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**HOLCIM (AUSTRALIA) PTY LTD
HOLCIM JANDABUP QUARRY BANKSIA WOODLANDS TEC
AND BLACK COCKATOO SURVEY**

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0	A. Craigie, S. Plant	S. Grein	04/02/2025	S. Grein	J. Moro	04/02/2025

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ecologia Environment
463 Scarborough Beach Rd
OSBORNE PARK WA 6017
Phone: 08 6168 7200
Email: admin@ecologia.com.au

EXECUTIVE SUMMARY

Holcim (Australia) Pty Ltd (Holcim) is keen to understand its position with respect to vegetation clearing under the State and Commonwealth for current and future activities within at the Jandabup sand quarry (mining leases M70/1248 and M70/1250, and pending tenements M70/1247 and M70/1249), which are primarily within pine plantation or cleared plantation with some natural regrowth. The survey area covers 670 ha and is approximately 5 km east of Wanneroo, and approximately 23 km north of Perth, Western Australia. Ecologia Environment (*ecologia*) was engaged by Holcim to conduct a black cockatoo habitat assessment and a Banksia Woodland TEC assessment of the remaining vegetation to determine their presence within the survey area. The field assessment was undertaken from the 1st to 2nd of October 2024.

Banksia Woodlands TEC Assessment

The Banksia Woodlands TEC Assessment was carried out in accordance with the *Approved Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain ecological community* (Threatened Species Scientific Committee, 2016). A single patch of woodland in good to very good condition within the survey area corresponded to the EPBC Act listed *Banksia* Woodlands of the Swan Coastal Plain TEC. This patch occurred in the southeast of M70/1250 and along the western edge of M70/1249 and accounted for 1% (6.73 ha) of the survey area. The remaining vegetation consisted of degraded plantation, regrowth, and revegetation, which did not correspond with the TEC.

Black Cockatoo Assessment

An assessment was undertaken to investigate potential breeding habitat, night roosting habitat, and foraging habitat for the three black cockatoo species with the potential to occur within the survey area. Three forest red-tailed black cockatoos were recorded overflying the survey area during the field survey. No potential habitat trees (> 500 mm DBH without suitable hollows) were recorded within the survey area.

The quality of black cockatoo foraging habitat within the survey varied from ‘higher quality’ to ‘low quality’ or cleared. One patch of remnant *Banksia* woodland and three patches of rehabilitated marri (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*) woodland were assessed as ‘higher quality’, and three patches of pine plantation were assessed as ‘moderate quality’ foraging habitat. No evidence of foraging activity was recorded during the survey despite observations of the species overflying the site. Given the absence of trees with suitable breeding hollows, it is unlikely that black cockatoos are currently utilising trees within the survey area as breeding or roosting habitat.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

Holcim is keen to understand its position with respect to vegetation clearing under the State and Commonwealth for current and future activities in relation to remaining pine plantation (now protected as a habitat for black cockatoos) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed '*Banksia Woodlands of the Swan Coastal Plain*' Threatened Ecological Community ('*Banksia Woodlands TEC*' or '*TEC*'). Mining leases M70/1248 and M70/1250 (totalling 469 ha) and pending M70/1247 and M70/1249 at Holcim's Jandabup sand quarry are currently located within areas of pine plantation or cleared plantation with some natural regrowth occurring (Map 1). To better understand the ecological value of the pine plantation to black cockatoos or whether any regrowth areas constitute the *Banksia Woodland TEC*, Holcim required the area to be surveyed for black cockatoos along with an assessment of the remaining vegetation to determine whether the *Banksia Woodland TEC* occurs and needs to be included in any State and Commonwealth referral. Pine plantation/and regrowth is considered potential foraging habitat for black cockatoos. Ecologia Environment (*ecologia*) was engaged by Holcim to undertake a *Banksia Woodlands TEC* assessment and black cockatoo habitat assessment at the Jandabup sand quarry.

The Jandabup sand quarry survey area (mining leases M70/1248, M70/1250 and pending tenements M70/1247, M70/1249) (the 'survey area') covers approximately 670 hectares (ha) of native vegetation, road, road verge, quarry and associated infrastructure (Map 1). The survey area is located approximately 23 km north of Perth in Western Australia (WA), and occurs within the Swan Coastal Plain IBRA region (DSEWPac, 2012).

1.2 SCOPE OF WORK

Holcim engaged *ecologia* to undertake an assessment of the *Banksia Woodlands TEC* and of black cockatoo habitat of the Jandabup sand quarry survey area. The assessments were to be undertaken in accordance with the following guidelines:

1. Approved Conservation Advice (incorporating listing advice) for the *Banksia Woodlands of the Swan Coastal Plain* ecological community (Threatened Species Scientific Committee, 2016).
2. Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016).
3. Referral Guidelines for 3 WA Threatened Black Cockatoo Species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black-cockatoo (DAWE, 2022).

Map 1: Location of the survey area.

2 METHODOLOGY

2.1 BANKSIA WOODLANDS TEC ASSESSMENT

2.1.1 Survey Timing

The *Banksia* Woodlands TEC assessment was conducted by an *ecologia* botanist from 1 – 2 October 2024. The survey was completed in accordance with the *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016) and the *Approved Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain ecological community* (Threatened Species Scientific Committee, 2016), primarily by sampling vascular plant species within quadrats.

2.1.2 Field Survey

Sampling site locations were selected using a combination of aerial photography, topographic features, land system mapping, pre-European vegetation mapping, and field observations, to represent all areas of potential *Banksia* woodlands within the survey area. 10 m x 10 m quadrats were sampled in all patches of potential *Banksia* Woodlands TEC. Less intensive vegetation descriptions were sometimes done in areas that were unlikely to or did not represent the TEC. Ten quadrats and five vegetation description sites were assessed within the survey area.

