



Albemarle Kemerton Plant

Report

Flora and Vegetation Monitoring and Management Plan

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Albemarle Kemerton Plant Revision: 1 Flora and Vegetation Monitoring and Management Plan

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Albemarle Lithium Pty Ltd Albemarle Kemerton Plant Flora and Vegetation Monitoring and Management Plan November 2018





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Executive Summary

This Flora and Vegetation Management and Monitoring Plan (FVMMP) has been prepared in accordance with Ministerial Statement No.1085 Conditions 6-1 to 6-3 for the Albemarle Lithium Pty Ltd (Albemarle) Kemerton Plant (the Project). The FVMMP provides management and monitoring measures for native vegetation and flora that are potentially impacted by the Project. In particular, it has been developed for the Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) (Banksia Woodland TEC) and the Low lying *Banksia attenuata* Woodlands or Shrublands Priority Ecological Community (PEC) along with the Dwarf Bee-orchid (*Diuris micrantha*), Glossy-leafed Hammer-orchid (*Drakaea elastica*) and Dwarf Hammer-orchid (*D. micrantha*). These have been identified by the Department of the Environment and Energy (DotEE) and the Environmental Protection Authority (EPA) as communities / species that may potentially be impacted upon by activities associated with the Project.

The purpose of this FVMMP, in the context of EPA objectives, is summarised in Table 1. The Project management objectives and criteria intended to measure achievement of the management objectives are summarised in Table 2.

Title of Proposal	Albemarle Kemerton Plant	
Proponent name	Albemarle Lithium Pty Ltd (Albemarle)	
Ministerial Statement No.	1085	
Purpose of this FVMMP	To fulfil requirements of conditions 6-1 to 6-3 of Ministerial Statement 1085.	
	To provide management and monitoring measures for native vegetation and flora that are potentially impacted by the Project. In particular, the Banksia Woodland TEC, Low lying <i>Banksia attenuata</i> Woodlands or Shrublands PEC and the three threatened orchids.	
EPA's environmental objectives for the key environmental factors	Flora and Vegetation – To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	
Proponent's environmental outcome	Albemarle shall ensure that the construction and ongoing operation of the Project is undertaken in a manner that avoids direct and indirect impacts (outside of the approved clearing area) to Threatened Flora and Communities. This includes the Banksia Woodlands of the Swan Coastal Plain TEC and Low Lying <i>Banksia attenuata</i> woodlands or shrublands and <i>Drakaea elastica, D. micrantha</i> and <i>Diuris micrantha</i> .	

Table 1 Purpose and Objective of the Albemarle Kemerton Plant FVMMP

Table 2 Management objectives and targets for the Albemarle Kemerton Plant FVMMP

Management Objectives	Management targets
Avoid indirect impact to known threatened orchid species	No reportable decline of nearby Endangered/ Declared Rare Flora (DRF) <i>Drakaea elastica</i> individuals or habitat, attributable to the Project
Avoid indirect impact to vegetation and flora (Banksia Woodland TEC / Low lying <i>Banksia attenuata</i> woodlands or shrublands PEC) outside of the Development Envelope	No reportable decline to adjacent areas representative of the <i>Banksia</i> Woodlands of the Swan Coastal Plain TEC/ Low lying <i>Banksia</i> <i>attenuata</i> woodlands or shrublands PEC, attributable to the Project No incidents of fire originating within, and spreading outside of, the Development Envelope
Avoid clearing or removal of vegetation (Banksia Woodland TEC / Low lying <i>Banksia attenuata</i> woodlands or shrublands PEC) outside of the Development Envelope	No incidents of vegetation clearing outside of the approved Development Envelope
Prevent introduction and/or spread of weeds into adjacent areas	No new Declared Weeds or Weeds of National Significance within surrounding vegetation, attributable to the Project No significant increase in weed cover within immediately adjacent vegetation, attributable to the Project
Avoid introduction and/or spread of Dieback within adjacent areas	No evidence of new Dieback infestation identified within immediately adjacent areas/ vegetation resulting from the Project

1. Context and Scope

1.1 Proposal

Albemarle Lithium Pty Ltd (Albemarle) is proposing to establish the Albemarle Kemerton Plant, a Lithium Hydroxide Product manufacturing plant and associated infrastructure, within the Kemerton Strategic Industrial Area (KSIA), approximately 17 kilometres (km) north-east of Bunbury, Western Australia (WA) (referred to as the Project) (Figure 1).

The Project has been assessed by the Western Australian (WA) Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act). The Project was approved by the WA Minister for Environment on 26 October 2018.

The Project has also been assessed by the Commonwealth Department of the Environment and Energy (DotEE) under the *Environment Protection and Biodiversity Act 1999* (EPBC Act) due to impacts on threatened species and communities. The Project was approved by the DotEE on 26 November 2018 (reference number 2017/8099).

The Project includes the construction and operation of a Lithium Hydroxide Product manufacturing Plant (the Plant) and associated infrastructure. The Development Envelope for the Project is approximately 89.25 ha and is located wholly within Lot 253 (Deposited Plan 411027), Wellesley Road. Development of the Project will require the clearing of no more than 87.7 ha of vegetation within the Development Envelope.

Development of the Project will commence in late 2018 and include:

- Initial earthworks involving clearing of vegetation, cut-to-fill earthworks and establishment of drainage systems.
- Construction of the Plant and associated infrastructure including: administration facilities, workshop, supply warehouse / store, fuel and reagent storage, amenities, laboratory, control centre, water management infrastructure and a service corridor.
- Construction of the Plant. Construction will be undertaken in stages, with the first of five process trains expected to be completed by 2020.
- Operation of the Plant. Operation is expected to commence in 2020 and the Plant has an intended operation life of approximately 25 years.

Further information on the Project activities is provided in Albemarle Kemerton Plant Environmental Referral Supporting Document and Additional Information Request Response (GHD 2017 and GHD 2018).

The Banksia Woodlands of the Swan Coastal Plain (SCP) Threatened Ecological Community (TEC) (Banksia Woodland TEC) and the Low lying *Banksia attenuata* Woodlands or Shrublands Priority Ecological Community (PEC) along with the Dwarf Bee-orchid (*Diuris micrantha*), Glossy-leafed Hammer-orchid (*Drakaea elastica*) and Dwarf Hammer-orchid (*D. micrantha*) have been identified by the DotEE and the EPA as communities / species that may potentially be impacted upon directly and indirectly by activities associated with the Project.

1.2 Key environmental factors

This Flora and Vegetation Monitoring and Management Plan (FVMMP) addresses the EPA's flora and vegetation environmental factor. The EPA's objective for this factor is: *To protect flora and vegetation so that biological diversity and ecological integrity are maintained.*

1.3 Purpose of this management plan

This FVMMP provides management and monitoring measures for native vegetation and flora that are potentially impacted by the Project. In particular, this Plan has been developed for the Banksia Woodland Threatened Ecological Community (TEC), Low lying *Banksia attenuata* Woodlands or Shrublands Priority Ecological Community (PEC) and the three threatened orchids *Drakaea elastica, D. micrantha* and *Diuris micrantha*).

This FVMMP has been prepared to meet Conditions 6-1 to 6-3 of Ministerial Statement 1085 (see section 1.4 for further details).

The Plan provides a summary of the potential impacts to the TEC/PEC and threatened orchids that may occur in the context of the Project, and their management and monitoring measures are described.

This FVMMP includes:

- Management actions that will be undertaken to prevent impacts from weeds, dieback, fire, edge effects/litter, surface and groundwater changes;
- Trigger criteria that will trigger implementation of contingency actions to prevent direct or indirect impacts to the threatened flora (orchids) and Banksia Woodland TEC / PEC;
- Management or contingency actions to be implemented in the event the trigger criteria are exceeded; and
- Monitoring methodology including the frequency, timing and indicative locations for the threatened orchid and Banksia Woodland TEC / PEC monitoring sites.

1.4 Condition requirements

This FVMMP has been prepared to address the requirements under Condition 6 of Ministerial Statement 1085, as outlined in Table 3.

Condition	Requirement
6-1	The proponent shall ensure that the construction and ongoing operation of the proposal is undertaken in a manner that avoids direct or indirect impacts to Threatened Flora and Communities, including Glossy-leafed Hammer Orchid (<i>Drakaea elastica</i>), Dwarf Bee-orchid (<i>Diuris micrantha</i>), Dwarf Hammer-orchid (<i>Drakaea micrantha</i>), Banksia Woodlands of the Swan Coastal Plain and Low lying banksia attenuata woodlands or shrublands outside of the Albemarle Development Envelope, as shown in Schedule 1.
6-2	Prior to ground-disturbing activities or as otherwise agreed by the CEO, the proponent shall prepare and submit Flora and Vegetation Monitoring and Management Plan (FVMMP) to the CEO. The Plan shall:
	1) when implemented, substantiate and ensure that condition 6-1 is being met;
	2) detail the proposed frequency, timing and indicative locations of Threatened Flora and Communities monitoring to be implemented during construction and operational phase of the Albemarle Plant;
	3) specify management actions for potential impacts including but not limited to those from weeds, <i>Phytophthora cinnamomi</i> (Dieback), increased fire risk and litter, and changes to surface water and groundwater regimes that will be

Table 3 Ministerial Condition 1085 Conditions

Condition	Requirement
	implemented during construction and operations to ensure the management objective in condition 6-1 is achieved;
	4) specify trigger criteria that will trigger the implementation of contingency actions to prevent direct or indirect impacts to Threatened Flora and Communities outside of the Albemarle Development Envelope; and
	5) specify management or contingency actions to be implemented in the event that the criteria identified required by condition 6-2(4) have been triggered.
6-3	In the event that the monitoring specified in the Plan indicates that the criteria specified in the Plan have been triggered, the proponent shall:
	1) report such findings to the CEO within twenty-one (21) days of the criteria being triggered;
	2) provide evidence to the CEO which allows for determination of the likely cause of the trigger criteria being reached and to identify any additional contingency actions required to prevent the criteria being triggered in the future; and
	3) if the triggering of the criteria is determined by the CEO to be a result of activities undertaken implementing the proposal, implement the management and/or contingency actions specified in the Flora and Vegetation Monitoring and Management Plan and continue implementation of those actions until the trigger criteria are met, or until
	4) the CEO has confirmed by notice in writing that it has been demonstrated that the objective in condition 6-1 will continue to be met and implementation of the management and/or contingency actions is no longer required.



