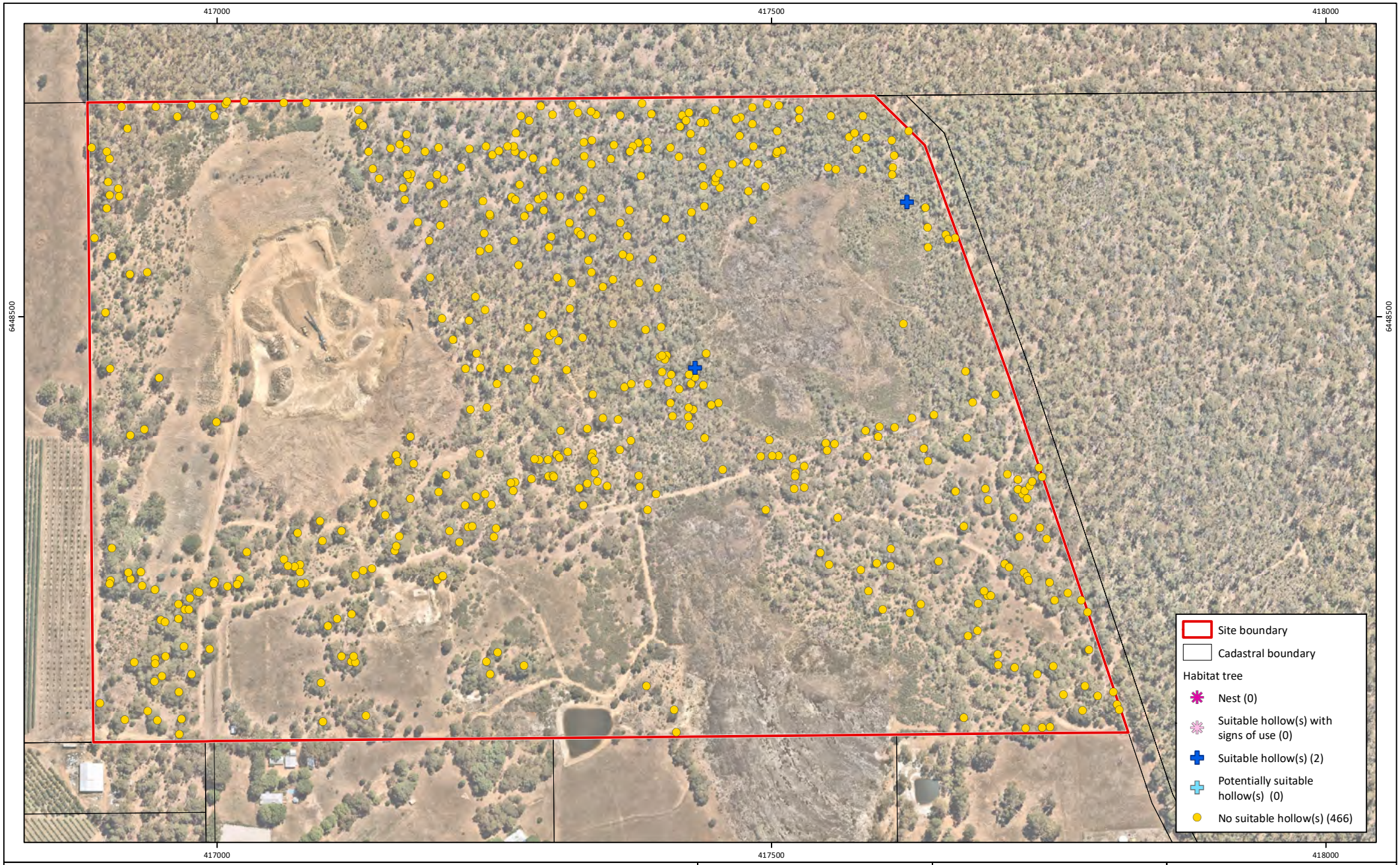

Figure 3: **Black Cockatoo Habitat Trees**

Project: Targeted Black Cockatoo Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(05)--F44a

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Checked:	SCM
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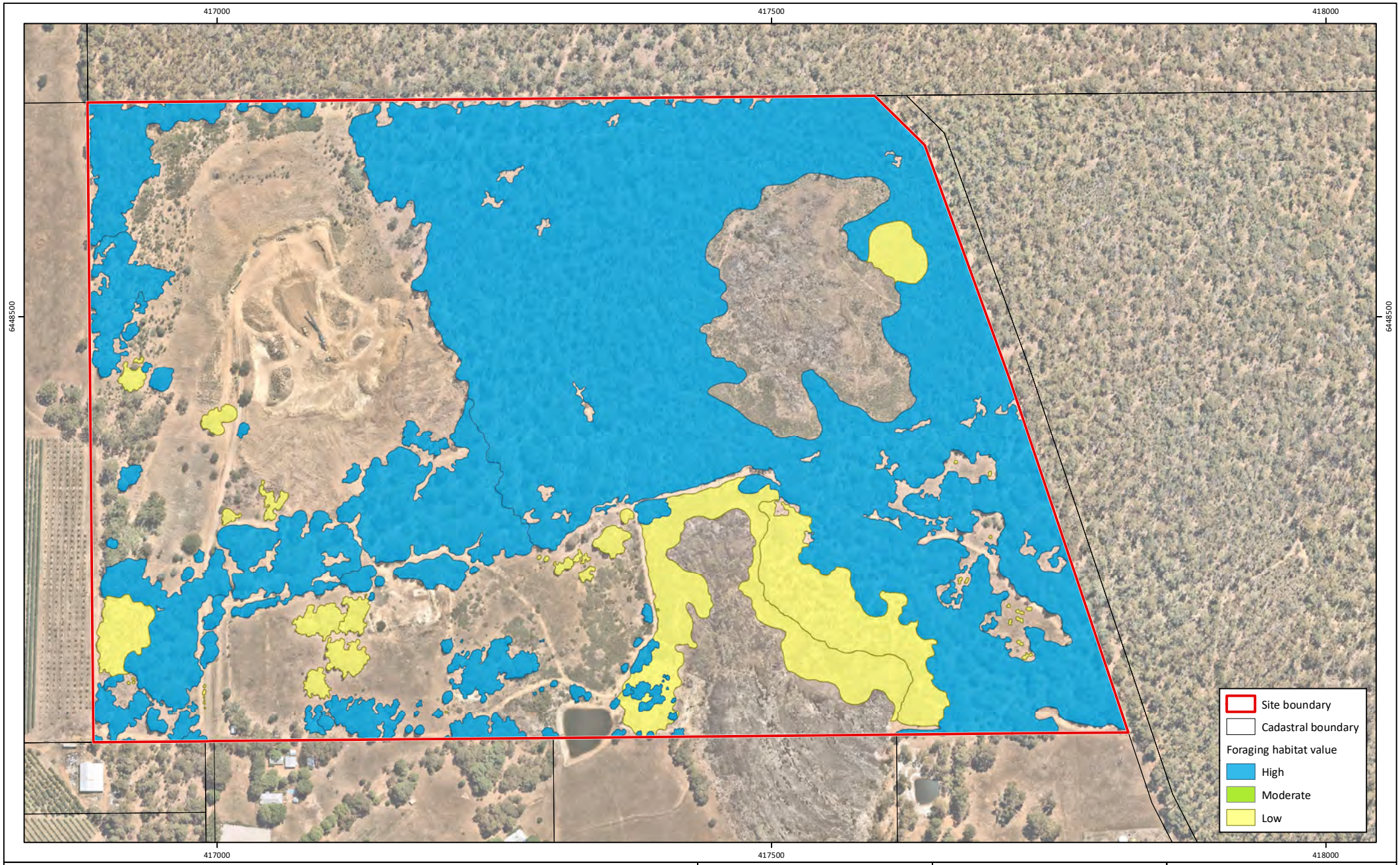

Figure 4: **Baudin's Cockatoo Foraging Habitat**

Project: Targeted Black Cockatoo Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(05)--F45a

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Checked:	SCM
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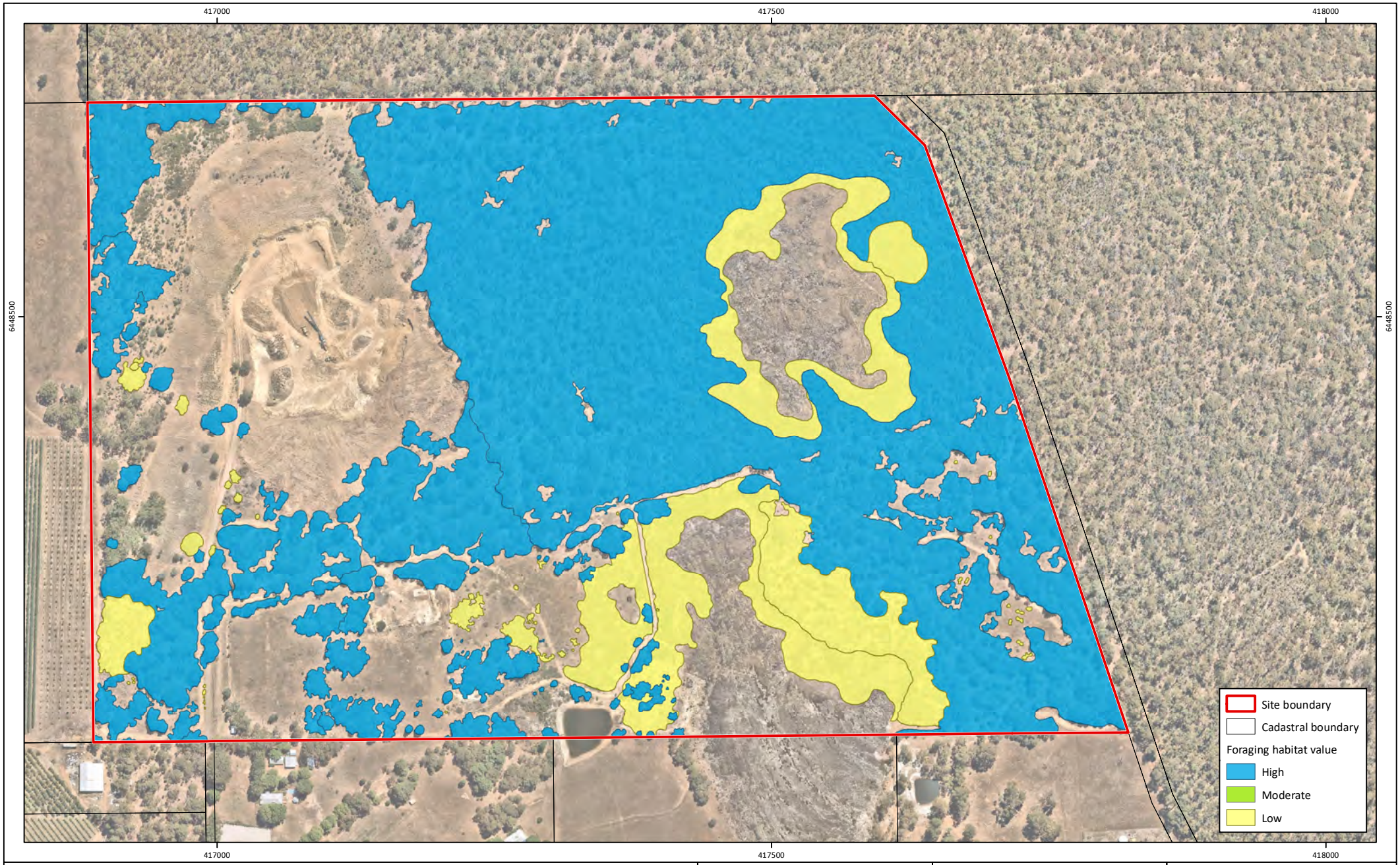

Figure 5: Carnaby's Cockatoo Foraging Habitat

Project: Targeted Black Cockatoo Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(05)--F46a

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Checked:	SCM
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emerge ASSOCIATES

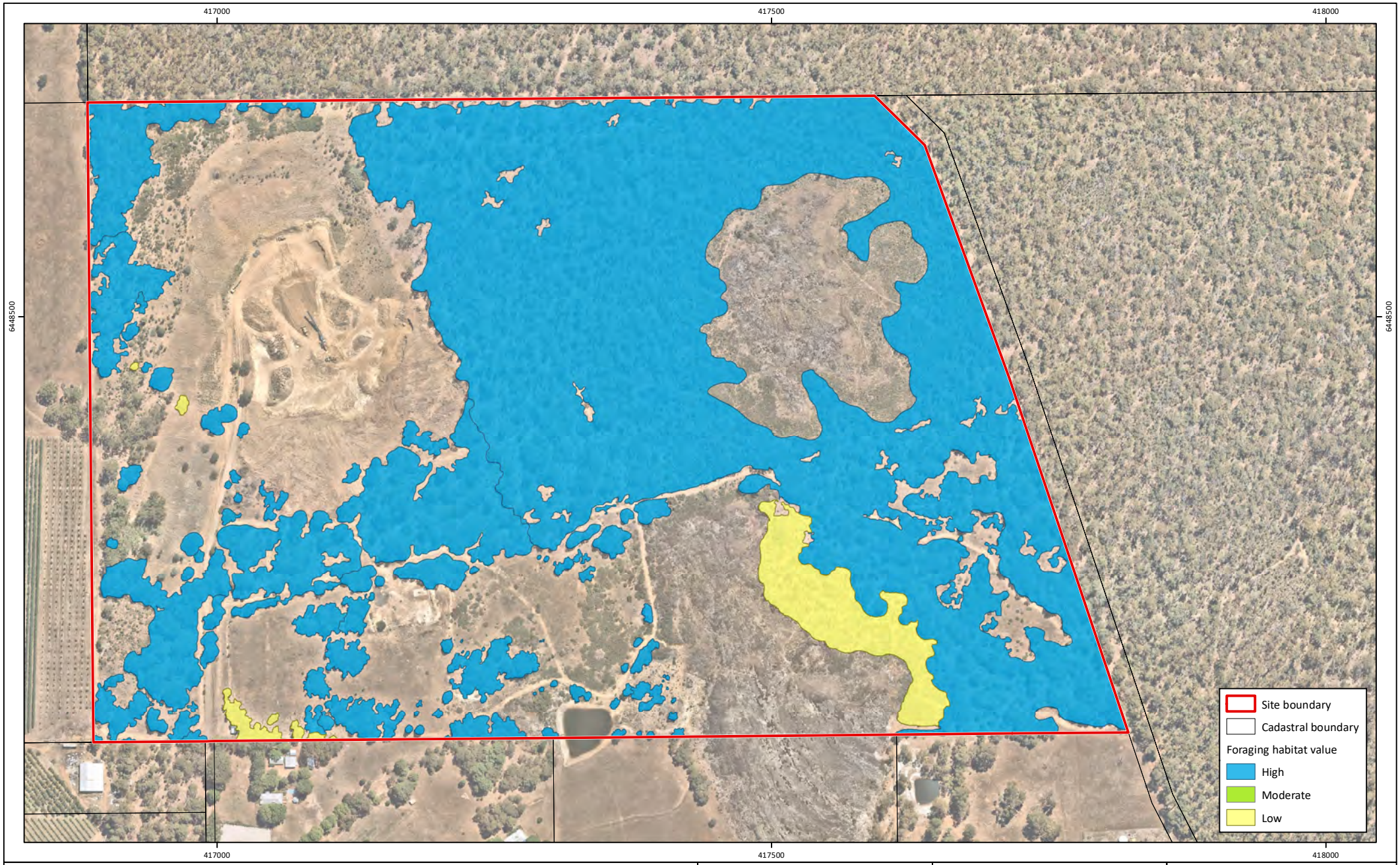

Figure 6: **Forest Red-tailed Black Cockatoo Foraging Habitat**

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Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
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Checked: SCM
Approved: TAA
Date: 28/07/2021

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GDA 1994 MGA Zone 50

emerge ASSOCIATES

Appendix A

Additional Information

Conservation Significant Fauna

Threatened and priority fauna

Fauna species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, fauna species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as 'threatened', 'migratory' or 'marine' as described in **Table 1**.

Migratory species comprise birds recognised under international treaties including:

- *Japan Australia Migratory Bird Agreement 1981* (JAMBA)
- *China Australia Migratory Bird Agreement 1998* (CAMBA)
- *Republic of Korea-Australia Migratory Bird Agreement 2007* (ROKAMBA)
- *Bonn Convention 1979* (The Convention on the Conservation of Migratory Species of Wild Animals).

Fauna species listed as threatened and migratory are protected in Australia as 'matters of national environmental significance' (MNES) under the EPBC Act.

Table 1: Definitions of conservation significant fauna species pursuant to the EPBC Act

Conservation Code	Category
X	Threatened Fauna –Extinct There is no reasonable doubt that the last member of the species has died.
EW[#]	Threatened Fauna –Extinct in the Wild Taxa which are known only to survive in cultivation, captivity or as a naturalised population outside its past range, or taxa which have not been recorded in its known and/or expected habitat despite appropriate exhaustive surveys.
CR[#]	Threatened Fauna – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN[#]	Threatened Fauna – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU[#]	Threatened Fauna – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
Migratory[#]	Migratory Fauna All migratory species that are: (i) native species; and (ii) from time to time included in the appendices to the Bonn Convention; and (b) all migratory species from time to time included in annexes established under JAMBA, CAMBA and ROKAMBA; and All native species from time to time identified in a list established under, or an instrument made under, an international agreement approved by the Minister.
Ma	Marine Fauna Species in the list established under s248 of the EPBC Act

[#]matters of national environmental significance (MNES) under the EPBC Act

In Western Australia, fauna taxa may be classed as 'threatened', 'extinct', or 'specially protected' under the *Biodiversity Conservation Act 2016* (BC Act), which is enforced by Department of Biodiversity Conservation and Attractions (DBCA) (DBCA 2019a). The definitions of these categories are provided in **Table 2**.

Table 2: Definitions of specially protected fauna schedules under the BC Act (DBCA 2019a)

Category	Conservation Code	Definition
Threatened	CR	Critically endangered Threatened species considered to be facing an extremely high risk of extinction in the wild in the immediate future.
	EN	Endangered Threatened species considered to be facing a very high risk of extinction in the wild in the near future.
	VU	Vulnerable Threatened species considered to be facing a high risk of extinction in the wild in the medium-term future.
Extinct	EX	Extinct Species where there is no reasonable doubt that the last member of the species has died.
	EW	Extinct in the wild Species that is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form. Note that no species are currently listed as EW.
Specially protected	MI	Migratory species Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth Includes birds that subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds.
	CD	Species of special conservation interest (conservation dependent fauna) Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
	OS	Other specially protected species Fauna otherwise in need of special protection to ensure their conservation.

Fauna species that may be threatened or near threatened but lack sufficient information to be legislatively listed may be added to the DBCA's *Priority Fauna List* (DBCA 2018). Species listed under priorities 1-3 comprise possible threatened species that do not meet survey criteria or are otherwise data deficient. Species listed under priority 4 are those that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons (DBCA 2019a).

Priority fauna species are considered during State approval processes. Priority fauna categories and definitions are listed in **Table 3** (DBCA 2019a).

Table 3: Definitions of priority fauna categories on DBCA's Priority Fauna List (DBCA 2019a)

Conservation Code	Category
P1	Priority 1 – Poorly known 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.
P2	Priority 2 – Poorly known 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.
P3	Priority 3 – Poorly known 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.
P4	(a) Priority 4 – Rare species 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) Priority 4 – Near Threatened Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Priority 4 – Other Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

Black cockatoos

Three threatened species of black cockatoo occur on the Swan Coastal Plain (referred to herein collectively as 'black cockatoos'):

- *Calyptorhynchus latirostris* (Carnaby's cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus baudinii* (Baudin's cockatoo) which is listed as 'endangered' under the EPBC Act and the BC Act.
- *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo) which is listed as 'vulnerable' under the EPBC Act and the BC Act.

There are a range of regional studies and spatial datasets available which provide information on black cockatoo records and potential habitat mapping. These are detailed below.

Species distribution and breeding range

Broad-scale maps are available for the modelled distribution of Baudin's cockatoo, Carnaby's cockatoo and forest red-tailed black cockatoo (DSEWPaC 2011; DoEE 2016a, b).

The modelled distribution maps also include 'known breeding areas' and 'predicted breeding range' for Baudin's cockatoo and 'breeding range' and 'non-breeding range' for Carnaby's cockatoo.

No breeding range modelling is available for forest red-tailed black cockatoo but the species is known to breed mainly in the jarrah forest region (DBCA 2017) and in small populations on the Swan Coastal Plain within the Baldivis, Stake Hill, Lake McLarty and Capel area and increasingly in the Perth metropolitan area (DAWE 2020).

Breeding habitat

Department of Environment and Conservation (DEC, now Department of Biodiversity, Conservation and Attractions (DBCA)) and fauna experts, have identified and mapped Carnaby's cockatoo habitat on the Swan Coastal Plain and Jarrah Forest regions (Glossop *et al.* 2011). This dataset includes mapping of Carnaby's cockatoo breeding sites based on point records of breeding from a range of sources. Breeding sites were classified as 'confirmed' where eggs or chicks were recorded and 'possible' where observations relating to Carnaby's cockatoo breeding that did not include actual records of eggs or chicks (e.g. chewed hollows or records of breeding or nesting behaviour by an expert observer).

A 12 km buffer applies to each site to 'reflect the flexible use of these areas by cockatoos and to indicate the important zone for access to potential feeding habitat' (Glossop *et al.* 2011). Glossop *et al.* (2011) state that the areas mapped in the dataset are not a comprehensive record of Carnaby's cockatoo breeding and that many nesting sites are not known.

While this dataset only applies to Carnaby's cockatoo, the information it contains is also applicable for Baudin's cockatoo and forest red-tailed black cockatoo as they have similar breeding habitat requirements. That is, breeding sites that are suitable for Carnaby's cockatoo may also be suitable for

Baudin's cockatoo and forest red-tailed black cockatoo, if located within their distribution/breeding ranges.

BirdLife Australia also maintain a database of confirmed black cockatoo breeding sites which is accessible via a paid search system. BirdLife Australia have advised that their database is comprised of data collected during surveys by staff and volunteers of which most (>99%) surveys are of Carnaby's cockatoo. They have also advised that the dataset is not comprehensive and that an absence of known nests does not necessarily indicate a lack of breeding activity.

The Carnaby's cockatoo recovery plan also identifies 13 'important bird areas' for Carnaby's cockatoo, which are identified as 'sites of global bird conservation importance' (DPaW 2013). These 'important bird areas' comprise sites supporting at least 20 breeding pairs or 1% of the population regularly utilising an area in the non-breeding part of the range.

Confirmed roost sites

BirdLife Australia undertakes annual monitoring of black cockatoo overnight roost sites as part of the annual 'Great Cocky Count' community-based survey. Information gathered from these monitoring events provides roost locations and recorded black cockatoo numbers (Peck *et al.* 2019).

Native foraging habitat

Glossop et al. (2011) also mapped 'areas requiring investigation as Carnaby's cockatoo feeding habitat' for the Swan Coastal Plain and Jarrah Forest regions, based on regional vegetation mapping that may contain plant species known to be foraged upon by Carnaby's cockatoo. Note that this dataset does not include observations or point records of Carnaby's cockatoo feeding. This dataset represents areas of vegetation that may potentially provide foraging habitat for Carnaby's cockatoo.

Given this dataset was created in 2011 and in order to account for clearing of native vegetation that has occurred since this time, Emerge have updated this dataset using the current native vegetation extent as provided by DPIRD (2019a) to only show potential foraging habitat that currently exists (Emerge Associates 2020a).

Pine plantations also provide an important food source for Carnaby's cockatoo, but were not included in the Glossop et al. (2011) dataset. Mapping of pine plantations is available from the Forest Products Commission (Forest Products Commission 2020).

The Glossop et al. (2011) dataset is broadly applicable to other black cockatoos as many plant species that are foraged upon by Carnaby's cockatoo are also consumed by Baudins' cockatoo (e.g. fruit of *Banksia* spp., *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah)) and forest red-tailed black cockatoo (e.g. jarrah and marri fruit). However, using the Glossop et al. (2011) potential foraging habitat dataset for forest red-tailed cockatoos likely overestimates available foraging habitat as it includes multiple plant species that are not consumed by this species (e.g. *Banksia* spp.), and to a lesser extent the foraging value is also over-estimated for Baudin's cockatoo.

Emerge Associates (2020b) have used a similar methodology to Glossop et al. (2011) to define potential foraging habitat for forest-red tailed cockatoos. Specifically, DBCA (2019b) regional vegetation complex mapping has been used to determine which areas of remnant vegetation

support plant species known to be foraged upon by forest red-tailed cockatoos, including *Allocasuarina fraseriana* (sheoak), *Corymbia calophylla* (marri), *Eucalyptus gomphocephala* (tuart) and *Eucalyptus marginata* (jarrah). Where these vegetation complexes intersect remnant vegetation mapped by DPIRD (2019b) they were considered to represent potential foraging habitat for forest red-tailed cockatoos.

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Appendix B

Black Cockatoo Foraging Plants

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Acacia baileyana	Cootamundra wattle	Secondary			Groom 2011
Acacia pentadenia	Karri wattle	Secondary			Groom 2011
Acacia saligna	Orange wattle	Secondary			Groom 2011
Agonis flexuosa	Peppermint tree	Secondary			Groom 2011
Allocasuarina fraseriana	Sheoak		Secondary	Secondary	Johnstone & Storr 1998; Johnstone et al. 2010; Johnstone 2017; DoEE 2017
Allocasuarina spp.		Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Anigozanthos flavidus	Tall kangaroo paw		Secondary		Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Araucaria heterophylla	Norfolk island pine	Secondary			Groom 2011; DoEE 2017
Banksia ashbyi	Ashby's banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia attenuata	Slender banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia baxteri	Baxter's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia carlinoides	Pink dryandra	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia coccinea	Scarlet banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia dallanneyi	Couch honeypot dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia ericifolia	Heath-leaved banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia fraseri		Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia gardneri	Prostrate banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia grandis	Bull banksia	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia hookeriana	Hooker's banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia ilicifolia	Holly banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Johnstone & Storr 1998; DoEE 2017
Banksia kippistiana		Primary	Secondary		Groom 2011; DoEE 2017
Banksia leptophylla		Primary	Secondary		Groom 2011; DoEE 2017
Banksia lindleyana	Porcupine banksia	Primary	Secondary		Johnstone et al. 2010; DoEE 2017

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Banksia littoralis	Swamp banksia	Primary	Secondary		Saunders 1980; Groom 2011Johnstone & Storr 1998; Johnstone et al. 2010; DoEE 2017
Banksia menziesii	Firewood banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia mucronulata	Swordfish dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia nivea	Honeypot dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia nobilis	Golden dryandra	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Banksia praemorsa	Cut-leaf banksia	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prionotes	Acorn banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia prolata		Primary	Secondary		Johnstone et al. 2010; DoEE 2017
Banksia quercifolia	Oak-leaved banksia	Primary	Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia sessilis	Parrot bush	Primary	Secondary		Saunders 1980; Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia speciosa	Showy banksia	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Banksia squarrosa	Pingle	Primary	Secondary		Johnstone et al. 2010; Groom 2011; DoEE 2017
Banksia tricuspis	Pine banksia	Primary	Secondary		Groom 2011; DoEE 2017
Banksia undata	Urchin dryandra	Primary	Secondary		Groom 2011; DoEE 2017
Banksia verticillata	Granite banksia	Primary	Secondary		Saunders 1980; Groom 2011; DoEE 2017
Brassica campestris	Canola	Secondary			Groom 2011; DoEE 2017
Callistemon spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Callistemon viminalis	Captain cook bottlebrush	Secondary			Groom 2011
Callitris sp.		Secondary			Johnstone et al. 2010; Groom 2011
Carya illnoinensis	Pecan	Primary	Secondary		Johnstone et al. 2010; Groom 2011; Groom 2014; DoEE 2017
Casuarina cunninghamiana	River sheoak	Secondary			Groom 2011
Citrullus lanatus	Pie or afghan melon	Secondary			Johnstone et al. 2010; Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Corymbia calophylla	Marri	Primary	Primary	Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Saunders 1979; Johnstone & Kirkby 2008
Corymbia citriodora	Lemon scented gum	Secondary	Secondary	Secondary	Johnstone et al. 2010; DSEWPaC 2012; Groom 2011; Johnstone 2017
Corymbia ficifolia	Red flowering gum	Secondary			Groom 2011
Corymbia haematoxylon	Mountain marri	Secondary		Secondary	Groom 2011; DoEE 2012; DoEE 2017
Corymbia maculata	Spotted gum	-	-	-	-
Darwinia citriodora	Lemon-scented darwinia	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Diospryros sp.	Sweet persimmon	Secondary	Secondary		Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eremophila glabra	Tarbush	Secondary			Groom 2011
Erodium aureum		Secondary			Groom 2011
Erodium botrys	Long storksbill	Secondary	Secondary		Groom 2011; Johnstone & Storr 1998; Johnstone et al. 2010
Erodium spp.		Secondary	Secondary		Johnstone et al. 2010; DoEE 2017
Eucalyptus accedens	Powderbark	-	-	-	-
Eucalyptus caesia	Silver princess	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone 2017
Eucalyptus camaldulensis	River red gum			Secondary	DoEE 2012; DoEE 2017
Eucalyptus decipiens	Red heart/moit			Secondary	Johnstone 2017
Eucalyptus diversicolor	Karri			Primary	Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998
Eucalyptus erythrocorys	Illyarrie	Secondary		Secondary	DSEWPaC 2012; DoEE 2017; Johnstone 2017, Johnstone et al. 2010
Eucalyptus globulus	Tasmanian blue gum	-	-	-	-
Eucalyptus gomphocephala	Tuart	Secondary		Secondary	Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus grandis	Flooded gum, rose gum			Secondary	DoEE 2012; DoEE 2017