The following attributes were recorded from each quadrat:

- Site code.
- GPS coordinate of all corners.
- Photograph from the north-west corner.
- A comprehensive species list (including introduced species) and the dominant height class (ESCAVI, 2017) and estimated percentage foliage cover (using a variant of the Domin scale) of each species (< 1%, 1-4%, 5-9%, 10-24%, 25-32%, 33-49%, 50-74%, 95-100%).
- Vegetation condition according to EPA (2016) (adapted from Keighery (1994)) (Table 1) and description of disturbance.
- Additional information to assist vegetation characterisation, including landform, slope, soil type, surface geology, and fire history.

2.1.3 Specimen Identification

Specimen identification was undertaken with reference to current taxonomic literature and herbarium reference specimens. Scientific names used in this report follow the species concepts currently adopted by the Western Australian Herbarium. Specimens that could not be adequately identified to genus or species level due to the absence of reproductive material required for positive identification were indicated with a query but were not considered to be otherwise anomalous.

2.1.4 Vegetation characterisation and mapping

Patches of the *Banksia* Woodlands TEC were identified from floristic quadrat data using the criteria outlined below in Section 2.1.5, and other non-TEC vegetation types were described according to dominant species and structural features. Vegetation was mapped using ground-truthed site data and aerial imagery. For the TEC, consideration was given to condition thresholds, minimum patch size given vegetation condition, and small-scale gaps (< 30 m) between examples of the community.

2.1.5 Identifying the *Banksia* Woodlands of the Swan Coastal Plain TEC

A number of key diagnostic characteristics are used to define the Banksia Woodlands of the Swan Coastal Plain ecological community, which are outlined in *Banksia Woodlands of the Swan Coastal Plain Approved Conservation Advice* (Threatened Species Scientific Committee, 2016). These are summarised below, and were used to determine whether patches of vegetation, represented by quadrat and other sampling site data, corresponded with the TEC.

Key Diagnostic Characteristics

Location

- Swan Coastal Plain IBRA bioregion (SWA01, SWA02), and extending into the Jarrah Forest Bioregion (JAF01, JAF02).

Soils and Landform

- Well drained, low nutrient soils on sandplains - Bassendean and Spearwood sands and occasionally on Quindalup sands; it is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau, and in other less common scenarios.

Structure

- The community is typically a woodland (although it may occur as a shrubland, open woodland or forest) with a distinctive upper sclerophyllous layer of low trees typically dominated or co-dominated one or more diagnostic *Banksia* species (below), with at least 2% canopy cover of those species.
- Emergent trees of medium or tall (>10 m) eucalypts (typically *Corymbia calophylla*, *Eucalyptus gomphocephala*, or *Eucalyptus marginata*) or *Allocasuarina* may be present above the *Banksia* canopy.
- An often highly species-rich understorey of shrubs and herbs.

Composition

- The canopy is most commonly dominated by *Banksia attenuata*, *Banksia menziesii*, *Banksia prionotes*, or *Banksia ilicifolia*, and must include at least one of these species.
- If present, the emergent tree layer often includes *Corymbia calophylla*, *Eucalyptus marginata*, *E. gomphocephala*; lower trees often include *Eucalyptus todtiana*, *Nuytsia floribunda*, *Allocasuarina fraseriana*, *Callitris arenaria*, *Callitris pyramidalis*, and *Xylomelum occidentale*.

Patch Condition

A patch must meet at least the 'Good' condition category (Keighery 1994), typically with at least 'low' native plant species diversity (relative to the expected range of diversity for that vegetation unit, where comparative data exists) and weeds at 5-50% cover. Patches that do not meet the minimum condition thresholds are excluded from national protection.

For this assessment, mean species richness of patches in the survey area will be compared to Floristic Community Type (FCT) 23b of Gibson et al. (1994): Northern *Banksia attenuata* – *B. menziesii* woodlands, which is likely to be a comparable community to any *Banksia attenuata* or *B. menziesii* woodland within the survey area.

Minimum Patch Size Threshold

To be part of the TEC, minimum patch sizes apply based on vegetation condition (Keighery 1994): ‘Pristine’ (no minimum patch size); ‘Excellent’ (minimum of 0.5 ha); ‘Very Good’ (minimum of 1 ha); ‘Good’ (minimum of 2 ha).

Additional Considerations

- A patch is a discrete and mostly continuous area of the ecological community and may include small-scale (<30 m) variations, gaps and disturbances, such as tracks, paths or breaks.
- Variation in canopy cover, quality or condition of vegetation across a patch should not initially be considered evidence of multiple patches.
- The community is highly diverse and variable; the composition often changes across the patch, but structure and the presence of a significant *Banksia* component are unifying features.
- Restored (revegetated or replanted) sites are not excluded from the listed community.

Table 1. Vegetation condition scale.

Vegetation condition	Criterion
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. 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. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, 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. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, 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 and shrubs.

2.2 BLACK COCKATOO HABITAT ASSESSMENT

Three Threatened species of black cockatoo listed under both the EPBC Act and the BC Act occur within the south-west of Western Australia (Table 2). The Department of Agriculture, Water and the Environment (DAWE) *Referral Guideline for 3 WA Threatened Black Cockatoo Species* (DAWE, 2022) provide modelled distributions for the three species of black cockatoo, including breeding areas, with the survey area intersecting the modelled distribution for all three species.