Albemarle Kemerton Plant Regional Location

FIGURE 1

Map Projection: Transverse Mercator Horizontal Datum: GDA 1994 Grid: GDA 1994 MGA Zone 50

1.5 Limitations

This report: has been prepared by GHD for Albemarle Lithium Pty Ltd and may only be used and relied on by Albemarle Lithium Pty Ltd for the purpose agreed between GHD and the Albemarle Lithium Pty Ltd as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Albemarle Lithium Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this Report on the basis of information provided by Albemarle Lithium Pty Ltd and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the Report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Rationale and Approach

2.1 Vegetation and flora assessment

A number of vegetation and flora assessments have been undertaken within the Development Envelope and wider KSIA. Baseline assessments that are relevant to the Project were identified and discussed in the Albemarle Kemerton Plant Environmental Referral Supporting Document and Additional Information Request Response (GHD 2017 and GHD 2018).

The key findings of these assessments were:

- The desktop assessment and field surveys identified the presence of one EPBC Act listed TEC within the Development Envelope, *Banksia* Woodlands of the Swan Coastal Plain (SCP). Areas of this TEC align with the Low lying *Banksia attenuata* woodland or shrublands, which are a PEC at the state level. As the occurrence of the PEC is directly aligned with the TEC, for the purposes of this Plan, the PEC has been referred to as the Banksia Woodlands TEC.
- There are no known occurrences of EPBC Act or WC Act listed flora species within the Development Envelope. Surveys confirmed the presence of one priority species, *Acacia semitrullata* (Priority 4) within the Development Envelope. Three threatened orchids species (EPBC Act and WC Act listed), *Drakaea elastica, D. micrantha* and *Diuris micrantha*, are known to occur within the KSIA.

2.2 Threatened and priority ecological communities

Surveys within the KSIA and the Development Envelope identified vegetation communities closely resembling Floristic Community Type (FCT) 21c. This FCT is listed as the PEC 'Low lying *Banksia attenuata* woodlands or shrublands. In 2016, the Banksia Woodlands TEC was listed as endangered under the EPBC Act. FCT 21c is also recognised as a community that comprises part of the Banksia Woodlands TEC.

Vegetation communities that are representative of FCT 21c, and the Banksia Woodlands TEC and Low lying *Banksia attenuata* woodlands or shrublands PEC, have been identified within the Development Envelope and the KSIA. Based on information presented in ELA (2013 and 2017 a, b) and GHD (2018), the vegetation communities listed in Table 4 are considered to be representative of the Banksia Woodland TEC.

The Development Envelope contains 6.37 ha of Banksia Woodland TEC, with an additional 3,122 ha occurring within the broader KSIA. The location of the Banksia Woodland TEC is shown in Figure 2.

Table 4 Extent of Banksia Woodlands of the SCP TEC / PEC within the Development Envelope and KSIA

Vegetation type	Condition and Extent in Development Envelope	Extent in surrounding area (KSIA)*
EmKgMr - <i>Eucalyptus marginata</i> subsp. <i>marginata</i> and <i>Banksia ilicifolia</i> low open woodland over <i>Kunzea glabrescens</i> tall sparse shrubland over <i>Macrozamia riedlei</i> and <i>Xanthorrhoea brunonis</i> shrubland.	Excellent $-$ 0.09 ha Good $=$ 0.24 ha Completely Degraded - 0.1 ha Total $-$ 0.43 ha	2.83
EmCcXb - Eucalyptus marginata subsp. marginata and Corymbia calophylla woodland with Allocasuarina fraseriana, Banksia attenuata and Xylomelum occidentale isolated trees over Xanthorrhoea brunonis, Acacia pulchella and Adenanthos meisneri shrubland over Ehrharta calycina open grassland over Dasypogon bromeliifolius open forbland on uplands.	Good – 5.94 ha	71.32
EmCcBa - Woodland of <i>Eucalyptus marginata</i> subsp. <i>marginata</i> with the occasional <i>Corymbia</i> <i>calophylla</i> over <i>Banksia attenuata</i> , <i>Banksia ilicifolia</i> and <i>Banksia grandis</i> with the occasional <i>Agonis</i> <i>flexuosa</i> and <i>Kunzea glabrescens</i> over <i>Melaleuca</i> <i>thymoides</i> , <i>Xanthorrhoea brunonis</i> , <i>Hibbertia</i> <i>hypericoides</i> and <i>Dasypogon bromeliifolius</i> over <i>Lyginia imberbis</i> , <i>Drosera stolonifera</i> , <i>Burchardia</i> <i>congesta</i> and <i>Caladenia flava</i> subsp. <i>flava</i> on lower slopes to flats of gently undulating dunes on white to grey sand. ELA (2013) – aligned with FCT21C		2,885.23
BaBiKg - Woodland to Low Forest of <i>Banksia</i> attenuata, <i>Banksia ilicifolia</i> , <i>Kunzea glabrescens</i> and <i>Eucalyptus marginata</i> subsp. <i>marginata</i> over <i>Dasypogon bromeliifolius</i> , <i>Hibbertia hypericoides</i> , <i>Hibbertia vaginata</i> and <i>Xanthorrhoea brunonis</i> over <i>Conostylis serrulata</i> , <i>Hypolaena exsulca</i> , <i>Hovea</i> <i>trisperma</i> , <i>Drosera stolonifera</i> , <i>Lyginia imberbis</i> , <i>Pyrorchis nigricans</i> , <i>Drosera erythrorhiza</i> and <i>Burchardia congesta</i> on lower slopes to flats on grey sand. ELA (2013) – aligned with FCT21C		155.74
EmBiKgAs - Eucalyptus marginata subsp. marginata, Agonis flexuosa and Banksia attenuata woodland over Banksia ilicifolia low open woodland over Kunzea glabrescens and Jacksonia sternbergiana tall sparse shrubland over Acacia semitrullata (P4), Hibbertia hypericoides subsp. hypericoides and Xanthorrhoea brunonis sparse shrubland over Dasypogon bromeliifolius sparse forbland		11.81
CcBaKgXb - Corymbia calophylla open woodland over Banksia attenuata, Banksia ilicifolia and Melaleuca preissiana low open woodland over Kunzea glabrescens tall sparse shrubland over Xanthorrhoea brunonis low open shrubland over Dasypogon bromeliifolius open forbland	6 27 ha	1.06
I OTAI	6.37 ha	3,128

*Vegetation within the broader KSIA has not been assessed against criteria for TEC (TSSC 2016). These are assumed to be the TEC based on vegetation type assessments presented in various previous reports.

2.3 Threatened orchid assessment

A number of vegetation and flora surveys have been completed within the KSIA and Development Envelope between 1999 to 2017 (see GHD 2017 for further details). Most recently ELA (2017) and GHD (2017) completed spring flora surveys for the Development Envelope and surrounds. None of the previous surveys identified the presence of any conservation significant orchid species within the Development Envelope. However, conservation significant orchids were identified within the broader KSIA. A brief summary of the surveys, which identified threatened orchids within the KSIA is provided below. The location of previous threatened orchids recorded during the surveys in relation to the Development Envelope is provided in Figure 2.

Aecom (2012) – Kemerton Industrial Park – Threatened Orchid Survey

The survey area, which included patches of native vegetation within the Development Envelope as well as areas to the north and west, was carried out in spring 2011. The target species (based on the baseline survey) were *Caladenia procera, Drakaea elastica* and *D. micrantha*. The survey involved traverses or sweeps in a grid format with personnel spaced 20 m apart. Areas that contained particularly suitable habitat within vegetation in good condition were searched more thoroughly. The survey was carried out over a period of 17 days between the 3 and 27 October 2011 by six to eight personnel. The survey identified:

- Nine *Drakaea elastica*. One location (with three plants) was located immediately north (45 m) from the Development Envelope and another location (with two plants) was located north west (approximately 80 m) from the Development Envelope.
- Four confirmed *Drakaea micrantha* and five possible *D. micrantha*. All records were over 700 m from the Development Envelope.

Ecological Australia (ELA) (2013) – Targeted Ecological Surveys for Kemerton Industrial Park

Surveys were completed in August and September 2013 using a transect method. The surveys included the native vegetation within the Development Envelope, and those within the broader KSIA. The results confirmed:

- Drakaea elastica was recorded from Lot 511 and Lot 40 with a total of 69 individuals recorded. This survey recorded *D. elastica* at the same location as Aecom (2012) –the closest record at approximately 45 m north of the Development Envelope boundary.
- Drakaea micrantha was recorded from Lot 511, Lot 2 and Lot 40 with 39 flowering and 25 non-flowering individuals recorded. The non-flowering plants were recorded as possibly *D. micrantha* with flowers required to confirm the identification.