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Eucalyptus lehmannii	Bushy yate			Secondary	Johnstone 2017
Eucalyptus leucoxylon	Yellow gum	Secondary			Groom 2014
Eucalyptus longicornis	Red morrell	-	-	-	-
Eucalyptus loxophleba	York gum	Secondary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Eucalyptus marginata	Jarrah	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017; Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone 2017
Eucalyptus megacarpa	Bullich	-	-	-	-
Eucalyptus occidentalis	Swamp yate	-	-	-	-
Eucalyptus patens	Blackbutt	Primary		Primary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017; Johnstone 2017; Groom 2011
Eucalyptus pleurocarpa	Tallerack	Secondary			Groom 2011
Eucalyptus preissiana	Bell-fruited mallee	Secondary			Groom 2011
Eucalyptus robusta	Swamp mahogany	Secondary			Johnstone et al. 2010; Groom 2011
Eucalyptus rudis	Flooded gum	-	-	-	-
Eucalyptus salmonophloia	Salmon gum	Primary			Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DSEWPaC 2012; DoEE 2017
Eucalyptus salubris	Gimlet	-	-	-	-
Eucalyptus staeri	Albany blackbutt			Secondary	Johnstone & Storr 1998
Eucalyptus todtiana	Coastal blackbutt	Secondary			Saunders 1980; Johnstone et al. 2010; Groom 2011; Johnstone & Kirkby 2008
Eucalyptus wandoo	Wandoo	Primary	Secondary	Primary	Saunders 1980; Johnstone et al. 2010; Groom 2011; DSEWPaC 2012; DoEE 2017
Ficus sp.	Fig	Secondary			Groom 2011
Grevillea armigera	Prickly toothbrushes	Primary			Groom 2011
Grevillea bipinnatifida	Fuschia grevillea	Primary			Groom 2011

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Grevillea hookeriana	Red toothbrushes	Primary			Groom 2011
Grevillea hookeriana subsp. apic	Black toothbrushes	Primary			Groom 2011
Grevillea paniculata	Kerosene bush	Primary			Groom 2011
Grevillea paradoxa	Bottlebrush grevillea	Primary			Groom 2011
Grevillea petrophiloides	Pink poker	Primary			Groom 2011
Grevillea robusta	Silky oak	Primary			Johnstone et al. 2010; Groom 2011
Grevillea spp.		Primary			Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Grevillea wilsonii	Native fuchsia		Secondary		Johnstone et al. 2010
Hakea auriculata		Primary			Saunders 1980; Groom 2011
Hakea candolleana		Primary			Groom 2011
Hakea circumalata	Coastal hakea	Primary			Groom 2011
Hakea commutata		Primary			Groom 2011
Hakea conchifolia	Shell-leaved hakea	Primary			Groom 2011
Hakea costata	Ribbed hakea	Primary			Groom 2011
Hakea cristata	Snail hakea	Primary	Secondary		Groom 2011; Johnstone et al. 2010
Hakea cucullata	Snail hakea	Primary			Groom 2011
Hakea cyclocarpa	Ramshorn	Primary			Saunders 1980; Groom 2011
Hakea eneabba		Primary			Groom 2011
Hakea erinacea	Hedgehog hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea falcata	Sickle hakea	Primary			Groom 2011
Hakea flabellifolia	Fan-leaved hakea	Primary			Groom 2011
Hakea gilbertii		Primary			Saunders 1980; Groom 2011
Hakea incrassata	Golfball or marble hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasiantha	Woolly flowered hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lasianthoides		Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea laurina	Pin-cushion hakea	Primary			Johnstone et al. 2010; Groom 2011
Hakea lissocarpha	Honeybush	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea marginata			Secondary		Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Hakea megalosperma	Lesueur hakea	Primary			Groom 2011
Hakea multilineata	Grass leaf hakea	Primary			Groom 2011
Hakea neospathulata		Primary			Groom 2011
Hakea obliqua	Needles and corks	Primary			Saunders 1980; Groom 2011
Hakea oleifolia	Dungyn	Primary			Groom 2011
Hakea pandanicarpa subsp. crassifolia	Thick-leaved hakea	Primary			Groom 2011
Hakea petiolaris	Sea urchin hakea	Primary			Groom 2011
Hakea polyanthema		Primary			Groom 2011
Hakea preissii	Needle tree	Primary			Groom 2011
Hakea prostrata	Harsh hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea psilorrhyncha		Primary			Groom 2011
Hakea ruscifolia	Candle hakea	Primary	Secondary		Saunders 1980; Groom 2011; Johnstone et al. 2010
Hakea scoparia	Kangaroo bush	Primary			Groom 2011
Hakea smilacifolia		Primary			Groom 2011
Hakea spp.		Primary	Secondary		Saunders 1979; DSEWPaC 2012; DoEE 2017
Hakea stenocarpa	Narrow-fruited hakea	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Hakea sulcata	Furrowed hakea	Primary			Groom 2011
Hakea trifurcata	Two-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea undulata	Wavy-leaved hakea	Primary	Secondary		Saunders 1980; Johnstone et al. 2010; Groom 2011
Hakea varia	Variable-leaved hakea	Primary	Secondary		Saunders 1980; Groom 2011
Harpephyllum caffrum	Kaffir plum			Secondary	Johnstone 2017
Helianthus annuus	Sunflower	Secondary			Johnstone et al. 2010; Groom 2011
Hibiscus sp.	Hibiscus	Secondary			Groom 2011
Isopogon scabriusculus		Secondary			Groom 2011
Jacaranda mimosifolia	Jacaranda	Secondary	Secondary		Johnstone et al. 2010; Groom 2011

		Foraging category as assigned by Emerge			
Species name	**Common name**	**CBC**	**BBC**	**FRTBC**	**Literature references**
Jacksonia furcellata	Grey stinkwood	Secondary			Groom 2011
Kingia australis	Kingia		Secondary		Johnstone et al. 2010
Lambertia inermis	Chittick	Secondary			Johnstone & Storr 1998; Groom 2011
Lambertia multiflora	Many-flowered honeysuckle	Secondary			Saunders 1980; Groom 2011
Liquidamber styraciflua	Liquid amber	Primary		Secondary	Johnstone et al. 2010; Groom 2011; Groom 2014; Personal observation
Lupinus sp.	Lupin	Secondary			Saunders 1980; Groom 2011
Macadamia integrifolia	Macadamia	Primary	Secondary		Johnstone et al. 2010; Grooms 2011; Groom 2014
Malus domestica	Apple	Secondary	Secondary		Johnstone et al. 2010; Johnstone & Storr 1998; DSEWPaC 2012; DoEE 2017; Groom 2011
Melaleuca leuropoma		Secondary			Saunders 1980; Groom 2011
Melia azedarach	Cape lilac or white cedar	Secondary		Primary	Johnstone et al. 2010; Groom 2011
Mesomeleana spp.		Secondary			Johnstone et al. 2010; Groom 2011
Olea europea	Olive			Secondary	Johnstone 2017
Persoonia longifolia	Snottygobble			Secondary	Johnstone & Storr 1998; Johnstone & Kirkby 1999; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Pinus canariensis	Canary island pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus caribea	Caribbean pine	Primary			Johnstone et al. 2010; Groom 2011
Pinus pinaster	Pinaster or maritime pine	Primary			Groom 2011
Pinus radiata	Radiata pine	Primary	Secondary		Johnstone et al. 2010; Groom 2011
Pinus spp.		Primary	Secondary		Johnstone & Storr 1998; Saunders 1979; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Protea 'Pink Ice'		Secondary			Groom 2011
Protea repens		Secondary			Groom 2011
Protea spp.		Secondary			Johnstone et al. 2010

Species name	Common name	Foraging category as assigned by Emerge			Literature references
		CBC	BBC	FRTBC	
Prunus amygdalus	Almond tree	Secondary			Johnstone & Storr 1998; Johnstone et al. 2010; Groom 2011; DoEE 2017
Pyrus communis	European pear		Secondary		Johnstone & Storr 1998; Johnstone et al. 2010; DSEWPaC 2012; DoEE 2017
Quercus spp.	Oak		Secondary		Johnstone et al. 2010
Raphanus raphanistrum	Wild radish	Secondary			Groom 2011; DoEE 2017
Reedia spathacea			Secondary		Johnstone et al. 2010
Rumex hypogaeus	Doublegee	Secondary			Saunders 1980
Stenocarpus sinuatus		Secondary			Johnstone et al. 2010
Syzygium smithii	Lilly pilly	Secondary			Groom 2014
Tipuana tipu	Tipu or rosewood tree	Primary			Groom 2011, Groom 2014
Xanthorrhoea preissii	Grass tree	Secondary	Secondary		Groom 2011; Johnstone et al. 2010
Xylomelum occidentale	Woody pear	Secondary			Groom 2014

CBC=Carnaby's cockatoo, BBC=Baudin's cockatoo and FRTBC=Forest red-tailed black cockatoo

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Appendix C

Black Cockatoo Habitat Tree Data

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
50	417607.48	6448275.91	-	*Eucalyptus marginata*	No suitable hollow(s)	
52	417203.75	6448266.87	-	*Eucalyptus marginata*	No suitable hollow(s)	
55	417544.14	6448287.52	-	*Corymbia calophylla*	No suitable hollow(s)	
55	417595.31	6448278.36	-	*Corymbia calophylla*	No suitable hollow(s)	
57	417580.62	6448272.14	-	*Corymbia calophylla*	No suitable hollow(s)	
57	417121.55	6448232.17	-	*Eucalyptus marginata*	No suitable hollow(s)	
58	417125.04	6448188.62	-	*Eucalyptus marginata*	No suitable hollow(s)	
64	417600.42	6448236.81	-	*Corymbia calophylla*	No suitable hollow(s)	
68	417625.16	6448233.27	-	*Corymbia calophylla*	No suitable hollow(s)	
68	417552.36	6448276.57	-	*Corymbia calophylla*	No suitable hollow(s)	
69	417123.38	6448194.27	-	*Eucalyptus marginata*	No suitable hollow(s)	
70	417494.95	6448326.10	-	*Corymbia calophylla*	No suitable hollow(s)	
70	417112.25	6448194.06	-	*Eucalyptus marginata*	No suitable hollow(s)	
72	417203.47	6448266.30	-	*Eucalyptus marginata*	No suitable hollow(s)	
73	417677.53	6448212.82	-	*Corymbia calophylla*	No suitable hollow(s)	
74	417121.05	6448189.59	-	*Eucalyptus marginata*	No suitable hollow(s)	
82	417587.54	6448253.14	-	*Corymbia calophylla*	No suitable hollow(s)	
84	417673.67	6448138.79	-	*Corymbia calophylla*	No suitable hollow(s)	
84	417198.69	6448263.18	-	*Eucalyptus marginata*	No suitable hollow(s)	
85	417634.84	6448241.09	-	*Corymbia calophylla*	No suitable hollow(s)	
86	417094.12	6448170.29	-	*Eucalyptus marginata*	No suitable hollow(s)	
90	417108.49	6448228.41	-	*Corymbia calophylla*	No suitable hollow(s)	
96	417650.95	6448280.14	-	*Corymbia calophylla*	No suitable hollow(s)	
111	417388.51	6448326.69	-	*Corymbia calophylla*	No suitable hollow(s)	
113	416993.68	6448200.65	-	*Corymbia calophylla*	No suitable hollow(s)	
130	417100.32	6448221.67	-	*Eucalyptus marginata*	No suitable hollow(s)	
156	417607.83	6448291.00	-	*Corymbia calophylla*	No suitable hollow(s)	
201	417289.79	6448606.45	93	*Corymbia calophylla*	No suitable hollow(s)	
204	417299.20	6448563.08	63	*Eucalyptus marginata*	No suitable hollow(s)	
205	417372.58	6448649.14	97	*Eucalyptus marginata*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
206	417622.27	6448603.72	78	Stag	Suitable hollow(s)	Mulch chips in base, hollow dimensions suitable for black cockatoos but no evidence of use by black cockatoos.
207	417431.14	6448445.75	68	Stag	No suitable hollow(s)	
208	417431.26	6448454.07	83	Stag	Suitable hollow(s)	Mulch in base, hollow dimensions suitable for black cockatoos but no evidence of use by black cockatoos.
210	417174.33	6448392.56	185	*Eucalyptus marginata*	No suitable hollow(s)	
249	417560.02	6448319.42	0	*Corymbia calophylla*	No suitable hollow(s)	
250	417582.21	6448633.33	80	Stag	No suitable hollow(s)	
251	417577.06	6448651.13	110	Stag	No suitable hollow(s)	
252	417525.22	6448678.87	90	Stag	No suitable hollow(s)	
253	417504.62	6448647.33	85	*Corymbia calophylla*	No suitable hollow(s)	
254	417479.41	6448613.21	60	Stag	No suitable hollow(s)	
255	417477.69	6448639.46	115	Stag	No suitable hollow(s)	
256	417404.40	6448588.54	56	Stag	No suitable hollow(s)	
257	417409.15	6448422.51	83	Stag	No suitable hollow(s)	
258	417698.08	6448249.26	64	*Corymbia calophylla*	No suitable hollow(s)	
901	417167.88	6448616.44	119	*Corymbia calophylla*	No suitable hollow(s)	
902	417201.56	6448582.68	96	*Eucalyptus marginata*	No suitable hollow(s)	
903	417237.14	6448559.36	72	Stag	No suitable hollow(s)	
904	417220.58	6448634.60	93	Stag	No suitable hollow(s)	
N/A	417412.53	6448145.95	81	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417387.34	6448167.92	74	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417276.79	6448185.98	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417243.17	6448189.36	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417124.86	6448267.33	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417131.62	6448271.60	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417139.63	6448273.22	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417414.48	6448125.90	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417401.25	6448465.46	77	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417399.47	6448463.90	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417404.11	6448461.94	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417405.59	6448465.61	76	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417246.56	6448177.97	79	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417253.10	6448197.98	76	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417134.29	6448140.81	80	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417095.74	6448135.28	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417438.84	6448438.83	60	Stag	No suitable hollow(s)	
N/A	417446.15	6448421.04	83	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417452.27	6448422.42	72	Stag	No suitable hollow(s)	
N/A	417498.22	6448389.32	58	Stag	No suitable hollow(s)	
N/A	417441.34	6448467.45	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417425.64	6448448.37	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417646.57	6448411.69	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417626.87	6448408.98	80	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417611.08	6448400.87	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417596.33	6448392.55	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417500.78	6448375.15	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417550.48	6448379.87	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417549.10	6448386.51	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417557.32	6448385.91	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417657.24	6448574.29	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417639.02	6448598.31	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417357.19	6448533.84	70	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417597.39	6448401.20	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417584.97	6448397.34	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417640.95	6448580.48	95	Stag	No suitable hollow(s)	
N/A	417659.72	6448570.10	74	Stag	No suitable hollow(s)	
N/A	417372.12	6448554.25	74	Stag	No suitable hollow(s)	
N/A	417370.37	6448573.08	53	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417363.86	6448584.77	55	*Eucalyptus marginata*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417371.97	6448596.48	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417348.19	6448527.22	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417357.14	6448493.60	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417381.00	6448530.70	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417366.07	6448556.08	65	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417274.36	6448681.38	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417281.67	6448677.12	50	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417292.13	6448690.17	67	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417302.67	6448682.39	70	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417382.48	6448627.38	74	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417375.09	6448654.26	73	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417380.25	6448657.08	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417383.65	6448692.47	55	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417363.63	6448681.88	52	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417337.94	6448638.22	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417331.19	6448644.93	80	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417320.81	6448690.63	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417325.77	6448684.01	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417337.56	6448685.55	73	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417341.92	6448682.37	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417346.69	6448607.14	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417305.56	6448639.62	57	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417285.34	6448643.45	68	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417276.07	6448646.14	58	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417330.80	6448657.56	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417338.05	6448659.50	58	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417358.19	6448655.23	64	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417355.46	6448642.68	53	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417328.37	6448573.95	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417325.51	6448577.48	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417317.99	6448584.73	74	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417294.20	6448632.87	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417309.30	6448608.94	75	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417330.30	6448614.88	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417326.95	6448608.53	67	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417306.78	6448535.76	75	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417320.03	6448531.21	80	Stag	No suitable hollow(s)	
N/A	417318.34	6448507.36	59	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417301.67	6448572.19	89	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417281.74	6448598.30	79	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417294.68	6448596.30	129	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417294.29	6448609.37	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417337.98	6448540.11	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417335.16	6448551.06	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417338.58	6448571.16	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417338.20	6448594.32	57	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417293.18	6448502.39	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417303.89	6448485.85	60	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417308.00	6448478.67	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417329.87	6448481.51	58	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417416.97	6448435.22	50	Stag	No suitable hollow(s)	
N/A	417425.31	6448418.88	54	Stag	No suitable hollow(s)	
N/A	417429.49	6448416.47	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417409.98	6448448.35	54	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417401.47	6448450.17	68	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417407.30	6448440.68	83	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417427.79	6448439.63	86	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417519.49	6448372.53	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417676.55	6448391.09	116	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417675.22	6448450.94	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417681.58	6448423.17	91	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417425.19	6448410.45	58	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417410.85	6448410.56	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417490.69	6448374.62	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417506.45	6448374.97	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417694.88	6448248.90	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417755.49	6448244.62	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417739.99	6448177.87	76	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417704.17	6448196.43	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417685.79	6448217.79	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417686.82	6448241.74	107	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417692.11	6448253.09	61	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417744.06	6448129.91	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417751.32	6448130.41	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417780.64	6448145.28	88	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417814.04	6448146.21	66	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417754.56	6448185.20	81	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417782.92	6448167.58	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417763.73	6448159.66	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417729.44	6448129.57	125	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417785.21	6448234.11	66	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417779.55	6448245.15	66	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417767.43	6448251.26	74	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417751.02	6448261.11	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417811.83	6448150.96	71	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417808.63	6448162.46	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417794.41	6448158.47	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417786.43	6448200.09	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417727.92	6448269.90	74	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417673.61	6448311.36	55	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417666.09	6448343.01	60	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417693.25	6448345.11	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417714.39	6448274.89	63	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417710.78	6448277.85	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417731.85	6448262.39	81	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417730.88	6448266.04	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417718.18	6448319.26	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417730.88	6448336.33	89	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417745.27	6448365.93	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417747.97	6448358.19	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417695.60	6448335.15	145	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417723.70	6448302.34	69	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417748.25	6448299.88	66	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417742.32	6448310.03	76	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417726.60	6448340.61	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417723.26	6448344.91	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417722.62	6448353.55	91	Stag	No suitable hollow(s)	
N/A	417712.77	6448358.35	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417735.38	6448351.66	55	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417733.15	6448347.76	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417728.55	6448343.84	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417722.60	6448344.46	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417520.47	6448345.15	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417521.41	6448356.80	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417521.77	6448359.57	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417529.83	6448365.40	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417641.43	6448370.19	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417637.57	6448381.24	53	Stag	No suitable hollow(s)	
N/A	417586.66	6448374.62	61	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417529.80	6448346.56	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417290.57	6448371.44	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417309.05	6448373.04	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417298.49	6448371.62	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417306.76	6448375.90	57	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417303.90	6448356.37	83	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417303.33	6448357.14	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417299.09	6448356.77	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417286.22	6448372.18	67	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417363.16	6448380.24	96	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417340.87	6448359.55	86	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417340.40	6448370.63	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417337.82	6448374.05	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417316.56	6448378.20	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417309.98	6448397.32	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417334.03	6448399.40	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417361.99	6448407.72	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417343.01	6448351.69	74	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417351.82	6448347.66	89	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417265.07	6448350.73	68	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417268.84	6448351.20	73	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417339.03	6448377.05	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417330.44	6448330.86	98	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417326.91	6448346.13	67	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417333.87	6448349.96	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417161.63	6448375.61	61	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417243.19	6448418.51	61	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417315.39	6448452.46	52	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417236.92	6448376.66	75	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417206.97	6448357.90	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417177.55	6448367.53	71	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417163.56	6448369.86	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417388.81	6448440.09	102	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417373.09	6448388.52	66	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417380.52	6448357.32	75	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417381.17	6448347.24	55	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417373.71	6448440.19	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417367.70	6448437.14	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417338.97	6448430.04	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417348.11	6448408.83	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416997.68	6448681.12	79	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417080.91	6448693.00	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417060.24	6448693.27	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417028.61	6448695.01	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417396.03	6448340.82	59	Stag	No suitable hollow(s)	
N/A	417456.15	6448362.92	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417426.11	6448401.81	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417440.07	6448391.06	66	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416964.37	6448680.74	60	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416944.85	6448689.78	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416914.09	6448689.64	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416919.06	6448669.95	65	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417009.08	6448694.41	69	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417007.68	6448692.07	73	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416995.64	6448688.20	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416977.12	6448691.15	71	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416912.11	6448608.70	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416911.01	6448615.90	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416903.23	6448609.96	90	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416900.68	6448597.96	50	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416886.84	6448652.39	78	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416900.46	6448649.07	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416903.24	6448642.66	50	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416901.81	6448621.59	57	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416899.38	6448504.06	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416999.45	6448405.32	70	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416947.99	6448444.81	96	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	416903.75	6448453.54	90	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416889.58	6448571.05	57	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416905.47	6448554.77	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416921.65	6448538.38	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416937.01	6448540.72	73	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417267.48	6448343.65	59	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416977.16	6448177.87	68	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417241.85	6448340.80	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417018.42	6448259.10	71	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416974.69	6448236.29	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417075.65	6448259.63	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416970.24	6448203.32	117	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416975.74	6448246.60	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417247.59	6448331.30	70	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416937.41	6448144.87	83	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417161.93	6448293.67	57	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417152.05	6448321.43	97	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417095.26	6448298.45	76	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417092.75	6448315.84	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416894.51	6448152.17	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416997.06	6448259.43	89	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417063.84	6448275.81	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416968.06	6448137.78	76	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416953.52	6448194.43	72	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417020.69	6448263.08	70	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416965.77	6448162.04	106	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416943.51	6448171.84	107	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416983.83	6448251.98	100	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417230.47	6448311.20	80	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417072.65	6448305.04	66	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416944.43	6448187.71	83	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417112.18	6448307.03	57	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416998.27	6448262.21	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417209.75	6448307.60	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417079.72	6448260.32	83	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417251.91	6448309.61	61	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417199.75	6448342.31	70	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417160.23	6448289.25	100	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417141.02	6448332.33	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417174.59	6448336.03	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417164.39	6448302.13	94	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416917.16	6448137.18	78	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417218.50	6448297.13	73	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417009.63	6448257.42	70	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417027.03	6448288.61	89	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417226.71	6448311.08	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416946.36	6448136.94	57	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417060.66	6448281.89	63	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417074.97	6448276.69	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417070.17	6448274.98	73	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416950.56	6448176.68	81	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417283.91	6448354.21	73	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	416981.93	6448252.63	55	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417075.21	6448270.36	76	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417233.93	6448338.18	71	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417704.63	6448186.23	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417719.28	6448184.14	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416944.21	6448191.58	77	*Corymbia calophylla*	No suitable hollow(s)	
N/A	416966.17	6448124.35	94	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417223.99	6448330.89	54	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417249.79	6448301.82	94	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417449.28	6448686.68	50	*Corymbia calophylla*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417436.54	6448675.60	50	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417440.31	6448675.30	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417437.81	6448635.48	50	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417702.28	6448429.99	68	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417619.19	6448494.17	75	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417641.47	6448562.75	58	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417665.57	6448571.04	59	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417419.78	6448681.79	62	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417417.89	6448671.46	66	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417409.07	6448652.65	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417416.59	6448644.40	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417437.60	6448649.67	53	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417427.47	6448665.44	90	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417423.31	6448677.05	50	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417425.61	6448684.38	67	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417388.51	6448651.71	62	Stag	No suitable hollow(s)	
N/A	417388.36	6448657.81	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417391.74	6448683.11	54	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417386.72	6448488.96	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417400.48	6448490.95	59	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417397.08	6448525.96	51	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417393.09	6448552.42	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417468.13	6448678.30	73	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417472.07	6448680.44	51	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417482.95	6448689.06	53	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417496.23	6448692.16	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417419.45	6448571.59	74	Stag	No suitable hollow(s)	
N/A	417428.13	6448594.83	59	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417439.17	6448618.31	56	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417471.37	6448663.14	78	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417465.15	6448638.25	53	*Eucalyptus marginata*	No suitable hollow(s)	

Tag No.	Easting	Northing	DBH (cm)	Species	Category	Notes
N/A	417452.95	6448629.73	62	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417449.97	6448625.27	56	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417483.07	6448673.87	52	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417483.90	6448653.93	58	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417505.36	6448649.00	83	Stag	No suitable hollow(s)	
N/A	417488.37	6448637.56	168	Stag	No suitable hollow(s)	
N/A	417494.57	6448617.98	106	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417509.97	6448650.59	57	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417449.52	6448621.94	78	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417453.44	6448616.21	52	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417439.61	6448599.80	78	*Eucalyptus marginata*	No suitable hollow(s)	
N/A	417483.12	6448587.07	107	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417551.24	6448634.74	78	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417558.33	6448633.13	99	Stag	No suitable hollow(s)	
N/A	417553.60	6448680.99	65	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417575.15	6448665.97	51	Stag	No suitable hollow(s)	
N/A	417505.21	6448667.40	64	*Corymbia calophylla*	No suitable hollow(s)	
N/A	417507.09	6448691.14	63	*Eucalyptus marginata*	No suitable hollow(s)	

Appendix D

Black Cockatoo Habitat Tree Hollow Data

Black Cockatoo Hollow Data

Lots 9 Brookton Highway, Karragullen

Tree ID 206

Project no.: EP20-040(05)
Inspection date: 8/12/2020
DBH (cm): 78
Species: Stag
No. hollows: 1
Hollow suitability: 1

Hollow ID	1
Hollow type:	Top entry
Inspection type(s):	Ground
	Go Pro

Hollow characteristics

Hollow entrance >10cm
Hollow distance from ground >3 m
Hollow internal diameter >30 cm
Hollow depth approx 50-200 cm
Hollow orientation vertical or near vertical

Evidence of nesting

Fledglings: No
Egg/s or egg fragments: No
Feathers: No
Nest material No
Other: N/A

Evidence of hollow use

Fauna observed: None
Chew marks: None
Other N/A

Determined hollow category

~~Confirmed nest~~
~~Potential nest~~
Suitable hollow(s)
~~Potentially suitable hollow(s)~~
~~No suitable hollow(s)~~

Reason:
Mulch chips in base, hollow dimensions suitable for black cockatoos but no evidence of use by black cockatoos.

Black Cockatoo Hollow Data

Lots 9 Brookton Highway, Karragullen

Tree ID 208

Project no.: EP20-040(05)
Inspection date: 8/12/2020
DBH (cm): 83
Species: Stag
No. hollows: 1
Hollow suitability: 1

Hollow ID	1
Hollow type:	Top entry
Inspection type(s):	Ground
	Go Pro

Hollow characteristics

Hollow entrance >10cm
Hollow distance from ground >3 m
Hollow internal diameter >30 cm
Hollow depth approx 50-200 cm
Hollow orientation vertical or near vertical

Evidence of nesting

Fledglings: No
Egg/s or egg fragments: No
Feathers: No
Nest material No
Other: N/A

Evidence of hollow use

Fauna observed: None
Chew marks: None
Other N/A

Determined hollow category

~~Confirmed nest~~
~~Potential nest~~
Suitable hollow(s)
~~Potentially suitable hollow(s)~~
~~No suitable hollow(s)~~

Reason:
Mulch in base, hollow dimensions suitable for black cockatoos but no evidence of use by black cockatoos.

Appendix D

Acoustic Assessment - Lot 9 Brookton Highway, Karragullen
(Lloyd George Acoustics 2021)

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Vinci Quarry Expansion

Stage 5 Noise Assessment

Lot 9 Brookton Highway, Karragullen

Reference: 20115962-01.docx

Prepared for:

Vinci Gravel Supplies c/- Emerge Associates

Report: 20115962-01.docx

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Date:	Rev	Description	Prepared By	Verified
24-Mar-21	0	Issued to Client	Olivier Mallié	Terry George

Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

Vinci Gravel Supplies are proposing to expand their existing gravel extraction pit on Lot 9 Brookton Highway, Karragullen. The expansion is referred to as Stage 5 with excavation starting to the east of existing Stage 4, as shown on *Figure 1-1*. Stage 4 will be rehabilitated while Stage 5 is excavated.

The gravel pit, shown in *Figure 1-1*, operates within the daytime hours of 7.00 am to 7.00 pm Monday to Saturday.

This report has been prepared to assess the likely noise impacts from the pit in relation to Stage 5 expansion, and compares the predicted noise levels against the *Environmental Protection (Noise) Regulations 1997*. Where the noise is predicted to exceed the Regulations, noise mitigation measures have been recommended. The existing pit and proposed Stage 5 expansion areas are shown in *Figure 1-2*.

As per previous phases, loading of materials may occur between 6.00am and 7.00am however, there would be no additional truck movements to the 5 trucks per hour during this period, which was considered to be the critical time period (refer report 13102581-02 dated October 2014). Noise emissions from loading of trucks is addressed as the loading area moves closer to the receivers.

Appendix A contains a description of some of the terminology used throughout this report.

