Appendix G

Flora and Fauna Report

GHD

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Department of Agriculture and Food

Report for State Barrier Fence Esperance Extension: Scoping Study

Preliminary Flora and Fauna Assessment

July 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Purpose

The Department of Agriculture and Food Western Australia (DAFWA) has proposed the construction of an extension to the State Barrier Fence (SBF). The proposed extension will extend from the current SBF's most southerly point at Jerdacuttup to the Indian Ocean east of Esperance.

GHD Pty Ltd (GHD) was commissioned to undertake a scoping study to compare and assess the various alignments in regards to their potential to provide optimum vermin control and minimal environmental and social impact. As part of this scoping study GHD conducted an initial flora and fauna assessment in order to provide information on ecological aspects for the scoping study. This assessment provides information to enable the comparison of the flora and fauna issues relevant to the various alignments. The information from this preliminary flora and fauna assessment will be assessed along with information on other environmental, social and technical components during the process of providing a recommended route(s).

The preliminary flora and fauna assessment will also assist DAFWA in the identification of any major ecological issues associated with the SBF and the requirements for further investigations. It is GHD's assumption that this project will require further approvals and that this document will provide a basis for further reports.

1.2 Project Background

The SBF has been established in Western Australia since 1901. For the last 111 years it has been a physical barrier designed to protect Western Australia's agricultural resources from vermin and predators. It was originally constructed to protect the state from invasive rabbits. This failed for various reasons and its most significant role today is the exclusion of emus and wild dogs.

The SBF originates at the Zuytdorp Cliffs north of Kalbarri and runs southwards along the perimeter of the agricultural region to Jerdacuttup in the Ravensthorpe Shire. The existing fence is currently over 1700km in length with the Yilgarn extension currently under renovation. The Zuytdorp Cliffs provide a strong geographical barrier preventing vermin and predators from entering at the most northern point of the SBF. At the present most southern point there is no physical barrier in place to stop the migration of vermin around the fence.

The proposed Esperance extension aims to complete the physical barrier from coast to coast and increase the resilience of the associated agricultural area's vermin control.

Its length will be between 500 km and 730 km depending on the route chosen. The proposed SBF will broadly run along the interface between agricultural and vacant crown lands in a broad arc from Jerdacutttup to the southern coast to the east of Esperance (the 'Project Area'). The SBF will mostly consist of a 1.3 m "ring lock" netted fence with an angled skirt. This design allows for movement of native fauna while excluding emus and wild dogs, which are of concern.

The SBF will be located in the centre of a 20 m wide cleared easement. This gives a possible maximum Project Area clearing size of between 1000 and 1460 ha depending on the length of the alignment chosen.

A large proportion of the SBF is expected to be constructed adjacent to existing cleared tracks/roads which may be used as the 10 m buffer on one side of the alignment. For the purpose of the scoping study the alignment options will be assessed for 100 m either side of the proposed route to ensure all significant factors affecting the fence are considered and to provide options for the detailed work required to establish a final alignment for the SBF that will be constructed.

1.3 State Barrier Fence Alignment Options

The proposed SBF extension commences at Jerdacuttup, approximately 150 km west of Esperance. The first section of the SBF extension follows Bandalup Rd and West Point Rd, whereafter it passes along the interface between agricultural and vacant crown lands in a general north-east direction. It crosses the Coolgardie-Esperance Highway approximately 35 km to the north of Salmon Gums, the most northerly point. The SBF extension then heads in an approximate south-east direction along the edge of the agricultural land until it turns directly south before Cape Arid National Park. There are a number of alternative end point options being discussed, including an off-coast endpoint just north of Fisheries Road and a coast endpoint at a granite outcrop at the western end of Cape Arid National Park.

The proposed SBF can be dissected into a series of sections and options. These options are not mutually exclusive and in some sections of the Project Area only one option for alignment exists. A section refers to a portion of the SBF where there is only one proposed route. An option refers to a portion of the alignment where there is more than one proposed route. The origin near Jerdacuttup and the southernmost endpoint are sections where no other proposed option exists.

The alignment options being considered in this study can be further classified according to their distance from the current agricultural border to the south and west of the proposed SBF. The options have been assigned a letter according to this classification under the following criteria:

- Option A – The outermost route
- Option B - The median route between A and C
- Option C – The innermost route
- Option BC – Where options B and C merge
- Section – where no other options exist

The proposed SBF alignments are mapped at Figure 1,Appendix A.

There are also a number of subsections where alternatives to the fence are provided. These primarily occur at creek crossings where building a fenceline can be technically difficult, costly and have environmental implications. In these areas there is the potential to use "wings" to divert the target fauna instead of building a connecting fenceline. These diversion wings curve the fence back towards itself in a large arc on either side of the obstacle to focus the target fauna backwards and divert them from the area being protected by the wing.

Generally the alignment runs along the boundary between the agricultural land and the remnant vegetation within the UCL. Where options exist, Option C, the innermost option, follows the boundary between the cleared private property and the UCL while Option A, the outermost option, generally follows the shortest route across the UCL.

1.4 Scope of Works

DAFWA contracted GHD to undertake this study to identify the expected primary flora and fauna impacts of the various alignments of the proposed Esperance extension of the SBF and to assess the alignment options based on the identified issues. This assessment includes:

- A relevant literature and database review; and
- A Level 1 site assessment conducted in May 2012 to assess key areas and identify the potential major flora and fauna constraints along the alignments.

For the purpose of the scoping study, an area of 100 m width along all the alignment options and sections was investigated (the 'Project Area'). However, as the Project Area is a very large area, and access to some sections of it was very difficult, the field survey only assessed key sites within the Project Area (see Section 2.2).

2. Methodology

2.1 Desktop Assessment

The desktop assessment was carried out to identify potential flora and fauna constraints which may be in, or adjoining, the SBF extension. This included a literature search to identify information pertaining to the Project Area and to provide information on any aspects of ecological significance. The following aspects were included:

- A review of the Department of Environment and Conservation's (DEC) Threatened Ecological Communities (TEC) and Priority Ecological Communities (PEC) databases to determine the potential for TECs or PECs to be present within the Project Area. This included those communities listed under the *Environment Protection and Biodiversity Conservation* Act, *1999* (EPBC Act).
- A search of DEC's Threatened Flora Databases and Priority Flora List;
- A review of the Western Australian Museum's (WAM) and DEC's *NatureMap* – to determine terrestrial vertebrate fauna species and flora species lodged in the Museum and the State Herbarium from within or adjacent to the Project Area;
- A review of the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters database, with a buffer distance of 10 km – to identify species listed under the EPBC Act potentially occurring within the Project Area;
- A discussion of broad vegetation types shown in existing mapping (e.g. Beard *et al.* 1973); and
- An assessment of DEC's information on scrub-rolled clearing corridors.
- A review of other pertinent literature including: *A Biodiversity Audit of Western Australia's 53 Biogeographical Subreregions in 2002* (Comer *et al.*, 2001 *and* Comer *et al.*, 2002); *A Biodiversity and Cultural Conservation Strategy for the Great Western* Woodlands (DEC, 2010); *Advice on the Ecological Effects of the Esperance Extensions on Native Wildlife Field Assessment* (DAFWA, 2012)

2.2 Field Survey

The field survey sought to confirm the desktop assessment and provide information on the existing environment in the Project Area. The survey included a preliminary examination of the physical environment, vegetation and flora and fauna within the Project Area.

The flora and vegetation survey was a Level 1 survey conducted with reference to the Environmental Protection Authority (EPA) Guidance Statement No. 51 *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004a).

The fauna survey was undertaken in conjunction with the flora and vegetation survey and consisted of a Level 1 survey in regard of the requirements of the EPA's Guidance Statement No. 56 *Assessment of Environmental Factors for Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia* (EPA, 2004b) and the DEC and the EPA's Technical Guide *Terrestrial Biological Surveys as an Element of Biodiversity Protection: Position Statement No. 3* (EPA, 2002).

The survey targeted key areas and sites of concern (such as areas containing conservation significant communities or species). Representative sites were surveyed to allow the remainder of the mapping to be extrapolated based on aerial photography, landform and previous surveys.

The flora and fauna survey included:

- Opportunistic collection and identification of flora species present on the site. Any conservation significant species identified in the field were recorded with a GPS location and their sub-population size estimated;
- Ground truthing of key areas to verify the information gathered from the desktop survey;
- Assessment of the potential fauna habitat present;
- Determination of suitable habitat for significant fauna;
- Confirmation of species identification using resources at the WA Herbarium;
- Electronic mapping using aerial photography to delineate vegetation units, vegetation condition, water courses and conservation significant species observed;
- An inventory of the vertebrate fauna species in the Project Area through opportunistic recording of species; and
- Identification of potential impacts.

Experienced, qualified GHD ecologists undertook the survey of the Project Area between the 22 May and 29 May 2012. The site was traversed by vehicle using roads, firebreaks and other cleared areas adjacent to the SBF alignment options. Key sites were selected on the basis of previous mapping (Beard, 1973), geology and soils mapping, access and aerial photography.

Representative flora and vegetation sites were surveyed by using both non-permanent quadrat and Rapid Assessment sites (RAs) (Figure 2, Appendix A). The field survey aimed to place one quadrat (10 m x 10 m) in each broad vegetation type. Twenty-eight quadrats were assessed across the Project Area and at each quadrat a photo was taken and the following aspects were recorded (details provided in Appendix C):

- Landform;
- Soil;
- Slope;
- Ground cover (bare ground, logs, twigs, leaves);
- Vegetation condition and disturbance factors;
- Age since fire;
- Vegetation Type;
- Cover class of vegetation structural layers; and
- Flora species list.

The RAs were a less detailed assessment of areas, predominantly aimed at determining the dominant species and a search for any conservation significant species. One hundred RAs were undertaken across the Project Area and at each RA a photo was taken and the following aspects recorded (details provided in Appendix C):

- Vegetation type;
- Any significant landform or soil features;

- Vegetation condition and disturbance factors; and
- Flora species list for dominant species and conservation significant flora.

Nomenclature

Nomenclature used in this report follows that used by the DEC's online *FloraBase* program (http://florabase.dec.wa.gov.au/) for flora species and online *NatureMap* program (http://naturemap.dec.wa.gov.au/default.aspx) and Christidis and Boles (2008) for fauna species as these references are deemed to contain the most up to date species information for Western Australia.

2.3 Limitations

This assessment was a scoping study in order to determine the likely optimum alignment for the SBF extension; it was not a comprehensive impact assessment. Potential impacts from the SBF have been discussed to some extent but a full assessment of impacts has not been undertaken. Prior to further works and referral to gain environmental approvals, further studies and impact assessment will be required.

The desktop assessments used a variety of spatial and online resources where the responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

The Project Area has been very poorly studied in the past with little systematic survey data available. Desktop studies were based on broad-scale information sources.

The field survey was a reconnaissance survey (Level 1) aimed at determining the major flora and fauna issues associated with the various alignments. A flora and fauna list was compiled during the field surveys but this was not a comprehensive list. Complete flora and fauna surveys can require multiple surveys, at different times of year, and over a period of a number of years, to enable observation of all species present. Some flora species, such as annuals, are only available for collection at certain times of the year and others are only identifiable at certain times (such as when they are flowering). Additionally, climatic and stochastic events (such as fire) may affect the presence of plant species. Species that have a very low abundance in the area are more difficult to locate, due to above factors.

This field survey was not conducted at the optimum time of year to record certain flora species, such as annuals, or to obtain the necessary flowering and fruiting material required to identify certain plants. Further surveys undertaken during optimal conditions, in Spring, would be required to record plants that could not be identified during this survey.

The fauna assessment was primarily aimed at determining the major fauna habitats associated with the various alignments. The assessment only addressed the broadscale issues associated with the various alignment options; more detailed investigations are required at the next stage of this project.

This assessment considered only vertebrate fauna species, impacts on invertebrate fauna species was not included in the scope of this assessment.

2.3.1 Dieback

Dieback is not discussed within this assessment, as a separate report on this issue has been prepared by Great Southern Bio Logic (Spencer, 2012).

3. Regional Context

3.1 Bioregion

The Western Australian Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into 85 bioregions based on biological and geographic/geological attributes. The southern section of the Proposal area is within the Recherche subregion (ESP2) of the Esperance bioregion, which is characterised by proteaceous scrub and mallee heaths on sandplain overlying Eocene sediments, rich in endemics (Comer *et al.*, 2001). Vegetation types in this area are diverse and include heath, coastal dune scrub, mallee, mallee-heath and granite heath (Comer *et al.*, 2001). Known ecosystem values within the Recherche subregion, which may occur within the Project Area, include:

- The scrub heath on deep sand with *Banksia* and *Lambertia,* and *Banksia* scrub heath of the Esperance sandplain;
- Threatened fauna, including the Western Ground Parrot, Malleefowl, Carnaby's Cockatoo, Peregrine Falcon, Australasian Bittern, Chuditch, Red-tailed Phascogale, Black-footed Rock-wallaby, Heath Rat; Dibbler, the reptiles *Parasuta spectabilis bushi, Phyllodctylus* sp. Cape Le Grand and Carpet Python;
- Threatened flora species;
- Granite hills and outcrops at Cape Arid; and
- Extensive salt lakes.

(Comer *et al.*, 2001)

The northern section of the Project Area is located within the Eastern Mallee subregion (MAL1) of the Mallee bioregion, which is gently undulating, predominantly mallee over myrtaceous-proteaceous heaths on duplex (sand over clay) soils (Comer *et al.*, 2002). This area includes mallee on sandplains, samphire around small salt lakes, mallee and patches of woodland on clay, and scrub-heath on sandstone (Comer *et al.*, 2002). Known ecosystem values within the Eastern Mallee subregion, which may occur within the Project Area, include:

- Rare fauna including, Western Whipbird, Western Ground Parrot, Malleefowl, Cape Barren Goose, Slender-billed Thornbill, Chuditch, *Parasuta spectabilis bushi;*
- Rare ecosystems and plant assemblages of the Russell Range;
- Granite outcrops, which are likely to be significant as refugia; and
- Salt lake systems which are likely to have a high level of species diversity.

(Comer *et al.*, 2002)

3.2 Vegetation

Broad-scale mapping of the vegetation of the area was undertaken by Beard (1973). This mapping is presented in Figure 2, Appendix A.