GHD (2018) – Albemarle Kemerton Plant – Response to EPA Notice of Decision to Assess: Additional Information Request

GHD (2017) completed revised desktop searches (EPBC Act Protected Matters database, Department of Biodiversity, Conservation and Attractions (DBCA) *NatureMap* and Western Australian Herbarium (WAHERB) databases and reviewed previous reports for the Development Envelope and surrounds. No threatened orchids were recorded within the Development Envelope. The searches confirmed the presence of *Drakaea elastica* and *Drakaea micrantha* with records at the same distances as reported in Aecom (2012) and ELA (2013).

A third threatened orchid, *Diuris micrantha* is known to occur in the KSIA, with the closest known location 2.3 km north east of the Development Envelope.

2.3.1 Targeted orchid species and habitat

The key orchid targeted in this FVMMP is *Drakaea elastica*, which is the closest known threatened orchid (45 m from the Development Envelope) and may be indirectly impacted by the Project. The surrounding Banksia woodland community provides potential habitat for *Drakaea elastica*.

Although other threatened orchids are known to occur within the KSIA, these have not been recorded within 735 m of the Development Envelope. It is therefore considered unlikely that the known locations of these orchids would be impacted by the Proposal. While other orchid species have not specifically been included in this monitoring program, management measures in this FVMMP provide provisions for the avoidance / minimisation of impacts beyond the Development Envelope. The monitoring program also allows for the identification of changes in vegetation condition / floristic composition in the surrounding vegetation that would provide indication of orchid habitat modification and trigger a contingency response. These measures are considered adequate to avoid direct and indirect impacts to other threatened flora species and their habitats.

2.4 Dieback assessment

A dieback assessment was undertaken for the Development Envelope and vegetation immediately surrounding (i.e. within 50 m) for the presence of *Phytophthora cinnamomi* (Dieback) in August 2018. The presence of Dieback was based on symptoms and disease signatures in susceptible vegetation. Indicator species includes several species of *Banksia, Patersonia, Persoonia,* and *Xanthorrhoea.*

Due to the disturbed nature of the Development Envelope, the presence or absence of Dieback could not be determined. Vegetation adjacent to the Development Envelope where dieback indicator species are present, has been assessed as uninfested (Figure 3). This includes the vegetation surrounding the previously recorded *Drakaea elastica* location (45 m north of the Development Envelope) and areas of Banksia woodland TEC.





G1611362861GISMapsWorkinglOrchidMgmIPIanl6136286_002_OrchidLocations_Rev2.mxd Print date: 18 Jun 2018 - 11:25

Data source: Amec Foster Wheeler: Site boundary - 20170908; Landgate: Aerial photography (Virtual Mosaic) - 20180509, Roads - 20170821; EcoLogical: Threatened flora - 20170914. . Created by: krawlinson



 RoadNetworkMRWA_514
 P_mul_cit_years17_pub
 P_cinnamomi_public_all_years_2017
 P_arenaria_public_all_years_2017
 Cad

 A
 P_nicotianae_public_all_years_2017
 P_inundata_public_all_years_2017
 *
 P_pseudocryptogea_public_all_years_2017
 DPAWManagedLandsandWatersDPAW_026

CadastreAddressLGATE_002_1 (?)

Figure 3 - Baseline Dieback Assessment Results



GHD

Albermarle Kemerton Plant

Phytophthora cinnamomi Occurrence Map

OCCURRENCE CATEGORIES INFESTED Determined by a registered interpreter to have plant disease symptoms consistent with the presence of Phytophthora cinnamon UNINFESTED Determined by a qualified interpreter to be free of plant disease symptoms which indicates the presence of Phytophthora cinnamo UNINTERPRETABLE Where susceptible plants are absent or too few to enable the Interpretation of Phytophthora cinnamomi presence or absence TEMPORARILY UNINTERPRETABLE (Included within assessment area) Areas of temporary disturbance where natural vegetation is likely to recover NOT YET RESOLVED (Included within assessment area) Areas where Phytophthora cinnamomi occurrence diagnosis cannot t easily made within the required timeframe because of inconsistent ev EXCLUDED (excluded from assessment area) Areas of long-term high disturbance where natural vegetation has been cleared and is unlikely to recover. OVERLAYS HIGH IMRACT (current and predicted-forest areas only) (Demarcated to include Very High Impact areas which may occur within) (Demarcated to include Very High Impact areas which may occur within) Implement to exercise the predicted areas only in the set of VERY HIGH IMPACT (ourrent-forest areas only) (Delineated but not demarcated within High Impact areas) Where the oversforey inpact from Phylophitora cinnamoni is greater than 50%, and including areas where post epidemic recovery of oversforey is occurring DISEASE RISK ROAD PROJECT BOUNDARY

		Map details	
Assessment completion	Interpreters	Map produced by	Expires
Aug 2018	EB	EB	July 2019

			Overlays	
	Areas (Ha)	Unprotectable	High Impact	Very High Impact
	0	0		
	7.6	0	1	
	0	0		
	0	0		
table	0	0		3
	7.6	0		
	19.8	0	1	
	27.4			



2.5 Threatened community and orchid description

2.5.1 Banksia Woodlands of the Swan Coastal Plain

EPBC Act: Endangered State – Low Lying *Banksia attenuata* woodlands or shrublands (Priority 3)

The information on the Banksia Woodland TEC is summarised from the Threatened Species Scientific Committee (TSSC) 2016 unless otherwise referenced.

Description: the ecological community is a woodland associated with the SCP of southwest WA. A key diagnostic feature is a prominent tree layer of *Banksia*, with scattered eucalypts and other tree species often present among or emerging above the *Banksia* canopy.

The national TEC also relates to eight Western Australian PECs, including the Low lying *Banksia attenuata* woodlands or shrublands (FCT21c) that occur within the Development Envelope and surrounds.

This TEC typically occurs on well drained, low nutrient soils in sands of dune landforms, in particular deep Bassendean and Spearwood sands, or occasionally on Quindalup sands. It is also common on sandy colluvium and aeolian sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau.

Banksia Woodlands vary in their structure and species composition across the region where they occur. They all have a dominant Banksia component, which includes at least one of the four key species, *Banksia attenuata*, *B. menziesii*, *B. prionotes* and *B. ilicifolia*. *Banksia littoralis* and *B. burdettii* may also be co-dominant but where they become dominant it typically is not the *Banksia* Woodland TEC. The understorey is species rich and has many wildflowers, including sclerophyllous shrubs, sedges and herbs.

In September 2016, the Banksia Woodlands was listed as a TEC. Its listing took into account the following:

- The community has undergone a decline of about 60 per cent in its extent
- Almost all of the remaining ecological community, occurs as highly fragmented patches; less than 10 ha in size. It is estimated that over 12,000 patches now exist, compared to 132 previously, with the median patch size now being only 1.6 ha
- The TEC has recorded a severe reduction in its community integrity due to the combined effects of clearing and fragmentation, dieback disease, invasive weeds and feral animals, changes to fire regimes, hydrological degradation, climate change, and other disturbances.

Key threats: The TSSC (2016) lists the key threats to this community as:

- Clearing and fragmentation
- Dieback disease especially those caused by *Phytophthora* species
- Invasive species
- Fire regime change
- Hydrological degradation
- Climate change
- Grazing
- Decline in pollinating and seed dispersing fauna
- Loss of keystone Banksia species and fragmenting of nectar/pollen nutritional networks.

2.5.2 Glossy-leafed Hammer-orchid (Drakaea elastica)

WC Act: Threatened Flora (DRF – Extant)

EPBC Act: Endangered

The information on *Drakaea elastica* is summarised from the species recovery plan (DEC 2009).

Description: *Drakaea elastica* has a slender flower stem up to 30 cm high and a single distinctively glossy, bright green, prostrate, heart-shaped leaf 1 to 2 cm in diameter (Plate 1). The leaf emerges in May and starts to wither by the time the orchid flowers in September. The single flower is 3 to 4 cm long with a hinged labellum. Flowers are first seen in late September and continue flowering until late October or more rarely early November.



Drakaea elastica

Photos: A. Brown & S.D. Hopper

Plate 1 Images of Drakaea elastica (source: WA Herbarium 1998-)

Habitat: *Drakaea elastica* is known to occur over a range of approximately 350 km, from Cataby in the north to Busselton in the south. The species grows on bare patches of grey-white sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps and flats, typically in Banksia woodlands or Spearwood (*Kunzea glabrescens*) thicket vegetation (Hoffman and Brown 1998 in recovery plan).

Biology: Drakaea seed is very fine and wind-dispersed, often for many kilometres. It relies on an association with mycorrhizal fungus to germinate its seed and supply nutrients to the plant throughout its life cycle. If the fungus disappears from the habitat, the orchid cannot survive. *D. elastica* typically occurs in areas of sparse understorey, on bare sand or with light leaf litter. These are often nutrient poor.

Identification: Individual plants may not flower every year. The plant dies back to a dormant underground tuber over summer. *D. elastica* is distinguished from all other Drakaea species by its glossy light-green leaf. *D. glyptodon* and *D. livida* often grow in association with *D. elastica* but *D. glyptodon* has a grey, often prominently veined leaf while *D. livida* has a dull, slightly grey-green leaf (Hoffman and Brown 1998 in *D. elastica* recovery Plan). The best time to look for this plant is in July and August when the leaves are relatively conspicuous.