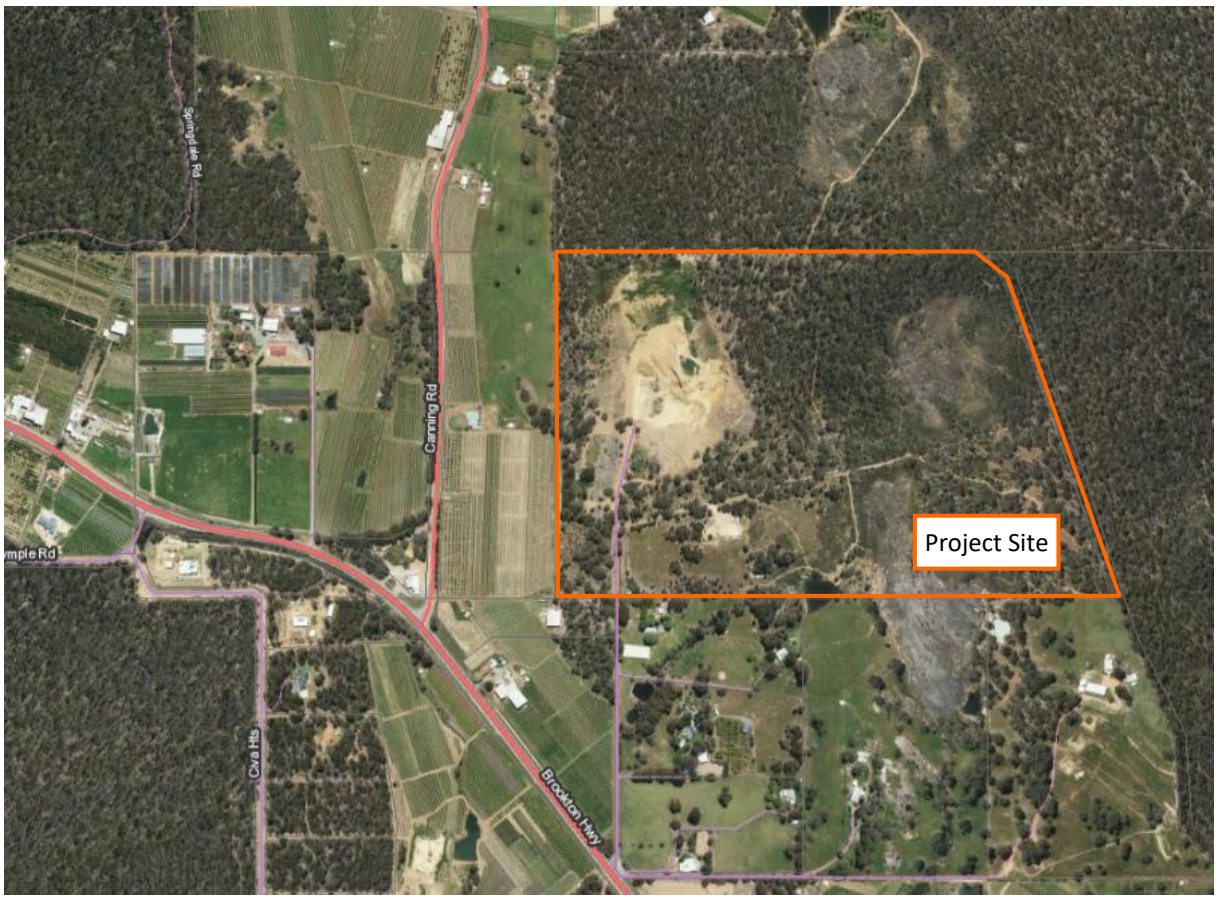


Figure 1-1 Project Locality

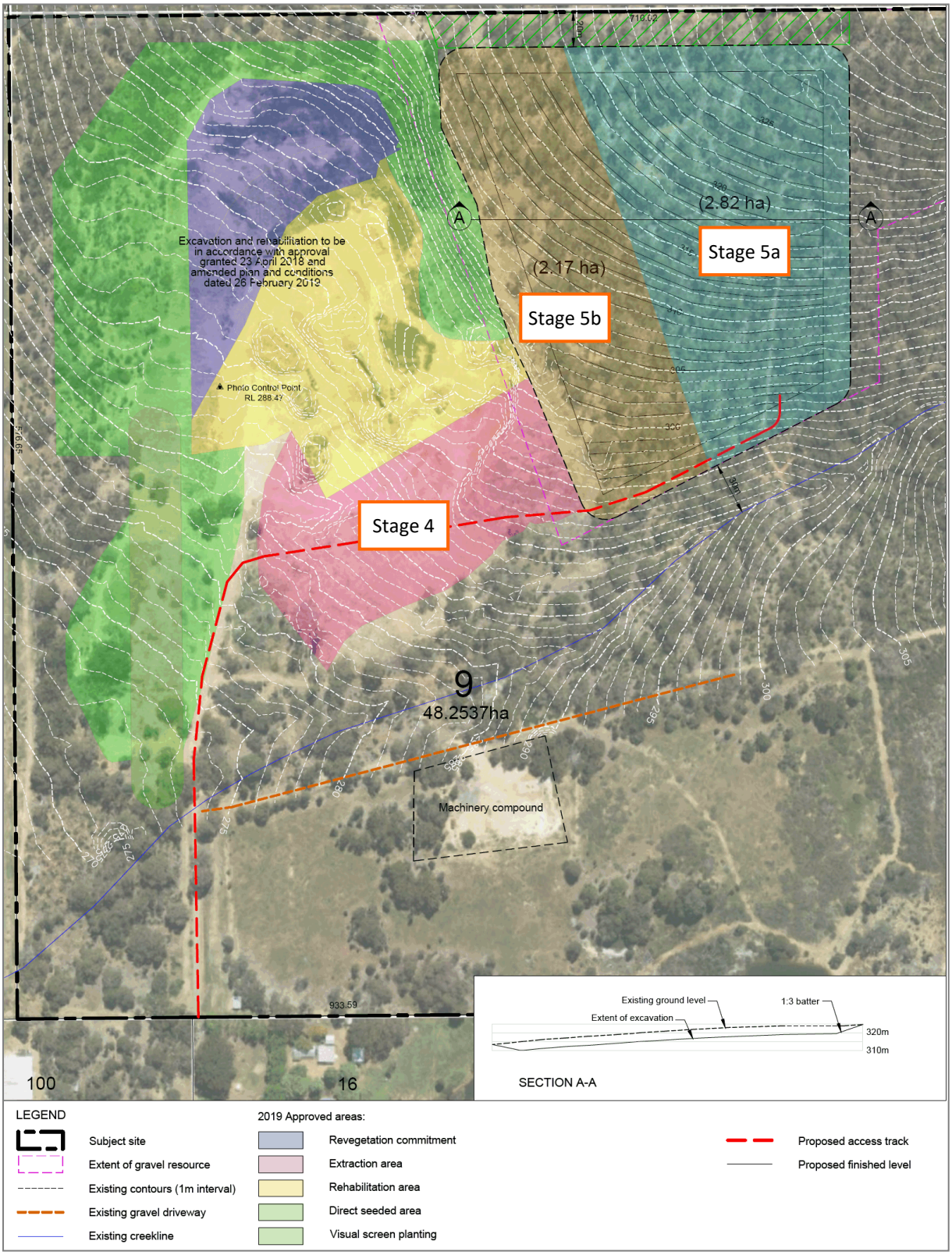


Figure 1-2 Proposed Gravel Pit Stage 5 Expansion

2 CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of –

i. tonality;

ii. impulsiveness; and

iii. modulation,

when assessed under regulation 9"

A "…noise emission is taken to significantly contribute to a level of noise if the noise emission … exceeds a value which is 5 dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard prescribed under regulation 7 after the adjustments of *Table 2-1* are made to the noise emission as measured at the point of reception.

Table 2-1 Adjustments Where Characteristics Cannot Be Removed

Where Noise Emission is Not Music			Where Noise Emission is Music	
Tonality	Modulation	Impulsiveness	No Impulsiveness	Impulsiveness
+ 5 dB	+ 5 dB	+ 10 dB	+ 10 dB	+ 15 dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in *Table 2-2*.

Table 2-2 Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial	All hours	60	75	80
Industrial	All hours	65	80	90

1. ***highly sensitive area*** means that area (if any) of noise sensitive premises comprising —
   (a) a building, or a part of a building, on the premises that is used for a noise sensitive purpose; and
   (b) any other part of the premises within 15 metres of that building or that part of the building.

The influencing factor is calculated from the percentage of commercial and industrial land, major roads and secondary roads within a 450m radius of a residence. For the noise sensitive receivers located close to the pit and therefore the most affected (Receivers A to E as shown in *Figure 2-1*), the influencing factors are determined by the percentage of industrial land (the gravel pit) contained within a 450m radius.

It is noted the development of Stage 5 was considered in the calculation of the influencing factor, however this does not result in a significant change. The influencing factors and resulting assigned levels for the pit operating times are shown in *Table 2-3*.

Table 2-3 Daytime Assigned Levels (7.00am to 7.00pm Monday to Saturday)

Premises Receiving Noise	Percentage of Industrial Land within 450m Radius	Influencing Factor	Daytime Assigned Level (dB)		
			L_{A10}	L_{A1}	L_{Amax}
A	10%	1	**46**	56	66
B	20%	2	**47**	57	67
C	10%	1	**46**	56	66
D	20%	2	**47**	57	67
E	10%	1	**46**	56	66
All Other Receivers	0%	0	**45**	55	65

The above are relevant to the excavation operations noise emissions however, truck loading can occur at night-time i.e. from 6.00am, and the night-time assigned noise levels are 10 dB lower than those presented above.

It must be noted the assigned noise levels above apply outside the receiving premises and at a point at least 3 metres away from any substantial reflecting surfaces but within 15 metres from a house (not a shed).

It is noted the assigned noise levels are statistical levels and therefore the period over which they are determined is important. The Regulations define the Representative Assessment Period (RAP) as *a period of time of not less than 15 minutes, and not exceeding 4 hours*, which is determined by an *inspector* or *authorised person* to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission. An *inspector* or *authorised person* is a person appointed under Sections 87 & 88 of the *Environmental Protection Act 1986* and include Local Government Environmental Health Officers and Officers from the Department of Environment Regulation. Acoustic consultants or other environmental consultants are not appointed as an *inspector* or *authorised person*. Therefore, whilst this assessment is based on a 4 hour RAP, which is assumed to be appropriate given the nature of the operations, this is to be used for guidance only.

2.1 Rehabilitation Works

Under regulation 13, rehabilitation works are considered 'construction noise' for which the assigned noise levels do not apply.

However, construction noise must comply with regulation 13, which states the following:

Regulation 7 does not apply to … construction work carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises … shows that –

a) The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b) The equipment used on the premises was the quietest reasonably available; and

c) *If the occupier was required to prepare a noise management plan … in respect of the construction site –*

   i. *The noise management plan was prepared and given in accordance with the requirement, and approved by the Chief Executive Officer; and*

   ii. *The construction work was carried out in accordance with the management plan.*

Regulation 7 does not apply to … construction work carried out other than between the [above] hours if the occupier of the premises … shows that –

a) *The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;*

b) *The equipment used on the premises was the quietest reasonably available;*

c) *The construction work was carried out in accordance with a noise management plan in respect of the construction site –*

   i. *Prepared and given to the Chief Executive Officer not later than 7 days before the construction work commenced; and*

   ii. *Approved by the Chief Executive Officer;*

d) *At least 24 hours before the construction work commenced, the occupier of the construction site gave written notice of the proposed construction work to the occupiers of all premises at which noise emissions received were likely to fail to comply with the standard prescribed under regulation 7; and*

e) *It was reasonably necessary for the construction work to be carried out at that time.*

3 METHODOLOGY

Computer modelling has been used to predict noise levels at each nearby receiver. The software used was *SoundPLAN 8.2* with the CONCAWE (ISO 17534-3 improved method) algorithms selected. These algorithms have been selected as they include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

3.1 Meteorological Information

Meteorological information utilised is provided in *Table 3-1* and is considered to represent worst-case conditions for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

Table 3-1 Modelling Meteorological Conditions

Parameter	Night (1900-0700)	Day (0700-1900)
Temperature (°C)	15	20
Humidity (%)	50	50
Wind Speed (m/s)	3	4
Wind Direction*	All	All
Pasquil Stability Factor	F	E

* Note that the modelling package used allows for all wind directions to be modelled simultaneously.

It is generally considered that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the above conditions occur for more than 2% of the time and therefore must be satisfied.

3.2 Topographical Data

Topographical data was based on site survey data provided by the project team. The contours are in 1 metre intervals and cover the noise sensitive premises of concern as well as the existing pit area.

The new excavation areas were then added manually with a pit depth of 4 metres.

3.3 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 0.5 has been used for the pits and 1.0 elsewhere.

3.4 Source Sound Levels

The sound power levels used in the modelling are provided in *Table 3-2*.

Table 3-2 Source Sound Power Levels, dB

Description	Octave Band Centre Frequency (Hz)								Overall dB(A)
	63	125	250	500	1k	2k	4k	8k	
CAT D9 Dozer*	110	115	113	104	105	101	96	88	**110**
Front-end Loader	105	109	104	106	106	102	97	94	**110**
Excavator	101	99	96	94	94	91	86	78	**98**
Truck moving at 25 km/h	104	103	101	97	95	90	86	77	**100**
Rock Breaker*	116	113	108	110	110	110	106	101	**116**
Mobile Jaw Crusher	104	116	113	111	108	105	99	93	**113**

* Denotes plant that were measured manually on site. Other plant is based on file data.

3.5 Operating Scenarios

It is our understanding that due to the number of personnel on site, the operation of the pit generally only allows for two items of plant to be in operation at any one time. Therefore, the following scenarios were determined as critical scenarios in terms of noise impact:

Scenario 1 Stage 5a excavation with the Rock Breaker and Dozer operating in the pit and behind the pit face.

Scenario 2 Stage 5b excavation with the Rock Breaker and Dozer operating in the pit and behind the pit face.

Scenario 3 Crushing – crusher in operations in either Stage 5a or Stage 5b with loader feeding crusher from behind a 4 metre high stockpile minimum.

Scenario 4 Truck Loading – Assumes trucks enter site and travel to the loading area within Stage 5a at an average speed of 25 km/hr. One front end loader is used to load product into trucks. The loader was modelled as operating from behind the stockpile, taken to be at least 4 metres high and located within Stage 5a pit (refer *Figure 4-1*).

The noise level predictions also assume that the pit will be mined from the northeast heading to the southwest as shown in *Figure 3-1*.

Managing the mining this way would ensure that the pit face provides a noise barrier to the houses located to the south and west of the pit. It is assumed that a pit face (southwest and southeast) at least 4m high will be maintained at all times.

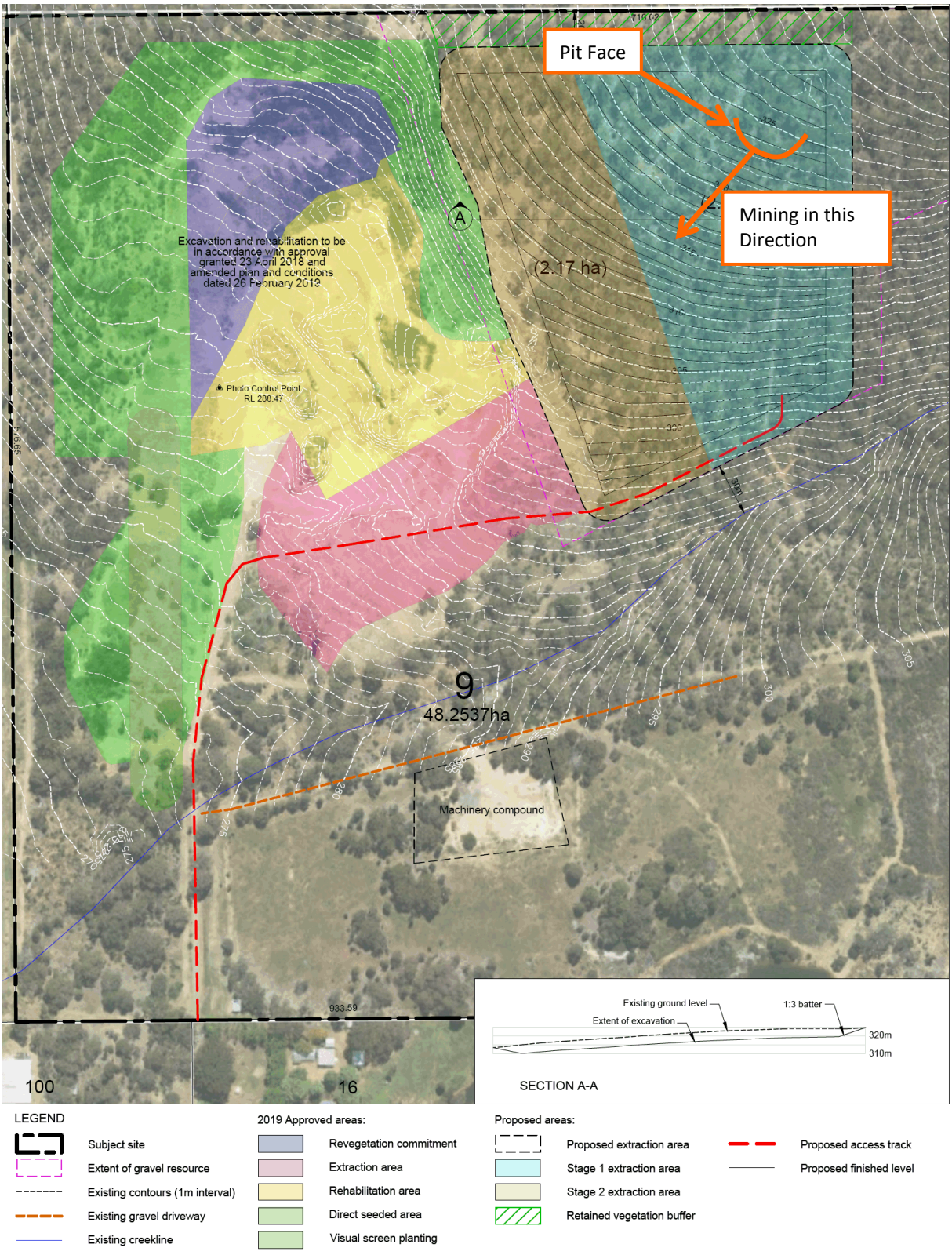


Figure 3-1 Assumed Mining Operations

4 RESULTS

4.1 Excavation and Crushing

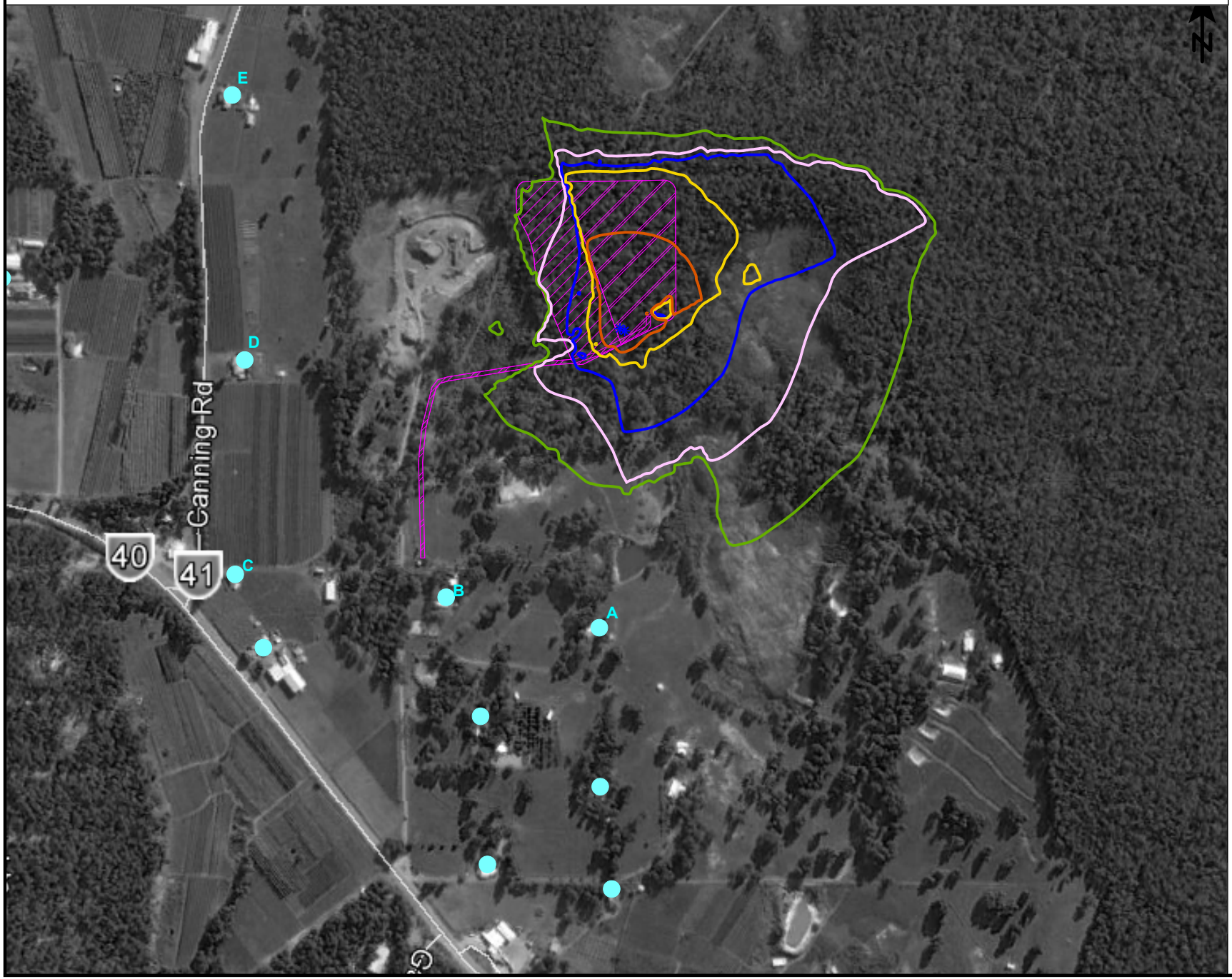
The predicted noise levels for the scenario described in *Section 3-5* are shown as noise contour maps in *Figure 4-2* to *Figure 4-4*, with *Table 4-1* providing the predicted noise level at each of the critical receivers. The predictions assume that the mining operations are at the closest point to sensitive receivers located to the south and west of the pit.

Table 4-1 Excavation and Crushing Operations Results

Premises Receiving Noise	Predicted Level (dB) L_{A10}				Assigned Noise Level, dB L_{A10}
	Stage 5a Excavation	Stage 5b Excavation	Stage 5a Crushing	Stage 5b Crushing	
A	40	39	38	35	**46**
B	35	37	35	34	**47**
C	32	33	31	31	**46**
D	34	37	35	35	**47**
E	31	26	26	29	**46**
All Others*	35	34	33	31	**45**

*Worst case receiver level shown

Figure 4-1 Scenario 1 Stage 5a Excavation Noise Levels, dB L_{A10}



Predicted Noise level

	= 45
	= 50
	= 55
	= 60
	= 65

Legend

- Receiver
- Stages 5a and 5b
- Point source

Scale 1:8000

0 50 100 200 300 m

Project No: 20115962
Consultant: OM
Date: 24-March-2021
Algorithm: ISO 9613
SoundPLAN Version: 8.2

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PO Box 717
HILLARYS WA 6923
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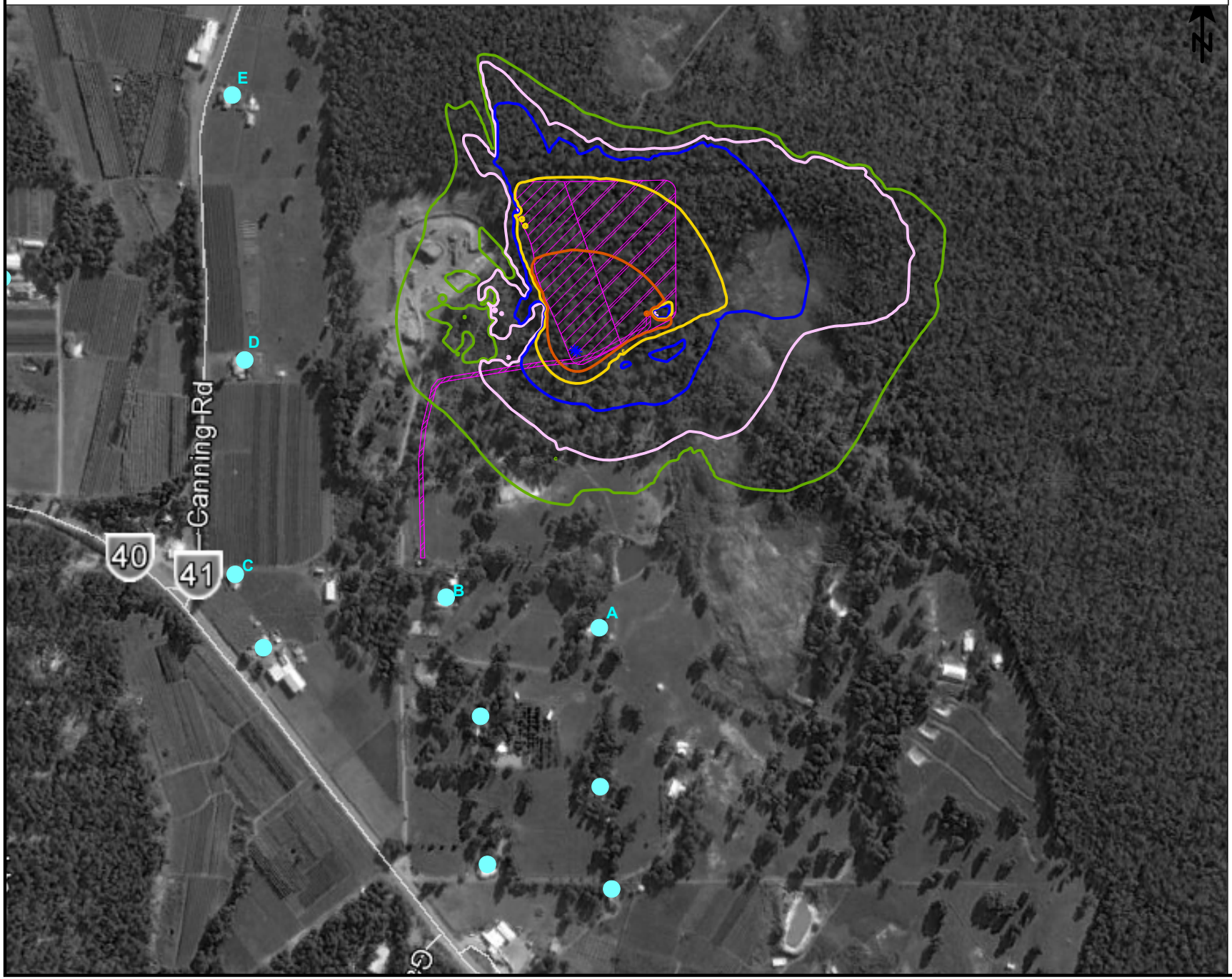
Figure 4-2 Scenario 2 Stage 5b Excavation Noise Levels, dB L_{A10}



Predicted Noise level

	= 45
	= 50
	= 55
	= 60
	= 65

Legend

- Receiver
- Stages 5a and 5b
- Point source

Scale 1:8000

0 50 100 200 300 m

Project No: 20115962
Consultant: OM
Date: 24-March-2021
Algorithm: ISO 9613
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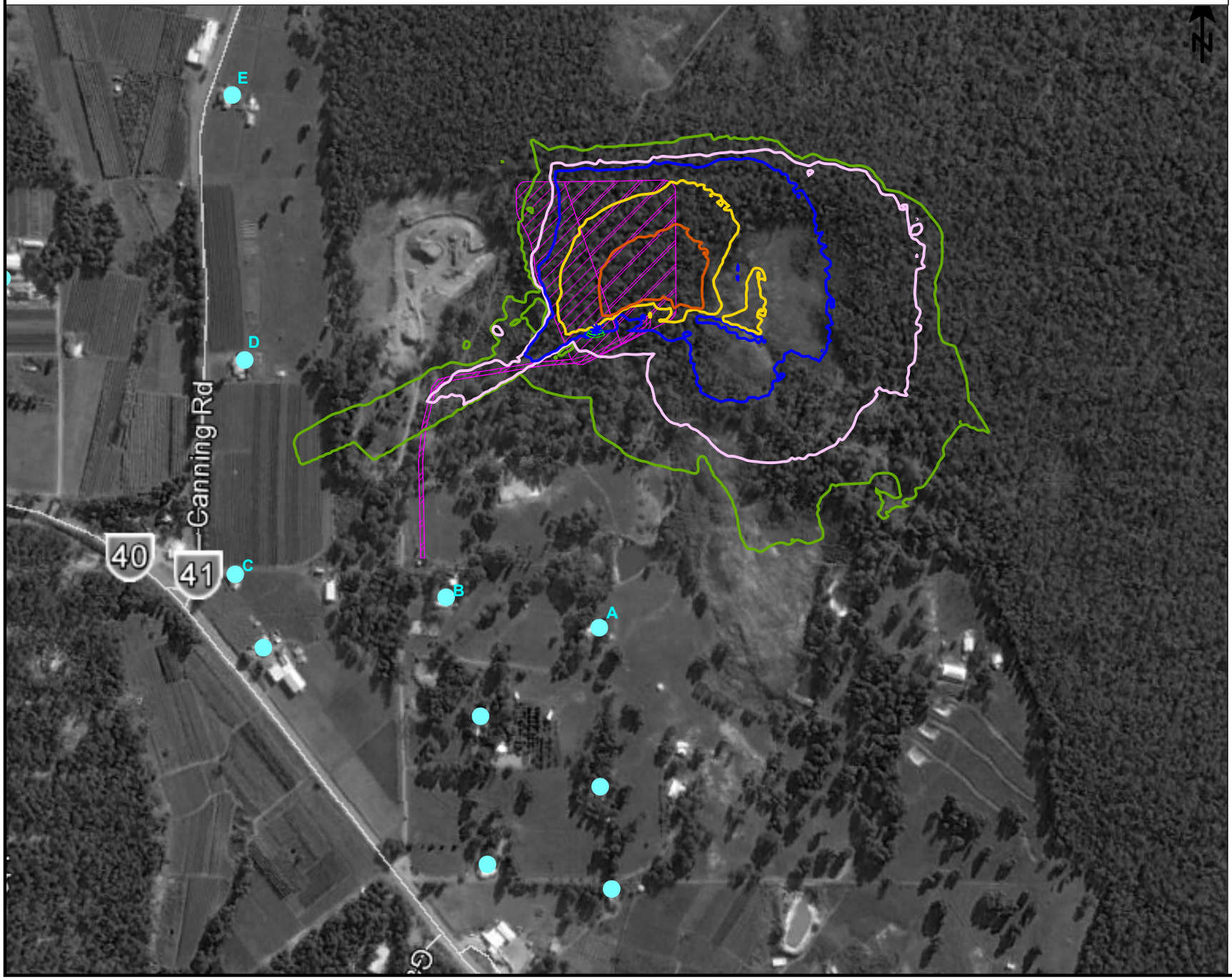
Figure 4-3 Scenario 3 Stage 5a Crushing Noise Levels, dB L_{A10}