The Project Area sits across a gently undulating plain with protruding granite domes and lake systems. Beard (1973) discusses the relationship of soils, lakes and vegetation in the area.

3.2.1 Soils and Vegetation

Generally on the Esperance Plains, in the southern section of the Project Area, the soil has an upper horizon of coarse to fine sand of variable depth overlying clay. In the southern portion of the Plain the upper horizon of sand is bleached and often coarser than further inland and the vegetation is scrub-heath and mallee-heath.

In western sections the shallower profiles often contain a band of pea ironstone at the base of the sand layer. Mallee dominates in these areas.

Further inland the surface layer of sand is shallower, of irregular depth, laterite is absent and mallee is the dominant vegetation. Even further inland calcareous soils begin to appear, first in patches and then the mallee gives way to *Eucalyptus oleosa* woodlands. The surface soil here is pink, loamy with a fluffy or floury texture, and overlies calcareous nodules or limestone.

In the east, near the coast, the *Eucalyptus cooperana* mallee zone grows on a thin red soil over limestone.

On Mt Ragged and the adjoining hills in the east of the Project Area there is only a thin layer of sand and humus over rock. The hills are surrounded by a belt of sand possibly derived from disintegration of the quartzite and supporting heath vegetation. The granite domes throughout the area are often largely bare of soil but may have granite rubble, sand and humus in patches that support vegetation (Beard, 1973).

3.2.2 Lake Systems

Much of the Project Area contains lake systems and these systems support various vegetation complexes. The lakes on the Esperance plain occur in three zones of differing character. On the more southern portion they are ephemeral small rounded depressions. Few are open lakes; most are covered with vegetation, either Melaleuca scrub in sandy areas, or *Eucalyptus occidentalis* woodland or mallee if on clay (Beard, 1973).

Where the vegetation changes from heath to mallee, there is a change in the lakes from fresh to salt and from circular to elongated. Most are oriented in an east-west direction and in areas they become very thickly clustered, separated by well-vegetated ridges of sand. The lakes are dry for most of the year and carry sparse samphire vegetation.

Further inland the lakes are salty, more irregularly scattered and generally more circular. They are often associated with granite outcrops (Beard, 1973).

3.2.3 Vegetation Extent

A vegetation type is considered under-represented if there is less than 30% of its original distribution remaining. From a purely biodiversity perspective, and not taking into account any other land degradation issues, there are several key criteria now being applied to vegetation (EPA, 2000). These are detailed below:

- The "threshold level" below which species loss appears to accelerate exponentially at an ecosystem level is regarded as being at 30% of the pre-European/pre-1750 extent for the vegetation type;
- 10% of the pre-European/pre-1750 extent for the vegetation type is regarded as being a level representing *Endangered*; and

- Clearing which would put the threat level into the class below should be avoided.

Such status can be delineated into five (5) classes:

- *Presumed Extinct*: Probably no longer present in the bioregion
- *Endangered**: <10% of pre-European extent remains
- *Vulnerable**: 10-30% of pre-European extent exists
- *Depleted**: >30% and up to 50% of pre-European extent exists
- *Least Concern*: >50% pre-European extent exists and subject to little or no degradation over a majority of this area.

* Or a combination of depletion, loss of quality, current threats and rarity gives a comparable status

The extent of the vegetation types mapped by Beard (1973) within the Project Area has been determined by the Government of Western Australia (2011) (Table 1). This indicates that the majority of the mapped vegetation types that occur within the Project Area are described as *Least Concern*. Three vegetation types (47, 1516, 2048) are *Depleted* and two vegetation types (512, 4801) are *Vulnerable*. These are highlighted in the table below.

Table 1 Broad Vegetation Types and Extent (After: Government of Western Australia, 2011)

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
9	Medium woodland; coral gum (*E. torquata*) & goldfields blackbutt (*E. le soufii*)	240509.33	235161.94	97.78	1.26
10	Medium woodland; red mallee group	145676.38	144160.85	98.96	0.45
42	Shrublands; mallee & acacia scrub on south coastal dunes	310084.5	295859.61	95.41	44.79
47	Shrublands; tallerack mallee-heath	1033054.74	372046.82	36.01	17.57
125	Bare areas; salt lakes	3492381.05	3269266.1	93.61	7.2
128	Bare areas; rock outcrops	329836.18	283024.14	85.81	14.95
129	Bare areas; drift sand	95286.17	63838.18	67	43.65
482	Medium woodland; merrit & red mallee	1628465	1612407.2	99.01	8.83

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
486	Mosaic: Medium woodland; salmon gum & red mallee / Shrublands; mallee scrub *Eucalyptus eremophila*	436130.37	254277.54	58.3	4.86
512	Shrublands; mallee scrub, *Eucalyptus eremophila* & Forrest's marlock (*E. forrestianna*)	237886.07	61978.71	26.05	2.4
516	Shrublands; mallee scrub, black marlock	607434.26	332304.86	54.71	24.07
519	Shrublands; mallee scrub, *Eucalyptus eremophila*	2333413.58	1418019.52	60.77	10.49
552	Shrublands; *Casuarina acutivalvus* & *Calothamnus* (also *Melalueca*) thicket on greenstone hills	33908.73	31506.82	92.92	0.89
924	Shrublands; mallee scrub, *Eucalyptus eremophila* & red mallee	107608.05	59929.4	55.69	22.64
925	Shrublands; mallee scrub, red mallee	5152.66	3780.93	73.38	1.84
1047	Shrublands; *Eucalyptus incrassata* mallee-heath	220297.22	186621.59	84.71	54.85
1516	Shrublands; mallee scrub, black marlock & Forrest's marlock	126686.24	58191.45	45.93	19.87
1519	Shrublands; mallee scrub, *Eucalyptus eremophila* & *Banksia*	3290.12	3290.12	100	
2048	Shrublands; scrub-heath in the Mallee Region	322219.98	158398.71	49.16	7.6
3106	Medium woodland; salmon gum & Dundas blackbutt	52660.8	51574.58	97.94	5.93
4048	Shrublands; scrub-heath in the Esperance Plains including Mt Ragged	50400.59	30021.61	59.57	47.59

Vegetation Association	Vegetation Description	Pre-European extent statewide (ha)	Current extent statewide (ha)	% remaining	% Pre-European extent in IUCN Class I-IV Reserves
	scrub-heath				
4801	Shrublands; heath with scattered *Nuytsia floribunda* on sandplain	58196.27	6304.65	10.83	3.32

The vegetation types that were determined to be *Depleted* or *Vulnerable* were further assessed to determine which Options or Sections they occurred in, and the extent to which they may be impacted for each of these Options or Sections (Table 2). For all Options and Sections, excepting Section 38, the amount of clearing required for each of these *Depleted* or *Vulnerable* vegetation types was less than 0.1 % of the remaining vegetation extents. Section 38 contains approximately 0.3 % of the remaining "Shrublands; heath with scattered Nuytsia floribunda on sandplain". This vegetation type is of particular concern as there is only 10.83 % of the pre-European extent remaining across the State. If further clearing of this vegetation type occurs it may drop below 10 % and be considered *Endangered.*

All of these calculations would be overestimates of the potential impact on these vegetation types as it has been assumed that clearing will be required for the entire alignment, with no consideration given to existing cleared or disturbed areas.

Table 2 Amount of *Depleted* or *Vulnerable* Vegetation Types Within the Options: includes the percentage of current extent remaining within option

Vegetation Association	Vegetation Description	Section Number	% of Pre-European extent remaining	Current extent statewide (ha)	Area (ha) of vegetation within option (20m width)	% of current extent within option
47	Shrublands; tallerack mallee-heath	1	36.01	372046.82	44.528	0.012
		7			4.598	0.001
		2A			1.268	0.000
		2B			2.318	0.008
		8A			1.737	0.009
		8B			0.021	0.009
		8C			0.007	0.000
512	Shrublands;	1	26.05	61978.71	31.481	0.051

Vegetation Association	Vegetation Description	Section Number	% of Pre-European extent remaining	Current extent statewide (ha)	Area (ha) of vegetation within option (20m width)	% of current extent within option
	mallee scrub, Eucalyptus eremophila & Forrest's marlock (E. forrestianna)	2A			26.544	0.043
		2B			42.153	0.068
		4C			23.005	0.037
		6C			37.903	0.061
		8C			3.168	0.005
1516	Shrublands; mallee scrub, black marlock & Forrest's marlock	25	45.93	58191.45	1.356	0.002
		23A			12.416	0.021
		23B			21.521	0.037
		24A			31.067	0.053
		24B			35.767	0.061
2048	Shrublands; scrub-heath in the Mallee Region	1	49.16	158398.71	1.831	0.001
4801	Shrublands; heath with scattered Nuytsia floribunda on sandplain	38	10.83	6304.65	18.408	0.292
		35C			3.181	0.050

3.3 The Great Western Woodlands

The Great Western Woodlands is a continuous band of native vegetation that stretches north and east from the edge of the wheatbelt, covering almost 16 million hectares. The woodlands cover much of the Unallocated Crown Land (UCL) within the Project Area, and the SBF extension runs along the edge of the woodlands for much of its length.

The Great Western Woodlands is an internationally significant area of great biological richness. It is the largest remaining intact Mediterranean climate woodland on earth (DEC, 2010). The woodlands are still in excellent biological condition but are under increasing pressure from pest animals, weeds and bushfires. The conservation strategy (DEC, 2010) for the Great Western Woodlands includes priorities for retaining the composition, structure and function of native ecosystems and to minimise clearing within the woodlands.

The Great Western Woodlands is an ecologically significant area and impacts on the woodlands should be avoided where possible. The greatest impacts on the woodlands from the SBF extension would be expected where the innermost alignments cross large areas of remnant vegetation. Impacts could be avoided by utilising the outside extents of the UCL, adjacent to the agricultural land.

4. Vegetation and Flora Results and Discussion

4.1 Vegetation Associations

The broad vegetation associations have been extrapolated from Beard (1973) vegetation types, soils mapping, aerial photography and observations made during the Level 1 survey. Where sufficient information has been was gathered during the survey the broad associations have been further refined into sub-associations.

There are large sections within the Project area that are difficult to interpret due to fire and scrub-rolling. Also field verification of vegetation was restricted to those areas assessed during the field visit, and was not undertaken across the whole Project extent. The Project area is highly diverse in vegetation associations and species and the descriptions provided within this document are not exhaustive. Further vegetation mapping is recommended during the detailed site investigation.

A discussion on the vegetation associations in a broad context is discussed below and descriptions of the associations are detailed in Table 3 and mapped at Figure 3.

Western Mallee Low Woodland Associations (Ravensthorpe end to Cups Road)

The western extent of the Project area contains a mosaic of mallee vegetation associations on undulating sandy plains (VT1, VT2, VT5, VT7, VT9, VT11 and VT12). *Eucalyptus occcidentalis* occurs in freshwater winter wet depressions (VA3). The Young River contains samphire communities (VT6) and *Allocasuarina* woodlands occur on the slopes of the Oldfieldii River (VT4). There are scattered occurrences of Allo*casuarina* shrublands with *Eucalyptus grossa* (VA8) on rises.

Salt Lake System

A band of salt lake systems containing samphire communities bounded by *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis* and *M. uncinata* (VT10) occurs east of Cascade Road and continues across most of the central area to Clare Road

These salt lakes and pans are irregular in shape, small or elongated.

Salmon Gums Mallees and Woodlands

The Salmon Gums area forms a transitional zone between the mallee associations to the south and the sclerophyll woodland further inland (Beard, 1973). In this area the vegetation mosaics and is dominated by mallee form associations with patchy woodlands (VT14 and VT15).

Eastern Mallee Low Woodland Associations

This area is similar to the western mallee associations. This section forms a gently undulating plain of mallee and woodland mosaics (VT16, VT17 and VT19) that are relieved by granite outcrops (VT18). The plain is intersected by many elongated salt lakes and pans (VT10).

This section of the Project was difficult to access and survey sites were limited. As such, the area has been assigned vegetation associations that are generally consistent with Beard (1973) mapping. The mallee and low woodlands

Coastal Section

The coastal section consists of a gently undulating sandy plain that is pockmarked with small rounded depressions which fill with water in winter to become freshwater lakes. These lakes support *Eucalyptus occidentalis* and *Melaleuca preissiana* woodland (VT3).

The sand plain consists of mallee heath associations (VT20, VT22, VT23 and VT24) that are high in diversity, particularly in proteaceae and myrtaceae species. In areas of deeper sand *Banksia speciosa* forms a dense shrubland.

Table 3 Broad Vegetation Associations in the Project Area

Vegetation Association	Photograph
VT 1. Mixed mallee heath over myrtaceous shrub on sandy plains This association occurs in the western portion of the Project. It consists of a mosaic of eucalypt mallees on an undulating sandy plain. The understorey contains a dense shrub layer dominated by myrtaceous species. Species that occur within this association include: Mallees (to 4m): *Eucalyptus eremophila, Eucalyptus flocktoniae, E. suggrandis, E. pleurocarpa, E. leptocalyx, E. incrassata* Shrubs 1-2 m: *Melaleuca subfalcata, M. calycina, M. uncinata, M. thymoides, M. sapientes, M. societalis, M. glaberrima* and *Banksia baueri.* Shrubs under 1 m: *Melaleuca suberosa, M. carrii, Calothamnus gibbosus, C. quadrifidus, Acacia bidenata, A. chrysocephala, A. ingrata, Leucopogon sp. Dragon Rocks (A.M Coates 2609), L. tamminensis var. australis, L. heterophyllus, L. sp.Coujinup (M.A. Burgman 1085), Hibbertia recurvifolia* and *H. acerosa.* Representative sites: Quadrat 1, Quadrat 2, Quadrat 25, RA1, RA2, RA9, RA10 and RA16. Beard Association: 519	 RA10  Quadrat 1

VT2. *Eucalyptus pleurocarpa* mallee over Proteaceous and Myrtaceous Heath on sandy plain

This association occurs in a mosaic with VT1. This vegetation type is distinguished by the dominance of *Eucalyptus pleurocarpa* in the mallee layer.

Species occurring in this association include:

Mallees (under 4 m): *Eucalyptus pleurocarpa, E. incrassata, E. flocktoniae* subsp. *flocktoniae, E. leptocalyx, E. dissimilata and E. dielsii.*

Shrubs (under 1.5 m): *Acacia maxwellii, Allocasuarina humilis, Banksia obovata, B. pulchella, Hakea laurina, H. cygna subsp. cygna, H. ilicifolia, Melaleuca subfalcata, M. cucullata, M. uncinata* and *Taxandria spathulata.*

Sub associations include:

2A*: E. pleurocarpa* over *Banksia spp.* heath.