The DAWE *Referral Guideline for 3 WA Threatened Black Cockatoo Species* (DAWE, 2022) recommend ‘habitat assessments’ as the primary method to inform decisions on the potential for significant impact for black cockatoos as short-term surveys for bird presence are unlikely to give a true representation of habitat use. Targeted black cockatoo habitat assessments should be undertaken in areas within the range focusing on key criteria such as foraging, roosting and breeding. Details on habitat types used by each black cockatoo species for breeding, foraging and night roosting are provided in Table 3. Known breeding and night roosting trees for black cockatoos are generally large with a diameter at breast height (DBH) of at least 500 mm, or 300 mm for salmon gum and wandoo (DAWE, 2022).

Table 2: Status of black cockatoos occurring within the south-west.

Common name	Taxon	EPBC Act	BC Act
Forest red-tailed black cockatoo	<i>Calyptorhynchus banksii naso</i>	Vulnerable	Vulnerable
Baudin’s cockatoo	<i>Zanda baudinii</i>	Endangered	Endangered
Carnaby’s cockatoo	<i>Zanda latirostris</i>	Endangered	Endangered

Table 3: Habitats used by black cockatoos (DAWE, 2022).

Habitat	Baudin's cockatoo	Carnaby's cockatoo	Forest red-tailed black cockatoo
Breeding	Generally, in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Karri (<i>Eucalyptus diversicolor</i>), Marri, Jarrah, Wandoo, Bullich (<i>E. megacarpa</i>) and Tuart.	Generally, in woodland or forest, but also breeds in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Salmon Gum, Wandoo, Tuart, Jarrah, Flooded Gum (<i>E. rudis</i>), York Gum, Powderbark (<i>E. accedens</i>), Karri and Marri.	Generally, in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly Marri, Karri, Wandoo, Bullich, Blackbutt (<i>E. patens</i>), Tuart and Jarrah.
Night roosting	Generally, in or near riparian environments or other permanent water sources. Any tall trees may provide roosting habitat, but particularly Jarrah, Flooded Gum, Blackbutt, Tuart and introduced eucalypts (Blue Gum (<i>E. globulus</i>), Lemon Scented Gum (<i>Corymbia citriodora</i>).	Generally, in or near riparian environments or natural and artificial permanent watersources. Any tall trees may provide roosting habitat, but particularly Flat-topped Yate (<i>E. occidentalis</i>), Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts and introduced pines.	Any tall trees may provide roosting habitat, but particularly tall Jarrah, Marri, Blackbutt, Tuart and introduced eucalypt trees or large trees on the edges of forests.
Foraging and common food items	Primarily seeds of Marri, rarely Jarrah, in woodlands and forest, and seeds of native proteaceous plant species (for example, <i>Banksia</i> spp. (includes <i>Dryandra</i> spp.) and <i>Hakea</i> spp.). During the breeding season feed primarily on native vegetation, particularly Marri (seeds, flowers, nectar and grubs). Also insects and insect larvae; pith of Kangaroo Paw (<i>Anigozanthos flavidus</i>); tips of <i>Pinus</i> spp.; <i>Macadamia</i> spp., almonds and pecans; seeds of apples and pears; and persimmons.	Native shrubland, kwongan heathland and woodland on seeds, flowers and nectar of native proteaceous plant species (<i>Banksia</i> spp., <i>Hakea</i> spp. and <i>Grevillea</i> spp.), as well as <i>Callistemon</i> spp. and Marri. Also seeds of introduced species including <i>Pinus</i> spp., <i>Erodium</i> spp., wild radish, canola, almonds, macadamia and pecan nuts; insects and insect larvae; occasionally apples and persimmons; and liquidambar.	Primarily seeds of Jarrah and Marri in woodlands and forest, and edges of Karri forests, including Wandoo and Blackbutt. Forages on <i>Allocasuarina</i> cones, fruits of Snottygobble (<i>Persoonia longifolia</i>) and Mountain Marri (<i>C. haematoxylon</i>). Other less important foods include Blackbutt, Bullich, <i>Allocasuarina fraseriana</i> , <i>Hakea</i> spp., Tuart, Redheart Moit (<i>E. decipiens</i>) and Bushy Yate (<i>E. lehmanni</i>). Also some introduced eucalypts such as River Red Gum (<i>E. camaldulensis</i>) and Rose Gum (<i>E. grandis</i>). On the Swan Coastal Plain, often feeds on introduced Cape Lilac (<i>Melia azedarach</i>), <i>E. caesia</i> , <i>E. erythrocorys</i> , Lemon-scented Gum and Kaffir Plum (<i>Harpephyllum caffrum</i>).

2.2.1 Breeding Habitat

The DAWE *Referral Guideline for 3 WA Threatened Black Cockatoo Species* (DAWE, 2022) define breeding habitat as habitat that contains known, suitable or potential nesting trees, including:

- Known nesting trees: Trees (live or dead but still standing) which contain a hollow/s where black cockatoo breeding has been recorded or which demonstrate evidence of breeding (i.e. showing evidence of use through scratches, chew marks or feathers).
- Suitable nesting trees: Trees with suitable nesting hollows present, although no evidence of use.
- Potential nesting trees: Trees that have a suitable DBH to develop a nest hollow, but do not currently have hollows. Trees suitable to develop a nest hollow in the future are 300-500mm DBH.

The DAWE referral guidelines define suitable nesting hollows as any hollow with dimensions suitable for use for nesting by black cockatoos (DAWE, 2022). Trees which contain deep, near vertical hollows with an entrance diameter of >100 mm and are >10 m high are classified as suitable for use by black cockatoos (Whitford, 2002; Whitford & Williams, 2002).