Predicted Noise level

	= 45
	= 50
	= 55
	= 60
	= 65

Legend

- Receiver
- Stages 5a and 5b
- Stockpile
- Point source

Scale 1:8000

0 50 100 200 300 m

Project No: 20115962
Consultant: OM
Date: 24-March-2021
Algorithm: ISO 9613
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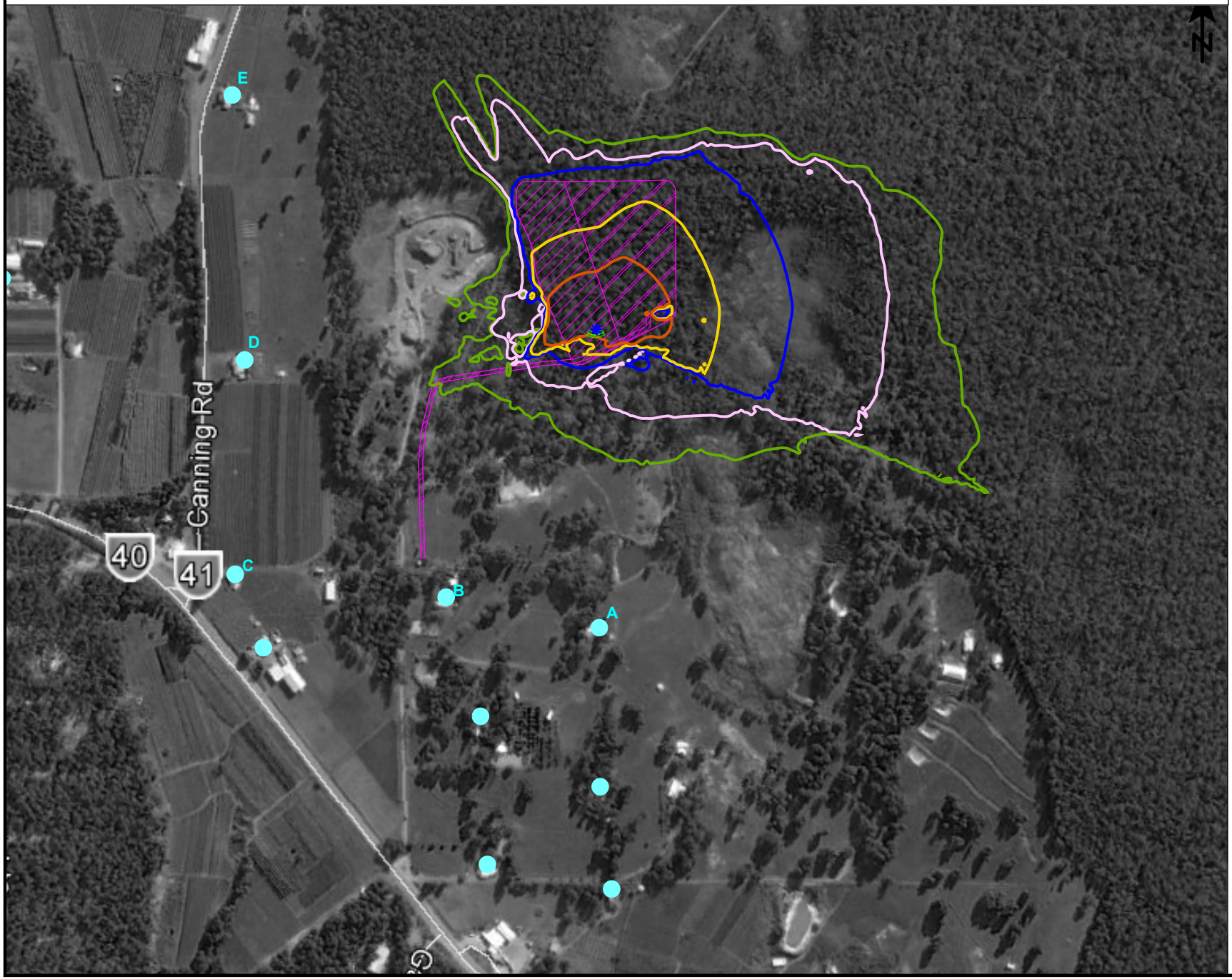
Figure 4-4 Scenario 3 Stage 5b Crushing Noise Levels, dB L_{A10}



Predicted Noise level

- = 45
- = 50
- = 55
- = 60
- = 65

Legend

- Receiver
- Stages 5a and 5b
- Stockpile
- Point source

Scale 1:8000

0 50 100 200 300 m

Project No: 20115962
Consultant: OM
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SoundPLAN Version: 8.2

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4.2 Truck Movements and Product Loading

It must be noted that the noise model can only accommodate stationary noise sources. As such, to determine the noise levels from trucks travelling on site along the route shown on *Figure 4-5*, a series of point sources are placed in the noise model on the assumed path of travel. The noise level from these individual point sources is then plotted against time for each receiver so that the various noise parameters (L_{A10} or L_{A1}) were calculated within a spreadsheet based on the following assumptions:

- Five trucks per hour between 6.00am and 7.00am,
- Average truck speed on site is 25 km/hr, and
- Truck idling noise is significantly less than the loader noise.

An example time history plot for Stage 5a is provided in *Figure 4-6* at receiver B over the first 30 minutes, showing the noise levels of the truck driving in, being loaded (noise from loader only) and the truck then leaving the site.

Because of this modelling methodology, the results are presented in tabular format as single point calculations in *Table 4-2*, since noise contour plots cannot be provided for a moving point source scenario. *Table 4-2* also shows the noise contribution from the loader in brackets i.e. truck is idling or with engine turned off during loading.

Table 4-2 Truck Movements and Loading Results

Premises Receiving Noise	Predicted Noise Levels		Assigned Noise Level, dB L_{A10}
	Stage 5a	Stage 5b	
A	35 (34)	35 (34)	**36**
B	38 (31)	38 (32)	**37**
C	35 (28)	35 (28)	**36**
D	37 (32)	37 (33)	**37**
E	24 (24)	24 (19)	**36**
All Others*	33 (28)	33 (28)	**35**

*Worst case receiver level shown

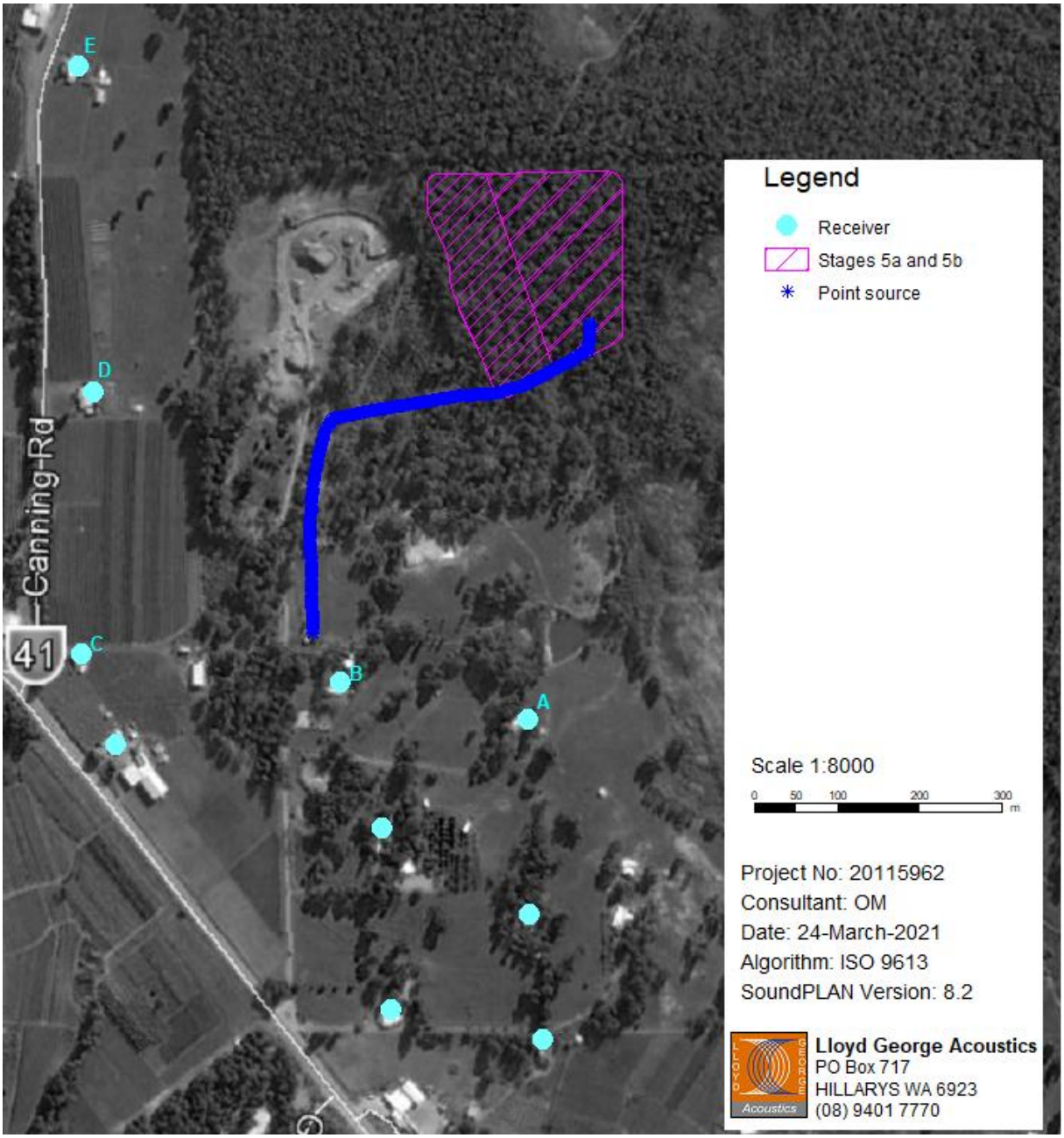


Figure 4-5 Stage 5a Truck Route in Blue

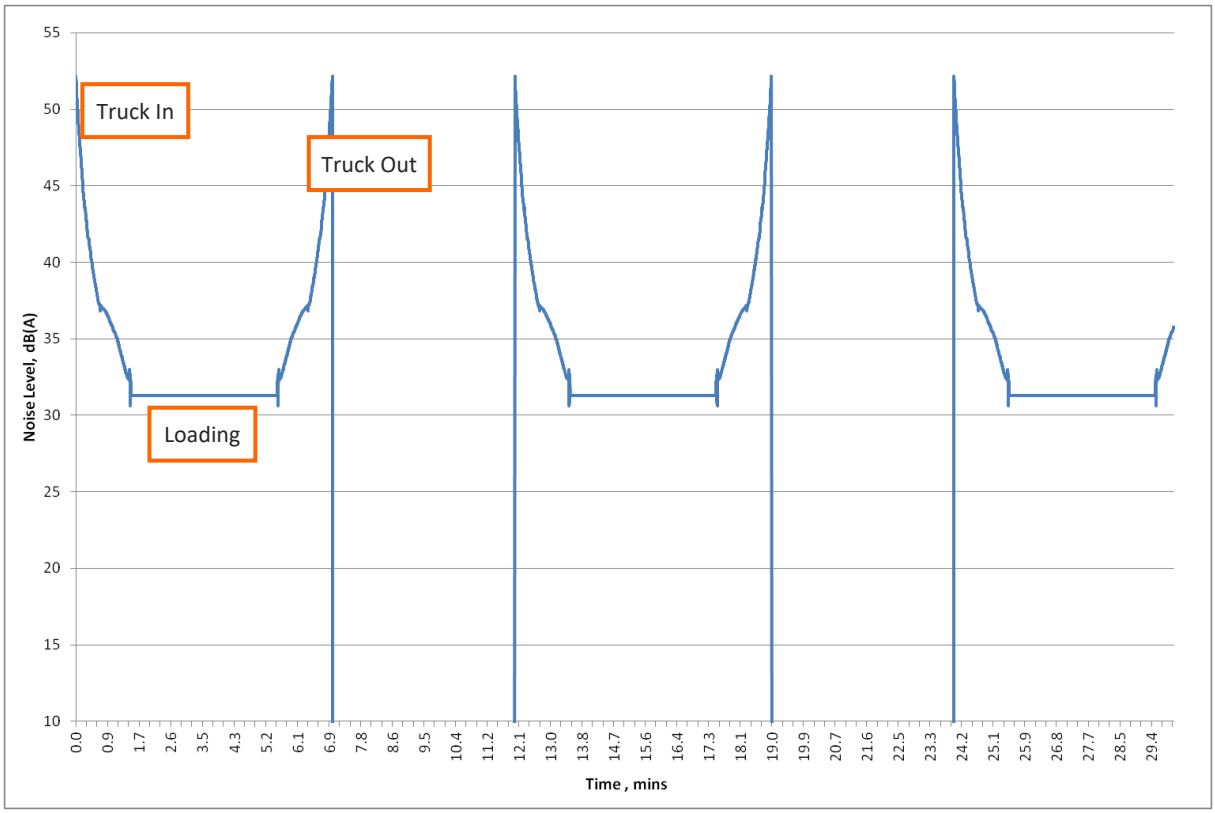


Figure 4-6 Stage 5a Time History Plot of Truck Movement at Receiver B

5 ASSESSMENT

The results presented in *Figure 4-1* to *Figure 4-4* and *Table 4-1* show that the noise levels under worst-case meteorological conditions are predicted to comply with the daytime L_{A10} assigned levels at all noise sensitive receivers.

While it is considered the daytime background noise levels in this area would be sufficiently high to mask any tonal noise characteristics associated with the pit operations, if it were found to be present then a +5 dB penalty would need to be applied as indicated in *Table 2-1*. However, the predicted noise levels would still comply with the daytime assigned levels even with this penalty applied. It is not expected that the noise from the pit would exhibit either impulsive or modulating noise characteristics, particularly considering the distance from the operations to the sensitive receivers and the high background noise levels under worst-case meteorological conditions. Note that the predictions are based on the assumption that plant will be operating at all times in the closest position to residences to the south and west and from behind a 4m high face.

With regard to the night-time loading of trucks, the noise emissions from the truck driving on site are not considered to be tonal based on measurements undertaken on site (report reference 13102581-02). Therefore, the truck noise level is predicted to comply at all receivers with the exception of receiver B, where a marginal 1 dB exceedence is predicted. However, this assumes worst-case meteorological conditions and that the wind is always blowing from source to receiver, which is conservative. Nonetheless, it is noted that reducing the truck numbers to 4 trucks per hour is predicted to reduce noise levels to compliance under worst-case meteorological conditions.

When loading, the loader noise could be tonal under worst-case conditions given that background noise levels are generally lower at night. If tonality was found to be present and a +5 dB penalty was added, then exceedances would be predicted at receivers A and D. In this case, the loader would need to operate from behind stockpiles at least 5 metres high to achieve compliance.

It is also noted that all rehabilitation works on site will be considered 'construction work' under Regulation 13, and were therefore not specifically assessed.

Finally, it is noted that Stage 5 operations are further away from the receivers than Stage 4, which have been successfully managed to date. As such, all ongoing control measures to reduce the noise impacts to nearby residences should be continued. These include regular maintenance of plant and ensuring any acoustic enclosures or covers fitted to plant are in use at all times.

Appendix A

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

Sound Power Level (L_w)
Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

Sound Pressure Level (L_p)
The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

L_{ASlow}
This is the noise level in decibels, obtained using the A frequency weighting and the S (Slow) time weighting as specified in IEC 61672-1:2002. Unless assessing modulation, all measurements use the slow time weighting characteristic.

L_{AFast}
This is the noise level in decibels, obtained using the A frequency weighting and the F (Fast) time weighting as specified in IEC 61672-1:2002. This is used when assessing the presence of modulation only.

L_{APeak}
This is the greatest absolute instantaneous sound pressure in decibels using the A frequency weighting as specified in IEC 61672-1:2002.

L_{Amax}
An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

L_{A1}
An L_{A1} level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{A10}
An L_{A10} level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{Aeq}
The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

L_{A90}
An L_{A90} level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

One-Third-Octave Band
Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

L_{Amax} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

L_{A1} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

L_{A10} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

Tonal Noise
A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

Modulating Noise
A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;

(b) is present for at least 10% of the representative.

Impulsive Noise
An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness is:

a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

Major Road
Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

Secondary / Minor Road
Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

Influencing Factor (IF)

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a 100m radius of the premises receiving the noise

$\%\ \text{Type A}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a 100m radius of the premises receiving the noise

$\%\ \text{Type B}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

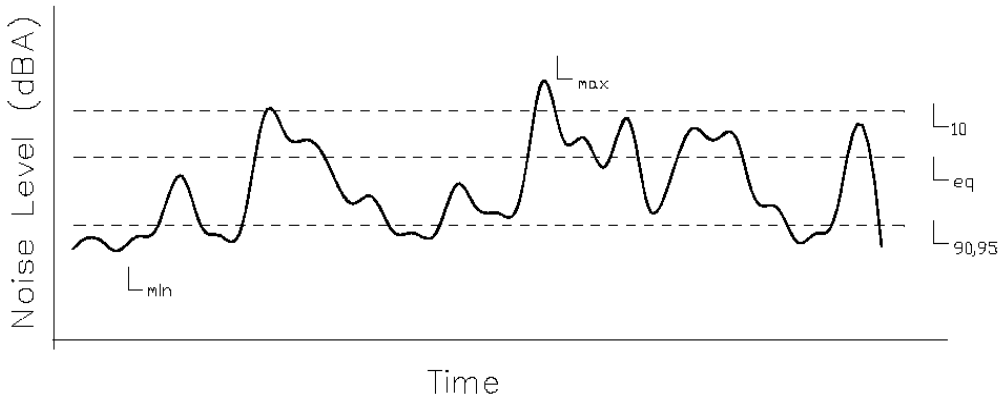
Representative Assessment Period
Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

Background Noise
Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

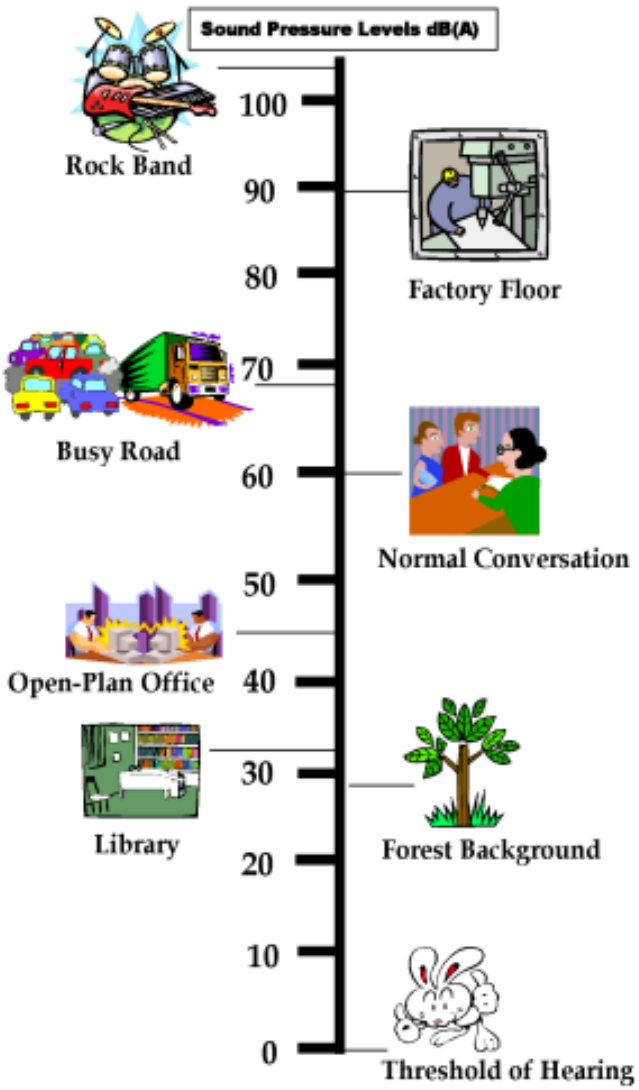
Ambient Noise
Means the level of noise from all sources, including background noise from near and far and the source of interest.

Specific Noise
Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

Chart of Noise Level Descriptors



Typical Noise Levels



Appendix E

Visual Impact Assessment, Lot 9 Brookton Highway, Karragullen Gravel Quarry Expansion (Emerge Associates 2021c)

Visual Impact Assessment

Lot 9 Brookton Highway, Karragullen

Project No: EP20-040

Prepared for Vinci Gravel Supplies Pty Ltd
May 2021

Document Control

Doc name:	Visual Impact Assessment Lot 9 Brookton Highway, Karragullen				
Doc no.:	**EP20-040(12)--007a BRB**				
Version	**Date**	**Author**		**Reviewer**	
1	May 2021	Bianca Bertelli	BRB	Emma Carr	EC
				Kirsten Knox	KK
	Report issued for client comment.				
A	May 2021	Kirsten Knox	KK	Kirsten Knox	KK
	Minor updates following client review.				

Executive Summary

Vinci Gravel Supplies Pty Ltd (the proponent) proposes to expand their existing gravel quarry at Lot 9 Brookton Highway, Karragullen (herein referred to as 'the site'). The site is 48.23 hectares (ha) in size and is located within the City of Armadale (CoA) municipality, 15 kilometres (km) east of Armadale Town Centre.

The CoA has previously granted approval for stages 1 to 4 of the gravel extraction and processing quarry, and the proponent is now seeking development approval (DA) and an Extractive Industry License (EIL) for a further expansion of the quarry, hereafter referred to as 'stage 5'. Stage 5 extends over 5 ha in total, divided into stage 5a (3.14 ha) and stage 5b (1.86 ha) located adjacent to the existing approved stage 4 to the west.

The site is currently zoned 'Rural' under the Metropolitan Region Scheme (MRS) and 'General Rural' under the CoA *Town Planning Scheme* (TPS) *No. 4* and is bounded by broad acre rural landholdings zoned 'General Rural' to the north and south, Midgegooroo National Park and Korong National Park to the north and east, and Brookton Highway and Canning Road to the south and west. Several scenic tracks are located in close proximity to the site including Springdale Road to the north-west and the Munda Biddi Cycle Track to the east. The landscape character of the area is dominated by the rolling low hills, broad open pasture, orchard and plantation trees and mature remnant native trees. The skylines are generally hills clad in woodland intersected by houses, sheds and linear planted orchards that punctuate an open character.

This Visual Impact Assessment (VIA) has been prepared to determine the likely visual impact of the proposed quarry expansion on the existing views from the surrounding landscape. The assessment process further aims to provide broad design advice to assist the proponent in best managing any visual impact that may be determined.

The preparation of the VIA has been undertaken in accordance with the method outlined within the Western Australian Planning Commission (WAPC) *Visual Landscape Planning in Western Australia Manual* (WAPC 2007) (Visual Landscape Manual) with consideration of the state planning framework requirements. In addition to this, consultation has been undertaken throughout the design process with the CoA with provided recommendations and advice adopted within this VIA.

A landscape character assessment was undertaken on the site and general surrounds and identified the following:

- The site and general area are located within the Darling Plateau – Darling Uplands landscape character type (LCT) (as identified within the *Reading the Remote: Landscape Characters of Western Australia* (Reading the Remote) (CALM et al 1994)). The site is located within rolling low hills dissected by deeply eroded, steep-sided valleys and studded with granite outcrops and boulders which protrude from the landscape. Vegetation is dominated by jarrah, marri and banksia forest, interspersed with areas of cleared pastoral and farming land and heath and herblands occurring on the rough granite outcrops.

- At a more local level, two landscape character units (LCU) are identified within the site and surrounds, as outlined below:
  - Natural LCU, large areas of intact remnant vegetation appearing along roadsides and associated with Midgegooroo National Park and Korong National Park with low visual penetration through undisturbed forests.
  - Rural LCU, including features such as rolling hills of cleared paddocks used for agricultural and fruit orchard purposes and existing buildings.

The overall management objective of the VIA is to ensure that stage 5 is designed and implemented in such a way that the existing landscape character at both the regional level (i.e. LCT in accordance with (Reading the Remote) (CALM et al 1994)) and local level (i.e. LCU in accordance with the Visual Landscape Manual (WAPC 2007) is protected and maintained.

To ensure the proposed quarry expansion does not detract from the scenic quality of the land and achieve the visual landscape objectives, management/mitigation measures have been recommended for stage 5, and include:

- Retention of a total of 35.55 ha native vegetation within the higher areas of the site to keep a naturally appearing vegetated backdrop, limiting the existing vegetated horizon line associated with the Korong and Midgegooroo National Parks being broken.
- The quarry expansion and operation areas being located a minimum 20 m from the northern and western boundaries of the site to allow for screening of the quarry, particularly Brookton Highway to the south-west.
- Staging excavation activities, beginning at the easternmost extent of the expansion. This enables vegetation associated with stage 5b, which is located closest to Brookton Highway, to remain during the stage 5a excavation activities and provide screening.
- Large visually prominent machinery such as the front-end loader used to load product into trucks and the gravel screener will operate from behind the 4 m high pit face which will be maintained at all times during activities.
- Ongoing rehabilitation works following the completion of each extraction stage whereby topsoil is replaced onto the previously excavated stage. This will allow blending of the bare orange-coloured post-mined pits by overlaying topsoil directly after pit closure that is darker in tone, reducing the overall visibility of the excavated areas.
- Restoration and reinstatement of the expansion site will be undertaken progressively upon the completion of each extraction stage. Upon pit closure, the landform will be returned to a gently sloping surface in alignment with the existing upland topography.
- Undertaking revegetation activities to enrich the local landscape and to mitigate the visual impacts associated with stage 5. This is proposed to include:
  - Planting of a visual screening strip to the west of the internal haul road with clusters of up to two (2) to three (3) trees species (proposed to be a mixture of native *Eucalyptus wandoo Eucalyptus patens, Eucalyptus lane-poolei, Eucalyptus laeliae and Corymbia calophylla*, determined based on existing vegetation within the site and surrounds) in a linear arrangement with a native understory for low visual penetration. At approximately 12 years maturity, this vegetation is expected to block views of the quarry expansion from the Canning Road and Brookton Highway users in the near views.

- Previously excavated portions of the site extending over 8.19 ha (existing approved quarry stages) will be revegetated via infill planting and direct seeding of local native species to align with existing natural vegetation within the surrounding National Parks. This incorporates the 4.9 ha conditioned under Clearing Permit Approval 8273-1. The remaining 3.29 ha comprises additional revegetation areas (i.e not already required as part of previous approvals) to counterbalance the residual impact of the stage 5 expansion site. In the short to medium term (6-9 years), this planting will blend with the existing remnant native vegetation to the north and east and will break up views of the quarry for Canning Road and Brookton Highway users in the distant views.
- Stage 5a and 5b extraction areas will be progressively revegetated on a yearly basis via direct seeding of local native species to align with surrounding native vegetation.

The desktop and site assessment identified that the existing quarry is visible and that stage 5 (particularly stage 5b) may be visible at times by users driving along Brookton Highway in an easterly direction (depending on location) when climbing a soft ridgeline in front of the site. In particular, at one location from Ferguson Road (Viewpoint 10) and two locations along Brookton Highway (Viewpoints 12 and 13), where the height of the viewer and clearing of vegetation for agricultural land uses over the ridgeline in the foreground and middle grounds enabled glimpses of the existing open quarry pit within the site. Stage 5 will not be visible from Brookton Highway to users south of the site and Canning Road users to the north of the site, due to the presence of dense vegetation within landholdings and road reserves (in addition to vegetation retained within the site). Due to a valley landform and the height and form of existing vegetation, stage 5 will not be visible from the scenic Munda Biddi Cycle track to the east of the site, Springdale Road walking trail and vehicle access tracks to the north west of the site.

The assessment of the proposed management measures, as shown within the cross-sections and photomontages, indicates that there will be short-to-medium term visual impacts associated with the stage 5 quarry expansion area, however staging of works (and starting at the easternmost point) will reduce the prominence of the quarry for the time it takes to complete stage 5a, while progressive topsoil application and rehabilitation will reduce the prominence of stage 5b. Rehabilitation/planting associated with Zone 1 and Zone 2 will be beneficial for mid-to-distant views, while rehabilitation of stage 5a will help minimise impacts for near views as stage 5b is being progressed. In general, the visual impact of the proposed stage 5 expansion will be synonymous with openings of a natural appearance associated with wetlands, granite outcrops and cleared paddocks, through the progressive rehabilitation of previously excavated stages.

Based on the existing landform and vegetation and proposed management measures, the existing visual quality of both the rural and natural landscape character units can be maintained and protected in the long-term and short-to-medium term impacts can be minimised, achieving the objectives determined for this VIA.

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Table of Contents

List of Tables

List of Plates

Figures

Appendices

Abbreviation Tables

Table A1: Abbreviations – General terms

General terms	
DA	Development application
EIL	Extractive Industry License
LCT	Landscape character type
LCU	Landscape character unit
LPS	Local Planning Strategy
TPS	Town Planning Scheme
VIA	Visual impact assessment

Table A2: Abbreviations – Organisations

Organisations	
DBCA	Department of Biodiversity Conservation and Attractions
CoA	City of Armadale
DWER	Department of Water and Environmental Regulation
DPLH	Department of Planning Lands and Heritage
WAPC	Western Australian Planning Commission

Table A3: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m^2	square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

Table A4: Key definitions

Key definitions	
Cross-section	Vertical profiles through a portion of the landscape. Cross-sections help to illustrate the relationship between landform and other landscape characteristics such as vegetation cover and land use.
Original photomontage	Technique of selecting, editing and piecing together a sequence of photos from a particular point to form a continuous whole.
Photomontage (3D perspective)	Computer simulated images of a proposed development using the original photomontage as a base, to assess changes to the visual landscape.
Viewshed or seen area analysis	The land visible from a point or a series of points. Viewshed analysis identifies an area of landscape that would be visible assuming no vegetation cover or built structures, based on the height of the stage 5 quarry extent (pit wall) compared to the existing landform.

1 Introduction

1.1 Background

Vinci Gravel Supplies Pty Ltd (the proponent) intends to expand an existing gravel quarry within Lot 9 Brookton Highway in Karragullen (referred to as the 'site'), as shown in **Figure 1**. The site is approximately 48.23 hectares (ha) in size and is located within the City of Armadale (CoA) municipality, approximately 15 kilometres (km) east of Armadale Town Centre.

The CoA has previously granted conditional approval for stages 1 to 4 of the gravel extraction and processing quarry, and the proponent is now seeking development approval (DA) and an Extractive Industry License (EIL) for a further expansion of the quarry, hereafter referred to as 'stage 5'. Stage 5 extends over 5 ha in total, divided into stage 5a (3.14 ha) and stage 5b (1.86 ha) located adjacent to stage 4 to the west, and is shown in **Figure 1**. The pit will be mined in an east to west direction with ongoing rehabilitation works undertaken progressively within completed cells. The proposed staging and development plan is provided in **Appendix A,** and shows the stage 5a and 5b excavation pits, internal haul road, vehicle/machinery compound, revegetation zones and visual screening areas.