2B- Scattered *E. pleurocarpa* over a shrubland of *Allocasuarina huegeliana, A. microstachya, Calothamnus quadrifidus, Hakea corymbosa, Melaleuca bromeliodes* on upper slope with coarse sand with quartz.

Representative sites: RA3, RA4, RA5, RA6,RA7, RA8, RA15, RA93 and RA94.

Beard Association: 47

RA5

RA3

VT3 – *Eucalyptus occidentalis* in a drainage depression and creeklines

This vegetation association occurs in depressions and creeklines throughout the Project area. These areas would fill with water during the winter months. These depressions support *Eucalyptus occidentalis* woodland with *Melaleuca preissiana* over sedges.

Sub-association

3A – *Eucalyptus occidentalis* in the coastal section along Merrivale Road and bordering Cape Arid National Park. In this section the landscape contains undulating low rises dissected by creeklines. *E. occidentalis* dominates the lower lying areas and transisions to other eucalypt species on higher slopes and hill crests.

Representative sites: Quadrat 10, Quadrat 18, RA11, RA12, RA32, RA35, RA36, RA37, RA38, RA39, RA40,

Beard Association: 3A is the same as Fany Cove 516

RA11

Quadrat 18

VT4 – *Allocasuarina* on slopes near drainage lines

This association was recorded at one location, near Oldfield River in the western portion of the study area.

Allocasuarina ?globosa forms a dense stand on the south facing hill slope.

Representative site: RA13.

Beard Association: 2048.

RA13

VT5 – Mixed mallee *Eucalyptus eremophila, E. flocktoniae, E. forrestiana* over myrtaceous shrubland on undulating plain

This association is similar in structure to VT1. It occurs in the sections east of West Point Road.

This section has been scrub rolled and contained regrowth vegetation.

Species recoded in this association include:

Mallees: *Eucalyptus. eremophila, E. flocktoniae, E. forrestiana, E. uncinata, E incrassata* and *E. perangusta.*

Shrubs: *Grevillea pectinata, Melaleuca coronicarpa, M. societalis, M. uncinata, M. coronicarpa, Acacia hadrophylla, A. crassuloides* and *A. nitidula.*

Sub – associations:

5A: Stand of *Eucalyptus kessellii.*

5B: Stand of *Eucalyptus dielsii* with *Melaleuca societalis, Acacia spp., Grevillea cf. concinna, Hakea laurina* in the shrub layer.

Representative sites: Quadrat 27, RA88, RA89, RA91 and RA92.

Beard Association 512

RA88

RA92

VT6 – *Eucalyptus platypus* over *Frankenia* and *Tecticornia* shrubs in in drainage lines

This association was recorded in in the Young River.

Mallee: *Eucalyptus platypus* subsp. *congreta*

Shrubs (1-2 m): *Melaleuca cuticularis, M. eleuterostachya, Acacia assimilis* subsp. *atroviridis* and *A. nitidula.*

Shrubs (under 1 m): *Frankenia tetrapetala, Tecticornia* sp.

Representative site: RA17 and RA95.

RA95

VT7: *Eucalyptus forrestiana* and *E. flocktoniae* Mallees on sand plains

This vegetation association is present in low lying plains near salt lakes in the western portion of the Project (near Rolland Road and Neds Corner Road).

Eucalyptus forrestiana and E. *flocktoniae* dominate the mallee layer with a dense shrubland of *Melaleuca coronicarpa, M. eleuterostachya, M. societalis* and *M. uncinata.*

Representative site: Q26.

Beard Association: 482.

Quadrat 26

VT8: *Eucalyptus grossa* mixed shrubs on coarse sand with quartz

Present in areas near rocky outcrops with coarse sand, some surface boulders and quartz.

Eucalyptus grossa is the key distinguishing mallee, with *E. dissimilata, E. forrestiana* and *E. pleurocarpa* also present.

The shrub layer includes *Allocasuarina huegeliana, Acacia glaucoptera, A. crassuloides, Callitris cf. columellaris, Hakea scoparia* subsp. *scoparia, Verticordia chrysantha, Grevillea anethifolia, Philotheca cf. gardneri subsp. globosa* (P1), *Melaleuca uncinata* and *Leucopogon* species.

Representative site: RA 22 and RA90.

Beard Association: 552

RA22

RA90

VT9: *Eucalyptus pleurocarpa* mixed mallee over myrtaceous and proteaceous heath

This association was recorded at the end of Field Road in the western portion of the study area. It is dominated by *E. pleurocarpa* over diverse shrub layer including *Banksia media, B. pulchella, Calothamnus gracilis, Grevillea anethifolia, Hakea corymbosa, Leucopogon sp. Bonnie Hill (K.R. Newbey 9831)* (P1), *Leucopogon sp.Bremer Bay (K.R. Newbey 4667), Callitris cf. columellaris, Melaleuca tuberculata* and *Melaleuca uncinata.*

There are affinities with VT2, however the shrub layer contains higher diversity and a different suite of species.

Representative site: Quadrat 5

Beard Association: 47

Quadrat 5

VT10: Salt lakes

A system of salt lakes and pans is present across the central extent of the Project. These consist of small round lakes or irregularly shaped elongated pans. They occur within lower lying depression in the undulating mallee plains.

Typically the lakes are dominated by samphire communities and bound by a mixture of salt tolerant *Melaleuca* species.

Species recorded within the salt lakes include: *Carpobrotus modestus, Atriplex sp., Tecticornia* species.

Fringing vegetation includes: *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis, M. uncinata, Scaevola spinescens* and *Rhagodia cf. ulicina.*

Representative sites: Quadrat 3, RA19, RA27, RA47,RA52, RA64

Beard Association: 125

RA52

RA47

VT11 Mixed mallee and woodlands of *Eucalyptus leptocalyx*, *E. eremophila*, *E. redunca* over Myrtaceous heath

This mixed mallee mosaic occurs in association with the salt lakes communities in the western portion of the Project. It forms a mosaic of changing mallees form and woodlands.

Sub-associations include:

11A: *Eucalyptus flocktoniae* subsp. *flocktoniae* and *E. valens* low woodland.

11B. *Eucalyptus calycogona* subsp. *calycogona* and *E. extensa* woodland.

11C*: Eucalyptus gracilis* woodland bordering salt lakes.

Representative sites: Quadrat 4, Quadrat 6, Quadrat 24, Quadrat 23, RA18, RA20, RA21, RA23, RA25 and RA26.

Beard Associations: 924 and 482

Sub-association 11A: Quadrat 23

Sub-association 11B: Quadrat 6

VT12: Mallee *Eucalyptus eremophila* and *E. flocktoniae* over myrtaceous and proteaceous heath on grey sandy plain

Occurs near Field Road. This association is dominated by *Eucalyptus eremophila* and *E. flocktoniae over Banksia speciosa, Grevillea anethifolia, G. pectinata, Melaleuca coronicarpa and M. uncinata.* It forms a mosaic with VT9 and VT11.

Representative site: RA24

Beard Association: 925.

RA 24

VT13 Shrublands; acacia, casuarina & melaleuca thicket

This vegetation association was not observed during the field survey due to access constrains. However, Beard (1973) mapping and aerial photography have been used to extrapolate its location.

Beard Association: 1413

VT14 Salmon gums mallee and woodland mosaic

The Salmon Gums area contains a mosaic mallee and patchy woodlands. These area was divided into several sub-associations:

14A: *Eucalyptus urna, E. gracilis, E. decipiens* and *E. cf. platycorys.*

14B: *Eucalyptus salmonophloia* and *E. platycorys* woodland.

14C: *E. eremophila, E. terebra* and *E. urna.*

14D: *Eucalyptus extensa, E. gracilis* and *E. phenax* subsp. *phenax.*

14E: Mosaic of mixed mallees including *E. terebra* and *E. gracilis* with *Melaleuca thyoides* shrubland in areas surrounding salt lakes. *E. salmonophloia* occurs in patchy location bordering salt lakes.

Representative sites: Quadrat 12, Quadrat 13, Quadrat 14, Quadrat 15, Quadrat 28, RA42, RA43, RA44, RA45, RA46, RA48, RA49, RA50, RA51, RA53, RA56, RA57, RA96, RA98, RA99 and RA100.

Beard Association: 486

Sub-association 14A: Quadrat 12

Sub-association 14E: RA99

VT15 *Eucalyptus dundasii* woodland

A small area of *Eucalyptus dundasii* woodland and mallee complex occurs on the eastern side of Salmon Gums. This association has been divided into two sub-associations:

15A: *Eucalyptus dundasii* woodland with a sparse shrubland of *Melaleuca bromeliodes, Scaevola spinescens, Westringia rigida* and *Ricinocarpos stylosus.*

15B: Mixed mallee form community.

Representative sites: Quadrat 16, RA54 and RA55.

Beard Association: 3106.

Sub-association 15A: Quadrat 16

Sub-association 15B: RA54

VT16 – Shrublands mallee scrub

This vegetation association has been extrapolated from Beard (1973) mapping and aerial photography as access was limited during the survey. It forms a mosaic mallee and low woodlands associated with salt lakes.

Species include *Eucalyptus uncinata, E. eremophila, E. platypus,* and *E. suggrandis.* Shrubs include: *Grevillea plurijuga subsp. plurijuga, Melaleuca coronicarpa, M. societalis, M. bromeliodes* and *M. cucullata.*

Representative sites: RA74, RA73 and RA72

Beard Association: 519.

RA73

RA74

VT17 – Beard (1973) Association RIDLEY 10

This vegetation association was not observed during the field survey due to access constrains. However, Beard (1973) mapping and aerial photography have been used to extrapolate its location.

This association is described as: Medium woodland; red mallee group.

VT18 –Granite Outcrops

In the eastern portion of the Project the mallee associations are relieved by granite domes. These granite domes contain *Eucalyptus tetraptera* with shrubs including *Calothamnus tuberosus, C. quadrifidus, Allocasuarina huegeliana, Hakea commutata, Melaleuca elliptica, M. glena, Acacia merrallii, A. pinguiculosa* subsp. *teretifolia* and *Calytrix tetragona.*

Representative sites: Quadrat 20, RA71, RA86 and RA87.

Beard Association: 128.

RA71

Quadrat 20

VT19 – Eastern woodlands and mallees mosaic

This association occurs along the eastern extent of the Project. It contains a mosaic of mallees and woodlands (similar to VT1) with elongated salt lakes in lower lying depressions. This association would contain a number of sub-association and requires further mapping during the detailed study.

Species include: *Eucalyptus dielsii, E. diptera, E. oleosa* subsp. *oleosa, E. forrestiana, E. redunca, flocktoniae, E. suggrandis, E. uncinata, E. grossa* and *E. pleurocarpa.*

Shrubs: *Melaleuca thyoides, M. societalis, M. coronicarpa, M. quadrifaria, M. uncinata, M. cucullata, M. bromeliodes, Beaufortia schaueri, Grevillea plurijuga* subsp. *plurijuga, G. pectinata, Acacia pritzeliana, A. delphina, A. nitidula, Microcybe pauciflora* subsp. *pauciflora, Daviesia* cf. *benthamii* subsp. *acanthoclona, Leucopogon* sp.Mount Heywood (M.A. Burgman 1211) and *Eremophila dichroantha.*

Representative sites: Quadrat 19, Quadrat 21,Quadrat 22, RA63, RA65, RA66, RA67, RA68, RA69, RA70, RA75, RA76, RA77, RA78, RA79, RA81, RA82, RA83, RA84 and RA85.

Beard Association: 1516 and 516.

Quadrat 22

Quadrat 19

VT20 *Eucalyptus incrassata* and *E. angulosa* mallee heath

This association transitions with VT19 inland and VT22 in the coastal area. Typically *E. angulosa* replaces *E. incrassata* towards the coast.

Mallee form of *Eucalyptus angulosa* and *E. incrassata* (to 1.5 m) over a proteaceous and myrtaceous heath.

Shrub species include: *Adenanthos cuneatus, Banksia media, Grevillea baxteri, Hakea trifurcata, H. cinerea, H. nitida, Xanthorrhoea platyphylla, Allocasuarina humilis, A. thuyoides, Acacia latipes* subsp. *latipes* and *A. gonophylla.*

Nuytsia floribunda and *Banksia speciosa* occurs in mosaics within the broader association. *B. speciosa* forms a dense shrubland in areas of deeper soils.

Sub-association:

20A: *E. angulosa* heath in coastal plain.

20B: *Nuytsia floribunda* shrubland.

20c: *Banksia speciosa* shrubland.

Representative sites: RA59, RA61 and RA62.

Beard Association: 1047.

Sub-association 20A: RA58

Sub-association 20A: Quadrat 17

VT21 – Proteaceae Heath

This association occurred at the crest of hills within VT20. The two mallees *Eucalyptus incrassata* and *E. uncinata* have a scattered occurrence. The proteaceous and myrtaceous heath species dominate including *Banksia sp., Allocasuarina humilis, Melaleuca striata, M. pentagona subsp. pentagona, Calothamnus gracilis, Grevillea baxteri* and *Hakea corymbosa.*

Representative site: RA60

Beard Association 4048

RA60

VT22 – Mixed mallee heath

This mallee heath occurs near in the coastal end. It forms a dense heath (under 1 m) of with high species diversity.

Mallee species include: *Eucalyptus tumida, E. uncinata, E. incrassata* and *E. angulosa.*

Shrubs: *Banksia tenuis, B. media, B. obovata, B. repens, Hakea marginata, H. prostrata, H. ruscifolia, Adenanthos cuneatus, Lysinema ciliatum, Calothamnus gracilis, Melaleuca suberosa, M. scabra, M. globifera, M. calycina, M. striata, Beaufortia schaueri, B. micrantha, Acacia myrtifolia, A. mutabilis subsp. angustifolia, Daviesia lancifolia, D. incrassata, Jacksonia viscosa, Leucopogon fimbriatus, L. woodsii, Boronia crassifolia* and *Spyridium microcephalum.*

Representative sites: Quadrat 8, Quadrat 9, RA31, RA34 and RA33.