Suitability of each breeding habitat tree identified was assessed from ground level and breeding habitat trees were categorised using the definitions within Table 4. For trees with a suitable DBH which are functionally capable of supporting a nest hollow, the following information was recorded:

- Fauna habitat.
- Fauna species.
- Flora species.
- DBH.
- Hollow suitability category (as per Table 4).
- Location (using a Global Positioning System [GPS]).
- Photographs of any trees classified as category 1, 2 or 3.

Trees with DBH > 500 mm which were deemed functionally unable to support a nest hollow (e.g. trees that branch into multiple thin trunks with DBH <500 mm within a metre of breast height or trees with completely hollowed out trunks), were excluded at the discretion of the recorder.

Table 4: Breeding habitat tree categories.

Tree Category	Description
Known nesting tree	Tree with suitable DBH which contains hollows where breeding has been recorded or evidence of breeding (scratches, chew marks or feathers)
Suitable nesting tree (confirmed)	Trees with suitable DBH which contains suitable nesting hollows, although no evidence of use (confirmed). Internal characteristics assessed.
Suitable nesting tree (unconfirmed)	Trees with suitable DBH which contains suitable nesting hollows, although no evidence of use visible from ground level. Internal characteristics not assessed.
Potential nesting tree	Trees with suitable DBH containing unsuitable nest hollows or no visible hollows. Note – multiple stemmed trees that branch above DBH may not be suitable.

2.2.2 Roosting Habitat

Black cockatoo flocks show strong fidelity to night roosts. Generally, these roost trees are close to high-quality foraging sites and important water sources. According to DAWE (2022) night roosting habitat is classified as habitat that contains one, or a group of, known or potential roosting trees, including:

- Known roosting tree: a tree (generally the tallest), native or introduced, known to be used for night roosting or which demonstrates evidence of roosting. Usually close to an important water source and within an area of high-quality foraging habitat
- Potential roosting tree: a tall tree of any species within close proximity to water.

2.2.3 Foraging Habitat

Black cockatoos rely on foraging resources to provide sufficient energy for their movements across their range and the availability of foraging habitat plays a critical role in the post-breeding period when individuals need to build condition after breeding, and teach juveniles where foraging resources are located (Commonwealth of Australia, 2017).

The DAWE referral guidelines define foraging habitat as any vegetation containing plant species known to support foraging **Error! Reference source not found.** within the range of each black cockatoo species (DAWE, 2022).

Habitat assessments and associated field observations must be sufficient to complete the scoring tool, provide justification for scores given to each attribute and support overall appraisal of foraging habitat quality (DAWE, 2022). This tool only applies to foraging areas >1 ha in size, as clearing of foraging habitat <1 ha in size is unlikely to require referral.

The survey area was traversed by foot and food sources known to be utilised by black cockatoos were identified and quantified in both the overstorey and understorey in order to complete the DAWE foraging quality scoring tool. A concurrent flora and vegetation assessment of the survey area facilitated this assessment. Specific effort was made to document sightings of black cockatoos in addition to evidence of chew marks around hollows or feeding debris (including characteristically chewed *Banksia* or pinecones and marri nuts). As feeding debris can remain on the ground for up to two years, foraging evidence can be assessed at any time of year (DAWE, 2022).

2.3 STUDY TEAM AND LICENCES

The personnel undertaking this assessment and project roles are listed in Table 5.

Table 5: Project staff and licences.

Project staff				
Name	Qualification	Role	Project role	Experience
Shaun Grein	B.App. Sc (Biol.); Grad. Dip. Nat. Resources; MBA	Managing Director/Senior Principal Scientist	Project management, QA	30+
Andrew Craigie	B.Sc (Hons.) (Botany); PhD (Botany)	Principal Botanist and Taxonomist	Specimen identification, reporting	15+
Sam Plant	B.Sc Cons. Biol. & Zool.; MWildlifeHth; Cert II Cons. Land Mgmt.	Zoologist	Field survey, reporting, GIS	5+
Amelia Shepherson	B.Sc. (Botany)	Level 1 Botanist	Field survey, specimen identification	2+
Licences				
Amelia Shepherdson	Flora Taking (Biological Assessment) Licence: FB62000723 (exp. 28/08/2025)			

2.4 LIMITATIONS AND CONSTRAINTS

An assessment of survey-specific issues and limitations is detailed in Table 6 for the flora and vegetation survey and Table 7 for the fauna survey. There were no significant limitations identified for either survey.

Table 6: Flora and vegetation survey limitations.

Aspect	Assessment	Constraint
Competency/experience of the team carrying out the survey, including experience in the bioregion surveyed	Key personnel leading the field survey, undertaking specimen identification, TEC identification mapping, and reporting have sufficient experience with flora and vegetation surveys in the Swan Coastal Plain IBRA bioregion.	Nil
Proportion of flora recorded and/or collected, any identification issues	Representative specimens of all taxa recorded in the field were collected for confirmation within sampling sites. Some specimens could not be identified to species level due to a lack of required reproductive material, but these did not have any impact on the confirmation of TEC.	Nil
Was the appropriate area fully surveyed (effort and extent)	The appropriate area was fully surveyed.	Nil
Access restrictions within the survey area	There were no significant access restrictions.	Nil
Survey timing, rainfall, season of survey	The survey was undertaken during the appropriate season for the bioregion.	Nil
Disturbance that may have affected the results of survey such as fire, flood or clearing	No significant limitations identified.	Nil

Table 7: Fauna survey limitations.