The site is currently zoned 'Rural' under the Metropolitan Region Scheme (MRS) and 'General Rural' under the City of Armadale Town Planning Scheme (TPS) No. 4 and is bounded by broad acre rural landholdings zoned 'General Rural' to the north and south, Midgegooroo National Park and Korong National Park to the north and east, and Brookton Highway and Canning Road to the south and west respectively. Several scenic tracks are located in close proximity to the site including Springdale Road to the north-west and the Munda Biddi Cycle track to the east.

As a component on the DA and EIL processes, the proponent has held discussions with the CoA with regards to visual impact concerns. In particular, CoA have raised concerns about the potential detrimental impact of the development on the landscape views from Brookton Highway and Canning Road, as well as adjacent rural residential landowners.

1.2 Purpose of this report

The CoA have asked the proponent to demonstrate that there will be no adverse amenity impacts on nearby land uses.

The aim of this visual impact assessment (VIA) report is to obtain, review, measure and determine the likely visual impact of the stage 5 quarry expansion on the existing views from the surrounding landscape, with particular consideration of surrounding rural residential dwellings, Brookton Highway and Canning Road. The assessment also aims to provide design advice to assist the proponent in best managing any visual impact that may be determined. Specifically, this report:

- Identifies and maps the proposed quarry design (**Section 2**).
- Identifies the existing visual landscape characteristics of the site and surrounds (prior to any works) and visual landscape objectives (**Section 3**).
- Assesses the visual impact created by the proposed expansion, through viewshed analysis and site assessment (including photomontages) and identifies key views of the site (**Section 4**).
- Outlines visual design strategies for the stage 5 expansion (**Section 4.2**).
- Outlines the visual management measures that will be employed by as part of the stage 5 expansion to mitigate potential impacts, with cross-sections and 3D perspectives photomontages to demonstrate these measures (**Section 6**).

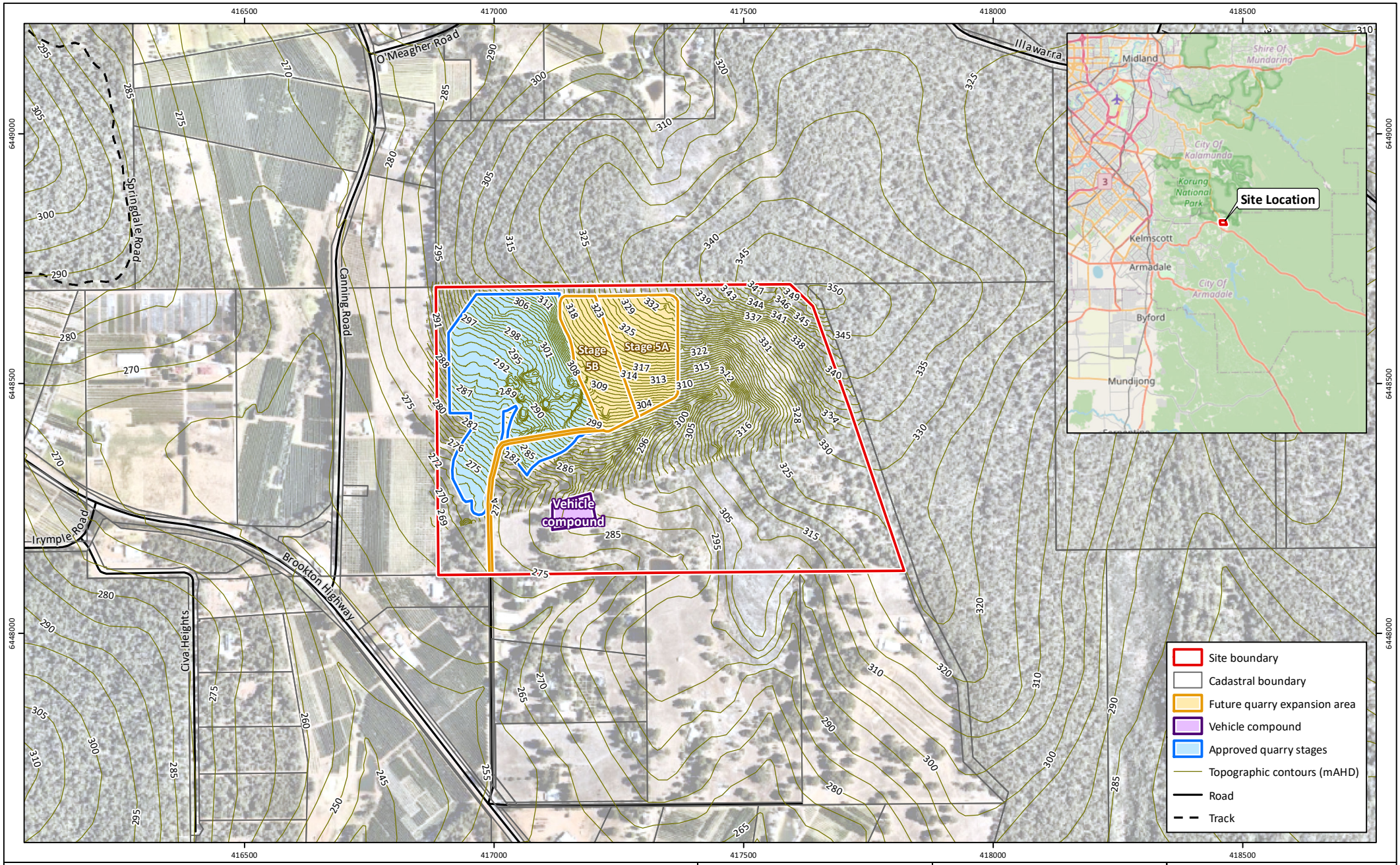

Figure 1: Site Location and Quarry Staging Plan

Project:	Visual Impact Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F24a

Drawn:	GAR
Date:	26/05/2021
Checked:	BRB
Approved:	KK
Date:	26/05/2021

N

0 100 200 300
Metres

Scale: 1:10,000@A4

GDA 1994 MGA Zone 50

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1.3 Applied method

The preparation of the VIA has been undertaken in accordance with the method outlined within the Western Australian Planning Commission (WAPC) *Visual Landscape Planning in Western Australia Manual* (WAPC 2007) (Visual Landscape Manual) with consideration of the state planning framework requirements. An outline of the visual landscape planning process is shown in **Plate 1**.

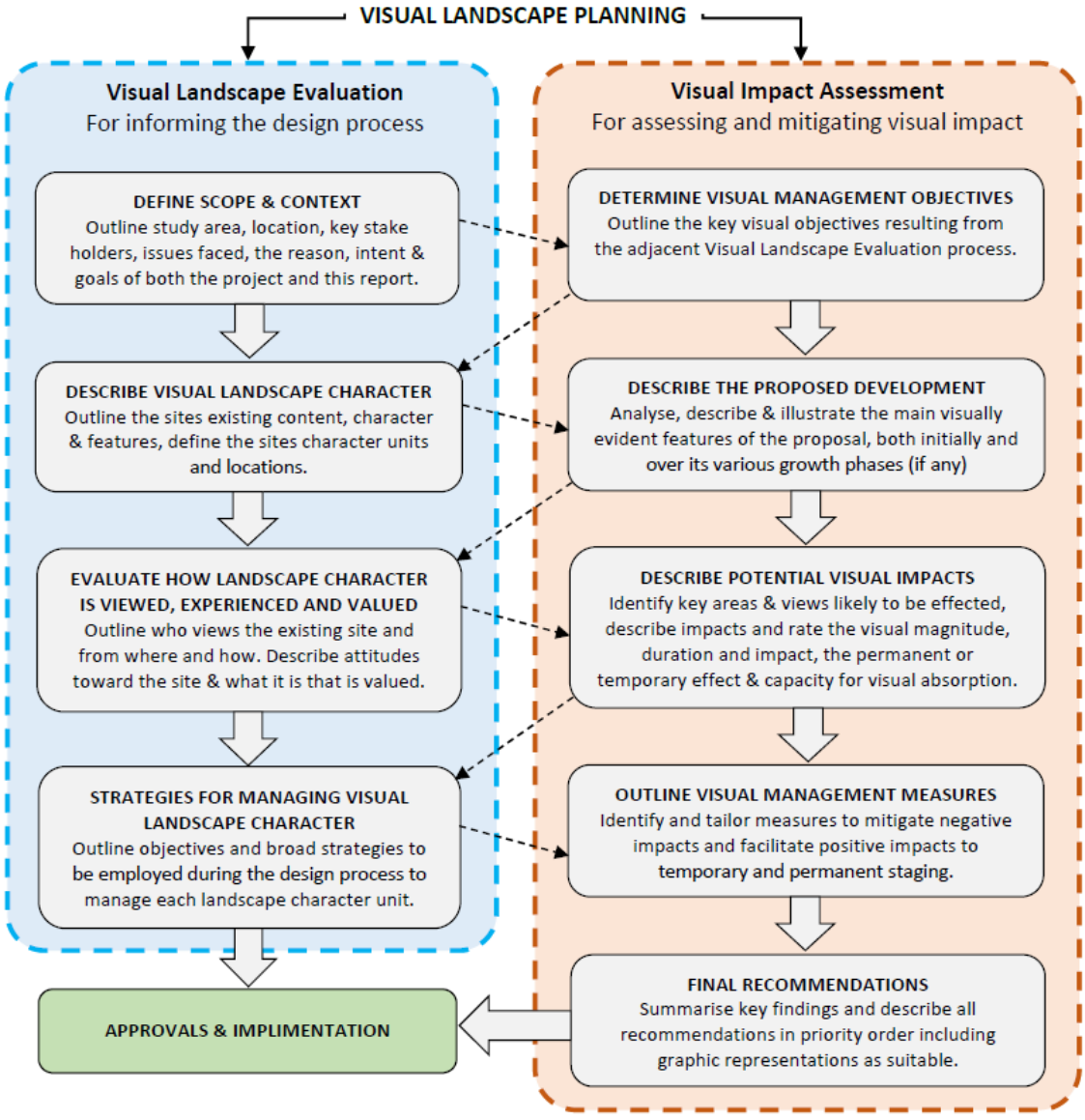

Plate 1: Visual landscape planning process as outlined within Visual Landscape Planning in Western Australia Manual (WAPC 2007)

1.4 Planning context

1.4.1 City of Armadale extractive industries license

The *City of Armadale Extractive Industries Local Law* (City of Armadale 2000) establishes the need for extractive industries to operate under a license. The CoA has previously issued EILs for stages 2 to 4 of the existing gravel quarry, subject to specific conditions. The proponent is currently preparing an EIL for approval by the CoA for stage 5 of the quarry.

1.4.2 City of Armadale development approval

Local and regional planning schemes provide guidance on what types of development and building activities require local government planning approval. Under the CoA TPS No. 4, activities involving the extraction of raw materials are to be addressed as part of a formal DA application. A summary of the planning approval's history for previous extraction phases within the site is provided in **Table 1**.

Table 1: Planning approvals history

Extractive stage	Date of Approval	CoA Reference	Details
Stage 1	28 October 2003	A117566: PRR	DA granted for proposed extractive industry renewal subject to conditions.
Stage 2	29 July 2014	PR5514; 10.2013.355.1	DA granted for expansion of existing extractive industry (gravel quarry) subject to conditions.
Stage 3	5 April 2016	PR5514; 10.2015.379.1	DA granted for expansion of industry – extractive (gravel) subject to conditions.
Stage 4	24 May 2018	PR5514; 10.2017.154.1	DA granted for industry extractive (gravel) – stage four extraction area subject to conditions. Conditions 2 & 4 subsequently revised 26 February 2019 through State Administrative Tribunal (SAT) review (DR148/2018).

The stage 5 quarry proposal will be subject to assessment and approval from the Western Australian Planning Commission (WAPC) through the DA process. The proponent has prepared or commissioned the following technical reports to support the stage 5 DA and EIL applications for the site:

- *Detailed Flora and Vegetation Survey - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021a)
- *Environmental Management Plan - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021b)
- *Level 1 Fauna Assessment - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2020b)
- *Targeted Black Cockatoo Habitat Assessment - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021c)
- *Acoustic Assessment - Lot 9 Brookton Highway, Karragullen* (Lloyd George Acoustics 2021)

1.4.3 City of Armadale Local Planning Strategy

The CoA has adopted the *City of Armadale Local Planning Strategy – Town Planning Scheme No. 4* (2016) (LPS) as a means to focus and guide development in accordance with TPS No. 4. The site is zoned 'General Rural' under CoA TPS 4 and within the LPS it is found within the 'Rural Hills Visual Landscape Strategy' area. Visual amenity is highlighted as a key issue within this strategy area, as summarised below:

- *The Armadale Hills helps define the sense of place and identity of the City and provides the wider regional community with a local tourist destination, recreational opportunities and visual and topographical relief from the more developed coastal plain areas of the Perth Metropolitan Area.*
- *The remaining rural areas of the Armadale Hills will be increasingly valued over time and also face greater development pressures with potential for negative impacts upon the visual landscape values.*
- *Future land capability and servicing assessments of land use and development proposals in the remaining rural hills areas will include special consideration of suitability of the specific site and particularly its impact on the visual landscape values of the surviving bushland and rural landscapes.*

1.4.4 Visual Landscape Planning in Western Australia

The *Visual Landscape Planning in Western Australia* (WAPC 2007) (Visual Landscape Manual) is a manual that has been developed to guide state agencies, local governments, developers and the community on techniques for incorporating visual landscape planning into the planning system. The manual explains fundamental planning tools of visual landscape evaluation and visual impact assessment (WAPC 2007). It provides guidelines for siting and design in relation to a range of landscape types and land uses, including development proposals. The methodology for this VIA follows the guidelines set out in the manual.

The Visual Landscape Manual outlines the main issues associated with a development/building located on important landscape features which should be considered in a proposal and include:

- Location and siting of development/building
- Development/building form and size
- Development/building height and roofline
- Materials and colour palette
- Screening/buffering of development/buildings
- Ancillary structures
- Consideration of roads and access drives
- Fencing and firebreaks.

1.4.5 Environmental Protection Act 1986

1.4.5.1 Part IV Environmental Protection Act 1986 (WA)

Part IV of the *Environmental Protection Act 1986* (EP Act) provides for the consideration of proposals that could result in a significant adverse impact on the environment. The proposed expansion will likely require referral to the Environmental Protection Authority (EPA) pursuant to Section 38 of the EP Act, on the basis that the proposal may impact on the following key environmental factors:

- Land – Flora and vegetation (the removal of intact native vegetation representative of the Yarragil Complex).
- Land – Terrestrial fauna (impacts to roosting, foraging and potential breeding habitat for the three species of threatened black cockatoo; CBC, FRTBC and BC (listed as endangered and vulnerable under the BC Act)).
- Water – Inland waters (e.g. uncontrolled runoff into Stinton Creek tributary and waterway management requirements).
- People – Social surroundings (visual amenity, dust and noise).

The proponent met with the Office of the EPA (OEPA) on 9 April 2021 to discuss the proposed expansion, specifically whether it is likely to warrant referral to the EPA under Part IV Section 38 of the EP Act to make the determination on whether it is a 'significant proposal'. The details discussed during the pre-referral meeting included: potential impacts, possible preliminary key environmental factors, stakeholder consultation, proposed management measures and possible assessment pathways, including possible level of assessment.

On review of the pre-referral information, the EPA did not raise any concerns with regards to the level of environmental investigations undertaken and the assessment of impacts to key environmental factors. It was considered likely that the proposed expansion can be adequately regulated through other state and federal environmental and planning approvals without the need for further regulation through Part IV Section 38 of the EP Act. The OEPA is interested in the outcome of the other environmental approvals including native vegetation clearing permit approval under Part V of the EP Act and approval under the EPBC Act given potential impacts on Matters of National Environmental Significance. In general, the OEPA noted no immediate concern to see a referral of the proposed expansion, particularly given there has been no previous community interest with the existing gravel extraction activities.

1.4.5.2 Part V Environmental Protection Act 1986 (WA)

A native vegetation clearing permit pursuant to Part V of the EP Act will be sought from the Department of Water and Environmental Regulation (DWER). It is noted that clearing permit ref. CPS 8273/1 (area permit) was previously granted by the DWER in June 2019 to facilitate the stage 4 quarry operations, and required the revegetation of approximately 4.9 ha of previously mined cells. Revegetation activities have commenced within previously disturbed portions of the site in accordance with CPS 8273/1, and infill planting and direct seeding will continue to occur at the densities required to reach the completion criteria, in accordance with the EMP (Emerge Associates 2021b) prepared for stage 5.

DWER regulates industrial emissions and discharges to the environment through a works approval and licensing process, under Part V of EP Act. Industrial premises with potential to cause emissions and discharges to air, land or water are known as 'prescribed premises' and trigger regulation pursuant to the EP Act. Prescribed premises categories are outlined in Schedule 1 of the *Environmental Protection Regulations 1987*.

The relevant prescribed premise for the quarry operations is category 70 (Part 2, Schedule 1), defined as '*screening etc. of material: premises on which material extracted from the ground is screened, washed, crushed, ground, milled, sized or separated.*' Category 70 applies to operations with a production or design capacity of 'more than 5,000 but less than 50,000 tonnes per year.' Should the annual extraction volumes of the proposed operations fall within this range a prescribed premises registration will be sought pursuant to Part V, Division 3 of the EP Act.

2 Stage 5 Quarry Extraction Activities

With the gravel resource in the stage 4 extraction area soon to be exhausted, the proponent is seeking approval to continue extraction of gravel within the site. The stage 5 quarry is proposed to be located to the east of the approved stage 4 extraction area and is shown in **Figure 1**. The proposed staging and development plan is provided in **Appendix A,** and shows the stage 5a and 5b excavation pits, internal haul road/access track, vehicle/machinery compound as well as revegetation zones and visual screening areas.

It is proposed that stage 5 will be cleared and mined on a staged basis (stages a and b) moving in a westerly direction. Progressive rehabilitation works will occur on a yearly basis following the closure of previously extracted areas of the pit, with the backslope to be rehabilitated in the first instance. Managing the extraction this way will ensure that the active pits are not as visually prominent in the landscape. It is projected that the gravel will be extracted at a rate of approximately 16,000m^3 a year (dependent on market demand) to a depth of 10 m, or as driven by the depth of the gravel resource. The quarry pit design and excavation methodology are consistent with the previously approved stages 1 to 4 and is summarised below:

- Topsoil will be removed (approximately 50 mm thick) and stockpiled in windrows so that it can be spread as a part of the gradual rehabilitation process. The topsoil stockpiles will be no more than 2 m high and 20 m wide with batters of 1:6.
- A bulldozer will rip the gravel and then blade it into a raw material stockpile. No over-excavation is to be undertaken below pit finished floor levels. The ultimate depth of excavation will be to a maximum of 10 m below the natural surface and batters of 1:3 (vertical: horizontal) will be maintained throughout the operation.
- The raw gravel material will subsequently be crushed by a mobile (tracked) impact crusher.
- Trucks will enter and cart material from the pit throughout the extraction period. Site access will continue to occur through a 6 m wide compacted gravel driveaway (internal haul road/access track) that traverses over a right-of-carriageway easement, which extends from Brookton Highway over three adjoining properties to the site.
- A pit face (south-west and south-east) of 4 m high or greater will be maintained at all times to provide a noise barrier to the houses located to the south and west of the pit.
- Infrastructure and production plant equipment will include gravel crusher, excavator and conveyor located within the confines of stage 5. Other man-made forms include the overburden and main sediment dam.
- Upon completion of extraction, the pit floor will be ripped prior to topsoil replacement. The area will be rehabilitated in accordance with the *Environmental Management Plan - Lot 9 Brookton Highway, Karragullen* (Emerge Associates 2021b), discussed further in **Section 6.1.3**.
- The existing cleared mineral earth 3 m wide firebreak located generally around all the internal boundaries of the site will be maintained at all times. The location is varied to avoid existing remnant vegetation.

3 Existing Landscape Character Assessment

Landscape values are a measure of the importance that the community places on the landscape at any particular place. Landscape values are a combination of the physical environment and the public perception of the environment.

The character of the landscape surrounding the site has been described in the subsequent sections based on broad landscape character types (LCT) and finer scale landscape character units (LCU). These are a useful way of describing patterns of characteristics such as landform, vegetation, water and land forms, as well as individual features, which can be used to understand how the extraction associated with stage 5 may work within the existing landscape, and views from the Brookton Highway/Canning Road and other important viewing locations.

3.1 Site context

The site is bounded by broad acre rural landholdings zoned 'General Rural' to the north and south, Midgegooroo National Park and Korong National Park to the north and east, and Brookton Highway and Canning Road to the south and west, as shown in **Figure 2**. Several scenic tracks are located in proximity (over 2 km) to the site including Springdale Road to the north-west and the Munda Biddi Cycle Track to the east. A number of existing individual dwellings are visible in the vicinity of the site, adding some built elements to the largely rural and natural character of the area. The dominant elements that comprise the district landscape character the site is found within can be summarised as:

- Undulating and rolling landforms with deep valleys, generally restricting views to the foreground and midground.
- Large rural landholdings supporting mixed uses including residential, orchard production, viticulture and industrial with clusters of remnant marri/jarrah forest. Land is divided into properties and paddocks by low wire or wooden post fences (visually permeable).
- Large blocks of native vegetation comprising mature native jarrah and marri within national parks. Gradual and naturally appearing transitions between agricultural and other land uses with forested land.
- Built form of a very low density with occasional punctuating low lightly coloured tin sheds and water tanks. Powerlines and infrastructure evident along roads and along property fence lines.
- Wide vehicular carriageways with remnant vegetation within road reserves.

A review of historical aerial imagery indicates the majority of the site supported relatively undisturbed native vegetation until 1974, after which gravel quarry activities began within the western portion of the site. The southern portion of the site was cleared circa 1974 for agricultural purposes including livestock grazing, with the exception of scattered paddock trees. Several small clearing events have occurred associated with the historic expansion of the quarry and construction of vehicle tracks through the northern portion of the site between 1977 and 2001. There is evidence of vegetation regrowth within the south-eastern portion of the site, however several bare ground areas are still evident due to historical clearing.

A detailed flora and vegetation survey was conducted by Emerge Associates between April to December 2020 (Emerge Associates 2021a) and identified that the northern and central portions of

the site support remnant native vegetation ranging from 'excellent' to 'very good' condition, meaning vegetation is relatively intact. The stage 5 clearing footprint was reduced to the minimum amount required to support the stage 5 excavation operations, with a total of 35.55 ha native vegetation proposed to be retained and protected within the broader site. The implementation of the EMP (Emerge Associates 2021b) will ensure that the biological diversity and ecological integrity of retained vegetation is maintained within and adjacent to the site. The extent of the clearing area will be clearly defined before any clearing activities commence to ensure there will be no encroachment of disturbance activities into vegetation proposed to remain undisturbed. Clearing of native vegetation will occur progressively as required for each extraction stage and rehabilitated upon closure, as detailed further in **Section 6.1.3** and in accordance with any clearing permit.

3.2 Landscape character type

Reading the Remote: Landscape Characters of Western Australia (Reading the Remote) (CALM et al 1994) provides a regional assessment of the varied and unique landscapes in Western Australia and is a common means of determining the broad landscape character classifications that may be applicable at a regional level. The LCT for the site is identified as the Darling Uplands (as shown in **Figure 2**) which can be generally described as the following:

- Undulating and steeply sloping terrain of distinct appearance with isolated peaks or hills and well-defined valleys. Several watercourses deeply dissect the surface of the Darling Uplands with irregular slopes, contributing to the extensive weathering evident over its surface.
- Vegetation is dominated by forests of jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) with a dense understory of smaller shrubs, climbers and herbaceous species including native *Banksia spp.*, *Hakea spp*. and grass trees (*Xanthorrhoea preissii*) with a low visual permeability.
- The forested areas are interspersed with areas of cleared pastoral and farming land, and heath and herblands occurring on the rough granite outcrops or groups of boulders.

3.3 Landscape character units

The (LCU is a smaller unit used to describe the appearance of the basic landscape elements such as landform, vegetation, human land use and water bodies. The LCT has common characteristics at a regional scale, while variations of the LCT can be mapped at a local scale and are called LCUs. At a more local scale, two LCUs have been identified for the site and broader area based on descriptions provided within the Visual Landscape Manual (WAPC 2007), including:

- Rural landscape
- Natural landscape

The rural landscape is the dominant unit in the western part of the broader area, with the natural landscape more evident to the east as part of the Midgegooroo National Park and Korong National Park to the north and east of the site respectively. The two landscape units are shown in **Figure 2** and are discussed in further detail in **Section 3.3.2** below.

3.3.1 Rural landscape character unit

The 'rural' LCU is the dominant unit in the broader area to the west (as seen in **Figure 2**) and can be described as the following:

- Large areas of cleared paddocks on undulating hills, used for agricultural purposes (i.e. grazing of horses and cattle). In these areas, native vegetation is largely removed, although may be present in patches or as paddock trees.
- Irregular rural buildings (homestead, sheds, water tanks and associated buildings), with variable colour and texture.
- Vertical but variable fencing and horizontal but random unsealed roads servicing rural lots and also providing access tracks within the Midgegooroo National Park and Korong National Park.

Farming structures and planted fruit orchards are visible within the broader area off Canning Road, shown in **Plate 2** and **Plate 3.** The areas identified as having a 'rural' LCU in relation to the site are shown in **Figure 2**. Viewpoint locations described in the plates are shown in **Figure 3** and **Figure 4**.

Plate 2: Viewpoint 6 – Fruit orchard and tin storage shed in foreground to midground with windbreak planting/retained vegetation along fence line. Other farming structures with light coloured walls/roof evident in the background, looking south-east from Littelys Road (north-west of the site).

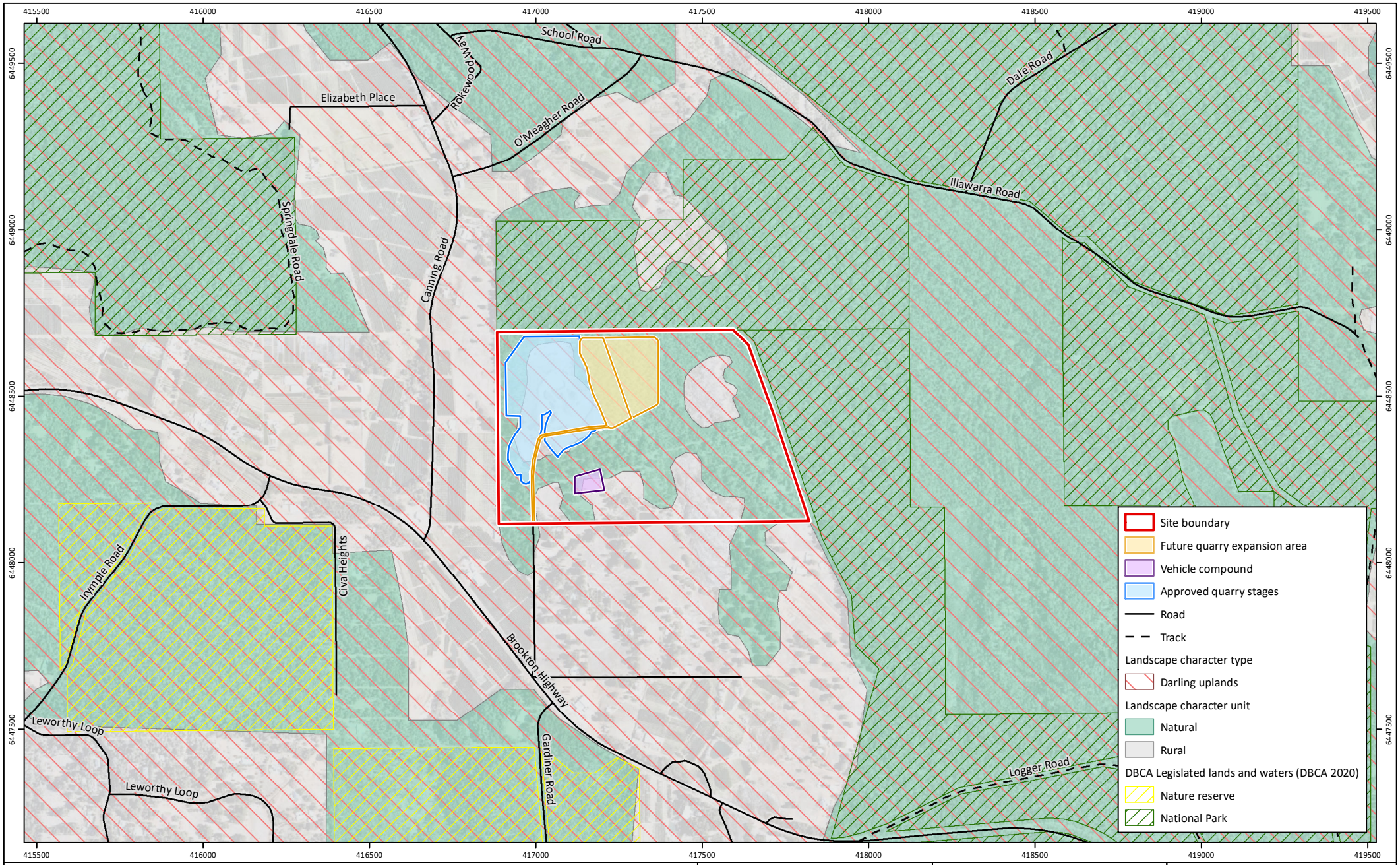

Figure 2: Landscape Character Units

Project:	Visual Impact Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F25a

Drawn:	GAR
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Approved:	KK
Date:	26/05/2021

N

0 250 500
Metres

Scale: 1:15,000@A4

GDA 1994 MGA Zone 50

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Plate 3: Viewpoint 10 – Residential buildings over rolling hills and cleared paddocks evident within the broader area with the existing gravel quarry in the background, looking east from Ferguson Road (west of the site).