RA31

RA33

VT23 – Coastal Dune

The coastal end point could not be accessed during the field investigation. Areas nearby were surveyed to provide an indication of the vegetation and floristics that occur. This has been extrapolated based on a survey site completed nearby.

The species include: *Acacia nigricans, Banksia speciosa, Darwinia vestita, Ispopogon polycephalus, I. trilobus, Daviesia apiculata* and *Verticordia minutiflora.* The groundlayer includes: *Lepidopermum gladiatum, Meeboldina crebriculmis* and *Schoenus* cf. *subflavus.*

Representative site: RA 28

Beard Association: 129.

RA28

VT24 - Coastal Heath

This association was recorded on undulating sand plains adjacent to the coastal dunes.

As access was restricted surveying of this association was made from only one location, and comments are extrapolated from notes made within the same association near the Project.

The association includes scattered occurrences of *Eucalyptus angulosa* (to 1 m) and *Nuytsia floribunda*. A dense heath layer (under 1 m) dominated by proteaceous species forms the dominant vegetation. This includes shrubs: *Banksia media, B. pulchella, B. repens, B. petiolaris, B. cuneata, Melaleuca striata, Lecupogon striatus, Beaufortia micrantha, Daviesia* species and *Boronia* species.

Gullies comprise a taller shrubland (up to 2 m) and include *Acacia myrtifolia, A. nigricans, A. subcaerulea, Banksia speciosa, Ricinocarpos megalocarpus* and *Leucopogon woodsii*.

It is also expected that in lower lying areas between dunes *Melaleuca* swamps will be present. However, none were accessible for this survey.

Representative site: Quadrat 7, RA30

Beard Association: 42.

RA30

Quadrat 7

4.1.1 Threatened and Priority Ecological Communities

Ecological communities are defined as 'naturally occurring biological assemblages that occur in a particular type of habitat' (English and Blythe, 1997). TECs are ecological communities that have been assessed and assigned to one of four categories related to the status of the threat to the community, i.e. *Presumed Totally Destroyed, Critically Endangered, Endangered, Endangered and Vulnerable*.

The DEC maintains a list of TECs which have been endorsed by the Minister for the Environment (April 2012). DEC listed ecological communities are given special consideration in environmental impact assessments and have special status under the land clearing regulations of the *Environmental Protection Act 1986* (EP Act). The EPA's position on TECs states that proposals that result in the direct loss of TECs are likely to require formal assessment. Some TECs are also protected under the EPBC Act.

Possible TECs that do not meet survey criteria are added to the DEC's PEC Lists under Priorities 1, 2 and 3. These are ecological communities that are adequately known; are rare but not threatened, but do not meet criteria for *Near Threatened*. PECs that have been recently removed from the threatened list are placed in Priority 4. These ecological communities require regular monitoring. *Conservation Dependent* ecological communities are placed in Priority 5.

An EPBC Act Protected Matters Search was undertaken for the Project Area (DSEWPaC, 2012). No EPBC Act listed TECs were indicated to occur within the search area.

A DEC TEC database search indicated that the closest recorded TEC ("Russell Range mixed thicket complexes") occurs 18 km to the east of Section 32A of the alignment, and should not be impacted by this project.

The DEC search indicated a number of PECs that occur within the broader area, with the closest PEC approximately five km from the SBF alignment. Additionally, the DEC's list of PECs within the South Coast area was examined to determine any other PECs that have the potential to occur within the area Table 4. A number of the PECs within the general area are not likely to occur in the Project Area as they are endemic to specific landforms, such as the flora associations of individual mountains or ranges.

During the Level 1 survey the PECs that may occur within the general were examined to determine the likelihood of their occurrence in the Project Area (Table 4). However, many of the PECs are poorly described and further detailed survey work, including floristic analysis, is required to confirm these results.

Table 4 Potential PECs within the Project Area

PEC	Status	Likelihood of Occurrence
Heath on Komatiite of the Ravensthorpe area	Priority 3	Not identified during the field survey – unlikely to occur
Melaleuca sp. Kundip Heath - Very Open mallee	Priority 1	Not identified during the field survey – unlikely to occur

PEC	Status	Likelihood of Occurrence
over *Melaleuca* sp. Kundip		
Eucalyptus purpurata woodlands	Priority 1	Not identified during the field survey – unlikely to occur
Banksia laevigata – Banksia lemanniana proteaceous thicket	Priority 1	Not identified during the field survey – unlikely to occur
Tallerack (*Eucalyptus pleurocarpa*) mallee-heath on seasonally inundated soils	Priority 2	*Eucalyptus pleurocarpa* occurs within the Project Area, further detailed floristic work would be required to assess the presence of this PEC
Melaleuca spathulata/Melaleuca viminea Swamp heath	Priority 1	Not identified during the field survey – unlikely to occur
Swamp Yate (*Eucalyptus occidentalis*) woodlands in seasonally inundated clay basins (South Coast)	Priority 3	This PEC generally occurs to the west of the Project Area – however, a number of *Eucalyptus occidentalis* woodlands in drainage lines or damplands were recorded during the field survey and a detailed floristic examination of these areas would be required to determine whether there is a match to this PEC.
Scrub heath on deep sand with *Banksia* and *Lambertia*, and *Banksia* scrub heath on Esperance Sandplain	Priority 3	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC
Taxandria spathulata Heath	Priority 4	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC
Dense, obligate seeding Proteaceae dominate shrublands and kwongan of the Esperance Sandplains	Priority 3	Potential to occur – a detailed floristic survey is required to assess the presence of this PEC

4.2 Vegetation Condition

The vegetation condition of the Project Area was assessed using the vegetation condition rating scale developed by Keighery (1994), which consists of six rating levels as outlined in Table 7, Appendix B. This scale recognises the intactness of vegetation and is defined by the following:

- Completeness of structural levels;
- Extent of weed invasion;
- Historical disturbance from tracks and other clearing or dumping; and
- The potential for natural or assisted regeneration.

The vegetation condition within the RA and quadrat sites was assessed during the field survey . The majority of the Project Area contained vegetation with a rating of Condition 3 (Very Good) or higher due to the location of the fence alignment within buffer strips. There was little evidence of weed invasion

across the Project Area and generally the structural levels remained intact. The areas of undisturbed vegetation were generally in Condition 1-2 (Excellent – Pristine or nearly so).

The vegetation within the older, low fuel modified buffer strips (discussed in more detail in Section 4.2.1, below) was generally in Condition 3 (Very Good) because, while they have been cleared in the past, the regeneration of species is very good and there is little weed invasion. The structural levels of these areas are not necessarily complete but the potential for regeneration is good. However, while these areas have the potential to regenerate it is assumed that regeneration will not be allowed as the process of scrub-rolling to maintain the buffer strip will continue.

4.2.1 Low Fuel Modified Buffer Strip

DEC currently maintains a low-fuel modified buffer strip, most recently installed in the 1990s by the then Bush Fires Board (now Fire and Emergency Services Authority of Western Australia), which runs along the majority of the UCL/agricultural land interface. At the edge of the buffer the DEC utilises existing roads (where possible) or a 10 m mineral earth access track. These roads or tracks are used as the base to subsequently maintain a low fuel zone varying in size, but averaging up to 50 m in width. This low fuel zone is scrub-rolled and then subject to a fuel reduction burn of any accumulative vegetation material, preferably within the same or following year. The buffer is generally re-treated approximately every 10 years, depending on factors such as risk to key infrastructure, private property assets, vegetation type, seed maturity cycles and viability and fuel loads. The access tracks innermost to the agricultural lands are maintained more frequently, either by grading or chemical application.

The low fuel modified buffer strip has been mapped at Figure 2 (Appendix A) from datasets provided by the DEC. The innermost option of the SBF alignment generally lies within the low fuel modified buffer strip, where possible. In the northern section of the alignment, from around Ainsworth Rd, west of Salmon Gums, to McCrea Rd, east of Salmon Gums the low fuel modified buffer strip does not occur. This means that the fence alignment in this area will require clearing of undisturbed vegetation along the UCL, which is currently in pristine – excellent condition. In some sections of this area a narrow cleared track runs along the interface between the UCL and the agricultural land which could be utilised as part of the clearing required for the fence. However, clearing of undisturbed vegetation along the edge of the UCL will still be required.

The buffer strip is, as expected, in lower condition than the undisturbed vegetation bordering this strip. However, while the vegetation within the buffer strip has been impacted by the scrub-rolling and burning, the older regrowth areas still show good diversity of species and low weed invasion (Plate 1). If these areas were allowed to regrow, it would be expected that the vegetation structure would be in good condition. The buffer strips that have been treated more recently, particularly in the north-east of the Project Area, are still dominated by the disturbance specialist species and the vegetation structure has been heavily impacted (Plate 2, below).

Plate 2 Regrowth scrub-rolled vegetation: shows undisturbed vegetation to the left of the photo, access track and scrub-rolled regrowth vegetation to the right.

Plate 1 Recently scrub-rolled and burnt vegetation: shows undisturbed vegetation to the left of the photo, access track and scrub-rolled vegetation to the right.

During the field survey the quadrats and RAs were generally done within the areas of undisturbed vegetation, in order to better assess the vegetation associations that would be present in the area without disturbance. However, RAs within the buffer strips were also conducted to provide information on the vegetation within these modified areas and to search for significant flora species, which can often be disturbance-response species.

Calculations on the extent to which each Option or Section is within the scrub-rolled vegetation or within undisturbed vegetation was conducted, based on the mapping (Table 13, Appendix C). Due to the scale at which the alignment was drawn there are areas where the alignment is shown outside of the scrub-rolled vegetation; however, it is possible to place the alignment within the scrub-rolled vegetation and thus minimise clearing of the vegetation in better condition. As such, the calculations of undisturbed vegetation clearing are sometimes over-estimated and can be reduced by refining the alignment to sit within the low fuel modified buffer strip.

4.2.2 Soil Health

Issues associated with soil health, in relation to flora and vegetation issues, include soil stability, erosion, and salinity. Within the Project Area soil health issues are generally relevant to the cleared areas around the edge of the farmland. Where clearing of areas of undisturbed vegetation will be required for the construction of the fenceline there is the risk that soil health would decline.

Issues associated with soil health can be minimised by using existing disturbed areas wherever possible. DAFWA have also indicated that after the initial construction of the fence, the methods for maintaining the cleared areas around the fence do not require scraping but may use low level methods for clearing, such as chemical application. This can help ensure the structural integrity of the soil by allowing some retention of plant material to help bind the soil.

4.3 Flora Diversity

4.3.1 Existing Flora Records

A *NatureMap* search (DEC, 2012) indicated more than 1500 flora taxa previously collected within a broad area with a buffer of 20 km around the SBF extension options. The diversity recorded within the *NatureMap* searches reflects the high diversity of the general area. The Esperance region is known for its high diversity of flora species and the SBF extension crosses a large variety of vegetation types, meaning a large number of flora species would be expected to occur across and near the Project Area.

During the Level 1 field survey the dominant species and any potential conservation significant species were recorded within each quadrat and RA site. Where identification was uncertain, species were confirmed using the resources of the Western Australian Herbarium.

The field survey recorded 395 taxa from 43 families for the Project Area. This number is considerably less than what would be expected from a full field survey. Additionally, the results were skewed by the season of the survey, as some species could not be identified due to lack of flowering and fruiting material, and due to annual species not being visible. This made identification of some of the dominant plants difficult, particularly for the Myrtaceae species. Other families that were underrepresented in the field survey, due to difficulties with identification, included the Chenopodiaceae, Asteraceae and the Poaceae.

The dominant families recorded within the Level 1 survey were:

- Myrtaceae 109 taxa
- Proteaceae 55 taxa
- Fabaceae 55 taxa
- Ericaceae 26 taxa
- Cyperaceae 22 taxa

Additionally, the dominant genera recorded were:

- Eucalyptus 39 taxa
- Melaleuca 37 taxa
- Acacia 31 taxa

- Hakea 19 taxa

A complete list of flora recorded within the Project Area is provided at Appendix C.

4.4 Conservation Significant Flora

Flora species considered to be significant are listed under the EPBC Act and the *Wildlife Conservation Act 1950* (WC Act). Any activities that are deemed to have a significant impact on species that are recognised by the WC Act and/or the EPBC Act can trigger referral to the EPA and/or the DSEWPaC (Table 8 and Table 9, Appendix B).

The DEC also maintains a list of Priority Listed Flora species which are species not currently protected under the WC Act (Table 9, Appendix B). Priority flora may be rare or threatened, but cannot be considered for declaration as rare flora until adequate surveys have been undertaken of known sites and the degree of threat to these populations have been clarified. Special consideration is often given to sites that contain Priority flora species, despite them not having formal legislatory protection.

Desktop searches of the EPBC Act Protected Matters database (DSEWPaC, 2012), DEC's rare flora databases and the *NatureMap* database with a very general 20 km buffer (DEC, 2012) indicate that there are 14 Threatened (Declared Rare) Plant Species and 145 Priority species recorded within the area intersected by the SBF alignment (Table 14). The DEC records indicate that 61 species occur within 1 km of the proposed alignments (Figure 3). However, these records should not be considered to indicate the only occurrence of significant species along the alignments. The Project Area is very large and contains a number of areas that have been very poorly studied. The majority of flora surveys would have occurred in areas with good access (such as along roads) or where surveys would have been required for previous projects (such as road developments). The lack of records of significant species in some sections of the alignment (particularly the areas that cut through the UCL) reflects a lack of surveys, not necessarily a lack of significant species along these areas.

The Level 1 field survey did not record any species listed as Threatened or Declared Rare under the EPBC Act or the WC Act. Eleven species on DEC's priority flora list were recorded during the Level 1 field survey. These species are included in Table 5 and mapped at Figure 2, Appendix A.

Identification of some potentially conservation significant species was limited due to lack of flowering and fruiting parts. Further detailed surveys for conservation significant species during Spring will be required at later stages of the Project.