Key threats: the recovery plan identifies the following key threats to this species:

- Land clearing
- Degradation and habitat fragmentation
- Edge effects exposure to weeds, increased wind speed, fertiliser and herbicide spray drift and runoff, modified hydrology and altered disturbance regimes, including fire and grazing
- Increased density of ground-level native vegetation
- Grazing
- Habitat degradation by rabbits, kangaroos and livestock
- Construction of infrastructure and other land development and maintenance
- Rubbish dumping
- Weeds
- Disease
- Inappropriate fire regimes
- Poor recruitment
- Recreation use of populations areas
- Sand extraction
- A rising saline water table

Recovery plan monitoring

Monitoring and surveys need to be undertaken at an appropriate time of year, preferably between June and August when the leaf is fresh and glossy or if necessary when in flower (September – early October). Monitoring of factors such as habitat degradation (including weed invasion, salinity and plant diseases such as *Phytophthora cinnamomi*), number of flowering and vegetative plants present, population stability, pollinator activity and seed production if evident (September – November), recruitment, longevity and predation are essential.

2.5.3 Dwarf Hammer-Orchid (Drakaea micrantha)

WC Act: Threatened Flora (DRF – Extant)

EPBC Act: Vulnerable

The following information on *Drakaea micrantha* was drawn from the Threatened Species Scientific Committee (TSSC) 2008a unless otherwise referenced.

Description: *Drakaea micrantha* is a tuberous terrestrial herb, which has a flower 1.2 to 2.5 cm long, on a stem up to 30 cm high. Its heart shaped leaf is silvery – grey with prominent green veins (Plate 2). The species flowers from September to October (Brown *et al.* 2013).

Habitat: *Drakaea micrantha* is known from scattered populations from Perth to Albany. The species is usually found in cleared fire breaks or open sandy patches that have been disturbed, and where competition from other plants has been removed.

Identification: The species is distinguished from the similar 'King-in-his-carriage' orchid (*Drakaea glyptodon*), by its smaller flower, prominent apical projection to the column and less pouched labellum (Brown *et al.* 2013).

Key threats: The main threat is fire between June and early October, when its above ground parts and replacement tuber are actively growing. The susceptibility of the plants to weeds is unknown. However, they are probably vulnerable to displacement by weed species.



Plate 2 Images of Drakaea micrantha (source: WA Herbarium 1998-)

2.5.4 Dwarf Bee-Orchid (Diuris micrantha)

WC Act: Threatened Flora (DRF – Extant)

EPBC Act: Vulnerable

The information presented below on *Diuris micrantha* was summarised from TSSC 2008b unless otherwise referenced.

Description: *Diuris micrantha* has a basal tuft of narrow, linear leaves and a loose, slender inflorescence up to 60 cm high. The yellow flowers, which can number up to seven, have reddish-brown markings and are the smallest in the genus (Plate 3). Flowers appear from August to early October.

Habitat: *Diuris micrantha* is known from east of Kwinana and south towards the Frankland area. It is found in small populations, on dark grey to blackish sandy clay-loam substrates in winter wet depressions or swamps. The bases of the flowering plants are often covered with shallow water.

Identification: This species is distinguished from other, often co-occurring members of the *Diuris laxiflora* complex by its smaller flowers, usually more rod petals and shorter, generally flattened labellum mid-lobe (Brown *et al.* 2013).

Key threats: The main threat is fire (especially between May and October) and weed invasion. Other threats include clearing, grazing, feral animals and changes in hydrology.



Plate 3 Images of *Diuris micrantha* (source: WA Herbarium 1998)

3. Threatened community and orchid management provisions

3.1 Threatened community and orchid potential impacts

Potential impacts to the Banksia Woodlands TEC and three threatened flora orchids are described in the Albemarle Kemerton Plant Environmental Referral Supporting Document and Additional Information Request Response (GHD 2017 and GHD 2018). A summary of the potential impacts which has been identified for the Project is included in the following sections.

3.1.1 Direct impacts

Vegetation representative of the Banksia Woodlands TEC occurs within the Development Envelope and 6.37 ha will be cleared¹ for the development of the Project (GHD 2018). Vegetation representative of the Banksia Woodlands TEC has also been mapped adjacent to the Development Envelope along a section of the northern and the western boundary as well as to the west of the access off Marriott Road (Figure 2). There is potential for further direct impact to this vegetation if clearing of the Development Envelope encroaches into this area.

There are no records of threatened orchids within the Development Envelope, furthermore they are not considered likely to occur given the disturbance history of the Development Envelope. Therefore, no direct impacts on threatened orchids are expected as a result of the Project.

The closest known record of *Diuris micrantha* is approximately 2.3 km north-east of the Development Envelope and *Drakaea micrantha* approximately 735 m north of the Development Envelope. Given the distance of these records from the Development Envelope and their position away from the planned flow of surface water (which will be directed east of the Development Envelope), it is not expected these species will be directly or indirectly impacted by the Project. *Drakaea elastica* been recorded approximately 45 m from the northern boundary of the Development Envelope. The Project has the potential to indirectly impact on this species.

3.1.2 Indirect impacts

A discussion in regards to indirect impacts to the Banksia Woodlands TEC and *Drakaea elastica* is included in the following sections.

Altered hydrology impacting Banksia Woodland TEC and / or orchids / orchid habitat

The alteration of natural surface water run-off has the potential to indirectly impact adjacent Banksia Woodland TEC and threatened orchids. The drainage design for the Project is selfcontained preventing surface water run-off from the Project entering the surrounding environment.

Albemarle has prepared a Water Management Plan (WMP) (RPS 2018) that details the potential impacts, management of surface and groundwater along with the monitoring requirements.

The Project does not require ongoing groundwater abstraction or dewatering therefore indirect impacts as a result of drawdown will not occur.

¹ Seed has been collected from the Banksia woodland TEC (within the Development Envelope) and will be made available to a local landcare group or nursery.

Acid Sulfate Soils (ASS) – leading to degradation of Banksia Woodland TEC and / or orchids / orchid habitat

There is the risk of exposure of ASS during the construction (earthworks) phase only. Disturbance of ASS can potentially mobilise acid and metals which can have a detrimental impact on native vegetation and flora as well as impact on groundwater quality.

Dust deposition from construction activities – leading to degradation of Banksia Woodland TEC and / or orchids / orchid habitat

There is a potential risk that air quality in close proximity to the Project may be affected due to dust from activities. Potential sources of dust include unsealed roads, vegetation clearing and earthmoving during the Project's construction phase. During the operational phase potential sources of dust may include spodumene concentrate stockpiles, open areas and stack emissions. The dust may settle on adjacent vegetation, potentially affecting the health of the Banksia TEC and threatened orchids and causing degradation to their habitat.

The risk to orchids of dust is very low, considering that any source of dust will be greater than 45 m from the nearest threatened orchid location.

The Albemarle Kemerton Plant has been designed to include emission control measures considered to be Best Available Techniques (BAT) in accordance with the European Commission Industrial Emissions Direction Best Available Techniques Reference Document for the Non-Ferrous Metals Industries in relation to preventing dust emissions. This design includes enclosed or covered storage for dust forming materials, covered conveyors, and bag filters, cyclones or scrubbers for process stacks or vents. Given the design, air emissions that could lead to impacts on the threatened orchids during the operational phase are considered unlikely.

Edge effects - weed / dieback spread into known orchid locations

Clearing and development of the Project will result in the creation of new edge zones, which will interact with a new land use element (the Project). There is the potential to introduce or spread weeds and dieback (*Phytophthora cinnamomi*) into adjacent vegetation particularly during the construction phase. The Development Envelope already has a high population and range of weeds, and there is a risk of dieback (dieback has been recorded south of Marriott Road) (GHD 2018b). Spread is mostly likely to occur as a result of poor hygiene practices of vehicles that enter the Development Envelope, particularly where vehicles may have driven in dieback infested areas. Cleared soils could also potentially cause spread of weeds and dieback if they are not contained within the Development Envelope.

Fire

Fire or inappropriate fire regimes is listed as one of the key threatening processes for the threatened orchids (DEC 2009, TSSC 2008 a and b) and the Banksia Woodland TEC (TSSC 2016). The Project could lead to the damage of surrounding vegetation through accidental generation of bushfire.

3.2 Threatened community and orchid management measures

Based on the requirements of Condition 6-1, the planned environmental outcome for threatened communities and flora for the Project is:

Albemarle shall ensure that the construction and ongoing operation of the Project is undertaken in a manner that avoids direct and indirect impacts (outside of the approved clearing area) to Threatened Flora and Communities. This includes the Banksia Woodlands of the Swan Coastal Plain TEC and Low Lying Banksia attenuata woodlands or shrublands and Drakaea elastica, D. micrantha and Diuris micrantha. To achieve this outcome management objectives have been developed to address the key potential impacts associated with the Project. Management actions have also been developed to achieve the objectives. The management objectives and actions which will be implemented in accordance with this plan are summarised in Table 5. Management objectives and actions relating to hydrological impacts are included in the WMP which will also be implemented for the Project in accordance with the requirements of Ministerial Statement 1085.