3.3.2 Natural landscape character unit

The 'natural' LCU is largely associated with the Midgegooroo National Park and Korong National Park, located to the north and west of the site, and further to the south (as seen in **Figure 2, Plate 4** and **Plate 5**) and can be described as the following:

- Large areas of intact remnant vegetation with variable texture and colour with openings of a natural appearance associated with wetlands and granite outcrops. Eucalyptus trees over 10 meters in height with an understory of low heath and shrubby herblands. Visual penetration into forest is moderate.
- Open forest and woodland offer structural diversity in colour and texture. Grey jarrah and marri trunks with vertical fibrous bark, mottled dark grass tree trunks with glossy green shoots, olive green leaved Banksia. Blackened fire damaged limbs and trunks of trees are interspersed throughout the forest.
- Views are broken by cavities resulting from grey granite and limestone outcrops, cleared pastoral land with sporadic roofing and farming infrastructure, large patches of pale orange in gravel pits and mines, geometric pine plantations, cleared power corridors and meandering walking tracks and bitumen roads.

The areas identified as having a 'natural landscape character' within the vicinity of the site are depicted in **Figure 2.**

Plate 4: Viewpoint 1 – Jarrah and marri forest within the Korong National Park off a gravel firebreak connecting onto the scenic Canning Mills Road, showing a diversity in colour and texture, and variable height of vegetation.

Plate 5: Viewpoint 25 – Views from Heath Road looking east towards the roadside native vegetation, demonstrating typical textured and diverse jarrah and marri forest (to the east of the site).

4 Principles and Objectives for Assessment

4.1 Visual landscape objectives

The overall management objective is to ensure that the stage 5 quarry expansion is designed and constructed in such a way that the existing landscape character at both the regional level (i.e. LCT in accordance with (Reading the Remote) (CALM et al 1994)) and local level (i.e. LCU in accordance with the Visual Landscape Manual (WAPC 2007) is protected and maintained.

Specific management objectives (as determined by Emerge Associates) relevant to each LCU are provided in **Table 2**.

Table 2: Landscape character management objectives

Landscape character unit	Management objectives
Rural	• To maintain and protect the quality of views of the rural landscape (including built form and rolling hills) and to integrate the gravel quarry into the landscape unit in such a way that existing views are protected. This includes maintaining the Armadale Hills experience (including components such as views of cleared paddocks on undulating hills, rows of planted orchards and granite/limestone outcroppings).
Natural	• To maintain the visual quality of the natural landscape including maintaining and protecting the: ○ The natural backdrop of the jarrah and marri forested ridgeline. ○ The quality of the views of natural features provided for users within Midgegooroo National Park and Korong National Park.

4.2 Visual Design Strategies

Upon identifying the key visual elements for the stage 5 expansion area, as described in **Section 2**, the following broad strategies are recommended as part of the design process to assist in the mitigation of any visual impact:

- Retain the vegetation within the higher areas of the site to keep a naturally appearing vegetated backdrop, to limit the existing vegetated horizon line associated with the Korong and Midgegooroo National Parks being broken.
- Retain existing vegetation between stage 5 and the Brookton Highway to the maximum extent possible, in particular stands of dense, taller remnant vegetation to assist with screening of the quarry.
- Ensure the distant views of stage 5 to align with the current viewing experience along Canning Road and Brookton Highway, and where possible are improved when compared to the current quarry.
- Blend the bare earth of the quarry pit (typically orange in colour) through progressive rehabilitation, including return of topsoil which is darker in tone, and replanting native species.

5 Landscape Visual Impact Assessment

5.1 Viewshed analysis

A viewshed analysis was performed to determine which locations in the vicinity of the site would have potential views of the stage 5 expansion area and considered the 'seen area' of the quarry, and is based on:

- The maximum height of the quarry wall associated with the currently approved quarry extent.
- The maximum height of the quarry wall associated with the stage 5 expansion.

A viewshed or 'seen area' is defined as:

A portion of the landscape that can be seen from one or more observer positions. The extent of the area that can be viewed is normally limited by landform, vegetation and distance. (WAPC 2007)

The viewshed applicable to the proposed building was based on:

- Identifying potentially significant visual receptors, these included major roads in proximity to the site; Brookton Highway and Canning Road, minor roads such as Gardiner Road, Ferguson Road and Logger Road, walking tracks through adjacent reserves such as Springdale Road through Korong National Park and surrounding rural residential dwellings surrounding the site.
- Identifying the extent of the 'seen area', where the quarry may be visible based on existing topographic contours only. The visible area is based on two scenarios, namely the maximum height of the quarry wall associated with the existing approved quarry extent and the maximum height of the quarry wall following the completion of the stage 5 quarry expansion, and any land equal to or greater than those heights.
- Overlaying the receptors on the viewshed to determine locations that would have a potential view of the stage 5 area.

Vegetation (and height of vegetation) is not considered as part of the viewshed analysis.

The outcomes of the viewshed analysis are shown in **Figure 3** (existing quarry) and **Figure 4** (stage 5 quarry expansion). The distance zones used for the viewshed analysis were sourced from the Visual Landscape Manual (WAPC 2007), and include the 'foreground' (from the site to 500 m) and 'middleground' (500 m to 6 km). Further views (e.g. greater than 6 km) were not considered in detail, as at that scale the stage 5 quarry is not likely to be distinguishable from the surrounding landscape features, particularly given the patchwork of human built form elements visible in the broader regional context.

The results of the viewshed analysis indicate that the majority of the potential visible areas are located within approximately the first 4 km of the site, and the 'seen area' for stage 5 is less than the existing quarry within approximately 500 m of the site.

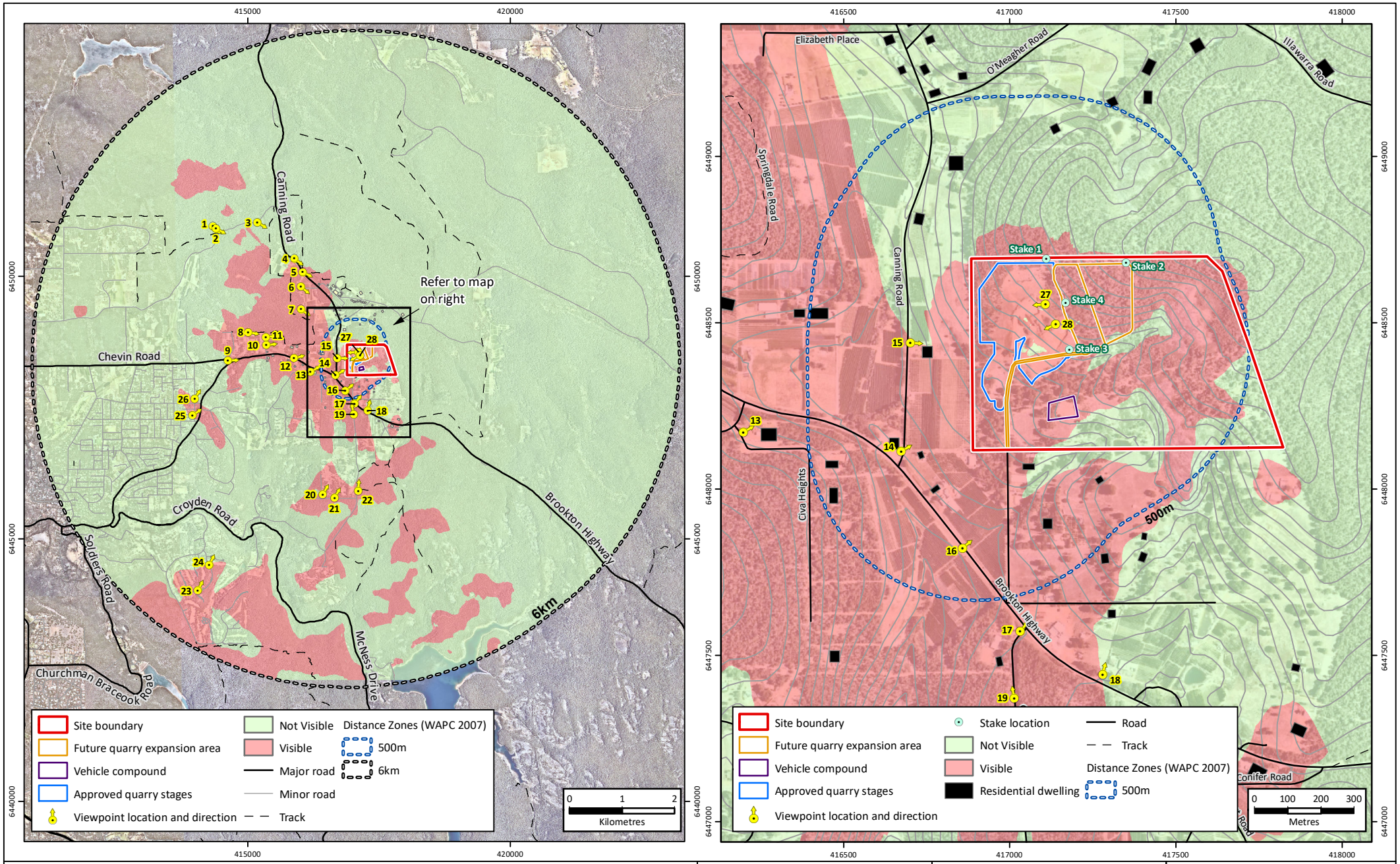

Figure 3: Viewshed Analysis - Existing Quarry

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
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Drawn: GAR
Date: 26/05/2021
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Date: 26/05/2021

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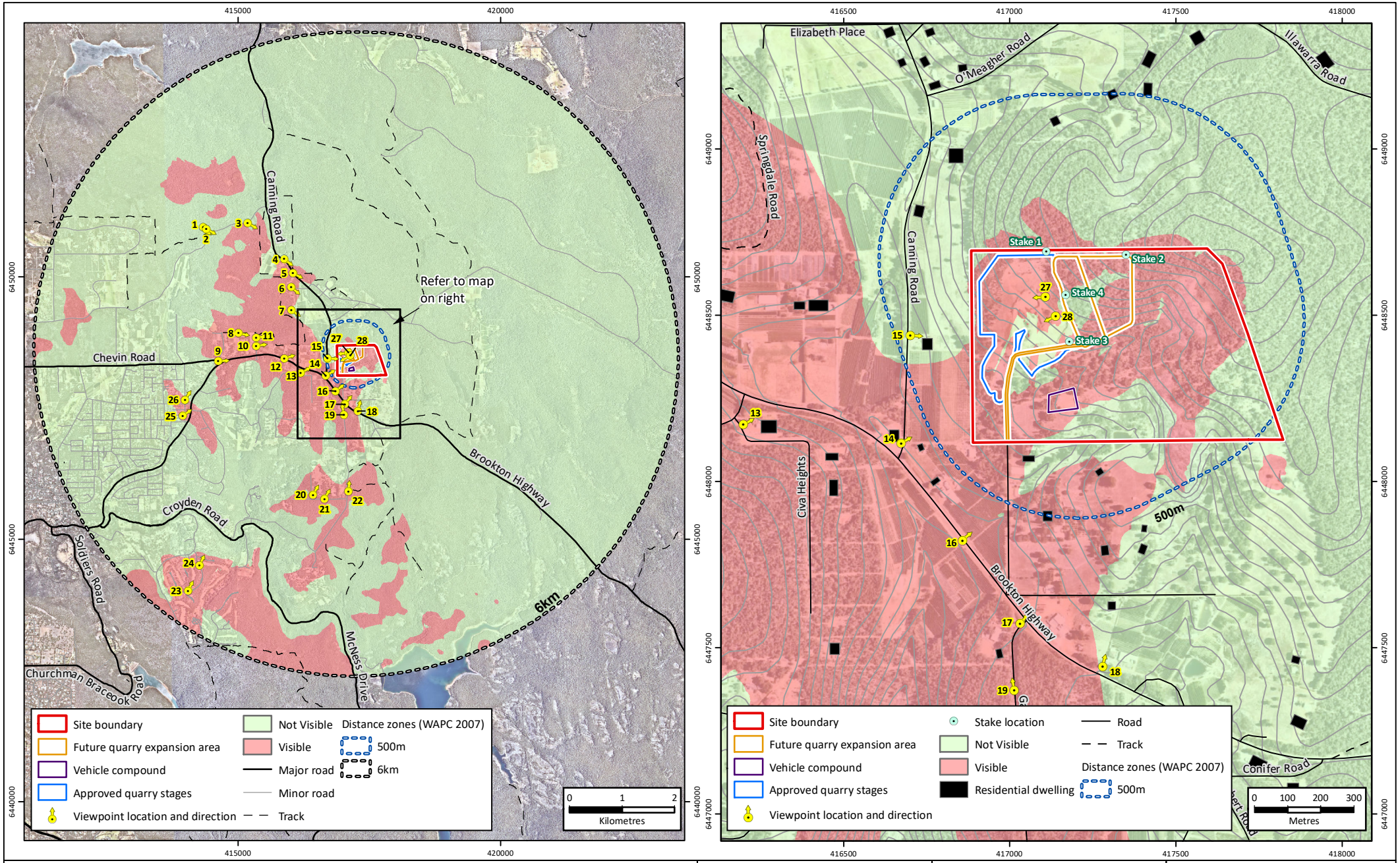

Figure 4: Viewshed Analysis - Stage 5 Quarry Expansion

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
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5.2 Site assessment

Following the viewshed analysis, a site visit was undertaken by a landscape architect and environmental consultant from Emerge Associates, on 28 January and 29 January 2021 to ground truth the outcomes from the viewshed analysis and determine locations where the stage 5 quarry expansion may be visible (based on the presence of existing vegetation and other features). The site visit included walking portions of the scenic walking trails such as Springdale Road in addition to several locations along Brookton Highway and Canning Road with various photos taken at a number of viewpoint locations. The viewpoint locations and associated photos are shown in **Figure 5** to **Figure 7**.

The photos were captured using a 50 mm digital SLR camera (and crop factor) with a focal length of approximately 75 mm which is generally equivalent to that recommended in the Visual Landscape Manual (WAPC 2007) (which suggests a 35 mm camera with a focal length of 90 mm) for representing what the human eye sees. Where relevant, photos have been assembled into a photomontage (referenced as 'original photomontage') to represent the breadth of the view (e.g. panorama) at certain viewpoints rather than taking a panorama or wide-angle view photo. This is in accordance with the Visual Landscape Manual (WAPC 2007).

To assist in understanding the visibility of stage 5 from the various viewpoints, four 7 m high aluminium poles with high visibility vests tied to the top were installed at prominent locations within the stage 5 quarry footprint as shown in **Plate 6**. The poles were generally aligned with the outer corners of the stage 5 footprint as shown in **Figure 3** and **Figure 4**, at the following locations:

- Stake 1 (-32.0950°S, 116.1215°E)
- Stake 2 (-32.0952°S, 116.1240°E)
- Stake 3 (-32.0975°S, 116.1223°E)
- Stake 4 (32.0962°S, 116.1222°E)

The poles were used to help understand the likely visibility of stage 5 at the different viewpoint locations (particularly given the presence of existing vegetation and topography, which made it difficult in locations to locate the existing quarry extent within the landscape).

Plate 6: 7 m poles with high visibility flags located within the existing and proposed quarry sites.

5.3 Viewpoint analysis

Viewpoints were selected at various locations along major and minor roads and rural residential access tracks and driveways surrounding stage 5 and were based on 'seen/visible' and 'unseen/not visible' areas identified in the viewshed analysis, as well as other potential viewing locations identified during the site visit along scenic walking trails such as Springdale Road and from within the existing quarry facing towards the surrounding residential dwellings to the west of the site.

Table 3 summarises whether any part of stage 5 is likely to be visible from the viewpoints based on the visibility of any of the poles. Each viewpoint location is shown in **Figure 5** to **Figure 7** along with the original photomontage from each viewpoint captured during the site visit.

Table 3: Likely visibility of stage 5 quarry expansion based on outcomes of the site visit

Visible	Viewpoint location												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Yes/No	N	N	N	N	N	N	N	N	N	**Y**	N	**Y**	**Y**
	14	15	16	17	18	19	20	21	22	23	24	25	26
Yes/No	N	N	N	N	N	N	N	N	N	N	N	N	N

While the viewshed analysis (**Figure 3** and **Figure 4**) indicates that the existing and proposed quarry may be visible at a number of locations (based on landform alone), the site visit indicated that existing vegetation at the boundary of the site and within the broader area (particularly along roads and associated with the national parks) shields the views of the existing quarry. It was determined that stage 5 has the potential to be visible at three (3) of the 26 viewpoints.

5.4 Summary of likely impacts

The site assessment and viewpoint analysis, confirmed the 'natural' and 'rural' LCUs are present at the local level, and that the visual characteristics of views associated with the site and general location are:

- The natural vegetated and rural nature of the site, consisting of remnant patches of jarrah and marri forest vegetation with variable texture and colour with openings of a natural appearance associated with granite outcrops and cleared paddocks.
- Larger rural residential lots along Brookton Highway with views of low orchards over rolling hills intersected by roofing and farming infrastructure, large patches of pale bare earth (orange in colour) associated with gravel pits and mines, cleared power corridors and main roads.
- Large blocks of retained marri/jarrah forest vegetation associated with Midgegooroo National Park and Korong National Park to the north and east of the site.
- Higher density residential development with a natural aesthetic to the west of the site.

Upon assessing the viewshed analysis and having visited the site and its surrounds, a series of key views to the site have become evident. These have formed the key assessment points for considering how the visual impact of stage 5 could be mitigated and are discussed further in the following sections.

The desktop and site assessment identified that stage 5 may be visible at times by users driving along Brookton Highway in an easterly direction when climbing a soft ridgeline in front of the site

(depending on location). In particular, one location at Ferguson Road (Viewpoint 10) and two points along Brookton Highway (Viewpoints 12 and 13) where clearing of vegetation for agricultural land uses in the foreground and middle ground enabled glimpses of the existing open pit within the site. Due to a valley landform and the height and form of existing vegetation along roadsides and within abutting National Parks, the existing stage 4 and proposed stage 5 will not be visible from the scenic Munda Biddi Cycle Track to the east of the site, Springdale Road walking trail and vehicle access track to the north west of the site, or Canning Road to the north of the site.

To minimise the potential visual impact of stage 5 on the surrounding landscape, mitigation measures have been proposed further in **Section 6.1**.

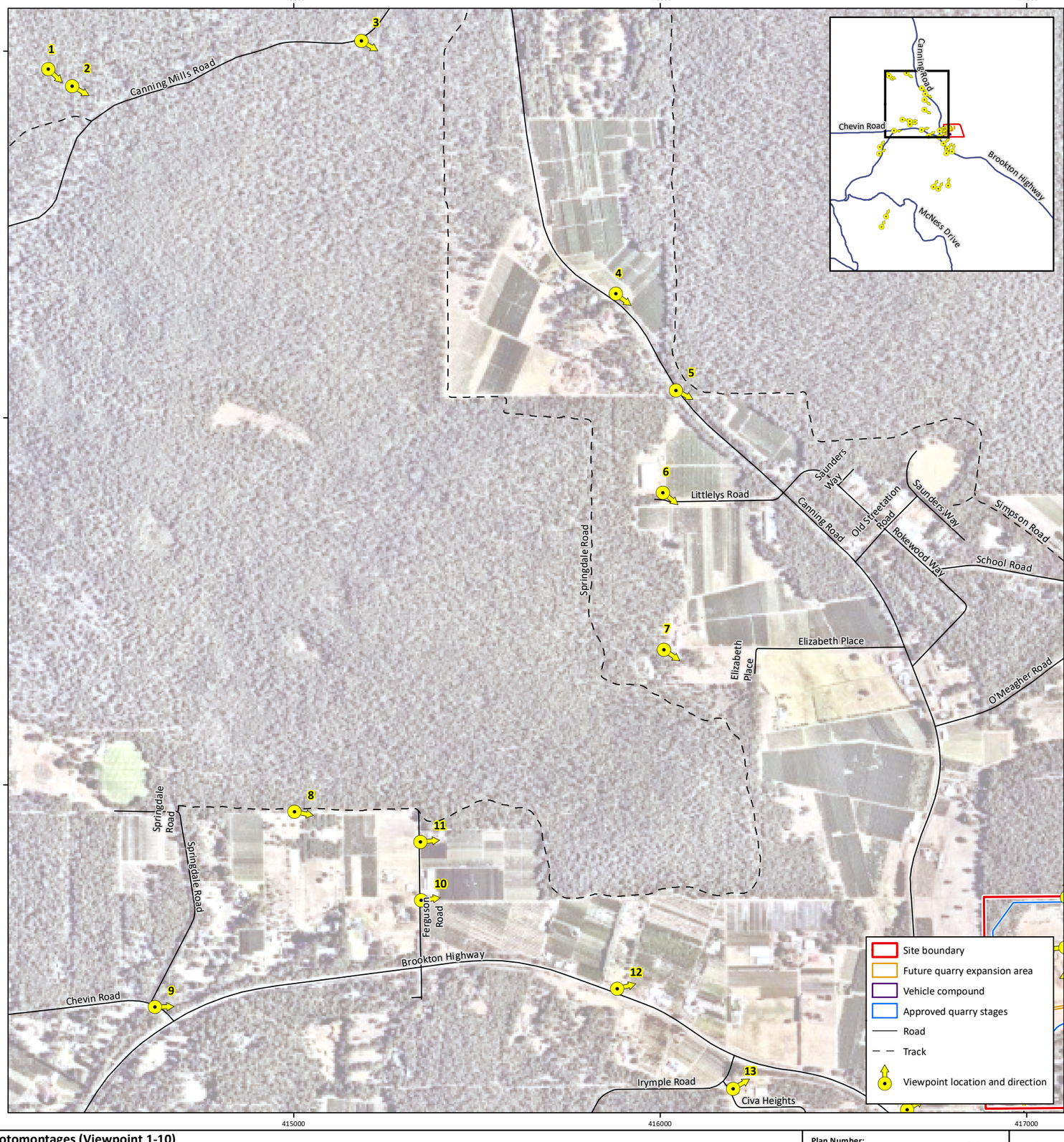

Figure 5: **North Viewpoint Location Plan and Original Photomontages (Viewpoint 1-10)**

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F28a
Drawn: GAR
Date: 26/05/2021
Checked: BRB
Approved: KK
Date: 26/05/2021

N

0 100 200 300 400
Metres
Scale: 1:12,000@A3
GDA 1994 MGA Zone 50

emerge ASSOCIATES

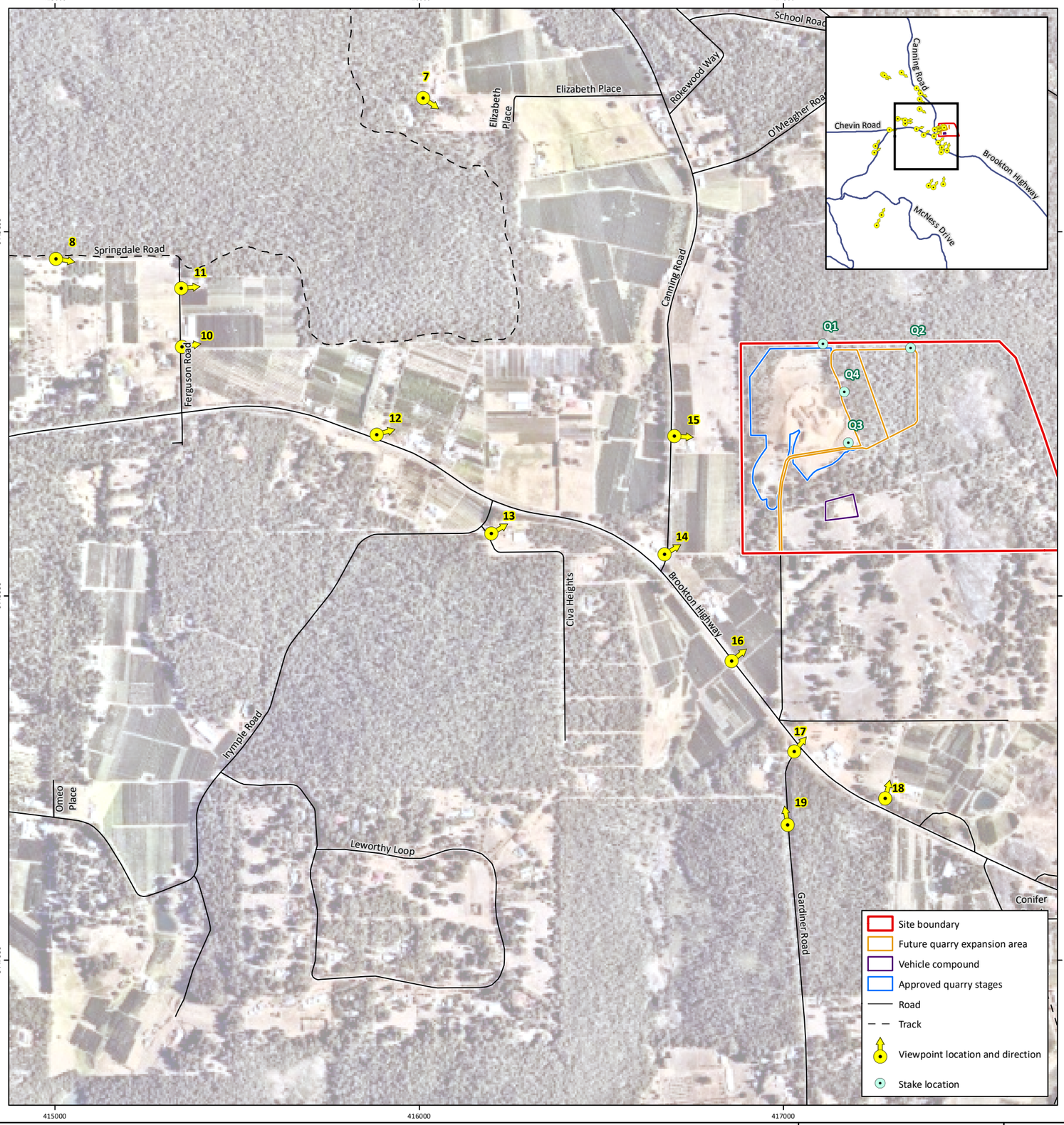

Figure 6: **Central Viewpoint Location Plan and Original Photomontages (Viewpoint 11-19)**

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F29a
Drawn: GAR
Date: 26/05/2021
Checked: BRB
Approved: KK
Date: 26/05/2021

N

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Metres
Scale: 1:12,000@A3
GDA 1994 MGA Zone 50

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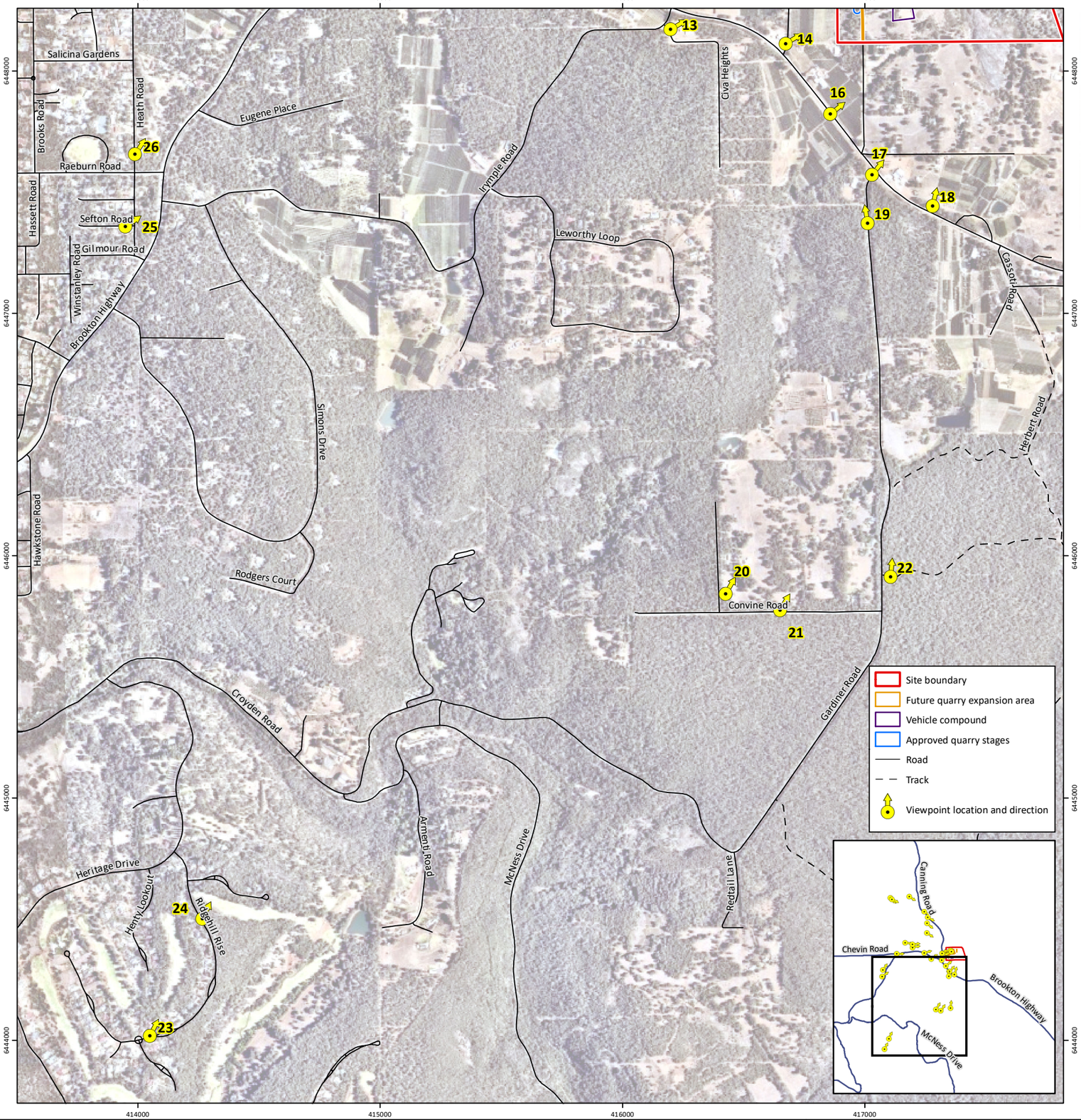

Figure 7: **South Viewpoint Location Plan and Original Photomontages (Viewpoint 20-26)**

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F30a
Drawn: GAR
Date: 26/05/2021
Checked: BRB
Approved: KK
Date: 26/05/2021

N

0 200 400 600
Metres
Scale: 1:18,000@A3
GDA 1994 MGA Zone 50

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6 Evaluation of Visual Impact Assessment

6.1 Visual mitigation and management measures

To ensure the stage 5 does not detract from the scenic quality of the land (and achieve the visual landscape objectives outlined within **Section 4.1**), specific mitigation measures have been recommended for stage 5. The recommendations have also considered the revegetation and acoustic requirements as outlined within the Acoustic Assessment (Lloyd George Acoustics 2021) and the Environmental Management Plan (Emerge Associates 2021b).