Aspect	Assessment	Constraint
Competency/experience of the consultant carrying out the survey.	The zoologist undertaking the fauna survey has more than five years of experience conducting terrestrial vertebrate fauna surveys in Western Australia.	Nil
Scope (what faunal groups were sampled and were some sampling methods not able to be employed because of constraints such as weather conditions).	A black cockatoo habitat assessment was undertaken as per the project scope.	Nil
Proportion of fauna identified, recorded and/or collected.	All fauna taxa observed were identified.	Nil
Sources of information (previously available information as distinct from new data).	Adequate information was available for the area to provide appropriate contextual information for the study.	Nil
The proportion of the task achieved and further work which might be needed.	Planned survey works were conducted and completed. No further work is required to complete the survey scope.	Nil
Timing/weather/season/cycle.	The survey was conducted during an appropriate time/season.	Nil
Disturbances which affected results of the survey (e.g. fire, flood, accidental human intervention).	There were no natural or human interventions that constrained the survey.	Nil
Intensity (in retrospect was the intensity adequate).	Survey intensity is considered adequate and is appropriate for a black cockatoo habitat assessment.	Nil
Completeness (e.g. was relevant area fully surveyed).	All vegetated areas of the survey area were assessed for black cockatoo suitability and habitat.	Nil
Resources (e.g. degree of expertise available in animal identification to taxon level).	Resources were adequate to carry out the survey and the zoologist undertaking the survey has numerous years' experience undertaking black cockatoo assessments.	Nil
Remoteness and/or access problems.	The survey area is not situated in a remote area and adequate access was available.	Nil
Availability of contextual (e.g. biogeographic) information on the region.	Adequate contextual information was available for the region.	Nil
Efficacy of sampling methods (i.e. any groups not sampled by survey methods).	Sample methods utilised were in accordance with relevant guidelines and tailored to detection and identification of black cockatoos and their habitats.	Nil

3 RESULTS AND DISCUSSION

3.1 BANKSIA WOODLANDS TEC ASSESSMENT

3.1.1 Vegetation within the Survey Area

Based on an assessment of floristic data from 10 quadrats and five vegetation description sites, only one vegetation type that was assessed as in better than Degraded condition was recorded within the survey area: BaEpLb (*Banksia attenuata*, *Banksia menziesii* low woodland; *Eremaea pauciflora*, *Petrophile linearis*, *Stirlingia latifolia* low shrubland; *Lyginia barbata*, *Austrostipa compressa*, *Briza maxima* low herbland/tussock grassland) (Table 8, Map 2). The remaining vegetated parts of the survey area, categorised as ‘Regrowth’, ‘Rehab’, and ‘Plantation’, were in Degraded to Completely Degraded condition, consisted mostly of weedy herbs and grasses with scattered native trees and shrubs (Table 8, Map 2), and are inconsistent with any pre-European vegetation type. A list of all species recorded within the survey area is shown in Appendix A and individual site data are shown in Appendix B.

3.1.2 *Banksia* Woodlands TEC within the Survey Area

A single patch of woodland within the survey area was assessed as corresponding with the EPBC Act listed *Banksia* Woodlands of the Swan Coastal Plain TEC. This patch occurred in the southeast of M70/1250 and along the western edge of M70/1249 and accounted for 1% (6.73 ha) of the survey area (Map 2). Although areas outside of the survey area were not assessed, it is assumed that this patch of TEC extends further to the west below the southern boundary of M70/1250.

The remaining vegetated parts of the survey area, while in some cases having scattered *Banksia attenuata* or *B. menziesii* trees, did not correspond structurally to a woodland and were below the required condition threshold according to the Approved Conservation Advice (Threatened Species Scientific Committee, 2016).

A summary of the patch assessment is shown below and in Table 9.

- The patch occurred on a sandplain landform within the Swan Coastal Plain IBRA bioregion.
- The broad community type present was *Banksia attenuata* and *B. menziesii* low woodlands with some emergent *Eucalyptus marginata*.
- Canopy cover of the indicator *Banksia* species was between approximately 25% to 40%, well above the minimum 2% cover threshold.
- Mean species richness for the quadrats representing the patch was 30 taxa, compared to 58.3 taxa at FCT23b (Gibson et al. 1994), so species richness may be considered ‘low’ to ‘moderate’ according to the Approved Conservation Advice. Native understory species were typical of FCT23b, including *Bossiaea eriocarpa*, *Eremaea pauciflora*, *Jacksonia floribunda*, *Lyginia barbata*, *Petrophile linearis*, and *Stirlingia latifolia*.
- Vegetation condition was assessed as ‘Good’ or ‘Very Good’ according to the scale of Keighery (1994) with less than 50% introduced species cover. The minimum condition threshold for the TEC was therefore satisfied.
- The patch occupies an area of 6.73 ha and is therefore above the minimum patch size for patches of woodland in ‘Good’ or ‘Very Good’ condition.

Table 8. Summary of vegetation types recorded within the survey area.