Table 5 Priority Flora Species Recorded During the Field Survey

Species	Status	Location
Acacia diaphana	P1	Q18
Allocasuarina cf. *globosa*	P1	RA13;
Leucopogon sp. Bonnie Hill (K.R. Newbey 9831)	P1	Q5
Philotheca cf. gardneri subsp. *globosa*	P1	RA90; Q26
Acacia cf. *euthyphylla*	P3	RA76

Species	Status	Location
Hibbertia hamata	P3	RA32;
Micromyrtus elobata subsp. *scopula*	P3	RA63; RA67; RA78; Q19
Darwinia cf. *polycephala*	P4	RA75; RA76; RA77
Eremophila serpens (Snake Eremophila)	P4	RA89
Grevillea baxteri (Cape Arid Grevillea)	P4	RA58; RA60; RA62;
Melaleuca fissurata	P4	RA64

4.5 Introduced (Weed) Species

The spread of weeds across a range of land uses or ecosystems is important in the context of socio-economic and environmental values. A Commonwealth initiative has led to the creation of a list of 20 Weeds of National Significance (WONS). The assessment used in determining the WONS was based on four major criteria:

- Invasiveness;
- Impacts;
- Potential for spread; and
- Socio-economic and environmental values.

Additionally, weeds that are, or may become a problem to agriculture or the environment can be formally classified as Declared Plants under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). The Department of Agriculture and Food and the Agriculture Protection maintains a list of Declared Plants for Western Australia. If a plant is declared for the whole of the State or for particular Local Government Areas, all landholders are obliged to comply with the specific category of control. Declarations specify a category, or categories, for each plant according to the control strategies or objectives which the Agriculture Protection Board believes are appropriate in a particular place. These Declared Plants are divided into five classes, which are detailed in Table 10, Appendix B.

A desktop search of the EPBC Act Protected Matters database (DSEWPaC, 2012) indicated the presence or potential presence of four significant invasive flora species within the Project Area. These include:

- * *Asparagus asparagoides* Bridal Creeper
- **Carrichtera annua* Ward's Weed
- **Lycium ferocissimum* African Boxthorn
- **Tamarix aphylla* Athel Tree

While these species have the potential to occur in the Project Area not all are known from the Esperance area. **Tamarix aphylla* is not currently a significant issue in the area but its record relates to planted trees in the townsite and on farms.

During the field survey the Project Area was assessed for the presence of weed species. A full list of weeds was not recorded during the field survey, but this should be undertaken during later, detailed surveys. The field survey noted weed species of significance, such as those on the WONS list.

Generally the weed species within the Project Area were weeds of the agricultural areas, such as pasture grasses and weedy daises. The majority of the introduced species were located directly adjacent to the disturbed areas, such as roads and paddocks. Weed invasion of native vegetation is minimal in both the scrub-rolled vegetation and the undisturbed vegetation. The only recorded areas of significant weed invasion within the native vegetation were at Quadrat 10 and at RA38 where bridal creeper (**Asparagus asparagoides*) has invaded remnant vegetation. These areas are along the boundary of Cape Arid National Park which is a concern for its potential impacts on the conservation values of the National Park. Bridal creeper is a serious environmental weed and is on the list of WONS.

Weed invasion has the potential to be a serious issue associated with the construction of the SBF extension. Where the fence will be built through remnant vegetation that has not been previously disturbed there is the potential for the construction of the fence to lead to increased weed invasion. To reduce the risk of weed invasion it would be preferable to construct the SBF extension in areas of existing disturbance, such as along firebreaks. Particular consideration should be taken in areas with high environmental significance, such as Cape Arid National Park.

5. Fauna Results and Discussion

Previous assessment of the potential impacts of the SBF extension on fauna has been conducted by DAFWA, *Advice on the Ecological effects of the Esperance Extensions on Native Wildlife* (DAFWA, 2012). These overall impacts, that are applicable to all the fence options, are not covered in detail within this flora and fauna report. Rather, this report compares potential fauna impacts from the various alignment options, determines measures to minimise potential impacts and discusses further works required to assess the overall fauna impacts.

5.1 Fauna Habitats

The dominant fauna habitat types recorded along the alignment during the field survey include:

- Woodlands: This is the dominant habitat type within the Project Area, occurring across the northern areas. Of particular importance within the woodlands are the old, large hollow-bearing trees that offer shelter and breeding habitat for a number of species.
- Salt lakes: Salt lakes are scattered throughout the Project Area, particularly around Salmon Gums. These lakes are often dry but can be important habitat areas for species such as ducks when they are filled after rain events.
- Shrub/Heath-lands: Heath and Mallee-heath occur in the western and eastern sections of the Project Area, particularly around Cape Arid National Park. The Proteaceous heaths are feeding habitat for a number of species.
- Creeklines: Creeklines are often important as fauna habitat and can have significance as fauna corridors. There are a number of major creeklines within the west of the Project Area and one adjacent to Cape Arid National Park.
- Rocky outcrops: Rock outcrops are generally considered to have high value for fauna habitat and support a number of unique species, particularly reptile species.
- Coastal dunes: The SBF extension passes through secondary dunes at the coastal end-point; however, impacts on the primary dunes and coast are avoided, as it ends at a rocky outcrop.

Areas that have high value as fauna habitat include rocky outcrops and creeklines, as they provide shelter and resource availability.

5.2 Habitat Linkages and Fragmentation

Ecological linkage is defined as a series of patches of native vegetation which act as stepping stones of habitat to facilitate the maintenance of ecological processes and the movement of organisms within, and across, a landscape (EPA, 2009).

The SBF will be a barrier for large, flightless fauna species that will be too big to pass through the fence mesh and which cannot pass over the fence. The 10 metres of cleared area on either side of the fence may also be a barrier for those species that will not cross open ground.

None of the fauna species for which the fence will be a barrier are truly migratory. However, even for the non-migratory species the fence may prevent animals accessing resources, such as water and habitat.

This is especially relevant in the areas where the fence causes fragmentation within remnant habitat and where animals may be isolated from areas within their existing range.

Where the SBF extension fragments habitat and isolates fauna populations there is the risk that these small populations will be unviable into the future. If recolonisation is prevented due to the barrier effect of the fence, the species may become locally extinct. In the longer term, isolation of populations may also alter gene flow within the meta-population and consequently reduce long-term viability of the population. These issues are particularly pertinent to the small-medium species which are unable or unlikely to pass through the fence and which may be threatened by other factors (DAFWA, 2012). Potentially impacted significant species are discussed further in Section 5.3.1.

Climatic variation and long-term climatic changes will impact on the availability of fauna resources. The distribution of fauna species will change as resources contract and move (DAFWA, 2012). The SBF may have a significant impact on fauna populations in the future if it reduces the connectivity of habitat that would allow some species to adapt to climatic changes.

5.3 Fauna Diversity

A *NatureMap* search (DEC, 2012) indicated 219 vertebrate, terrestrial fauna taxa have been previously recorded within a rough 20 km of the Project Area (Table 15, Appendix D). The *NatureMap* records show that Scincidae (21 taxa), Meliphagidae (15 taxa) and Anatidae (11 taxa) are the most represented families that have been recorded within this area. Opportunistic fauna sightings from the field survey are also provided at Table 15. However it should be noted that this field survey was primarily a reconnaissance survey and was not conducted during optimum conditions for fauna spotting and thus observations were limited.

Given the large Project Area and the variety of landforms and habitats that the alignment crosses, the number of species expected to occur within the Project Area would be large.

5.3.1 Conservation Significant Fauna

Statutory Framework

The conservation of fauna species and their significance status is currently assessed under both Commonwealth and State acts. The acts include the Commonwealth EPBC Act and State WC Act (*Wildlife Conservation (Specially Protected Fauna) Notice 2010).*

The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN). A description of Conservation Categories delineated under the EPBC Act are described in Table 8 and Appendix B.

The EPBC Act also protects migratory species that are listed under international agreements (see Appendix B) and marine species on Commonwealth lands and waters.

The WC Act uses a set of schedules, but also classifies species using some of the IUCN categories. These Schedules are described in Table 11, Appendix B.
In Western Australia the DEC also produces a supplementary list of Priority Fauna, these being species that are not considered Threatened under the Western Australian WC Act but for which the Government feels there is a cause for concern. These species have no special legislatory protection, but their presence would normally be considered. Such taxa need further survey and evaluation of conservation

status before consideration can be given to declaration as threatened fauna. Levels of Priority are described in Table 12, Appendix B.

Desktop and Field Assessment

From the searches of the *NatureMap* database (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) a number of protected fauna species were identified as potentially occurring within the survey area (Table 15, Appendix D). Additionally, some significant species have a distribution that may include the Project Area but were not recorded in the data searches. These species were determined from previous work by GHD ecologists. The protected species that have the potential to occur in the Project Area are presented in Table 6. This table provides information on the habitat of the species and discusses potential impacts from the SBF extension.

It should be noted that some species that appear in the EPBC Act Protected Matters Search Tool are often not likely to occur within the specified area, as the search provides a general guidance to matters of national significance that require further investigation. The records from the DEC searches of threatened fauna provide more accurate information for the general area; however some records of sightings or trappings can be dated and often misrepresent the current range of threatened species.

Table 6 Protected Fauna Species Potentially Occurring Within the Project Area (Source: DEC, 2012; DSEWPaC, 2012, Gaikhurst, G. *pers. comm.*)

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Pezoporus wallicus subsp. *flaviventrus* (Ground Parrot)	Endangered	Schedule 1 - Critically Endangered	The Western Ground Parrot once occurred to the north of Perth, as well as near Albany. They are now confined to the south coast at Waychinicup, Fitzgerald River and Cape Arid national parks. Ground Parrots live in low species-rich coastal kwongan (shrubby heath), no more than 50 cm high, particularly those containing low *Banksia* and *Hakea*. They are also attracted to *Daviesia pachyphylla* regenerating after fire. Nesting takes place on the ground in a shallow hollow under a bush (Burbidge, 2004).	Potential impacts would be spatially limited to the south western portion of the Project Area in the Cape Arid National park area as these species are unlikely to occur elsewhere though the alignment. The Ground Parrot is not currently known to occur within the Project Area (it occurs to the east of the Project Area, within the national park) and potential impacts are unlikely. However, the fence, once established, may limit future movement of this species through the landscape. The fence will potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Bettongia penicillata ogilbyi (Woylie)	Endangered	Schedule 1 – Endangered	The Woylie was once wide spread across the Australian continent is now restricted to a few geographically isolated populations, mainly in the South west of WA. Several of these populations have recently suffered precipitous declines. The species historically occurred in a wide variety of habits, however is now restricted to forests and areas where predation has been controlled (or excluded).	This species is unlikely to occur within the Project area though translocations of the species to conservation estate in the region has occurred (and may continue in the future). Consultation with DEC Wildlife branch would confirm the future translocation plans for the species and thus allow thorough assessment of impacts. The fence, once established, would limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Botaurus poiciloptilus (Australasian Bittern)	Endangered	Schedule 1 – Endangered	The Australasian Bittern inhabits shallow freshwater swamps with fairly dense low vegetation of reeds, sedges, rushes and grasses. In WA it is confined to the SW corner. It has disappeared from the Wheatbelt, and is now largely confined to coastal areas, especially along the south coast.	The clearing of vegetation may have some limited impact on this species. However there is very limited habitat for the bird within the Project Area and the fence, once established, will not limit movement.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Calyptohynchus latirostris (Carnaby's Black Cockatoo)	Endangered	Schedule 1 – Endangered	Carnaby's Cockatoo, also known as the Short-billed Black-Cockatoo, is distributed across the south-west of Western Australia in uncleared or remnant areas of *Eucalyptus* Woodland and Shrubland or Kwongan heath. Breeding usually occurs in the wheatbelt region of Western Australia, with flocks moving to the higher rainfall coastal areas to forage after the breeding season. These Cockatoos feed on the seeds of a variety of native plants, including *Allocasuarina, Banksia, Dryandra, Eucalyptus, Grevillea* and *Hakea,* and some introduced plants. They will also feed on the nectar from flowers of a number of species, and on insect larvae.	This species is known to occur in the area. Potential breeding trees were recorded within the northern section of the Project Area. Targeted survey would be required to determine all potential breeding trees within the final alignment and to inform the approvals processes. Clearing of breeding trees should be avoided. There is potential feeding habitat for this species within the western and eastern sections of the Project Area. During the field survey a large flock of Carnaby's Black Cockatoo was recorded roosting and feeding near Fisheries Rd in the east of the Project Area. This Project will likely require clearing of feeding habitat; this may be considered to be a significant impact and require approval at the Commonwealth and State levels.
Macronectes giganteus (Southern Giant Petrel)	Endangered	Schedule 1 – Endangered	The Southern Giant Petrel is a marine bird occurs in Antarctic to subtropical waters. They breed on Macquarie and Heard Islands and on other subantarctic islands. They are widespread in southern oceans, and have been recorded as far north as Shark Bay in WA.	Given the marine nature of these species the Project Area is not considered to contain significant habitat. Potential impacts on these species are negligible.
Halobaena caerulea (Blue Petrel)	Vulnerable		The Blue Petrel is a marine species of the Subantarctic and Antarctic seas. It has been recorded off the Australian coast between East Gippsland in Victoria to Perth area of WA. The Blue Petrel previously bred on Macquarie Island, but breeding is now restricted to offshore stacks near Macquarie Island (Garnett and Crowley, 2000).	
Macronectes halli (Northern Giant Petrel)	Vulnerable		The Northern Giant Petrel is a marine and oceanic species. It mainly occurs in sub-Antarctic waters, but regularly occurs in Antarctic waters of the southwestern Indian Ocean, the Drake passage and west of the Antarctic Peninsula (Marchant and Higgins, 1990). The range of the Petrel extends into subtropical waters mainly between winter and spring. It frequents both oceanic and inshore waters near breeding islands and in the non-breeding range.	
Pterodroma mollis (Soft-plumaged Petrel)	Vulnerable		The Soft-plumaged Petrel is a marine, oceanic species that is generally found over temperate and subantarctic waters in the South Atlantic, southern Indian and western South Pacific Oceans	