The potential visual impact from the stage 5 expansion can be minimised by utilising a staged mining approach with retention of vegetation between stages, progressively revegetating completed stages and retaining an existing vegetation buffer between the extraction area and the site boundary the north. The mitigation measures are further detailed in **Sections 6.1.1** to **6.1.3** below.

6.1.1 Proposed Stage 5 location and staging

The stage 5 expansion pit will be located a minimum 20 m from the northern and western boundaries of the site (as shown in **Figure 8**) enabling the retention of stands of taller remnant vegetation between stage 5 and Brookton Highway to the west. This will provide screening for between Canning Road/Brookton Highway and the quarry. A total of 35.55 ha native vegetation will be retained within the site, with the majority extending over the higher areas of the site to keep the vegetated backdrop and limit the existing vegetated horizon line associated with the Korong and Midgegooroo National Parks being broken.

Stage 5 extraction activities will begin at the easternmost extent, gradually expanding in a westerly direction, with progressive rehabilitation works to be undertaken following the completion of each extraction stage. The staged approach allows for vegetation to remain closest to Brookton Highway for the longest period of time, providing screening of the quarry activities. Once the Stage 5a area is exhausted, the remaining vegetation within Stage 5b will be removed, however at the same time Stage 5a will be overlain with topsoil and progressively rehabilitated so the pit is less prominent visually.

As part of the VIA, a 'worst case' scenario has been assumed whereby market demand is high for gravel and stage 5a is exhausted within 3 years of approval, after which excavation activities commence immediately over stage 5b. It is possible that stage 5a is excavated for a period of greater than 3 years, allowing for a longer time to lapse between stages and therefore more time for the existing revegetation areas to mature and contribute to screening/blending measures.

The pit will be mined in a southwest direction, to ensure that the pit face provides a noise barrier to the houses located to the south and west of the pit. All large visually prominent machinery such as the front-end loader used to load product into trucks and the gravel screening machinery will operate from behind a minimum 4 m high pit face at all times.

6.1.2 Topsoil replacement and landform reinstatement

Topsoil at the site will be stripped and stockpiled separately, prior to quarrying activities commencing. The dimensions of the topsoil stockpiles will not exceed two metres in height and will be located so as to not be visually prominent. Following the completion of each stage, stockpiled topsoil will be placed over the graded bare earth. This will allow blending of the bare mineral earth (typically a stark orange colour) with the topsoil that is darker in tone, thereby reducing the overall visibility.

Whilst the site is not known to contain any unique geological features or landforms, the extraction activities will focus on returning the post-mined landform to a gently sloping surface in alignment with the existing upland topography. During operations 1: 3 batters will be maintained within the pit. However, following the completion of each stage, restoration and reinstatement of the pit will commence. In areas where extraction is completed, and prior to the ultimate re-forming of the area for subsequent revegetation, slopes around the perimeter of the excavation area will be re-contoured to achieve stable gradients (less than 1:4 vertical to horizontal batter) and the pit floor will have at least a 1:100 fall, refer to **Figure 9** and also **Appendix A**.

6.1.3 Revegetation

An EMP (Emerge Associates 2021b) has been prepared to support the DA and EIL applications for stage 5 of the quarry, and outlines vegetation management activities to be undertaken during extraction and rehabilitation measures following completion of extraction. The EMP outlines three distinct rehabilitation zones which are depicted on **Figure 8** and outlined below:

- Zone 1 – Visual screening
- Zone 2 – Native revegetation of existing stages
- Zone 3 – Native revegetation of stage 5a and 5b.

A general planting list has been provided within **Appendix B**, with each zone outlined in detail in the following sections.

6.1.3.1 Visual screening (Zone 1)

Zone 1 comprises an area of 0.67 ha to the west of the internal haul road/access track, as shown in **Figure 8**. The purpose of this planting is to reduce any visual impacts associated with the extraction area through the use of dense vegetative screening. Zone 1 was originally planted in 2015 in accordance with previous development approval conditions and will continue to be revegetated with native species via direct seeding and infill planting to reach the completion criteria as outlined in the EMP (Emerge Associates 2021b). Recent site inspections indicate trees planted in 2019 as part of previous rehabilitation efforts are now at 6 m in height.

6.1.3.2 Native revegetation (Zone 2, 3)

Zone 2 consists of the stage 4 quarry pit and other disturbed areas extending over 8.19 ha within the western portion of the site, as shown in **Figure 8**. Revegetation activities have already commenced within portions of zone 2, conditioned under the clearing permit (CPS 8273/1). Recent site inspections indicate vegetation planted in 2019 as part of previous rehabilitation efforts are now at 4 m in height. A mix of infill planting and direct seeding will occur for areas where the plant density is not achieving the completion criteria.

Zone 3 consists of the proposed stage 5a and 5b extraction areas extending over 4.99 ha, as shown in **Figure 8**. The objective is to progressively revegetate these extraction areas via direct seeding of local native species, based on those present in areas of remnant vegetation within the site and nearby national parks.

Native revegetation areas (Zones 2 and 3) will be planted with a native density of approximately 0.8 plants / 1 m^2 and a species richness of no less than 15 species of tree, shrub and herbs. In the short to medium term, it is expected that this planting will blend with the existing remnant native vegetation to the north and east and will blend the view of the quarry with existing vegetation for distant views from Canning Road and Brookton Highway.

6.1.3.3 Other planting

Further revegetation activities will include infill planting of tree species (proposed to be *Eucalyptus wandoo, Eucalyptus patens, Eucalyptus lane-poolei, Eucalyptus laeliae and Corymbia calophylla,* based on existing vegetation within the site and surrounds) in a linear arrangement immediately adjacent to the western boundary of the site and will include clusters of up to 2 to 3 trees, 5 m apart at a density of 0.5 trees / 1 m^2 interspersed with a native scrub understory. At approximately 12 years maturity, this vegetation is expected to block views of stage 5 from Canning Road and Brookton Highway in the near view. As part of this VIA, this planting has been considered as part of 'Zone 1' when considering benefits of this planting.

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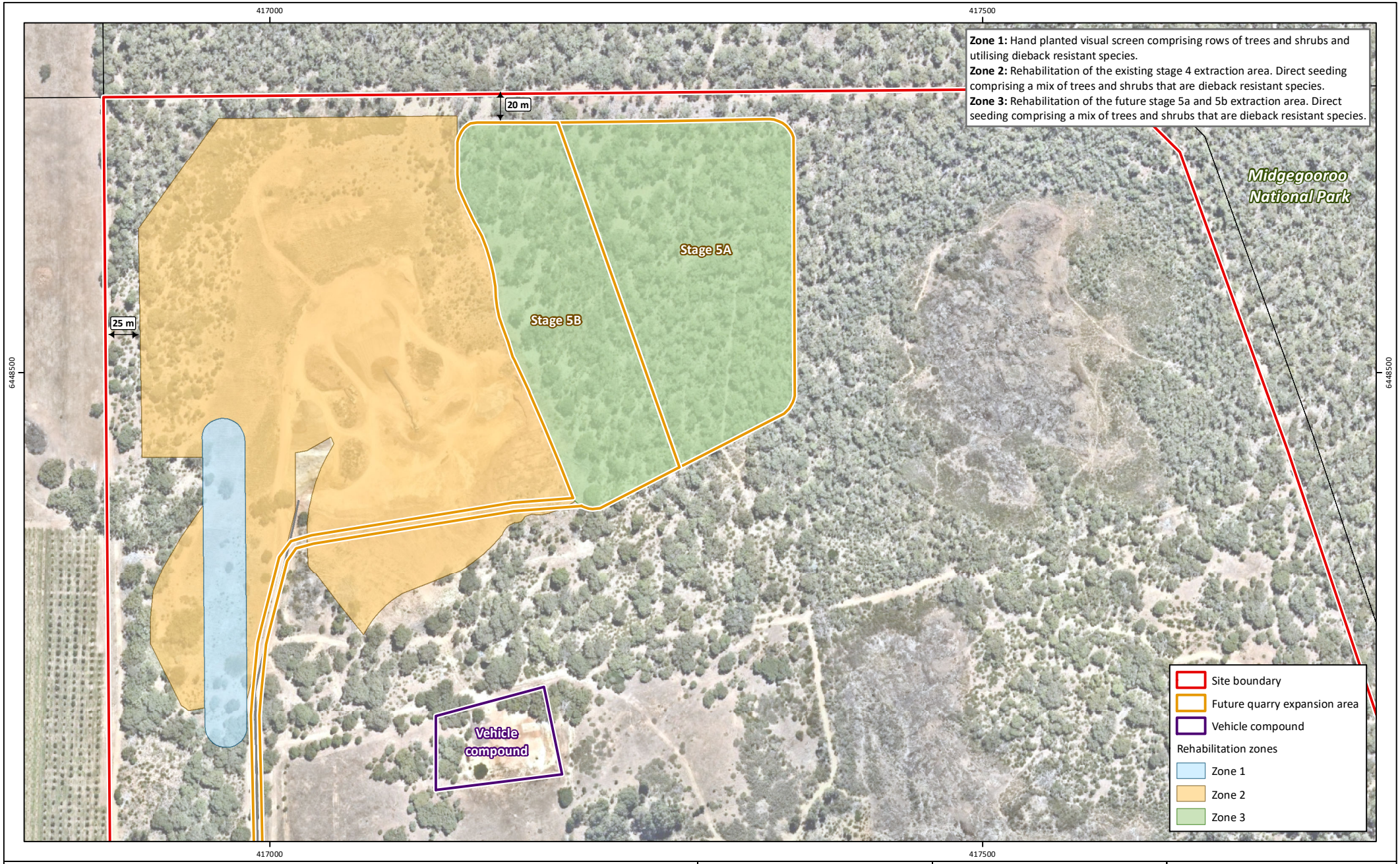

Figure 8: Rehabilitation Zones

Project:	Visual Impact Assessment Lot 9 Brookton Highway, Karragullen
Client:	Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F64a

Drawn:	GAR
Date:	26/05/2021
Checked:	BRB
Approved:	KK
Date:	26/05/2021

N

0 50 100 150
Metres

Scale: 1:3,500@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

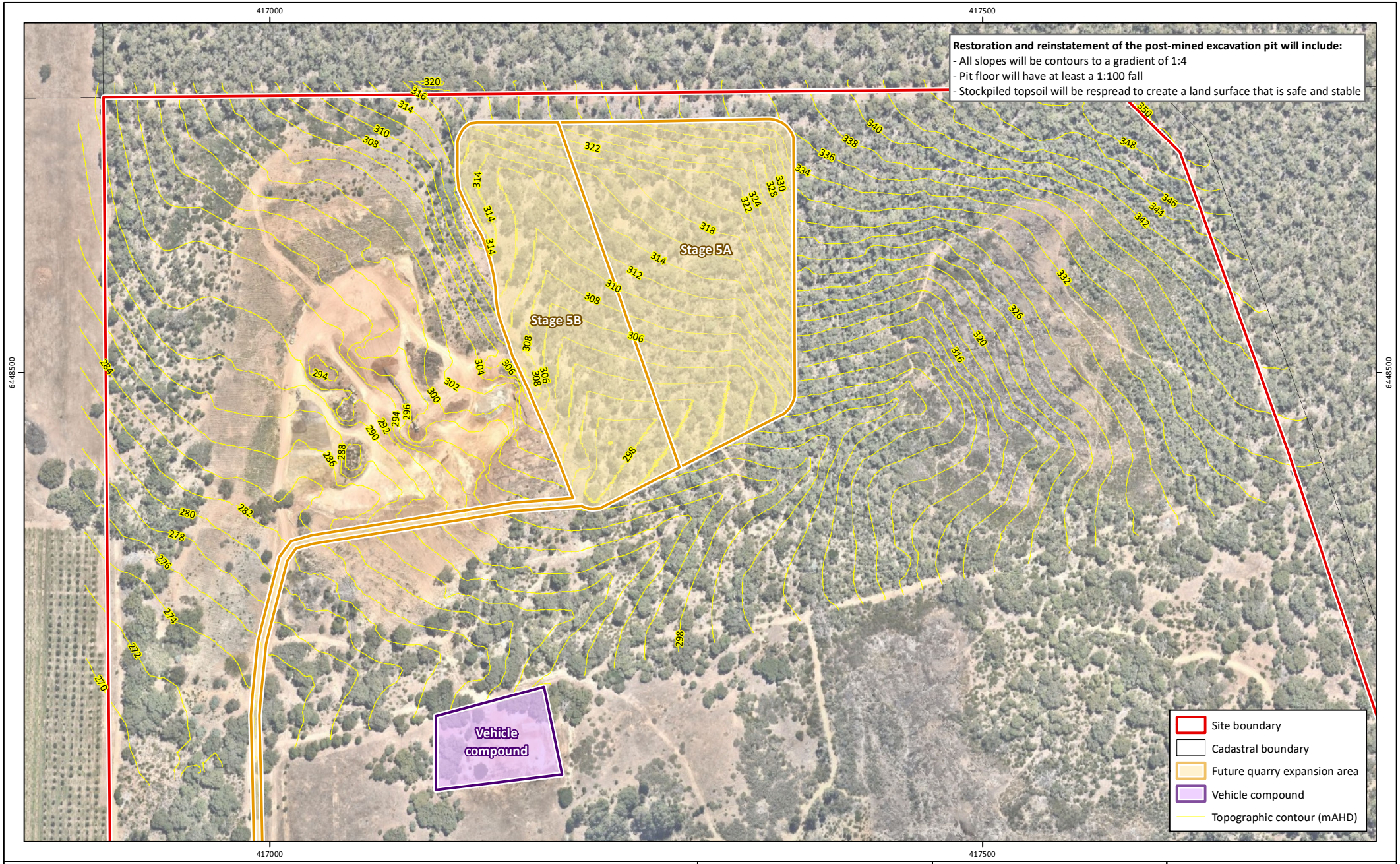

Figure 9: Quarry Closure Contours

Project: Visual Impact Assessment
Lot 9 Brookton Highway, Karragullen
Client: Vinci Gravel Supplies Pty Ltd

Plan Number:
EP20-040(12)--F65a

Drawn:	GAR
Date:	26/05/2021
Checked:	BRB
Approved:	KK
Date:	26/05/2021

N

0 50 100 150
Metres
Scale: 1:3,500@A4
GDA 1994 MGA Zone 50

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6.2 Assessment of visual impact management measures

To help 'test' the appropriateness of the proposed management measures, Emerge Associates have prepared a number of cross-sections as well as design montages (3D perspectives) which provide a visual depiction of the 'mitigated' scenario. These are to help demonstrate where the stage 5 expansion area is located within the landscape in comparison to the existing vegetation, as well as how the proposed management measures (described above) will assist with minimising visual impacts. The cross-sections and design montages (3D photo perspectives) are discussed further below.

The visual impact assessment has determined that the existing gravel quarry will not be visible from Brookton Highway to the south and Canning Road to the north due to the presence of vegetation within landholdings and road reserves (in addition to vegetation retained within the site), as detailed within **Table 3**. Viewpoints 16 to 19, located approximately 1 km to the south of the stage 5 quarry expansion area along Brookton Highway, demonstrates that the pit is located behind existing stands of vegetation (along the road, within landholdings) when viewed from the south, as shown in **Figure 6.**

6.2.1 Cross-sections

Three cross sections have been prepared for stage 5, associated with the three viewpoints where it was determined stage 5 would be visible. This is to help illustrate the relationship between existing landform and other landscape characteristics such as vegetation cover and land use and the proposed mitigation measures.

One point was chosen from the Ferguson Road (Viewpoint 10) to depict a stationary view experienced from a residential landholding (Lot 3 Brookton Highway) located on top of the ridgeline at 292 m AHD to the west of the site. Due to the expanse of clearing for orchards and pasture in the valley landform, Viewpoint 10 has a distant view of the quarry. Two points were chosen along Brookton Highway (Viewpoints 12 and 13) located at 280 m AHD and 273 m ADH respectively, to depict how the quarry is glimpsed through gaps in roadside vegetation whilst driving in an easterly direction.

The cross sections provide additional detail regarding the stage 5 location and extent within the topographic contours and the visual effect of revegetation and screening areas. The locations of the cross-sections were determined in consultation with the City of Armadale and includes close and distant viewpoints. A reference plan showing the locations of each of the cross sections has been provided in **Plate 7**, with the detailed cross-sections provided in **Plate 8** to **Plate 10.** A summary of each cross-section, the relevant viewpoints and the natural features and management measures shown is provided in **Table 4** (and includes consideration of 'Image 1' presented as part of the photomontages). The cross-sections depict the three zones of revegetation planting as discussed in **Section 6.1.3** and shown in **Figure 8**.

Table 4: Summary of cross-sections prepared for the site and outcomes demonstrated with each cross-section.

Cross-section (see Plate 8 to Plate 10)	Characteristics and/or management measures
1 (A to AA) Viewpoint 10 (see **Plate 8**) (Location of cross section shown on **Plate 7**)	• Existing agricultural landscape (orchards, cleared paddocks etc.) provide limited screening for viewers on Ferguson Road. • Existing (historic) excavation pit (Zone 2) will be visible until revegetation/planting establishes within Zone 1 and Zone 2. • Demonstrates that whilst the residential lots 1113-1119 Brookton Highway and 1143 Brookton Highway are situated at a lower elevation than stage 5 (maximum 319 mAHD), due to the mature remnant vegetation abutting Canning Road, approximately 20 m in height, the quarry will be blocked from the line of site. **Implementation of management measures:** • Stage 5a will be concealed by existing mature vegetation >12 m in height that will be retained in the stage 5b area. • When Stage 5b commences, until vegetation within Zone 2 grows to at least 9 m in height, all of stage 5 will be visible. Revegetation within Zone 2 will assist with screening the existing quarry.
2 (B to BB) Viewpoint 12 (See **Plate 9**) (Location of cross section shown on **Plate 7**)	• Existing agricultural landscape (orchards, cleared paddocks etc.) provide limited screening for viewers on Brookton Highway that may glimpse the site through gaps in mature vegetation. • Existing (historic) excavation pit (Zone 2) will be visible until revegetation/planting establishes within Zone 1 and Zone 2. • Demonstrates that residential lots 1143, 1153, 1189, 1759 and Lot 2 Brookton Highway are situated at a lower elevation than stage 5 (maximum 324 mAHD) and due to the existing topography or mature remnant vegetation abutting Canning Road and along the boundary of the site, approximately 20 m in height, the quarry will likely be blocked from the line of site. **Implementation of management measures:** • From Brookton Highway, stage 5a will be concealed by existing mature vegetation >12 m in height that will be retained in the stage 5b area. • From Brookton Highway, when Stage 5b commences, and until vegetation within Zone 2 grows to at least 9 m in height, all of stage 5 will be visible. Revegetation within Zone 2 will assist with screening the existing quarry.
3 (C to CC) Viewpoint 13 (see **Plate 10**) (Location of cross section shown on **Plate 7**)	• Existing agricultural landscape (orchards, cleared paddocks etc.) provide limited screening for viewers on Brookton Highway that may glimpse the site through gaps in mature vegetation. • Existing (historic) excavation pit (Zone 2) is generally screened by the existing mature vegetation adjacent to the site boundary. • Demonstrates that whilst Lot 2 Brookton Highway is situated at a lower elevation than stage 5 (maximum 329 mAHD), due to the mature remnant vegetation abutting site boundary, approximately 20 m in height, the quarry will be largely blocked from the line of site. **Implementation of management measures:** • Stage 5a will be concealed by existing mature vegetation >12 m in height that will be retained in the stage 5b area. • When Stage 5b commences, all of stage 5 will be visible. Revegetation within Zone 2 will assist with screening stage 5 but not until the vegetation is at least 9 m in height.

Vinci Quarry Visual Impact Assessment- Plate 7: Section Reference Plan

DWG **KA-VIA-02**
REV **C**
DATE **21.05.2021**

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\\EMERGE-FS01\Emerge\Projects\CURRENT PROJECTS\ENVIRO77-Karagullen VIA\XXX-01\Photos Drawings & Scans\XX-01\02_Concept Plans, Scans & Graphics\04 INDD\Karragullen VIA_RevC.indd

6.2.2 Design montage (3D photo perspective)

As outlined within **Section 5**, original site montages have been created for all viewpoints and are provided to **Figure 5** to **Figure 7**. The original site montages helped to identify key viewpoints (10, 12 and 13) in which the stage 5 expansion area may be visible to viewers, for which design montages (3D photo perspectives) have been prepared to demonstrate the appropriateness of the proposed management measures discussed in **Section 6.1**.

The design montages (3D perspectives) are a simulation/computer generated technique, and have been prepared based on overlaying the quarry footprint in 'plan' view and using this and the flags to identify the extent of the quarry pit face that would be visible at the various locations. The existing colour of the bare mineral earth (orange) was then used to indicate the likely visibility of the quarry. Vegetation height within the site has been accurately indicated based on assumed growth over time and height compared to existing features.

Three montages were prepared for each cross section provided in **Plate 8** to **Plate 10,** demonstrating the current conditions (Image 1), implementation of stage 5a implementation (Image 2) and implementation of stage 5b (Image 3). The quarry stages and associated revegetation activities depicted in each photomontage are outlined in **Table 5** below.

Table 5: Quarry stages and revegetation activities

Image	Timeframe	Quarry activities	Revegetation activities
1	Current	Existing	• Zone 1 and boundary planting currently at 6 years growth with vegetation 6 m high.
2	Current	Stage 5a extraction activities commenced.	• Topsoil spreading over Zone 2, indicated by a darker tone. • Zone 1 and boundary planting currently at 6 years growth with vegetation 6 m high.
3	3 years	Stage 5a exhausted, Stage 5b extraction activities commenced	• Topsoil spreading over Stage 5A, indicated by a darker tone. • Zone 1 and boundary planting is now at 9 years growth, vegetation estimated to be 9 m high (based on existing growth). • Zone 2 revegetation at 3 years growth with vegetation 3 m high.

As discussed in **Section 6.1.1**, a 'worst case' scenario has been assumed whereby stage 5a is exhausted within 3 years, after which extraction activities with stage 5b commence immediately. It is possible gravel will continue to be extracted from stage 5a for a longer duration of 5 to 7 years before the pit moves in a westerly direction, allowing additional time for vegetation within Zone 1 and Zone 2 to mature and increase in height.

The following three locations were regarded as key views in the viewshed analysis and site assessment, and 3D perspective photomontages and cross-sections have been prepared for each.

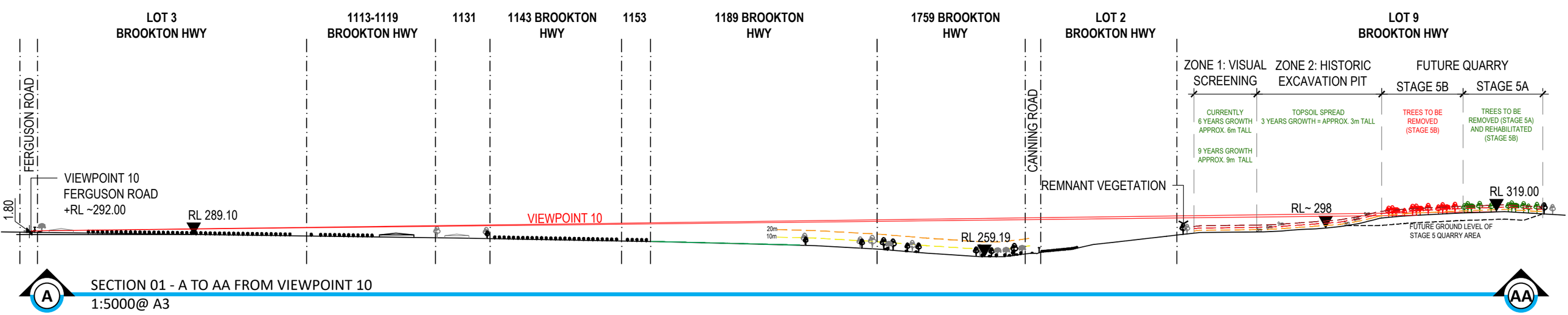
6.2.2.1 Viewpoint 10 (Plate 8)

This location is accessible by Ferguson Road, a minor access road off Brookton Highway and is representative of views of a number of existing residences to the west of the site will likely experience. The viewpoint is located approximately 1.8 km to the west of the site, and due to the lack of taller native vegetation between Ferguson Road and the site, stage 5 would be visible from this location. The 3D perspective photomontage shows:

- **Image 1:** Under current conditions, the stage 4 (existing) quarry area, represented by the bare mineral earth (orange-coloured), and extraction-related machinery is visible in the background. These features are partially hidden by the six-metre-tall vegetation associated with Zone 1 and the boundary planting. A black and blue conveyor belt within the site appears above the tree line.
- **Image 2:** Stage 5a extraction activities have commenced however is located behind vegetation associated with the uncleared stage 5b. Only partial glimpses of stage 5a is likely due to retained vegetation providing a screen. Application of topsoil within Zone 2 will blend existing bare mineral earth with surrounding native vegetation and granite outcrops. The planting within Zone 1 is currently 6 m high and conceals the lower westernmost portions of the existing quarry. This vegetation minimises the 'scar' in the forested tree line imposed by the previous vegetation clearing.
- **Image 3:** Closure of the stage 5a pit after 3 years and commencement of stage 5b extraction activities, with progressive topsoil spreading occurring within stage 5a. Planting within Zone 1 continues to increase in height and is now 9 m, and will assist with reducing the extent of the quarry face from stage 5b that is visible. Revegetation within Zone 2 provides a green cover blending the existing quarry so it is no longer visible, but does not provide any screening to stage 5a or 5b. Overall, the removal of vegetation from stage 5b creates a larger 'scar' in the jarrah and marri forested ridgeline, however the extent to which this is noticeable in the background is minimal due to the blending from the topsoil spread and rehabilitation activities.

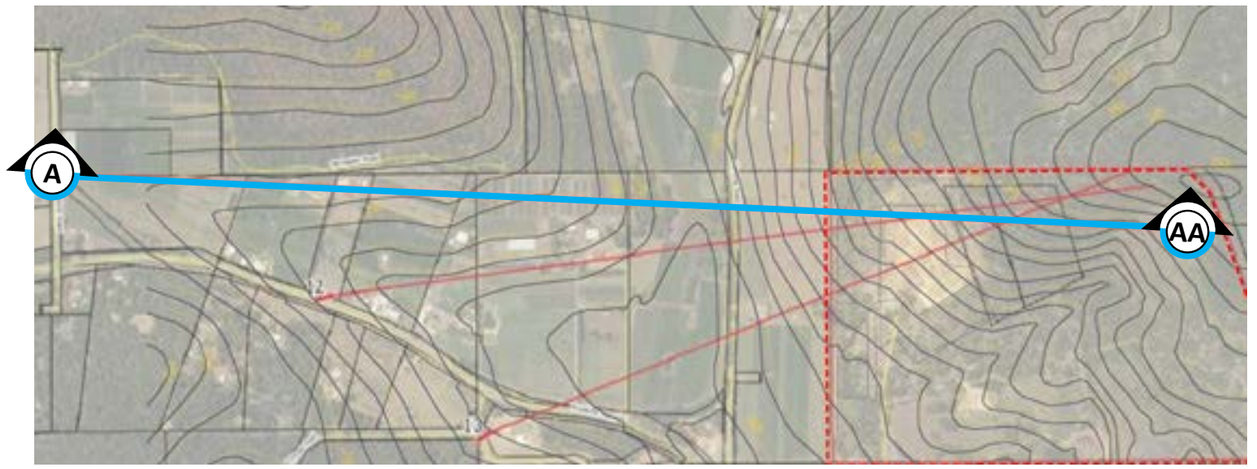
For this viewpoint, the rural LCU objective would apply, and with particular relevance to viewpoint 10, the objective will be maintaining the rural grassed hills and the natural backdrop of the Korong National Park and Midgegooroo National Park. This objective can be met with progressive topsoil spreading and revegetation of the extraction areas via direct seeding of local native species. This will enable the views of the current exposed quarry face to blend with the native vegetation in the midground and background. While stage 5b will be visible in the short to medium term, the visual impact will not be as prominent as the existing quarry area.

The 3D perspective photomontages and cross-sections for Viewpoint 10 are provided in **Plate 8.**



SECTION 01 - A TO AA FROM VIEWPOINT 10
1:5000@ A3

Image 1 - Existing site montage



Section location plan

Image 2 - Stage 5a quarry activities commenced
Photomontage of view assuming stage 5a excavation activities commenced, visual screening strip is at 6 years growth and topsoil spreading over revegetation areas.

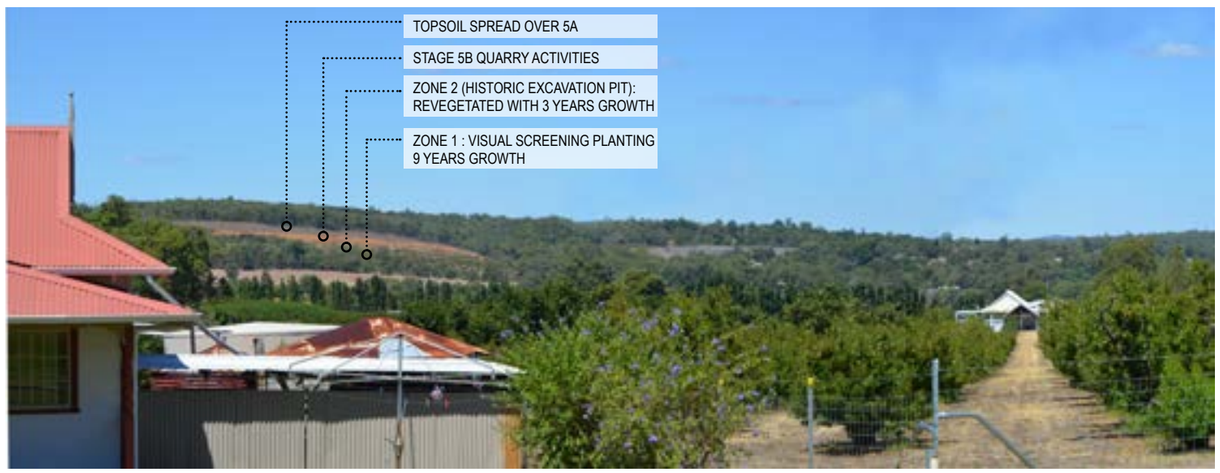


Image 3 - Stage 5b quarry activities commenced
Photomontage of view assuming topsoil spreading over 5a, stage 5b excavation activities commenced, visual screening strip at 9 years growth.