Map code	Description	Frequently occurring species	Landform	Vegetation condition	Mean site species richness (range)	Extent within survey area (ha) (%)	Representative sites
BaEpLb	<i>Banksia attenuata</i> , <i>Banksia menziesii</i> low woodland; <i>Eremaea pauciflora</i> , <i>Petrophile linearis</i> , <i>Stirlingia latifolia</i> low shrubland; <i>Lyginia barbata</i> , <i>Austrostipa compressa</i> , <i>Briza maxima</i> low herbland/tussock grassland.	<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i> , <i>Austrostipa compressa</i> , <i>Banksia attenuata</i> , <i>Banksia menziesii</i> , <i>Bossiaea eriocarpa</i> , <i>Briza maxima</i> , <i>Burchardia congesta</i> , <i>Daviesia triflora</i> , <i>Ehrharta calycina</i> , <i>Eremaea pauciflora</i> , <i>Gladiolus caryophyllaceus</i> , <i>Jacksonia floribunda</i> , <i>Lyginia barbata</i> , <i>Melaleuca</i> sp. 2, <i>Petrophile linearis</i> , Poaceae sp. 1, Restionaceae sp. 2, <i>Stirlingia latifolia</i> , <i>Wahlenbergia capensis</i> , <i>Xanthorrhoea preissii</i>	Sandplain	Good to Very Good	30 (30 - 30)	6.73 (1.00%)	JA_01, JA_02
Regrowth	Degraded fields with weedy grasses and herbs dominant (<i>Avena barbata</i> , <i>Briza maxima</i> , <i>Gladiolus caryophyllaceus</i>) with scattered native trees and shrubs (<i>Banksia</i> spp., <i>Corymbia calophylla</i> , <i>Eucalyptus marginata</i> , <i>Nuytsia floribunda</i>)	NA	Sandplain	Completely Degraded to Degraded	17.5 (12 - 23)	430.12 (64.15%)	JA_03, JA_04, JA_05, JA_06, JA_07, JA_09, JA_10, JA_11, JA_15, JA_17
Rehab	Degraded rehabilitation areas with weedy grasses and herbs dominant (<i>Avena barbata</i> , <i>Briza maxima</i> , <i>Vicia</i> sp., <i>Trifolium</i> spp.) with scattered native shrubs and trees (<i>Acacia cyclops</i> , <i>Xanthorrhoea preissii</i> , <i>Eucalyptus marginata</i>)	NA	Sandplain	Completely Degraded to Degraded	20.3 (14 - 24)	56.17 (8.38%)	JA_12, JA_13, JA_16
Plantation	Pine plantation	NA	Sandplain	Completely Degraded	NA	98.52 (14.69%)	NA
Cleared	Cleared areas	NA	Sandplain	NA	NA	78.99 (11.78%)	NA

Table 9. Banksia Woodlands TEC patch assessment.

Patch	Representative sites	Key diagnostic characteristics				Patch condition				Patch size (within survey area)
		IBRA subregion	Soils and landform	Community structure	Community composition	Mean species richness of FCT23b (Gibson et al. 1994)	Mean species richness of patch within the survey area	Weed cover	Overall patch condition	
1	JA_01, JA_02	Swan Coastal Plain (SWA)	White to grey sand, sandplain	<i>Banksia</i> low woodland with species rich native understory consisting of sclerophyllous shrubs, herbs, and grasses	Canopy of codominant <i>Banksia attenuata</i> and <i>Banksia menziesii</i> with occasional emergent <i>Eucalyptus marginata</i>	53.8	30	< 50%	Good to Very Good	6.73 ha

Map 2. Location of the *Banksia* Woodlands TEC within the survey area.

3.2 BLACK COCKATOO HABITAT ASSESSMENT

3.2.1.1 Breeding Habitat

No large eucalypt trees with the potential to form suitable breeding habitat for the black cockatoo in the near future were recorded in the survey area. One small hollow was recorded in a single *Eucalyptus todtiana* with DBH of 860 mm within the remnant Banksia Woodland habitat. However, the species does not support hollows large enough for black cockatoos to breed or nest in. Additionally, the survey area contained multiple patches of rehabilitated eucalypt woodlands, comprising Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*). All trees within the patches were significantly undersized (DBH <300 mm) to be suitable as breeding habitat.

Black cockatoo spatial data sourced from Data WA shows three Carnaby's cockatoo breeding buffer zones within 25 km of the survey area.

3.2.1.2 Roosting Habitat

Flocks of black cockatoos demonstrate a strong site fidelity to night roosts that are near high-quality foraging habitat (Saunders 1986). Roosting habitat is classified as a tree (or group of trees) where there are records or recent evidence of night roosting. Night roosts are usually located in the tallest trees within an area and in proximity (usually within 6 km) to both quality foraging habitat and an important water supply. Flocks will use different night roosts, often for weeks, or until the local food supply is exhausted. However, due to changing patterns of resource availability not all night-roosts are used every year.

Trees with a DBH greater than 500 mm may be tall enough to provide roosting habitat for Carnaby's black cockatoos (Department of Sustainability Environment Water Population and Communities, 2012). Black-cockatoos tend to have traditional roosting sites and these have been documented in the Great Cocky Count (Byrne, Barrett, Blythman, Finn, & Williams, 2015).

Black cockatoo roost spatial data sourced from Data WA shows three roosts within the site; however, no roosting trees were present at the time of the survey and the records are likely historical and attributed to the area prior to initial clearing. There are multiple roosting buffer zones within 5 km of the survey area. No large trees with DBH > 500mm were identified and the survey area is unlikely to provide suitable roosting habitat within the near future.

3.2.1.3 Foraging Habitat

Black cockatoos rely on foraging resources to provide sufficient energy for their movements across their range and availability of foraging habitat plays a critical role in the post-breeding period when individuals need to build condition after breeding and teach juveniles where these foraging resources are located (Commonwealth of Australia, 2017).

One patch of remnant *Banksia* woodland, located in the southern section of mining lease M70/1250, was assessed as 'higher quality' foraging habitat, specifically for Carnaby's cockatoo. Additionally, three patches of rehabilitated Eucalypt woodland comprising marri (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*), located in the west of mining lease M70/1248, and pending tenement M70/1248, were assessed as 'higher quality' foraging habitat for all species of black cockatoo.

The survey area also contained multiple patches of mature pine plantation, located in pending tenements M70/1247 and M70/1249, and the south of mining lease M70/1250. Pine plantations are classed as 'moderate quality' foraging habitat for the Carnaby's cockatoo.

The remaining areas were classed as 'low quality' foraging habitat (scattered foraging plants or small stand of foraging plants) and cleared areas. Higher quality and moderate quality black cockatoo

foraging habitat is displayed in Map 3: Moderate and high-quality black cockatoo foraging habitat in the survey area.