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Thalassarche chrysostoma (Grey-headed Albatross)	Endangered	Schedule 1 – Vulnerable	A number of albatrosses are listed as threatened in Western Australia. These species of Albatross are marine, pelagic and aerial. Albatrosses breed on subantarctic and other southern ocean islands and fly enormous distances in the southern oceans searching for food.	Given the marine nature of these species the Project Area is not considered to contain significant habitat. Potential impacts on these species are negligible.
Diomedea exulans (Wandering Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche cauta (Shy Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche chlororhynchos (Yellow-nosed Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Thalassarche melanophris (Black-browed Albatross)	Vulnerable	Schedule 1 – Vulnerable		
Cereopsis novaehollandiae subsp. grisea (Cape Barren Goose)	Vulnerable	Schedule 1 – Vulnerable	The Cape Barren Goose breeds only on islands in the Archipelago of the Recherche, off Esperance, and other islands in the vicinity. It resides on islands but is occasionally seen on the mainland, near Esperance (Burbidge, 2004).	The clearing of vegetation is likely to have a limited impact on this species. This species has large homeranges and the fence, once established, will not limit movement. Potential impacts on these species are negligible.
Dasyurus geoffroii (Chuditch)	Vulnerable	Schedule 1 – Vulnerable	The Chuditch formerly ranged over nearly 70 % of Australia. Chuditch currently survives only in south-western WA, in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland. This reduction in range and decline in population numbers have been caused by habitat alteration, impacts from the introduction of foxes and cats, hunting and poisoning. The site contains some habitat that is suitable for Chuditch and they have been known to occur in the region, so there is the potential for this species to utilise parts of the Project Area.	The clearing of vegetation may have some impact on this species. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Leipoa ocellata (Malleefowl)	Vulnerable	Schedule 1 - Vulnerable	The Malleefowl generally occurs in semi-arid areas of Western Australia, from Carnarvon to south east of the Eyre Bird Observatory (south-east Western Australia). It occupies shrublands and low woodlands dominated by mallee vegetation (DSEWPaC, 2012b). The Malleefowl uses areas of eucalypt or native pine, *Callitris* woodlands, acacia shrublands, Broombush *Melaleuca uncinata* vegetation or coastal heathlands.	The clearing of vegetation may have some impact on this species. Malleefowl, while general ground-dwelling, can fly and may be able to cross the fence; however, it is unknown whether this species may see the fence as a barrier. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Falco peregrinus (Peregrine Falcon)	-	Schedule 4.	The Peregrine Falcon is uncommon but wide-ranging across Australia. Habitat is extremely diverse, from rainforest to arid scrub, from coastal heath to alpine. The Peregrine Falcon nests primarily on ledges of cliffs, shallow tree hollows, and ledges of building in cities.	The clearing of vegetation may have some impact on this species. However, this species has large homeranges and the fence, once established, will not limit movement.
Platycercus icterotis xanthogenys (Western Rosella – inland subspecies)		Schedule 1 – Vulnerable	The inland sub- species of the Western Rosella is found in open and partly cleared eucalypt woodland and forest, riverine forest, farmland, orchards, wooded savannah and shrubland. The inland populations have been affected by massive, large scale deforestation. The bird feeds on grass seeds, herbs, insects, fruits, berries, flowers, nectar and buds. The Rosella is generally seen in pairs or small groups which are known to be quiet and fairly tame, the species often f forms larger flocks where food is abundant and breeds in August to September in nests in tree-hollows.	The clearing of vegetation, particularly where there are potential nesting trees (such as around the Salmon Gums area) may impact this species. However, the fence, once established, will not limit movement.
Lerista viduata (Ravensthorpe Range Slider)		Priority 1	The Ravensthorpe Range Slider is known only from the Ravensthorpe area at the eastern extent of the Project Area. The small skink shelters in leaf litter at the base of trees and shrubs in Eucalyptus woodlands within its restricted range.	The clearing of vegetation may have some impact on this species. However, the fence, once established, will not limit movement on a micro scale. However the track associated with the fence may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat and population linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Acanthophis antarcticus (Southern Death Adder)		Priority 3	The Southern Death Adder habitat ranges from rainforest to shrublands and heaths. This species is declining in many areas, probably due to habitat destruction and altered fire regimes (Wilson and Swan, 2008).	The clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Paroplocephalus atriceps (Lake Cronin Snake)		Priority 3	The Lake Cronin Snake is a poorly known species, known from only five specimens, all collected from the vicinity of Lake Cronin. Whilst there is limited information on the biology of the moderately large snake, it is known that the diet includes lizards, it is active during the night and day, and is possibly arboreal. Taxonomic information requires further review and the conservation status of the species is related to data insufficiency.	Further studies to assess the level of impact would be required as it is unknown whether this species occurs within the Project Area; however, clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, may limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Ardeotis australis (Australian Bustard):		Priority 4;	The Australian Bustard occurs across much of Australia, including across most of Western Australian, except in heavily wooded areas in the south. The Australian Bustard occurs mainly in open country, such as grasslands, low heath or lightly wooded grassland. This species is typically widespread and nomadic, but locally scarce.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Burhinus grallarius (Bush Stonecurlew)		Priority 4	The Bush-stone Curlew inhabits dry open woodlands, lightly timbered country, mallee and mulga; anywhere with groundcover of small sparse shrubs, grass or litter of twigs (Morcombe, 2000). It avoids dense forest and closed canopy habitats.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Macropus irma (Western Brush Wallaby)		Priority 4	The Western Brush Wallaby, a medium sized macropod, is a grazer found primarily in open forest and woodland. This species was once very common in the south-west of Western Australia but has undergone a reduction in range and a significant decline in abundance in its current habitat. The decline in populations of this species has resulted from extensive clearing within its original distribution and from predation of juvenile Western Brush Wallabies by foxes.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Morelia spilota subsp. imbricata (South-west Carpet Python)	-	Schedule 4 - Priority 4;	The Carpet Python occurs in a large range of habitats including woodlands, forests and dense coastal scrub, on granite and limestone outcrops and along watercourses. The distribution of the species is from Geraldton and Yalgoo in the North east to Pinjin, Kalgoorlie, Fraser Range and most of the remaining south west (Storr *et al.* 2002). It is often arboreal and preys on birds, other reptiles and small to medium size mammals.	The clearing of vegetation may have some impact on this species. Snakes are known to get tangled in fences, though the level of movement restriction is unknown. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.
Oreoica gutturalis gutturalis (Crested Bellbird – southern)		Priority 4	The Crested Bellbird occurs along semi-arid coastlines and the arid inland. The occur in acacia shrublands, euclayptu woodlands, spinifex and chenopod plains.	The clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Thinornis rubricollis (Hooded Plover);	-	Priority 4;	The Hooded Plover is a wader that is endemic to Australia with most of the remaining birds occurring in southern Western Australia. Hooded Plovers live on ocean beaches and on coastal and inland salt lakes. This species is known to occur on coastal areas and inland lakes in the Esperance region. They are mainly found on the coast during the dry season, but some birds move inland during the wet season. They feed on invertebrates such as worms, shellfish, crustaceans, insects and seeds. Hooded Plovers are particularly vulnerable in the first stages of their lives. They take approximately four weeks to hatch and are flightless for five to six weeks after that. The eggs and flightless chicks can easily be hunted and eaten by foxes, dogs and cats. Being highly camouflaged they are also accidentally crushed by pedestrians, 4WD vehicles and trail bikes.	Impacts to this species would be limited to the coastal areas and salt lake areas of the Project area. However, the clearing of vegetation may have some impact on this species. The fence, once established, is unlikely to limit movement through the landscape; however it would potentially fragment habitat patches on a small scale and fragment habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species. Potential impacts on nesting birds may result if the access tracks along the fenceline lead to an increase in 4WD access in nesting areas.
Isoodon obesulus subsp. fusciventer (Quenda)	-	Priority 5	The Quenda or Southern Brown Bandicoot is an omnivorous marsupial that occurs in the southwest of Western Australia. This species prefers areas with dense understorey vegetation, particularly around swamps and along watercourses. However, it also occurs in woodlands, and may use less ideal habitat where this habitat occurs adjacent to the thicker, more desirable vegetation. This species is relatively common in parts of the greater Perth and south west region.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Species	Status (EPBC Act)	Status (WC Act) /DEC listing	Habitat	Potential Impacts
Macropus eugenii subsp. derbianus (Tammar Wallaby, WA subsp.)	-	Priority 5	The Tammar Wallaby is a small grey-brown, nocturnal wallaby occurring in the south-west of Australia. The species inhabits dense, low vegetation, such as coastal scrub, heath, dry sclerophyll forest and thickets of Mallee and woodland during the day and open grassy areas for feeding at night. Males and females live to 11 and 14 years, respectively and occupy their own home range with no social grouping. The Tammar Wallaby is herbivorous and eats mostly grasses (such as *Austrodanthonia setacea*) as well as *Gastrolobium bilobum* and *Corymbia calophylla*. Research has suggested that the species needs to drink water to survive, with some evidence it can drink sea water when fresh water is unavailable. The breeding habits are not known for this subspecies. Tammar Wallaby populations are thought to be threatened by fox predation, loss of suitable habitat due to inappropriate fire regimes and land clearing.	The clearing of vegetation may have some impact on this species. The fence, once established, will limit movement through the landscape; potentially fragmenting habitat patches on a small scale and fragmenting habitat linkages on a regional scale. The fence also has the potential for alteration of predator behaviour such as preferential predation along fence lines, increasing predation on native species.

Migratory Fauna

From the searches of the *NatureMap* database (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) a number of migratory fauna species were identified as potentially occurring within the survey area

- *Haliaeetus leucogaster* (White-bellied Sea-Eagle)
- *Apus pacificus* (Fork-tailed Swift)
- *Ardea ibis* (Cattle Egret)
- *Pluvialis fulva* (Pacific Golden Plover)
- *Diomedea exulans* (Wandering Albatross)
- *Thalassarche chrysostoma* (Grey-headed Albatross)
- *Thalassarche cauta* (Shy Albatross)
- *Thalassarche chlororhynchos* (Yellow-nosed Albatross)
- *Thalassarche melanophris* (Black-browed Albatross)
- *Hydroprogne caspia* (Caspian Tern)
- *Merops ornatus* (Rainbow Bee-eater)
- *Ardenna carneipes* (Fleshy-footed Shearwater)
- *Ardenna tenuirostris* (Short-tailed Shearwater)
- *Macronectes halli* (Northern Giant Petrel)
- *Macronectes giganteus* (Southern Giant Petrel)
- *Pterodroma macroptera* (Great-winged Petrel)
- *Pterodroma mollis* (Soft-plumaged Petrel)
- *Pezoporus wallicus subsp. flaviventrus* (Ground Parrot)
- *Arenaria interpres* (Ruddy Turnstone)
- *Calidris acuminata* (Sharp-tailed Sandpiper)
- *Calidris alba* (Sanderling)
- *Gallinago megala* (Swinhoe's Snipe)
- *Gallinago stenura* (Pin-tailed Snipe)
- *Numenius minutus* (Little Curlew)
- *Tringa nebularia* (Common Greenshank)

5.3.2 Feral Animals

The *NatureMap* search (DEC, 2012) and the EPBC Act Protected Matters Search Tool (DSEWPaC, 2012) indicated that a number of feral animals may occur within 20 km of the Project Area. These include:

- **Capra hircus* (Goat);
- **Felis catus* (Feral Cat);
- **Oryctolagus cuniculus* (European Rabbit);
- **Rattus rattus* (Black Rat)
- *Streptopelia senegalensis* (Laughing Turtle-Dove)
- **Sus scrofa* (Pig); and
- **Vulpes vulpes* (Red Fox);

This desktop search indicates all the potential species, however, it is likely that the species of concern in the area be limited to the Feral Cat, European Rabbit, Red Fox and Wild Dog.

The SBF extension is aimed at preventing the movement of dogs but may also impact on the movement of other large feral animals. Additionally, there is the potential for the exclusion of dogs from the agricultural area to change the predator-prey relationships within the farmland, leading to increases in populations of cats and foxes. However, little information is available on the population dynamics of these species and impacts are hard to predict without detailed, ongoing studies.

5.3.3 Impacts on species

The clearing required for the SBF will reduce the amount of habitat and resources available for fauna species. This is particularly relevant for the areas of restricted and high value fauna habitat and for habitat of the significant species. The south-eastern area of the alignment contains large tracts of potential Carnaby's Black Cockatoo feeding habitat and potential breeding habitat for this species also occurs in the north of the Project Area. Impact on these areas should be minimised and clearing of this habitat avoided.

The SBF also has the potential to create a barrier and cause habitat fragmentation. Some of the significant species that may occur in the area, such as the Western Brush Wallaby and Tammar Wallaby, are unlikely to pass over or through the fence. If small populations of these species are isolated by the fence these populations may become unviable or susceptible to predation by cats and foxes. It is recommended that habitat fragmentation be minimised wherever possible.

Further surveys will be required to determine the presence of significant species along the alignment, or within areas of habitat that will be fragmented.

Risk from Fauna Interactions with the Fence

The potential risks to wildlife from the SBF extension were assessed by the Vertebrate Pest Research Section of DAFWA (2012). The risk for large mammals and emus, but also for other birds (particularly nocturnal species), bats, reptiles and smaller mammals, includes potential collisions and entrapment with fences, which can lead to mortality. Entanglements with fences for smaller wildlife can include getting caught in

upper wires (especially barbed wires for birds and bats), ensnarement under fences and lower wires and entanglement against electrified wires (DAFWA, 2012).

While fences are a permanent collision and entanglement risk to wildlife the risk is greatest immediately after construction of a new fence (DAFWA, 2012). Thus, risks will be minimised where the SBF extension can be constructed along existing fencelines or through disturbed vegetation.

6. Conclusions and Recommendations

6.1 Conclusions

The preliminary flora and fauna assessment involved a desktop investigation and a Level 1 Flora and Fauna Assessment of key areas and sites of concern. This assessment determined the following:

- The Project Area lies along and within the southern section of the Great Western Woodlands, which is an internationally significant area of great biological richness.
- The extent of the vegetation types mapped by Beard (1973) and determined by the Government of Western Australia (2011) indicates that the majority of the mapped vegetation types that occur within the Project Area are described as *Least Concern*. Three Beard (1973) vegetation types are *Depleted* and two vegetation types are *Vulnerable*. For all Options and Sections, excepting Section 38, the amount of clearing required for each of these *Depleted* or *Vulnerable* vegetation types was less than 0.1 % of the remaining vegetation extents. Section 38 contains approximately 0.3 % of the remaining "Shrublands; heath with scattered *Nuytsia floribunda* on sandplain".
- This assessment described 24 broad vegetation associations. These associations were extrapolated from Beard (1973) vegetation types, soils mapping, aerial photography and observations made during the Level 1 survey. These broad associations are partly desktop based and will need to be refined further by detailed investigations. These vegetation associations can be grouped to describe the broad sections of the Project Arae:
  - **Western Mallee Low Woodland Associations (Ravensthorpe to Cups Road):** The western extent of the Project area contains a mosaic of mallee vegetation associations on undulating sandy plains. *Eucalyptus occcidentalis* occurs in freshwater winter wet depressions. The Young River contains samphire communities and *Allocasuarina* woodlands occur on the slopes of the Oldfieldii River. There are scattered occurrences of Allo*casuarina* shrublands with *Eucalyptus grossa* on rises.
  - **Salt Lake System:** A band of salt lake systems containing samphire communities bounded by *Eucalyptus salmonophloia, Melaleuca quadrifaria, M. thyoides, M. linguiformis* and *M. uncinata* occurs east of Cascade Road and continues across most of the central area to Clare Road. These salt lakes and pans are irregular in shape, small or elongated.
  - **Salmon Gums Mallees and Woodlands:** The Salmon Gums area forms a transitional zone between the mallee associations to the south and the sclerophyll woodland further inland (Beard, 1973). In this area the vegetation mosaics and is dominated by mallee form associations with patchy woodlands.
  - **Eastern Mallee Low Woodland Associations:** This area is similar to the western mallee associations. This section forms a gently undulating plain of mallee and woodland mosaics that are relieved by granite outcrops. The plain

is intersected by many elongated salt lakes and pans. This section of the Project was difficult to access and survey sites were limited. As such, the area has been assigned vegetation associations that are generally consistent with Beard (1973) mapping.