Table	5 Threatened	community	and orchid	management	measures

Management objective	Key management action	Timeframe/ Project Phase
Avoid indirect impact to known threatened orchid species	• Stockpiling of all soil and vegetative materials from clearing will be within the Development Envelope, at least 10 m from the boundary to avoid impacting adjacent areas.	Construction
Avoid indirect impact to vegetation and flora	• A spotter will be used when clearing in proximity of the Threatened taxon (<i>Drakaea elastica</i>) to ensure clearing remains within the demarcated clearing boundary	
(Banksia Woodland TEC / Low lying <i>Banksia</i>	 Vehicles shall be restricted to movement along designated tracks and cleared areas, unless undertaking clearing. 	
attenuata woodlands or shrublands PEC) outside of the	• A perimeter fence will be established around the Development Envelope boundary prior to commencing land clearing.	
Development Envelope	 Dust suppression measures will be regularly implemented within the Development Envelope during the construction phase. Suppression can include water carts or application of dust suppressants. 	
	• Daily monitoring of meteorological conditions will be undertaken during the construction phase to identify and prepare or modify operations for conditions which increase the risk of windblown dust.	
	 An ASS investigation will be completed within the Development Envelope prior to commencing ground disturbance. 	
	• Where in-situ soils, identified as requiring treatment of ASS through an ASS investigation, are excavated the material will be treated via one of the following:	
	 application of Aglime to the excavated soils, 	
	 stockpiling of soils on a limestone pad or 	
	 sent offsite to a licensed soil treatment facility. 	

Management objective	Key management action	Timeframe/ Project Phase
	 Validation testing will be undertaken prior to use of treated soils to confirm acidity has been effectively neutralised. 	
	 In areas where treatment of soils for ASS is required, the walls and base of excavations/scrapped areas will be covered with a thin layer of aglime to provide buffering capacity against minor releases of acidity. 	
	 Calcareous sands will be included in imported fill for development of the eastern part of the Development Envelope to provide neutralising/buffering capacity. 	
	• The integrity of the perimeter fence will be maintained.	Construction and
	 Vehicle speeds will be restricted (~ 25 km/h) on unconsolidated surfaces in dry conditions. 	Operation
	All Shire restrictions on fire and machinery movement will be strictly adhered to	
	 Lighting of fires is prohibited unless express permission has been sought from the Shire to undertake burning for a specific purpose. 	
	 Machinery to be fitted with approved spark arresting exhaust systems Relevant personnel shall be trained in the use of emergency fire suppressant equipment All vehicles, plant and equipment will be fitted with fire extinguishers. 	
	• Fires are to be immediately extinguished if identified, and practicable to do so, and reported to the Site Manager.	
	A Hot Work Permit System will be implemented.	
	Implement the Albemarle Kemerton Plant WMP	
	• All dust forming material storage facilities will be covered or silos/bins. This includes spodumene ore concentrate, acid roasted solids, tailings, Lithium Hydroxide Product and Sodium Sulfate By-product, and dust producing reagents.	Operation

Management objective	Key management action	Timeframe/ Project Phase
	 All Lithium Hydroxide Product and Sodium Sulfate By-product produced by the Plant will be packaged in enclosed, lined bags and transported in enclosed containers. 	
	• All transfer points will either be enclosed or have dust extraction.	
	 All conveyors outside of buildings will be enclosed or covered to prevent water ingress and dust egress. 	
	• There will be no visible process generated dust on vehicle wheels leaving the Development Envelope. Washdown or other suitable technique will be provided if necessary.	
	• Road sweeping campaigns will be included within operational procedures for the Project as required.	
Avoid clearing or removal of vegetation	 Vegetation clearing will be undertaken in accordance with a Land clearing procedure. The procedure will include the following requirements: 	Construction
(Banksia Woodland TEC / Low lying <i>Banksia</i> attenuata woodlands or	 An authorised internal clearing permit must be issued prior to undertaking any vegetation clearing. 	
shrublands PEC) outside of the	 Clearing boundaries must be clearly marked and checked to confirm they are accurate prior to undertaking clearing. 	
Development Envelope	 A survey of cleared areas will be undertaken post clearing to confirm boundaries have been adhered to. 	

Management objective	Key management action	Timeframe/ Project Phase
Prevent introduction and/or spread of weeds	 Vehicles, plant and equipment to be maintained and cleaned to reduce the spread of weeds throughout the Development Envelope. 	Construction
into adjacent areas	• Prior to commencing ground disturbance conduct a baseline survey for evidence of weeds within the area immediately outside the Development Envelope boundary and record the result of the survey for future reference.	
	 Restrict movement of machines and other vehicles to within the Development Envelope or on designated tracks outside the area. 	
	 Plant and soil materials are not allowed to be brought to site unless approved for a specific purpose. 	
	• Comply with the requirements of the <i>Biosecurity and Agriculture</i> <i>Management Act 2007</i> (BAM Act) for listed Declared Pests recorded within the Development Envelope.	
Avoid introduction and/or spread of Dieback within adjacent	 Conduct a baseline survey for evidence of dieback within the area immediately outside the Development Envelope boundary and record the result of the survey for future reference. 	Construction
areas	• Implement a Hygiene Procedure/Standard for vehicles and machinery entering the Development Envelope which includes a requirement for all vehicles/plant/equipment which have been working in, or travelling through, areas with known or potential dieback to be cleaned prior to arrival on site, and presented for inspection to confirm they are free from soil and vegetative material.	
	 Any fill material sourced off-site must be clean fill from sources known to be free of dieback. 	
	 Plant and soil materials are not allowed to be brought to site unless approved for a specific purpose. 	

Management objective	Key management action	Timeframe/ Project Phase
	 Restrict movement of machines and other vehicles to within the Development Envelope or on designated tracks outside the area. 	

3.3 Management targets and monitoring

In order to measure performance against the overarching environmental outcome and management objectives, measureable management targets have been developed with associated triggers. Monitoring will be implemented to provide sufficient information to determine when triggers are being exceeded. Further detail on the proposed threatened flora and community monitoring is included in Section 4. This information is summarised in Table 6.

Management Objectives	Management targets	Trigger	Monitoring	Reporting
Avoid indirect impact to known threatened orchid species	No reportable decline of nearby Endangered/Declared Rare Flora (DRF) <i>Drakaea elastica</i> individuals or habitat, attributable to the Project No incidents of fire originating within, and spreading outside of, the Development Envelope	Trigger 1 - Exceedance of hydrological trigger criteria for groundwater levels or quality with predicted impacts extending into known threatened orchid locations / adjacent Banksia Woodland TEC	Annual <i>Drakaea elastica</i> and Banksia TEC monitoring (using quadrats and photographic reference points) for five years. The monitoring method and parameters selected comprise a combination of quantitative and qualitative measures that will provide an overall assessment of the	Compliance with this FVMMP, monitoring results and performance against management targets will be reported annually in the Compliance Assessment Report
Avoid indirect impact to vegetation and flora (Banksia Woodland TEC / Low lying <i>Banksia attenuata</i> woodlands or shrublands PEC) outside of the Development Envelope	No reportable decline to adjacent areas representative of the <i>Banksia</i> Woodlands of the Swan Coastal Plain TEC/ Low lying <i>Banksia attenuata</i> woodlands or shrublands PEC, attributable to the Project No incidents of fire originating within, and spreading outside of, the Development Envelope	Trigger 2 - Threatened orchid not re-recorded or in reportable decline / orchid habitat in reportable decline Trigger 3 – Banksia Woodland TEC in reportable decline and / or Drakaea elastica habitat in reportable decline	 the health <i>D. elastica</i> habitat and the Banksia Woodland TEC and any evidence of disturbance from the Project. This includes: Quadrats: 2 impact and 2 reference for <i>D. elastica</i> Transects with five (5 x 5 m) plots: 3 impact and 2 reference 20 photographic reference points. 	(CAR). Exceedance of trigger criteria will be reported to the DWER – EPA Service within 21 days of MS 1085 Condition 6-3)

Table 6 Flora and vegetation objectives, management targets, triggers, monitoring and reporting

Management Objectives	Management targets	Trigger	Monitoring	Reporting
Avoid clearing or removal of vegetation (Banksia Woodland TEC / Low lying <i>Banksia attenuata</i> woodlands or shrublands PEC) outside of the Development Envelope	No incidents of vegetation clearing outside of the approved Development Envelope	Trigger 4 – Any clearing of vegetation outside of the Development Envelope	Vegetation clearing will be undertaken in accordance with a Land clearing procedure. The procedure will include the following monitoring requirements: - Survey of cleared areas post clearing to confirm boundaries have been adhered to.	
Prevent introduction and/or spread of weeds into adjacent areas	No new Declared or Weeds of National Significance within surrounding vegetation, attributable to the Project No significant increase in weed cover within immediately adjacent vegetation, attributable to the Project	Trigger 5 – Banksia TEC and / or <i>Drakaea</i> <i>elastica</i> monitoring identifies significant increase in weeds or new declared weed species present or visual evidence of dieback.	As part of the Banksia TEC and <i>D. elastica</i> monitoring the following will be recorded at transects and quadrats: - pathogen attack – visual evidence of dieback - plant death: - number of dead shrubs or trees and	
Avoid introduction and/or spread of Dieback within adjacent areas	No evidence of Dieback infestation identified within immediately adjacent areas/ vegetation resulting from the Project		 an percentage for grasses / groundlayer within each quadrat percentage death of upper, mid and groundlayer for transects all species present and the per cent cover including weeds. 	

Reportable decline

Section 5 provides a monitoring program for the Banksia Woodland TEC and threatened orchid / orchid habitat. A reportable decline is considered where monitoring shows:

- A decline in the number of Threatened orchids present at monitoring sites that is attributable to the Project
- A 20 % or greater decline in Banksia TEC / *Drakaea elastica* habitat at monitoring sites (habitat quality / species composition and / or health attributes) against the change at reference sites that is attributed to the Project.

3.4 Triggers and contingency actions

3.4.1 Over-arching contingency management

Incident reporting and investigations will be undertaken in accordance with a Project-specific incident reporting and investigation procedure, and root causes will be determined. Corrective actions will be identified and implemented to address the root causes.