No primary or secondary evidence of foraging by black cockatoos was recorded during the survey. No significant water sources which may be utilised by black cockatoos occur within the survey area.

3.2.1.4 Direct Observations

Three forest red-tailed black cockatoos were recorded overflying the north-eastern corner of the mining lease M70/1248 on the afternoon of Wednesday the 2nd of October. No black cockatoos were observed interacting with terrestrial habitat or foraging resources within the survey area during the survey period.

3.3 FAUNA ASSEMBLAGE

A total of 30 vertebrate fauna species were incidentally recorded on site, comprising one reptile, one mammal and 28 birds (one introduced) (Table 10).

Table 10: Vertebrate fauna recorded during the survey.

Common name	Scientific name
BIRD	
Australian magpie	<i>Gymnorhina tibicen</i>
Australian raven	<i>Corvus coronoides</i>
Australian ringneck	<i>Barnardius zonarius</i>
Australian white ibis	<i>Threskiornis molucca</i>
Black-faced cuckooshrike	<i>Coracina novaehollandiae</i>
Black-faced woodswallow	<i>Artamus cinereus</i>
Brown honeyeater	<i>Lichmera indistincta</i>
Crested pigeon	<i>Ocyphaps lophotes</i>
Fan-tailed cuckoo	<i>Cacomantis flabelliformis</i>
Forest red-tailed black cockatoo	<i>Calyptorhynchus banksii</i>
Galah	<i>Eolophus roseicapilla</i>
Grey butcherbird	<i>Cracticus torquatus</i>
Laughing kookaburra	<i>Dacelo novaeguineae</i>
Australian kestrel (Nankeen kestrel)	<i>Falco cenchroides</i>
New Holland honeyeater	<i>Phylidonyris novaehollandiae</i>
Red wattlebird	<i>Anthochaera carunculata</i>
Red-capped parrot	<i>Purpureicephalus spurius</i>
Red-tailed black cockatoo	<i>Calyptorhynchus banksii</i>
Domestic pigeon (rock dove)	<i>Columba livia</i>
Rufous songlark	<i>Cincloramphus mathewsi</i>
Rufous whistler	<i>Pachycephala rufiventris</i>
Grey-breasted white-eye (silveryeye)	<i>Zosterops lateralis</i>
Singing honeyeater	<i>Gavicalis virescens</i>
Welcome swallow	<i>Hirundo neoxena</i>
Western gerygone	<i>Gerygone fusca</i>
Western little wattlebird (Western wattlebird)	<i>Anthochaera lunulata</i>
White-winged triller	<i>Lalage tricolor</i>
Willie wagtail	<i>Rhipidura leucophrys</i>
MAMMAL	
Western grey kangaroo	<i>Macropus fuliginosus</i>
REPTILE	
Tiger snake	<i>Notechis scutatus</i>

Map 3: Moderate and high-quality black cockatoo foraging habitat in the survey area.

4 CONCLUSIONS

The key findings for the survey area were:

- One patch of the 'Banksia Woodlands of the Swan Coastal Plain' TEC in Good to Very Good condition was identified within M70/1250 and M70/1249, totalling at 6.73 ha (1% of the survey area).
- Based on aerial imagery the TEC is likely to occur outside the survey area along the southern boundary of M70/1248 and M70/1250.
- No potential black cockatoo breeding habitat trees (trees with DBH >500mm) were recorded during the current survey.
- No evidence of night roosting was recorded during the current survey and no trees were recorded as potential roosting habitat, or likely future roosting habitat for black cockatoos in the survey area.
- Three patches of 'higher quality' black cockatoo foraging habitat were assessed in the survey area, comprising one patch of remnant *Banksia* woodland, and two patches of rehabilitated marri (*Corymbia calophylla*) woodland. Additionally, three patches of mature pine plantation, and one patch of rehabilitated Eucalypt woodland comprising marri and jarrah were assessed as 'moderate quality' foraging habitat. The remainder of the survey area was assessed as 'lower quality' foraging habitat or cleared. No evidence of foraging activity was recorded during the survey.
- A group of three forest red-tailed black cockatoo were recorded overflying the north-east corner of mining lease M70/1248 on one occasion during the survey period. No black cockatoos were recorded interacting with habitat within the survey area during the current survey.

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6 APPENDICES

Appendix A Plant species recorded within the survey area.