- **Coastal Section:** The coastal section consists of a gently undulating sandy plain that is pockmarked with small rounded depressions which fill with water in winter to become freshwater lakes. These lakes support *Eucalyptus occidentalis* and *Melaleuca preissiana* woodland. The sand plain consists of mallee heath that is high in diversity, particularly in proteaceae and myrtaceae species. In areas of deeper sand *Banksia speciosa* forms a dense shrubland.

- The database searches did not indicate the presence of any TECs within the Project Area. A number of PECs are known to occur in the general area, but no recorded PECs are intersected by the alignments. The field survey did not record any PECs but further floristic examination of the vegetation types would be required to confirm their presence or absence.
- The majority of the Project Area contains vegetation in excellent condition and there is little evidence of disturbance or weed invasion across the Project Area. However, DEC currently maintains a low-fuel modified buffer strip, which runs along the majority of the UCL/agricultural land interface. The vegetation within this strip has been previously disturbed and cleared. These areas could potentially regenerate, however, it is assumed that this will not occur as scrub-rolling to maintain the buffer strip is expected to continue.
- The Project Area crosses through an area with high diversity, and passes through numerous vegetation types. During the Level 1 field survey 395 flora species were recorded in a limited number of sites. A greater number of species would be expected to be identified during the flowering period.
- A number of conservation significant flora species have been recorded within the Project Area. Eleven flora species on the DEC's priority list were recorded within the Project Area during the field survey.
- Within the Project Area weed invasion was generally restricted to the disturbed areas along the edges of roads and paddocks. However, Bridal Creeper, an invasive environmental weed was recorded in native vegetation at a number of sites. The introduction of weeds into undisturbed vegetation could be a significant issue associated with the SBF extension.
- The alignment passes through a number of fauna habitats along the alignment, including shrublands, woodlands and coastal dunes. Areas that have high value as fauna habitat include rocky outcrops and creeklines, as they provide shelter and resource availability.
- The SBF extension has the potential to fragment fauna habitat. The SBF will be a barrier for large, flightless fauna species that will be too big to pass through the fence mesh and which cannot pass over the fence. The 10 metres of cleared area on either side of the fence may also be a barrier for those species that will not cross open ground. The options which will have the greatest impact are those that

pass through undisturbed vegetation. The options that have less impact are those that follow the edge of farmland.

- Given the large Project Area and the variety of landforms and habitats that the alignment crosses the number of species expected to occur within the Project Area would be very large.
- A number of conservation significant fauna species occur or potentially occur within the Project Area. The SBF extension has the potential to impact on fauna species through clearing of habitat, due to its barrier effect or to to direct impacts through fauna interactions with the fence or during construction. Impacts will be greatest in areas of undisturbed vegetation.
- Potential breeding trees for Carnaby's Black Cockatoo occur within the northern section of the Project Area, impacts on the trees should be avoided. Large areas of feeding habitat for black cockatoos occur in the eastern section of the Project Area.

6.2 Recommendations

It is recommended that the least constrained option identified in the scoping study be utilised where possible, in order to minimise impacts on flora and fauna. The least constrained alignment generally follows the innermost option, along the edge of the UCL, at the interface with the agricultural land. This means that the proposed alignment is usually within the scrub-rolled vegetation, which will require less clearing of native vegetation and will reduce the impacts on undisturbed vegetation, along with the associated indirect impacts, such as the introduction of weed species, dieback and increase in erosion and soil degradation. The innermost option also reduces habitat fragmentation by avoiding transecting large tracts of native vegetation, which reduces the impact on wildlife corridor connectivity.

Further detailed flora and fauna surveys and impact assessment are required once the final alignment has been determined.

The flora surveys should include mapping of significant flora locations along the preferred alignment and consideration of whether the location of the alignment can be refined within the 100 m buffer to avoid impacts on these species.

Where significant impacts on flora are determined, consideration should be given to mitigation measures, such as the creation of habitat corridors and moving the SBF into existing cleared areas (i.e. closing Rollond Rd). Where impacts are significant environmental offsets may be required.

The fauna surveys should include assessment of habitat, targeted searches for conservation significant species and determination of potential fragmentation of populations.

Animal ethic issues associated with the entire fenceline will need to be considered in more detail by DAFWA. The following issues should be taken into consideration:

- Choice of construction materials and physical structure of the fence: The fence needs to be designed to reduce wildlife impacts, for example, avoiding use of barbed wire, and low electrical wires, and choosing high visibility construction materials.
- Management implications, including humane dispersal or destruction, in the case of any build-up of numbers of animals against the fence.

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Appendix A
Figures

Figure 1 **Alignment Options**

Figure 2 **Vegetation Aspects**

Figure 3 **Vegetation Associations**

Figure 4 **Conservation Significant Aspects**

1:750,000 (at A3)

0 3.75 7.5 15 22.5 30 37.5

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

DAFWA Provided Alignment Options

No Alternative Option Provided

A

B

BC

C

2A Section Number with Option letter

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Alignment Options

Figure 1

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Data source: GA: NatMap 250.ecw - 2007; NatMap Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509. Created by: erice

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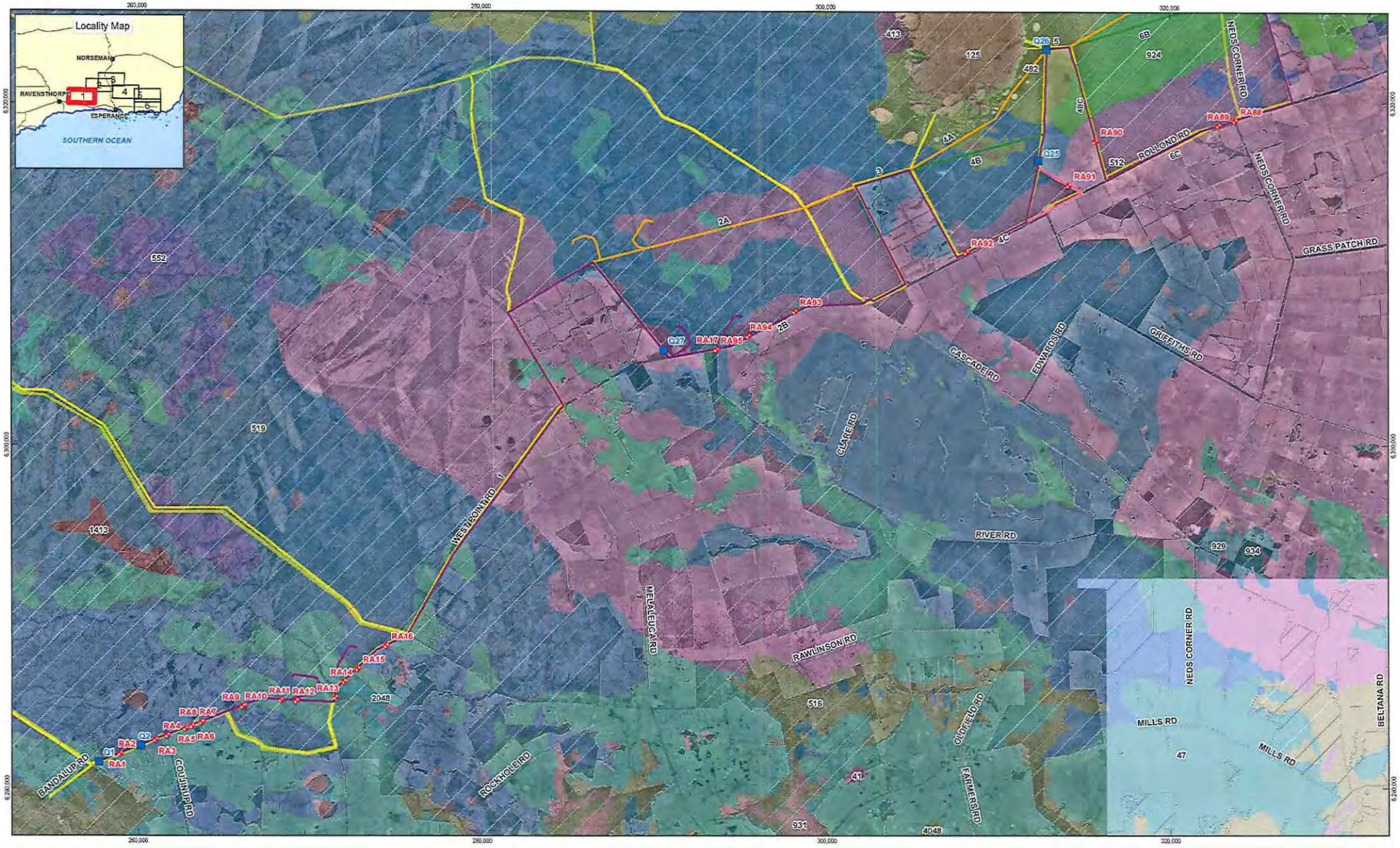

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Survey
- Quadrats
- Rapid Assessment

Alignment Options
- No Alternative Option Provided
- A
- B
- BC
- C

Current Native Vegetation
DEC Chainage
2A Section Number with Option letter

519 DAFWA Pre-European Vegetation Association Number, See attached Pre-European Vegetation Association Legend

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Vegetation Aspects

Figure 2

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Data source: GA: NatMap Geodata Topo Series 3 - 2006; DAFWA: Alignment Options - 20120508, Current Native Vegetation - 20120508, Pre-European Vegetation - 20120510, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: DEC Chainages - 20120508; GHD: GHD Survey - 20120705, Created by: erice

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Pre-European Vegetation Association

8	518
9	519
10	521
16	522
27	524
41	551
42	552
47	691
48	800
51	924
125	925
126	929
128	931
129	934
131	936
141	938
142	939
221	940
352	941
380	942
413	945
468	1047
482	1075
486	1148
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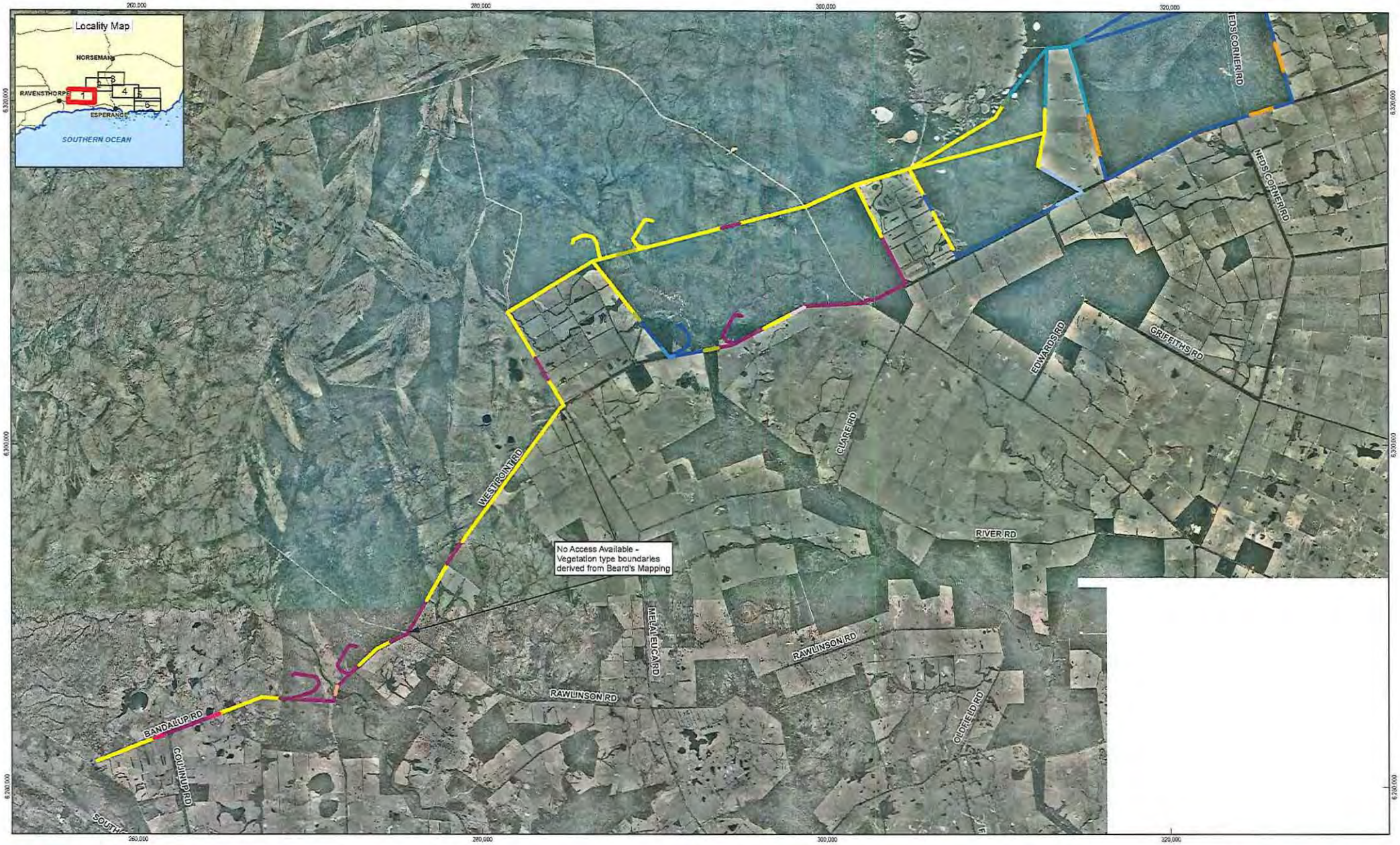
515	7048
516	