Incidents, 'near misses' and non-compliances with this FVMMP and other management documents will be reported and investigated in accordance with a Project-specific incident reporting and investigation procedure, and appropriate measures implemented to prevent recurrence. Where applicable, environmental incidents will be reported to the relevant government agency.

The following procedure will be implemented when a non-compliance occurs:

- Report the incident, investigate the cause and identify contingency actions
- Implement contingency actions which may include:
 - Review management measure's practicality or relevance
 - Improve training and education for all personnel
 - Improve and implement increased protective measures as necessary
- Monitor outcomes.

3.4.2 Monitoring thresholds

Thresholds for triggering future management intervention are difficult to determine given the cryptic / seasonal nature of the target orchid species i.e *Drakaea elastica* may 'naturally' not occur each year.

The monitoring program (Section 4) has been developed to assist in identifying impacts to threatened orchid, *D. elastica*, and the adjacent Banksia Woodland TEC from the Project. This monitoring program includes assessing reference and impact sites. The following triggers and contingency actions have been prepared to meet the objectives and performance indicators outlined in

Objective 1 – Avoid indirect impact to known threatened orchid species and Objective 2 -Avoid indirect impact to vegetation and flora (Banksia Woodland TEC / Low lying Banksia attenuata woodlands or shrublands PEC) outside of the Development Envelope

Trigger 1 - Exceedance of hydrological trigger criteria for groundwater levels or quality with predicted impacts extending into known threatened orchid locations / adjacent Banksia Woodland TEC

The WMP includes groundwater level and quality monitoring requirements and trigger levels / contingency actions. Should these trigger levels be exceeded, an assessment on the nature

and extent of the impacts will be undertaken. If the exceedance is predicted to extend beyond the boundary of the Project into an area known to contain threatened orchids or Banksia Woodland TEC the following will occur:

- 1. Implement WMP corrective actions, monitor and assess the success of the corrective actions.
- 2. Determine the magnitude and extent of the impact, and the likelihood for impacts to known threatened orchid locations / habitat and / or Banksia Woodland TEC.
- 3. If impacts are likely to threatened orchids / their habitat or the adjacent Banksia Woodland TEC- undertake monitoring (as described in section 4). If this is outside of the optimal timing for orchid presence, the monitoring will be undertaken and comparisons between vegetation health at the reference and impact sites will be used as a proxy.
- 4. Analyse data between all sites to determine any significant (reportable decline) differences in measured parameters.
- 5. If orchids or the Banksia Woodland TEC are in reportable decline, discuss the results with DBCA / EPA and implement agreed corrective actions. In the first instance this will involve management of the impact i.e if water contamination is the impact this will be remediated with further monitoring to assess the recovery of the community / habitat / orchids.

Trigger 2 - Threatened orchid not re-recorded or in reportable decline / orchid habitat in reportable decline

If monitoring identifies that the *Drakaea elastica* population or the measured orchid habitat parameters are in reportable decline the following will occur:

First year not re-recorded / decline

- Determine if habitat proxy data show a change compared to the reference sites. If there is greater than 20 per cent decline in comparison to reference sites – review water monitoring data to confirm whether there are any significant change in results. Review field data from flora and vegetation monitoring to determine if other disturbances are evident, such as grazing / fire / erosion. Review environmental incidents to determine their nature and extent and whether they could have impacted the sampling sites. Implement Trigger 1 contingency actions.
- If there are no changes in habitat proxy data and no evidence of other disturbances no further action is required in year 1. The null record may be due to the species not emerging each year or as a result of the influence of other external factors such as foraging animals.

Second plus years of reportable decline of orchid numbers but habitat data remains consistent with reference sites

- 1. Follow processes 1 2 outlined for year 1
- 2. Discuss results with DBCA / EPA
- 3. Implement agreed actions from the DBCA / EPA discussion
- 4. Continue to monitor at the standard frequency

Trigger 3 – Banksia Woodland TEC in reportable decline and / or Drakaea elastica habitat in reportable decline

If monitoring identifies that the Banksia Woodland TEC / *Drakaea elastica* habitat monitoring parameters has decreased (greater than 20 per cent) in comparison to the change at reference sites (reportable decline) the following will occur:

- 1. Review water monitoring data to confirm whether there are any significant changes in results. Review environmental incidents to determine their nature and extent and whether they could have impacted the sampling sites. Implement Trigger 1 contingency actions
- 2. If there have been no environmental incidences recorded / occurred. Assess monitoring sites and their adjacent area for evidence of other impacts, such as erosion or sedimentation, dumping of waste, dust accumulation on vegetation or an increase in weed species. Assess these impacts to determine whether they are likely to be sourced from the Project i.e. does the erosion extend from the Development Envelope into the TEC or is there evidence of alternative pathways.
- 3. Discuss findings with EPA / DBCA and implement management actions if impacts attributable to the Project are detected.
- 4. Monitor effectiveness of management actions and recovery of the Banksia Woodland / orchid habitat. Update / revise management measure if needed (impact persists despite management actions).

Objective 3 – Avoid clearing or removal of vegetation (Banksia Woodland TEC / Low lying *Banksia attenuata* woodlands or shrublands PEC) outside of the Development Envelope

Trigger 4 – Any clearing of vegetation outside of the Development Envelope

If monitoring (as outlined in Table 6) indicates that clearing has occurred beyond the Development Envelope that is attributable to the Project the following will occur:

1. Investigate and map the extent of clearing beyond the boundary and notify the EPA of the breach.

2. Determine the reason for the clearing and implement corrective actions to prevent future clearing beyond the Development Envelope

3. Undertake rehabilitation of any areas cleared outside of the Development Envelope.

Objective 4 – Prevent introduction and/or spread of weeds into adjacent areas and Objective 5 - Avoid introduction and/or spread of Dieback within adjacent areas

Trigger 5 – Banksia TEC and / or Drakaea elastica monitoring identifies significant increase in weeds or new declared weed species present or visual evidence of dieback.

If monitoring identifies there is a greater than 20 % increase in weeds species cover (since the baseline (2018) monitoring round), new declared weed species present, or the presence of dieback in areas previously dieback free (based on visual evidence of dieback susceptible species), the following will be undertaken:

- 1. Determine whether the increase in weeds / presence of dieback is attributable to the Project.
- 2. If dieback is expected, undertake a dieback survey to confirm visual observations of dieback are correct.

- 3. Discuss findings with EPA / DBCA and implement management actions if impacts attributable to the Project are detected.
- 4. Monitor effectiveness of management actions. Update / revise management measures if needed (impact persists despite management actions).

In the event that the monitoring specified in this FVMMP indicates that the trigger values (see section 3.4.2) or the objective / management targets (Table 6) have been triggered, Albemarle shall:

- Report such findings to the EPA within 21 days of the criteria being triggered.
- Provide evidence to the EPA which allows for determination of the likely cause of the trigger criteria being reached and to identify any additional contingency actions required to prevent the criteria being triggered in the future.
- If triggering the criteria is determined by the EPA to be a result of activities undertaken in implementing the Project, immediately implement the management and / or contingency actions specified in the FVMMP / other relevant management plans and continue implementation of those actions until the trigger criteria are met, or until the EPA has confirmed by notice in writing that is has been demonstrated that the objective in condition 6-1 (Table 3) will continue to be met and implementation of the management and / or contingency actions is no longer required.

4. Monitoring program

This monitoring program has been prepared to meet and demonstrate compliance with objectives and performance indicators outlined in.

4.1 Monitoring overview considerations

The monitoring program has been developed with reference to the following documents:

- Environmental Factor Guideline: Flora and Vegetation. Government of Western Australia (EPA 2016a)
- Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment. (EPA, 2016b)
- Survey guidelines for Australia's Threatened Orchids Guidelines for Detecting Orchids Listed as Threatened under the EPBC Act 1999 (DotEE 2013)
- Glossy-leafed Hammer Orchid (*Drakaea elastica*) Recovery Plan (DEC 2009)
- Banksia Woodland TEC Conservation Advice (TSSC 2016)

4.1.1 Personnel

Surveys will be conducted by a botanist with appropriate experience and qualifications, including:

- Demonstrated experience as a field botanist in the Swan Coastal Plain
- Experience in field identification of threatened orchid species and similar species that might be encountered in the area.

4.1.2 Optimal timing

Orchid

Drakaea elastica is distinguished from all other *Drakaea* species by its glossy light-green leaf. The best time to look for this plant is in July and August when the leaves are relatively conspicuous (DEC 2009). DBCA flora officer Andrew Webb has advised that late August to early September is typically suitable for *D. elastica* sampling in the Bunbury area (pers. comms Andrew Webb 31 May 2018).

Prior to the survey, the local DBCA office (flora officer) will be contacted to confirm if other known populations in the Bunbury area have leaf emergence.

Banksia Woodland TEC

Identifying the community and its general location is possible at most times of the year, however for this FVMMP, consideration has been given to the role the season may play in the assessment. The Banksia Woodland sampling would be carried out in conjunction with the *D. elastica* monitoring in late August / early September which provides the optimal time to survey both the TEC and the orchid.

4.1.3 Frequency

The monitoring program will be undertaken annually for the first five years (2018 to 2022). This will coincide with the Project's expected construction phase and at least two years of operation.

If there is no change to the threatened community / orchids or their habitat after this time, attributable to Project activities, monitoring will be reduced to every second year for four years

(2024 to 2026). If there is no change, attributable to the Project, after this four year period, the need to continue monitoring will be discussed with DotEE / EPA.