Vinci Quarry Visual Impact Assessment- Plate 8: Viewpoint 10
Sections and Montages

DWG **KA-VIA-01**
REV **C**
DATE **21.05.2021**

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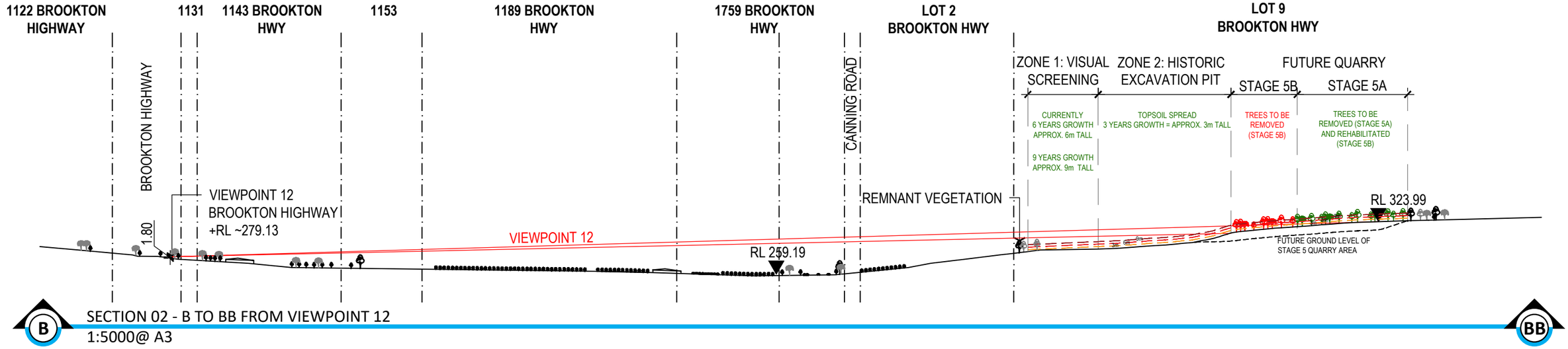
\\EMERGE-FS01\Emerge\Projects\CURRENT PROJECTS\ENVIRO\77-Karagullen VIA\XXX-01\Photos Drawings & Scans\XX-01\02_Concept Plans, Scans & Graphics\04 INDD\Karragullen VIA_Rev C.indd

6.2.2.2 Viewpoint 12 (Plate 9)

This location is accessible by users of Brookton Highway whilst driving in an easterly direction and is synonymous of views drivers may have when glimpsed through gaps in the existing vegetation. The viewpoint is located at 279 m AHD approximately 1.3 km to the west of the site. Whilst stands of remnant vegetation exists within residential landholdings, the quarry is situated on a ridgeline of higher elevation, and therefore stage 5 will be visible over the treetops from this location. The 3D perspective photomontage shows:

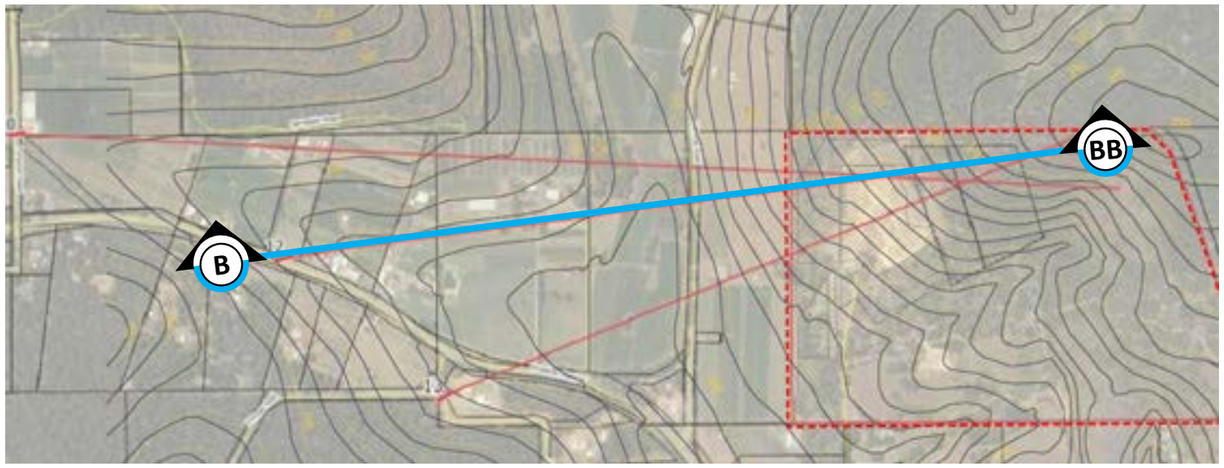
- **Image 1:** Under current conditions, the stage 4 (existing) quarry area, represented by the bare mineral earth (orange-coloured), and extraction-related machinery is visible in the background. These features are partially hidden by the six-metre-tall vegetation associated with Zone 1 and the boundary planting. A black and blue conveyor belt within the site appears above the tree line.
- **Image 2:** Stage 5a extraction activities have commenced however are located behind vegetation associated with the uncleared stage 5b. Only partial glimpses of stage 5a is likely due to retained vegetation providing a screen. Application of topsoil within Zone 2 will blend existing bare mineral earth with surrounding native vegetation and granite outcrops and existing planting within Zone 1 (6 m high) will conceals the lower westernmost portions of the existing quarry.
- **Image 3:** Closure of the stage 5a pit after 3 years and commencement of stage 5b extraction activities, with progressive topsoil spreading occurring within stage 5a. Planting within Zone 1 continues to increase in height and is now 9 m, and will assist with reducing the extent of the quarry face from stage 5b that is visible, however overall a larger area that is unvegetated will be visible compared to existing conditions. Revegetation within Zone 2 provides a green cover blending the existing quarry so it is no longer visible, and will provide some screening of stage 5b. Blending from the topsoil application in stage 5a will reduce visibility (and ongoing rehabilitation will also improve outcomes, as demonstrated in the cross but is not shown in the image).

For this viewpoint, the rural LCU objective would apply, and the visual mitigation objective will be equivalent to viewpoint 10, maintaining and protecting the rural grassed hills and the natural backdrop of the Korong National Park and Midgegooroo National Park. This objective can be achieved with the planting in Zone 1 and native revegetation areas in Zones 2 and Zone 3 (as it becomes established) minimising the extent of the quarry that will be visible and blending the previously excavated areas with the existing vegetation. The short to medium term view of the quarry will be similar to that of other cleared agricultural paddocks nestled in amongst areas of vegetation. The 3D perspective photomontages and cross-sections for Viewpoint 12 are provided in **Plate 9.**



SECTION 02 - B TO BB FROM VIEWPOINT 12
1:5000@ A3

Image 1 - Existing site montage



Section location plan

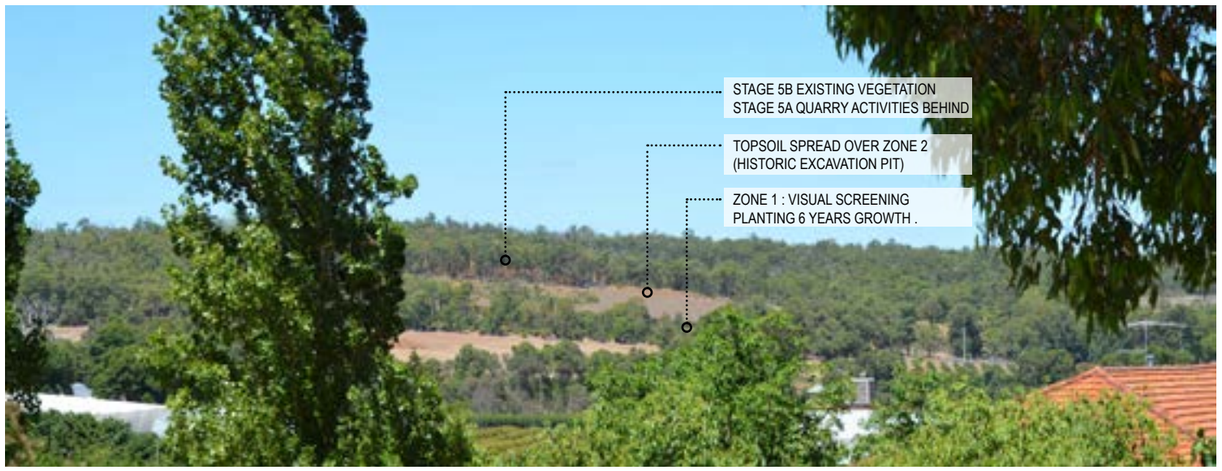


Image 2 - Stage 5a quarry activities commenced
Photomontage of view assuming stage 5a excavation activities commenced, visual screening strip is at 6 years growth and topsoil spreading over revegetation areas.

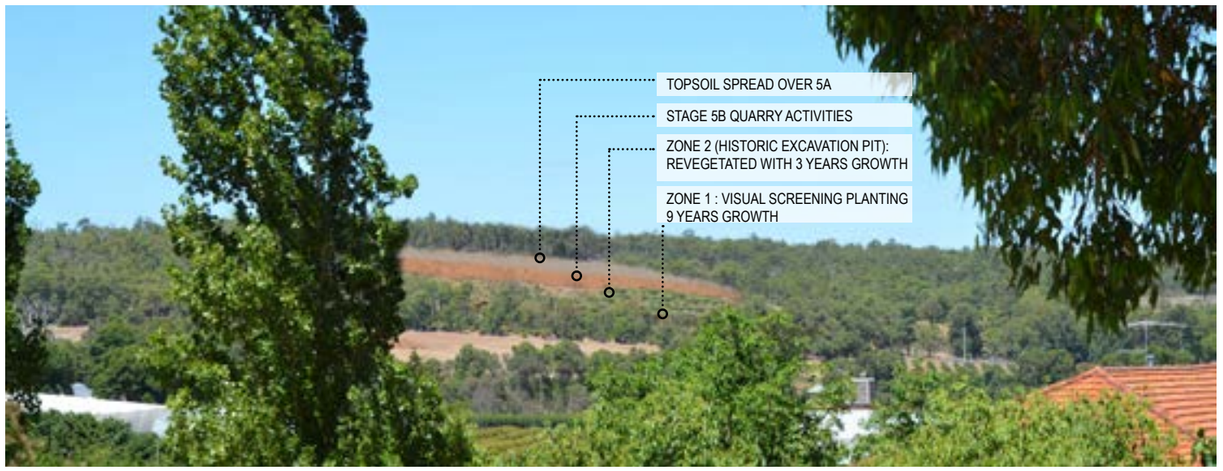


Image 3 - Stage 5b quarry activities commenced
Photomontage of view assuming topsoil spreading over 5a, stage 5b excavation activities commenced, visual screening strip at 9 years growth.

Vinci Quarry Visual Impact Assessment- Plate 9: Viewpoint 12
Sections and Montages

DWG **KA-VIA-02**
REV **C**
DATE **21.05.2021**

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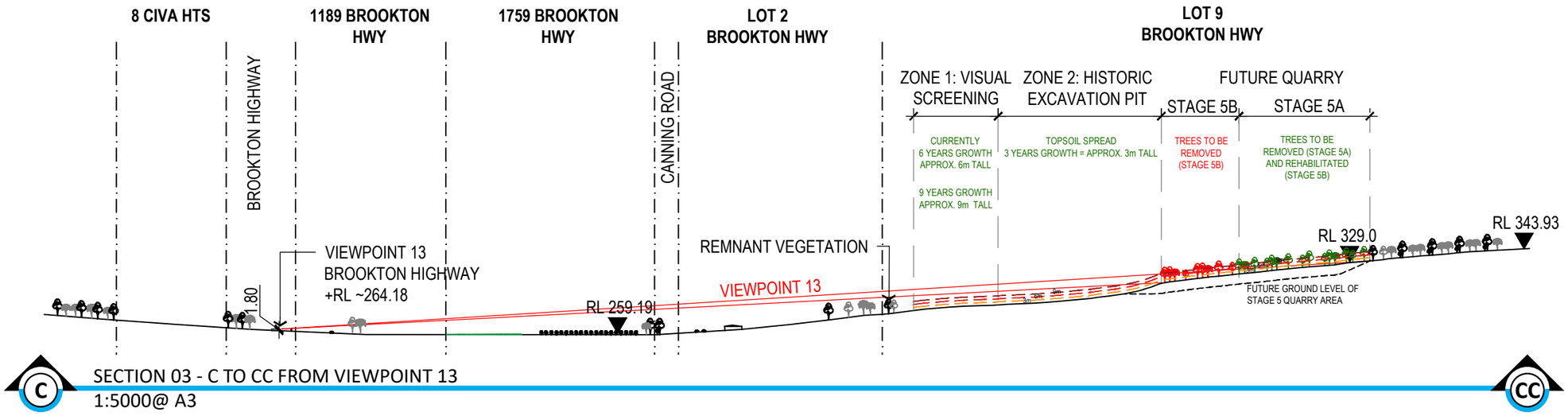
6.2.2.3 Viewpoint 13 (Plate 10)

This location is accessible from Brookton Highway off Civa Heights whilst driving in an easterly direction. The viewpoint is located at 273 m AHD approximately 1 km to the south-west of the site. While existing vegetation within the Brookton Highway and Canning Road reserves conceals the majority of the existing quarry from view, stage 5 may be visible over the treetops located at a higher elevation. The 3D perspective photomontage shows:

- **Image 1:** Under current conditions, only glimpses of the existing quarry are visible in the middle ground and are largely hidden by existing remnant vegetation present within the site along the property boundary and within residential lots in front of the site. While the viewer is closer, the quarry is considerably less prominent in this location than at Viewpoints 10 and 12.
- **Image 2:** Stage 5a extraction activities have commenced however are located behind vegetation associated with the uncleared stage 5b. Only partial glimpses of stage 5a is likely due to retained mature vegetation providing a screen. The glimpses of the existing quarry are further blended through the application of topsoil.
- **Image 3:** Closure of the stage 5a pit after 3 years and commencement of stage 5b extraction activities, with progressive topsoil spreading occurring within stage 5a. The quarry face will be more visible once the vegetation associated with stage 5b is removed, with rehabilitation/planting associated with Zone 1 and Zone 2 have minimal impact. Blending from the topsoil application in stage 5a will reduce visibility of the cleared area and look like a granite outcrop type feature (and ongoing rehabilitation will also improve outcomes, as demonstrated in the cross but is not shown in the image).

For this viewpoint, the natural and rural LCU objective would apply, and maintaining and protecting the presence of the jarrah and marri forested ridgeline will be important and will help draw the viewer's eye. This objective can be met through the progressive revegetation of the extraction areas (particularly stage 5a and 5b). The 3D perspective photomontages and cross-sections for Viewpoint 12 are provided in **Plate 10**

Overall, there will be short-to-medium term visual impacts associated with the stage 5 quarry expansion area, however staging of works (and starting at the easternmost point) will reduce the prominence of the quarry for however long it takes to complete stage 5a, while progressive topsoil application and rehabilitation will reduce the prominence of stage 5b. Rehabilitation/planting associated with Zone 1 and Zone 2 will be beneficial for mid-to-distant views, while rehabilitation of stage 5a will help minimise impacts for near views. Based on the measures outlined within **Section 6.1** and shown within the 3D perspective photomontages within **Plate 8** to **Plate 10**, the visual quality of both the existing rural and natural landscape can be maintained and protected, therefore the landscape objectives outlined within **Section 4.1** can be achieved.



SECTION 03 - C TO CC FROM VIEWPOINT 13
1:5000@ A3

Image 1 - Existing site montage

Section location plan

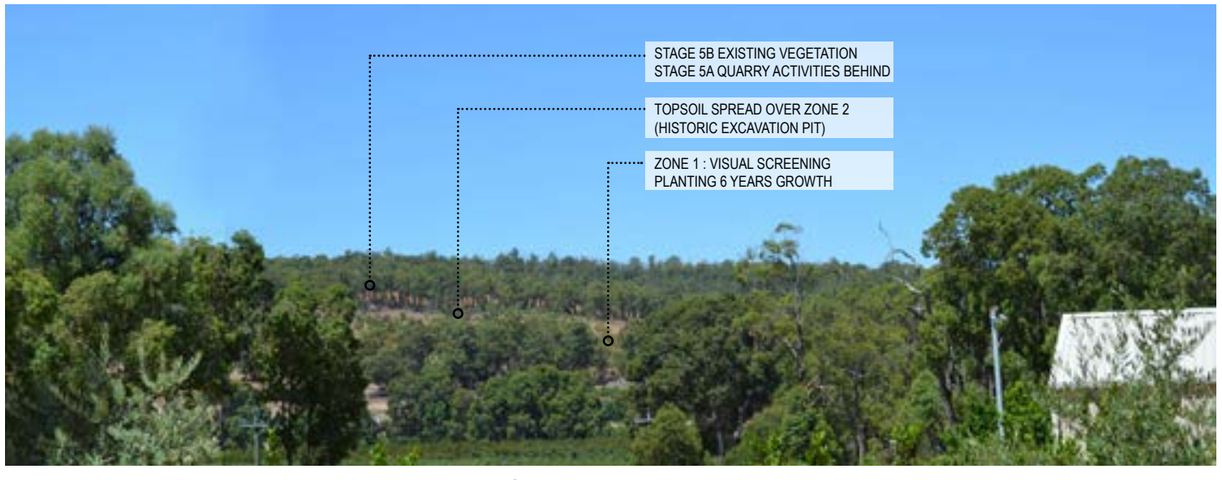


Image 2 - Stage 5a quarry activities commenced
Photomontage of view assuming stage 5a excavation activities commenced, visual screening strip is at 6 years growth and topsoil spreading over revegetation areas.

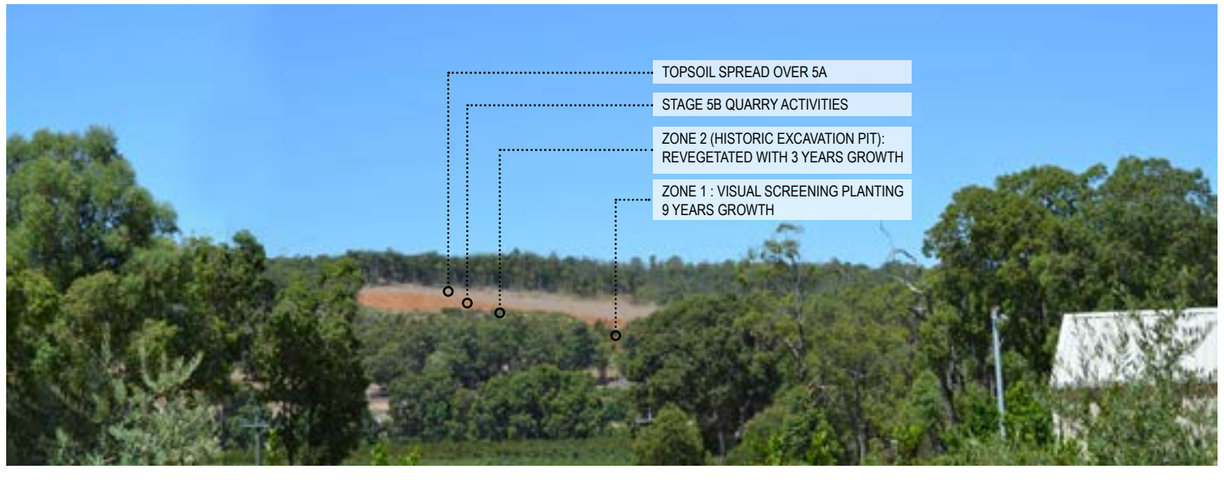


Image 3 - Stage 5b quarry activities commenced
Photomontage of view assuming topsoil spreading over 5a, stage 5b excavation activities commenced, visual screening strip at 9 years growth.

Vinci Quarry Visual Impact Assessment- Plate 10: Viewpoint 13
Sections and Montages

DWG **KA-VIA-03**
REV **C**
DATE **21.05.2021**

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7 Conclusion

Vinci Gravel Supplies Pty Ltd (the proponent) proposes to expand their existing gravel quarry at Lot 9 Brookton Highway, Karragullen. The site is 48.23 hectares in size and is located within the City of Armadale (CoA) municipality, 15 kilometres east of Armadale town centre.

The CoA have asked the proponent to demonstrate that there will be no adverse amenity impacts on nearby land uses. Accordingly, this VIA has been prepared to determine the likely visual impact of the proposed quarry expansion on the existing views within the surrounding Armadale Hills landscape and has used a number of the methods outlined within the Visual Landscape Manual (WAPC 2007) to assess the visual impact and recommended management measures. The VIA specifically:

- Identifies the existing visual landscape characteristics of the site (prior to any works) and identifies visual landscape objectives.
- Identifies and maps the proposed expansion in the context of the existing landscape.
- Outlines visual design strategies for the proposed expansion.
- Assesses the visual impact created by the proposed expansion, through a viewshed analysis and site assessment, determining key views with regard to existing landform and vegetation that require further assessment/consideration.
- Outlines visual management measures that could be used to minimise visual impacts and provides an assessment of these management measures through the use of photomontages and cross-sections.

It is important to note, that the VIA process and associated development design has been undertaken in consultation with the CoA and feedback provided during the preparation of this VIA has been adopted throughout the process.

The desktop and site assessment identified that the existing quarry is visible and that stage 5 (particularly stage 5b) may be visible at times by users driving along Brookton Highway in an easterly direction (depending on location) when climbing a soft ridgeline in front of the site, and from residences to the west that are located on a small ridge with existing cleared agricultural landscapes providing views towards the site. Stage 5 will not be visible from Brookton Highway to users south of the site and Canning Road users to the north of the site, due to the presence of dense vegetation within landholdings and road reserves (in addition to vegetation retained within the site). Due to a valley landform and the height and form of existing vegetation, stage 5 will also not be visible from the scenic Munda Biddi Cycle Track to the east of the site, Springdale Road walking trail and vehicle access tracks to the north west of the site.

The assessment of the proposed management measures, as shown within the cross-sections and photomontages, indicates that there will be short-to-medium term visual impacts associated with the stage 5 quarry expansion area, however staging of works (and starting at the easternmost point) will reduce the prominence of the quarry for however long it takes to complete stage 5a, due to existing vegetation providing screening to the new quarry face. Progressive topsoil application and/or rehabilitation and planting in Zones 1 (visual screening to internal haul road/access track), Zone 2 (existing quarry area) and Zone 3 (stage 5a and 5b) will reduce the prominence of stage 5,

particularly stage 5b, over time. Rehabilitation/planting associated with Zone 1 and Zone 2 will be beneficial for mid-to-distant views, while rehabilitation of stage 5a will help minimise impacts for near views as stage 5b is being progressed. In general, the visual impact of the proposed stage 5 expansion will be synonymous with openings of a natural appearance associated with wetlands, granite outcrops and cleared paddocks, through the progressive rehabilitation of previously excavated stages.

Based on the existing landform and vegetation and proposed management measures, the existing visual quality of both the rural and natural landscape character units can be maintained and protected in the long-term and short-to-medium term impacts can be minimised, achieving the objectives determined for this VIA.

8 References

8.1 General references

City of Armadale 2000, *Extractive Industries Local Law*.

City of Armadale 2016, *City of Armadale Local Planning Strategy - Town Planning Scheme No. 4*, Armadale

Emerge Associates 2020b, *Level 1 Fauna Assessment Lot 9 Brookton Highway, Karragullen*, EP20-040(04)--003 MS, Version 1.

Emerge Associates 2021a, *Detailed Flora and Vegetation Survey - Lot 9 Brookton Highway, Karragullen*, EP20-040(04)--002 RAW, Version 1.

Emerge Associates 2021b, *Environmental Management Plan - Lot 9 Brookton Highway, Karragullen* EP20-040(12)--007 BRB, 1.

Emerge Associates 2021c, *Targeted Black Cockatoo Assessment Lot 9 Brookton Highway, Karragullen*, EP20-040(05)--009 SCM, Version 1.

Lloyd George Acoustics 2021, *Vinci Quarry Expansion Stage 5 Noise Assessment - Lot 9 Brookton Highway, Karragullen*, 20115962-01.docx, Rev 0.

Western Australian Planning Commission (WAPC) 2007, *Visual Landscape Planning in Western Australia - a manual for evaluation, assessment, siting and design*, Perth.

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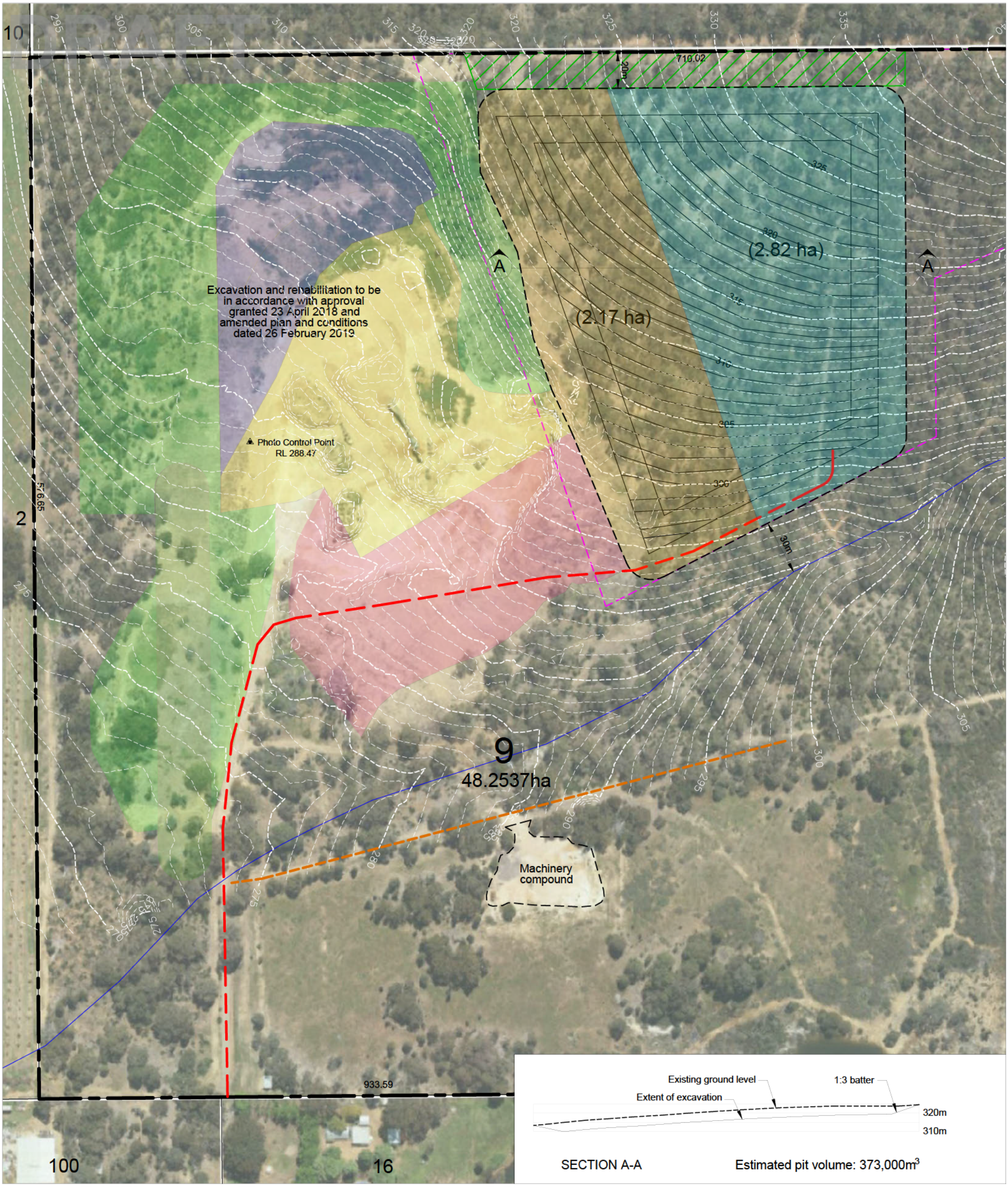
Appendix A

Proposed staging plan



LEGEND

- Subject site
- Extent of gravel resource
- Existing contours (1m interval)
- Existing gravel driveway
- Existing creekline

2019 Approved areas:

- Revegetation commitment
- Extraction area
- Rehabilitation area
- Direct seeded area
- Visual screen planting

Proposed areas:

- Proposed extraction area
- Stage 1 extraction area
- Stage 2 extraction area
- Retained vegetation buffer
- Proposed access track
- Proposed finished level

DEVELOPMENT SITE PLAN
PROPOSED EXTRACTION AREAS

Lot 9 on D042350, Brookton Highway, Karagullen

Date: 3 February 2021 Scale: 1:2000 @ A3 File: 20-112 PL2A Staff: AL / LC Checked: AL

0 50m

element.
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Appendix B

Planting list for revegetation areas

Table B1: Revegetation plant species list

Form	Species	
Groundcovers	*Hardenbergia comptoniana* *Kennedia coccinea* *Orthrosanthus laxus* *Dampiera linearis*	*Burchardia congesta* *Clematis pubescens* *Kennedia prostrata* *Conostylis aculeata*
Shrubs	*Allocasuarina humilis* *Calothamnus quadrifidus* *Hakea amplexicaulis* *Hakea lissocarpha* *Mirbelia dilatata* *Hakea petiolaris*	*Acacia drummondii* *Acacia huegelii* *Acacia preissiana* *Hemiandra pungens* *Hibbertia racemosa* *Acacia lateriticola* *Acacia pulchella*
Trees	*Eucalyptus patens* *Eucalyptus lane-poolei* *Eucalyptus laeliae*	*Eucalyptus wandoo* *Corymbia calophylla*