Family	Taxon	Naturalised status	WAOL status
Aizoaceae	<i>Carpobrotus edulis</i>	Introduced	Permitted - s11
Amaranthaceae	<i>Ptilotus polystachyus</i>	Native	Permitted - s11
Anarthriaceae	<i>Lyginia barbata</i>	Native	Permitted - s11
Asparagaceae	<i>Thysanotus ?manglesianus</i>	Native	Permitted - s11
Asteraceae	? <i>Chondrilla juncea</i>	Introduced	Declared Pest - s22(2)
Asteraceae	? <i>Sonchus oleraceus</i>	Introduced	Permitted - s11
Asteraceae	<i>Hypochaeris glabra</i>	Introduced	Permitted - s11
Asteraceae	<i>Podotheca gnaphalioides</i>	Native	Permitted - s11
Asteraceae	<i>Senecio pinnatifolius</i>	Native	Permitted - s11
Asteraceae	<i>Ursinia anthemoides</i> subsp. <i>anthemoides</i>	Introduced	Permitted - s11
Brassicaceae	<i>Brassica tournefortii</i>	Introduced	Permitted - s11
Campanulaceae	<i>Wahlenbergia capensis</i>	Introduced	Permitted - s11
Campanulaceae	<i>Wahlenbergia gracilentia</i>	Native	Permitted - s11
Caryophyllaceae	<i>Petrorhagia dubia</i>	Introduced	Permitted - s11
Colchicaceae	<i>Burchardia congesta</i>	Native	Permitted - s11
Cyperaceae	<i>Isolepis cernua</i>	Native	Permitted - s11
Dasypogonaceae	<i>Dasypogon bromeliifolius</i>	Native	Permitted - s11
Dilleniaceae	<i>Hibbertia ?hypericoides</i>	Native	Permitted - s11
Dilleniaceae	<i>Hibbertia racemosa</i>	Native	Permitted - s11
Fabaceae	<i>Acacia cyclops</i>	Native	Permitted - s11
Fabaceae	<i>Acacia pulchella</i> var. <i>glaberrima</i>	Native	Not listed
Fabaceae	<i>Acacia sessilis</i>	Native	Permitted - s11
Fabaceae	<i>Bossiaea eriocarpa</i>	Native	Permitted - s11
Fabaceae	<i>Daviesia divaricata</i> subsp. <i>divaricata</i>	Native	Not listed
Fabaceae	<i>Daviesia triflora</i>	Native	Permitted - s11
Fabaceae	<i>Hardenbergia comptoniana</i>	Native	Permitted - s11
Fabaceae	<i>Jacksonia ?furcellata</i>	Native	Permitted - s11
Fabaceae	<i>Jacksonia floribunda</i>	Native	Permitted - s11
Fabaceae	<i>Lupinus angustifolius</i>	Introduced	Permitted - s11
Fabaceae	<i>Trifolium arvense</i>	Introduced	Permitted - s11
Fabaceae	<i>Trifolium campestre</i>	Introduced	Permitted - s11

Family	Taxon	Naturalised status	WAOL status
Fabaceae	<i>Vicia</i> sp.	Introduced	NA
Geraniaceae	<i>Pelargonium capitatum</i>	Introduced	Permitted - s11
Goodeniaceae	<i>Dampiera linearis</i>	Native	Permitted - s11
Goodeniaceae	<i>Lechenaultia floribunda</i>	Native	Permitted - s11
Haemodoraceae	<i>Anigozanthos ?humilis</i>	Native	Permitted - s11
Haemodoraceae	<i>Conostylis ?aculeata</i>	Native	Permitted - s11
Haemodoraceae	<i>Conostylis ?juncea</i>	Native	Permitted - s11
Haemodoraceae	<i>Haemodorum spicatum</i>	Native	Permitted - s11
Iridaceae	<i>Gladiolus caryophyllaceus</i>	Introduced	Permitted - s11
Lauraceae	<i>Cassytha</i> sp.	Native	NA
Loranthaceae	<i>Nuytsia floribunda</i>	Native	Permitted - s11
Montiaceae	<i>Calandrinia liniflora</i>	Native	Permitted - s11
Myrtaceae	<i>Corymbia calophylla</i>	Native	Permitted - s11
Myrtaceae	<i>Eremaea pauciflora</i>	Native	Permitted - s11
Myrtaceae	<i>Eucalyptus rudis</i> subsp. <i>rudis</i>	Native	Not listed
Myrtaceae	<i>Eucalyptus ?todtiana</i>	Native	Permitted - s11
Myrtaceae	<i>Eucalyptus marginata</i>	Native	Permitted - s11
Myrtaceae	<i>Hypocalymma robustum</i>	Native	Permitted - s11
Myrtaceae	<i>Hypocalymma robustum</i>	Native	Permitted - s11
Myrtaceae	<i>Melaleuca</i> sp. 1	Native	NA
Myrtaceae	<i>Melaleuca</i> sp. 2	Native	NA
Myrtaceae	<i>Melaleuca</i> sp. 3	Native	NA
Myrtaceae	Myrtaceae sp.	Native	NA
Myrtaceae	<i>Scholtzia</i> sp.	Native	NA
Pinaceae	<i>Pinus pinaster</i>	Introduced	Permitted - s11
Poaceae	<i>Austrostipa compressa</i>	Native	Permitted - s11
Poaceae	<i>Avena barbata</i>	Introduced	Permitted - s11
Poaceae	<i>Briza maxima</i>	Introduced	Permitted - s11
Poaceae	<i>Ehrharta calycina</i>	Introduced	Permitted - s11
Poaceae	<i>Pentameris airoides</i> subsp. <i>airoides</i>	Introduced	Permitted - s11
Poaceae	<i>Phalaris ?paradoxa</i>	Introduced	Permitted - s11

Family	Taxon	Naturalised status	WAOL status
Poaceae	Poaceae sp.	Native	Permitted - s11
Proteaceae	<i>Adenanthos cygnorum</i> subsp. <i>cygnorum</i>	Native	Not listed
Proteaceae	<i>Banksia attenuata</i>	Native	Permitted - s11
Proteaceae	<i>Banksia menziesii</i>	Native	Permitted - s11
Proteaceae	<i>Conospermum ?stoechadis</i>	Native	Permitted - s11
Proteaceae	<i>Conospermum canaliculatum</i> subsp. <i>canaliculatum</i>	Native	Not listed
Proteaceae	<i>Petrophile linearis</i>	Native	Permitted - s11
Proteaceae	<i>Stirlingia latifolia</i>	Native	Permitted - s11
Restionaceae	<i>Hypolaena exsulca</i>	Native	Permitted - s11
Restionaceae	Restionaceae sp. 1	Native	Permitted - s11
Restionaceae	Restionaceae sp. 2	Native	Permitted - s11
Santalaceae	? <i>Exocarpos sparteus</i>	Native	Permitted - s11
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>	Native	Permitted - s11

Appendix B Floristic sampling site data.

Appendix C Fauna habitat assessment sheets.