4.1.4 Flora results

Any Threatened or Priority flora and TEC / PEC occurrences will be submitted following each and every monitoring occurrence as per the DBCA / WA Herbarium requirements.

4.2 Monitoring type and locations

The monitoring method and parameters selected comprise a combination of quantitative and qualitative measures that will provide an overall assessment of the presence / absence of *Drakaea elastica*, the health *D. elastica* habitat and the Banksia Woodland TEC and any evidence of disturbance from the Project.

As *Drakaea elastica* may not flower / emerge each year, the monitoring program allows for the collection of habitat and floristic data for use as a proxy in years when the orchids do not emerge.

4.2.1 Drakaea elastica monitoring sites

Tentative monitoring sites where nominated based on historical records, these included two permanent quadrats at the closest known *Drakaea elastica* sites and two reference quadrats (preferably within the KSIA). The tentative locations of the sites are described in Table 7.

An initial survey was undertaken to confirm whether *D. elastica* remains at the historical locations and confirm the monitoring sites. The survey was undertaken from 13 - 15 August 2018 by GHD Botanist Angela Benkovic who was accompanied on 13 August by Mr. Andrew Webb (Department of Biodiversity, Conservation and Attractions (DBCA) officer).

Mr. Andrew Webb assisted in the survey of potential reference site Lot 511 (DBCA managed land). At Lot 511 one occurrence of *D. micrantha* was recorded, there were no occurrences of *D. elastica*. On 14 August, A. Benkovic surveyed the two previously recorded locations of *D. elastica* (45 m and 80 m north from the Development Envelope) by meandering in a 10-20 m radius around the locations.

On August 15, A. Benkovic surveyed the potential reference site locations within Lot 40 (DBCA managed land). This area was also searched by meandering in a 10-20 m radius around the known locations.

Figure 4 shows the August 2018 survey locations.

No suitable reference site was selected for *Drakaea elastica* as only one small population was found (within Lot 40). Lot 40 had favourable conditions for *D. elastica* in that a recent fire (<2 yrs) would have opened up the vegetation to create bare ground and a section of Lot 40 (250 m south east) where the *D. elastica* were located was water logged. Hydrology is important to *D. elastica* and it is often found near watercourses or damp areas (DEC 2009). Locating this population confirms that with favourable site conditions, the timing of the survey was correct for the presence of the species.

Mr. Andrew Webb recommended monitoring effort focusses on monitoring the Banksia Woodland TEC vegetation instead of the three *D. elastica*. He commented that the population was too small to be of benefit as a reference site. He also noted that because the TEC monitoring would include measures of species density for component taxa, for example if the density monitoring found that geophytes were declining, then it could safely be assumed that any *D. elastica*'s in the area would also be doing the same (A. Webb pers. comm, 11 September, 2018).

Like many terrestrial orchids, *D. elastica* individuals may not flower every year, instead waiting until environmental conditions are favourable to do so. Due to this cryptic nature of *D. elastica* the historic locations (45 m and 80 m north of the Project and at reference sites) will be resurveyed in 2019 to confirm if the individuals were dormant in 2018 or have died off. If found, the monitoring locations will be confirmed at this time.

4.2.2 Banksia Woodland TEC monitoring

Three transects will be established on each side of the Development Envelope that contains Banksia Woodland TEC (North, West and South) and two reference transects in retained vegetation preferably within the buffer zone of the KSIA.

The transect locations were finalised during an initial site visit (August 2018) prior to commencing the first round of monitoring.

Photographic monitoring points will be positioned around the perimeter of the Development Envelope in Banksia Woodland TEC vegetation with at least one monitoring point positioned every 100 m.

The location of the five transects and 20 photographic monitoring sites is shown in Figure 5.

Site Number	Description	Туре	Comments
Drakaga glastic	ea monitoring sites	Турс	Comments
Quadrat 1	Drakaea elastica known location 45 m from Project northern boundary	Impact	Orchid site – last sampled in 2013. Three <i>D. elastica</i> known to be present. The area was searched on the 14 August 2018. No <i>D.</i> <i>elastica</i> observed.
Quadrat 2	<i>Drakaea elastica</i> known location 80 m from Project northern boundary	Impact	Orchid site – last sampled in 2013. Two <i>D. elastica</i> known to be present. The area was searched on the 14 August 2018. No D. elastica observed.
Quadrat 3 and 4	Location within DBCA managed lands within the KSIA buffer area. One site in Lot 40 and one site in Lot 511.	Reference	Previous records within the site. August 2018 survey - One record (3 plants) within Lot 40. Searches in Lot 511 did not record any <i>D.</i> <i>elastica</i> .
Banksia Woodla	and TEC Monitoring Sites		
Transect 1	Located in Lot 511 within the KSIA buffer area and in DBCA managed land.	Reference	Site confirmed as Banksia TEC and in Very Good condition.
Transect 2	Northern perimeter in vegetation mapped by ELA (2013) as EmCcBa in Excellent condition. This transect is located near the known <i>D.</i> <i>elastica</i> record.	Impact	Site confirmed as Banksia TEC and in Very Good condition.
Transect 3	Western corner of the Development Envelope in vegetation mapped in GHD (2018) as being EmCcXb in Good condition. This area was also mapped by ELA (2013) as EmCcBa.	Impact	Site confirmed as Banksia TEC and in Very Good condition.
Transect 4	On the southern boundary and west of the access road. This site is located in the Banksia block, which has been mapped by ELA (2013) and in GHD (2018) as EmCcBa in Very Good condition.	Impact	Site confirmed as Banksia TEC and in Good condition.
Transect 5	On the western side of Lot 40.	Reference	Confirmed as Banksia TEC, in Very Good

Table 7 Tentative monitoring locations

Site Number	Description	Туре	Comments
			condition with a section of Good condition at the initial plot due to the high percentage of weeds/ recent fire (< 2 years).
Photographic monitoring sites	One point at least every 100 m around the perimeter of the Development Envelope in Banksia Woodland TEC.	Impact sites – photographic monitoring.	20 photographic monitoring sites around the perimeter.





Dala source: Landgate: Imagery: GHD: Lot Boundaries - 20180302, Survey Effort - 20181116, Premises Boundary - 20171023, Drakaea elastica. Created by: afeene





Data source: Landgate: Imagery; GHD: Transects and Photo Monitoring Locations - 20181101. Created by: afeeney

4.3 Site establishment

4.3.1 Drakaea elastica - monitoring quadrats

Each quadrat (10 x 10 m plots) will be measured using a tape, and the corners of each plot will be marked with a galvanised steel post and geo-referenced (recorded using a handheld Global Positioning System (GPS). The height of each post will be measured and recorded. The quadrat will be orientated to include as many *Drakaea elastica* individuals as possible.

Each Drakaea elastica location will be geo-referenced with a Differential GPS unit.

4.3.2 Banksia Woodland TEC - monitoring transects

Transects will be established that are 45 m long by 5 m in width. Each transect will be positioned from the edge of the Banksia woodland closest to the Development Envelope into the Banksia Woodland. Along each transect, plots (5 x 5 m) will be established. Each plot will be measured using a tape, and the corners of each plot will be marked with a galvanised steel post and geo-referenced (recorded using a handheld GPS). The height of each post will be measured and recorded. The layout of the transect is shown in Figure 6.





Figure 6 Layout of Banksia Woodland monitoring transect

4.3.3 Banksia Woodland - photographic monitoring points

Visual vegetation health will be captured using photographs taken from permanent photographic points, the following will be noted at each point:

- Dominant species in each structural layer
- Weed species present and overall cover
- Site conditions (see 4.4.2)

Photographs will be replicated in subsequent monitoring events.

4.4 Monitoring parameters

The monitoring parameters selected comprise a combination of quantitative and qualitative vegetation measures that will provide an overall assessment of the health of the vegetation. The selected monitoring parameters are described below and summarised in Table 8. Data will be collected using standardised data sheets.

4.4.1 Vegetation community structure

Vegetation will be described based on structure, dominant taxa and cover characteristics. Vegetation unit descriptions will follow the National Vegetation Information System (NVIS) and will be consistent with NVIS Level V (Association). At Level V up to three taxa per stratum are used to describe the association (Executive Steering Committee for Australian Vegetation Information (ESCAVI 2003) (Appendix A).

4.4.2 Site conditions

The following site conditions will be assessed:

- Condition in accordance with the rating scale (EPA 2016)
- Pathogen attack visual evidence of dieback
- Fire history
- Erosion evidence description and photograph of erosion if present. Description to include depth and width characteristics
- Dust on vegetation record any evidence of dust on
- Plant death
 - number of dead shrubs or trees and an percentage for grasses / groundlayer within each quadrat
 - percentage death of upper, mid and groundlayer for transects
- Other disturbances (e.g. rubbish dumping, access tracks, grazing)

4.4.3 Species diversity

Monitoring quadrats (10 x 10 m) and transect plots (5 x 5 m)

In each quadrat the following will be collected:

- Species present identify all species present within the quadrat and their height range
- An estimate of cover and abundance of species using the Domin-Krajina scale (Appendix A)
- Ratio of exotics: natives
- Number of threatened orchids present.

4.4.4 Ground characteristics

The percentage of bare ground, leaf litter, twig and logs will be recorded in 5 % categories (i.e 0-5%, 5-10% etc).

Table 8 Monitoring quadrats and transect plots - selected parameters

Parameter	Quadrat (10 x 10 m) and transect plots (5 x 5 m)
Photographic monitoring	Each corner post – facing towards the centre of the quadrat / plot.
Vegetation community structure	Described for the quadrat / plot
Site conditions	Recorded for the quadrat / plot
Species diversity	Recorded for the quadrat / plot
% bare ground, leaf litter	Recorded for the quadrat / plot

4.5 Threatened orchid locations

For each threatened orchid identified in any of the monitoring methods (quadrats / traverse / transects) the following will be recorded:

- Identify and GPS each individual orchid.
- Pin tags to be placed near the location
- Plant growth form leaves emergent, flowering

- Herbivory impact / other notable damage
- Photograph in situ and habitat for each orchid
- Measure and photograph (with ruler showing) the length and width of leaves / flowers (if present).

4.6 Data analysis

Data collected from monitoring are to be entered into electronic spreadsheets and analysed for trends in vegetation health. Table 9 provides a summary of the calculations to be completed for each parameter. Photographs from each transect will be appropriately labelled and stored.

For the monitoring quadrats and transect plots, data analysis should include the use of parametric univariate statistical tests including a paired t-test (two sampling events) or ANOVA (more than two sampling events) when testing for change between years at sites or between sites within a single survey event.

Parameter	Description
Number of orchids present	Number of orchids recorded in each monitoring quadrat.
Species diversity	Diversity calculated by counting the number of different species present in the quadrat / plot.
Species composition	Per cent composition calculated by the per cent cover for each species.
Weed species	Number and total cover calculated.
Vegetation health	Visual comparison of photographs taken from permanent photo points at each transect.
Ground characteristics	Comparison of the previous years to note change over time.

Table 9 Summary of calculations

4.7 Reporting

The results of each monitoring round will be described in a report, which includes:

- Introduction and purpose
- Methodology this will be consistent with those described above, and include a record of discussion with DBCA
- Monitoring results and comparison with previous years
- Discussion and recommendations:
 - Discuss the changes observed between monitoring rounds and reference / impact sites
 - Comment on the seasonality and any other disturbances (fire, grazing and weeds) observed
 - Discuss the results in relation to trigger values and contingency actions and provide recommendations in relation to contingency measures
 - Provide a conclusion as to whether changes have occurred and if these are likely to be linked to the Project.

5. Management plan reporting and revision

Albemarle will undertake reporting in accordance with regulatory and legislative requirements. It is expected that the Plant will be required to operate in accordance with a Part V EP Act licence which will specify annual environmental and compliance reporting requirements.

The results of this FVMMP including the results of the monitoring program will be reported annually in the Project Annual Compliance Assessment Reports which will be submitted in accordance with Condition 4-6 of Ministerial Statement 1085.

In the event that this management plan / monitoring program is altered, a revised plan will be submitted to DotEE / EPA for approval.

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Appendices

GHD | Report for Albemarle Lithium Pty Ltd - Albemarle Kemerton Plant, 61/36286/

Appendix A – Methodology information

Domin Krajina scale

NVIS Vegetation Community Description Tables

DOMIN KRAJINA SCALE

Scale Score	Description
10	Any number of individuals of a species with complete cover (100%) in the stand
9	Any number of individuals of a species with greater than 75 % but less than 100%
8	Any number of individuals of a species with 50-75% cover
7	Any number of individuals of a species with 33-50% cover
6	Any number of individuals of a species with 25-33% cover
5	Any number of individuals of a species with 10-25% cover
4	Any number of individuals of a species with 5-10% cover
3	Scattered individuals of a species with 1-5% cover
2	Very scattered individuals of a species with less than 1% cover
1	Seldom found species with insignificant cover
+	Solitary plant with insignificant cover

NVIS	Structural	Classes
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		Cover Characteristics						
	Foliage cover *	70-100	30-70	10-30	2-10	<2n	<2t	unknown
	Crown cover **	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
	% Cover ***	>80	50-80	20-50	0.25-20	<0.25	0-5	unknown
	Cover code	d	C	i	r	bi	bc	unknown
Growth Form	Height Ranges (m)			Str	uctural Formation Cla	sses		
tree, palm	<10,10-30, >30	closed forest	open forest	woodland	open woodland	isolated trees	isolated clumps of trees	trees
tree mallee	<3, <10, 10-30	closed mallee forest	open mallee forest	mallee woodland	open mallee woodland	isolated mallee trees	isolated clumps of mallee trees	mallee trees
shrub, cycad,grass- tree, tree-fern	<1,1-2,>2	closed shrubland	shrubland	open shrubland	sparse shrubland	isolated shrubs	isolated clumps of shrubs	shrubs
mallee shrub	<3, <10, 10-30	closed mallee shrubland	mallee shrubland	open mallee shrubland	sparse mallee shrubland	isolated mallee shrubs	isolated clumps of mallee shrubs	mallee shrubs
heath shrub	<1,1-2,>2	closed heathland	heathland	open heathland	sparse heathland	isolated heath shrubs	isolated clumps of heath shrubs	heath shrubs
chenopod shrub	<1,1-2,>2	closed chenopod shrubland	chenopod shrubland	open chenopod shrubland	sparse chenopod shrubland	isolated chenopod shrubs	isolated clumps of chenopod shrubs	chenopod shrubs
samphire shrub	<0.5,>0.5	closed samphire shrubland	samphire shrubland	open samphire shrubland	sparse samphire shrubland	isolated samphire shrubs	isolated clumps of samphire shrubs	samphire shrubs
hummock grass	<2,>2	closed hummock grassland	hummock grassland	open hummock grassland	sparse hummock grassland	isolated hummock grasses	isolated clumps of hummock grasses	hummock grasses
tussock grass	<0.5,>0.5	closed tussock grassland	tussock grassland	open tussock grassland	sparse tussock grassland	isolated tussock grasses	isolated clumps of tussock grasses	tussock grasses
other grass	<0.5,>0.5	closed grassland	grassland	open grassland	sparse grassland	isolated grasses	isolated clumps of grasses	other grasses

Growth Form	Height Ranges (m)	Structural Formation Classes						
sedge	<0.5,>0.5	closed sedgeland	sedgeland	open sedgeland	sparse sedgeland	isolated sedges	isolated clumps of sedges	sedges
rush	<0.5,>0.5	closed rushland	rushland	open rushland	sparse rushland	isolated rushes	isolated clumps of rushes	rushes
forb	<0.5,>0.5	closed forbland	forbland	open forbland	sparse forbland	isolated forbs	isolated clumps of forbs	forbs
herb	<0.5,>0.5	closed herbland	herbland	open herbland	sparse herbland	isolated herbs	isolated clumps of herbs	herbs
fern	<1,1-2,>2	closed fernland	fernland	open fernland	sparse fernland	isolated ferns	isolated clumps of ferns	ferns
bryophyte	<0.5	closed bryophyteland	bryophyteland	open bryophyteland	sparse bryophyteland	isolated bryophytes	isolated clumps of bryophytes	bryophytes
lichen	<0.5	closed lichenland	lichenland	open lichenland	sparse lichenland	isolated lichens	isolated clumps of lichens	lichens
vine	<10,10-30, >30	closed vineland	vineland	open vineland	sparse vineland	isolated vines	isolated clumps of vines	vines
aquatic	0-0.5,<1	closed aquatic bed	aquatic bed	open aquatic bed	sparse aquatics	isolated aquatics	isolated clumps of aquatics	aquatics
seagrass	0-0.5,<1	closed seagrass bed	seagrassbed	open seagrassbed	sparse seagrassbed	isolated seagrasses	isolated clumps of seagrasses	seagrasses

* Foliage Cover is defined for each stratum as 'the proportion of the ground, which would be shaded if sunshine came from directly overhead'. It includes branches and leaves and is similar to the Crown type of Walker & Hopkins (1990) but is applied to a stratum or plot rather than an individual crown. It is generally not directly measured in the field for the upper stratum, although it can be measured by various line interception methods for ground layer vegetation. For the attribute COVER CODE in the Stratum table, the ground cover category refers to ground foliage cover not percentage cover.

** Crown Cover (canopy cover) as per Walker & Hopkins (1990). Although relationships between the two are dependent on season, species, species age etc (Walker & Hopkins (1990), the crown cover category classes have been adopted as the defining measure.

*** The percentage cover is defined as the percentage of a strictly defined plot area, covered by vegetation. This can be an estimate and is a less precise measure than using, for example, a point intercept transect methods on ground layer, or overstorey vegetative cover. That is for precisely measured values (e.g. crown densitometer or point intercept transects) the value measured would be 'foliage' cover. Where less precise or qualitative measures are used these will most probably be recorded as 'percentage' cover. The last column of the table is designed to cater for situations, in existing data, where the cover value for the growth form is unknown.

NVIS Height Classes

Height		Growth Form							
Height Class	Height Range (m)	tree, vine (M & U), palm (single-stemmed)	shrub, heath shrub, chenopod shrub, ferns,samphire shrub, cycad, tree- fern,grass-tree, palm (multi- stemmed)	tree mallee, mallee shrub	tussock grass, hummock grass, other grass, sedge, rush, forbs, vine (G)	bryophyte, lichen, seagrass, aquatic			
8	>30	tall	NA	NA	NA	NA			
7	2-10	mid	NA	tall	NA	NA			
6	<10	low	NA	mid	NA	NA			
5	<3	NA	NA	low	NA	NA			
4	>2	NA	tall	NA	tall	NA			
3	1-2	NA	mid	NA	tall	NA			
2	0.5-1	NA	low	NA	mid	tall			
1	<0.5	NA	low	NA	low	low			
Source: (Based on Walker & Hopkins 1990).									

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Document	Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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