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

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Vegetation Association

Figure 3

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Data source: GA: NatMap Geodata Topo Series 3 - 2006; GHD: Vegetation Association Description - 20120705; Landgate: Road Names - 20120509; DAFWA: Imagery - 2007-2009. Created by: erice, radelson

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Vegetation Association Description

Code	Description
VT1	Mixed mallee heath over myrtaceous shrub on sandy plains
VT2	*Eucalyptus pleurocarpa* mallee over Proteaceous and Myrtaceous Heath on sandy plain
VT2A	*E. pleurocarpa* over *Banksia cirsioides* heath
VT2B	Scattered *E. pleurocarpa* over a Allocasuarina shrubland
VT3	*Eucalyptus occidentalis* in a drainage depression and creeklines
VT3A	Eucalyptus occidentalis in the coastal section along Merrivale Road
VT4	*Allocasuarina* on slopes near drainage lines
VT5	Mixed mallee *Eucalyptus eremophila*, *E. flockiana*, *E. forrestiana* over myrtaceous shrubland on undulating plain
VT5A	Stand of *Eucalyptus kessellii*.
VT5B	Stand of *Eucalyptus dielsii*
VT6	Eucalyptus platypus over Frankenia and Tecticornia shrubs in in drainage lines
VT7	*Eucalyptus forrestiana* and *E. flocktoniae* Mallees on sand plains
VT8	*Eucalyptus grossa* mixed shrubs on coarse sand with quartz
VT9	*Eucalyptus pleurocarpa* mixed malle of myrtaceous and proteaceous heath
VT10	Salt lakes
VT11	Mixed mallee and woodlands of *Eucalyptus leptocalyx*, *E. eremophila*, *E. redunca* over Myrtaceous heath
VT11A	*Eucalyptus flocktoniae* subsp. *flocktoniae* and *E. valens* low woodland.
VT11B	*Eucalyptus calycogona* subsp. *calycogona* and *E. extensa* woodland.
VT11C	*Eucalyptus gracilis* woodland bordering salt lakes
VT12	Mallee *Eucalyptus eremophila* and *E. flockoniae* over myrtaceous and proteaceous heath on grey sandy plain
VT13	Shrublands; acacia, casuarina & melaleuca thicket
VT14	Salmon gums mallee and woodland mosaic
VT14A	*Eucalyptus urna*, *E. gracilis*, *E. decipiens* and *E. cf. platycorys*.
VT14B	*Eucalyptus salmoniphloia* and *E. platycorys* woodland.
VT14C	*Eucalyptus torquata* subsp. *conglobata*, *E. eremophila*, *E. terebra* and *E. urna*
VT14D	*Eucalyptus extensa*, *E. gracilis* and *E. phenax* subsp. *phenax*.
VT14E	Mosaic of mixed mallees including *E. terebra* and *E. gracilis* with *Melaleuca thyoides* shrubland in areas surrounding salt lakes. *E. salmoniphloia* occurs in patchy location bordering salt lakes.
VT15	*Eucalyptus dundasii* woodland
VT15A	*Eucalyptus dundasii* woodland with a sparse shrubland of *Melaleuca bromelioides*, *Scaevola spinescens*, *Westringia rigida* and *Ricinocarpos stylosus*.
VT15B	Mixed mallee form community.
VT16	Shrublands mallee scrub
VT17	Beard (1973) Association RIDLEY 10
VT18	Granite Outcrops
VT19	Eastern woodlands and mallees mosaic
VT20	*Eucalyptus incrassata* and *E. angulosa* mallee heath
VT20A	*E. angulosa* heath in coastal plain.
VT20B	*Nuytsia floribuna* shrubland.
VT20C	Banksia speciosa shrubland.
VT21	Proteaceae Heath
VT22	Mixed mallee heath
VT23	Coastal Dune
VT24	Coastal Heath

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Vegetation Association Legend

Figure 3

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1:200,000 (at A3)

0 1 2 4 6 8 10

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Conservation Significant Aspects

Map Sheet 1 of 6

Figure 4

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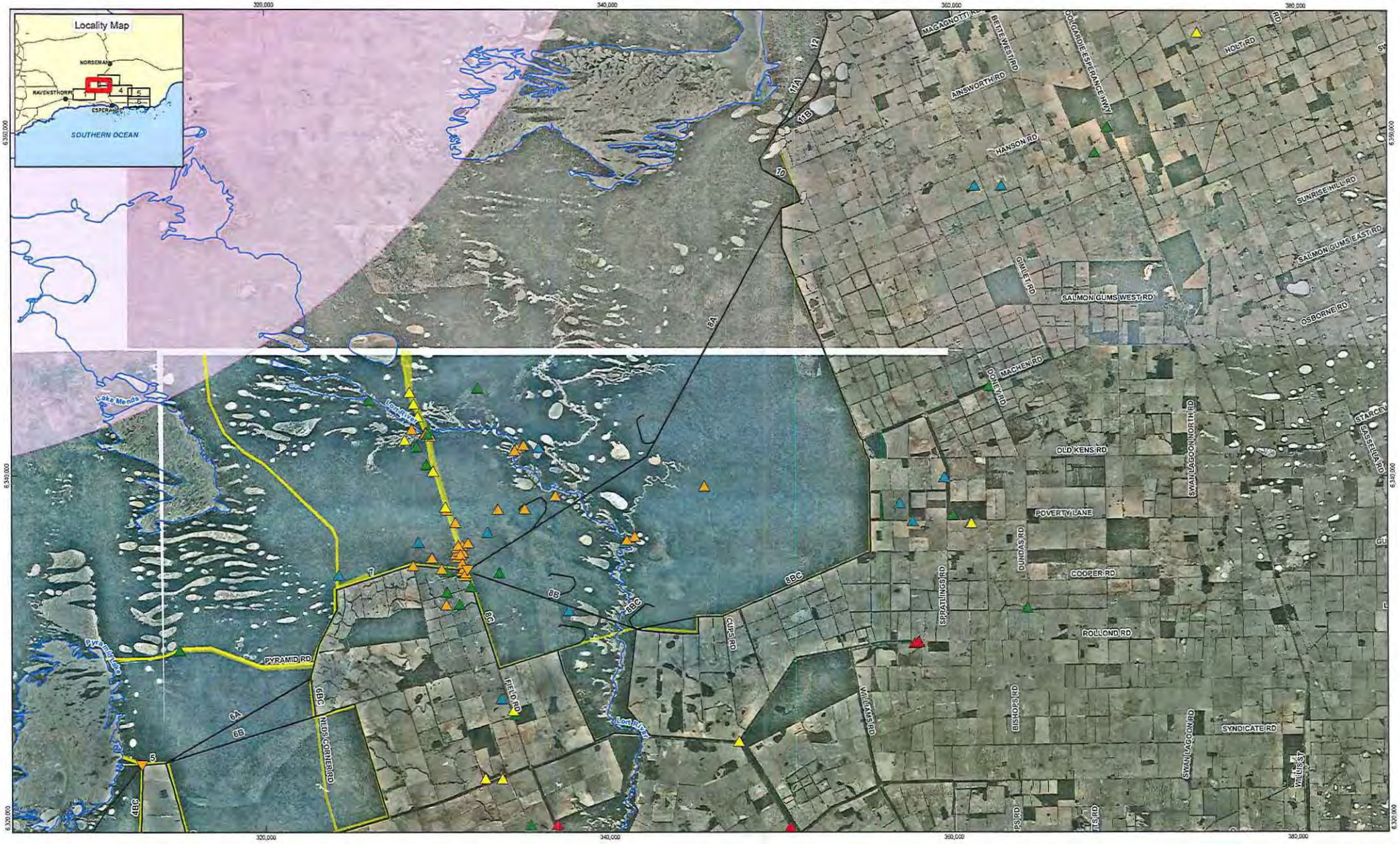

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

GHD Priority Flora
- P1
- P3
- P4

Threatened (Declared Rare) & Priority Flora
- (T) Threatened Rare Flora - Extant Taxa; T
- Priority 1 - Poorly Known Taxa
- Priority 2 - Poorly Known Taxa
- Priority 3 - Poorly Known Taxa
- Priority 4 - Rare Taxa
- Priority 5 - Conservation Dependent Taxa

GHD Survey June 2012
- Drainage Line
- Potential Cockatoo breeding trees
- Rocky Area

- DAFWA Provided Alignment Options
- Hydrography
- DEC Chainage
- Priority Ecological Community

2A Section Number with Option letter

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Data source: GA: Geodata Topo Series 3 - 2006; DAFWA: DAFWA Provided Alignment Options - 20120509, Imagery - 2007-2009; Landgate: Roads - 20120509; DEC: Threatened (Declared Rare) & Priority Flora - 20120522, DEC Chainage - 201208, Priority Ecological Community - 20120523; GHD: GHD Survey June 2012 - 20120609, GHD Priority Flora - 20120705; DOW: Hydrography - 20120508. Created by: once

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Kilometres

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LEGEND

GHD Priority Flora
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- P3
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Threatened (Declared Rare) & Priority Flora
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GHD Survey June 2012
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Kilometres

Map Projection: Transverse Mercator
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Figure 4

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Kilometres

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 51

N

LEGEND

See attached Legend for the Vegetation Association Description

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Vegetation Association

Figure 3

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Kilometres

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Vegetation Association

Figure 3

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Kilometres

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Vegetation Association

Figure 3

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Vegetation Association

Figure 3

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Kilometres

Map Projection: Transverse Mercator
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Vegetation Association

Figure 3

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Kilometres

Map Projection: Transverse Mercator
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N

LEGEND

GHD Survey
- Quadrats
- Rapid Assessment

Alignment Options
- No Alternative Option Provided
- A
- B
- BC
- C

Current Native Vegetation
DEC Chainage
2A Section Number with Option letter

519 DAFWA Pre-European Vegetation Association Number, See attached Pre-European Vegetation Association Legend

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Vegetation Aspects

Figure 2

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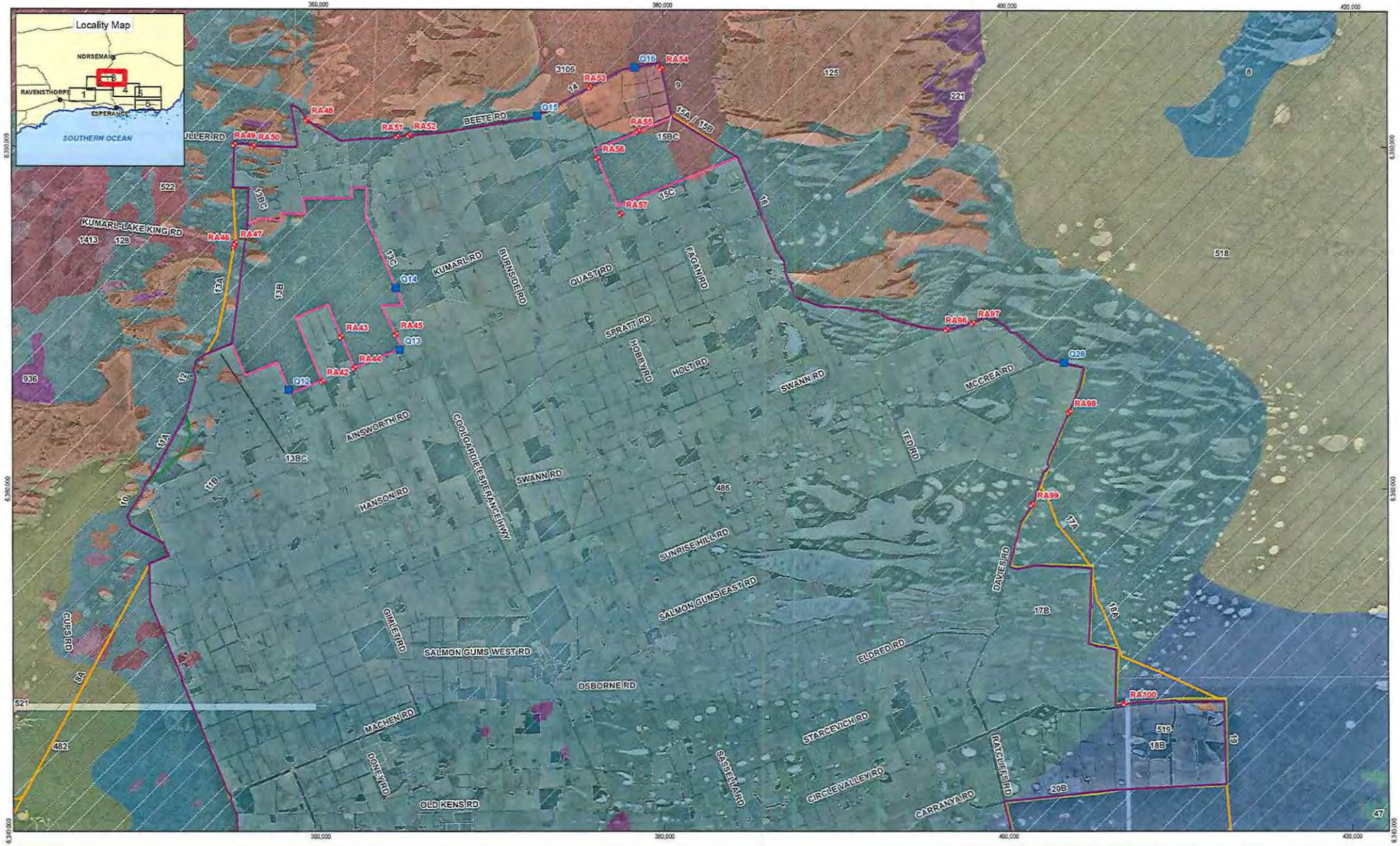

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Horizontal Datum: Geocentric Datum of Australia
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N

LEGEND

GHD Survey
- Quadrats
- Rapid Assessment

Alignment Options
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Current Native Vegetation
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Vegetation Aspects

Figure 2

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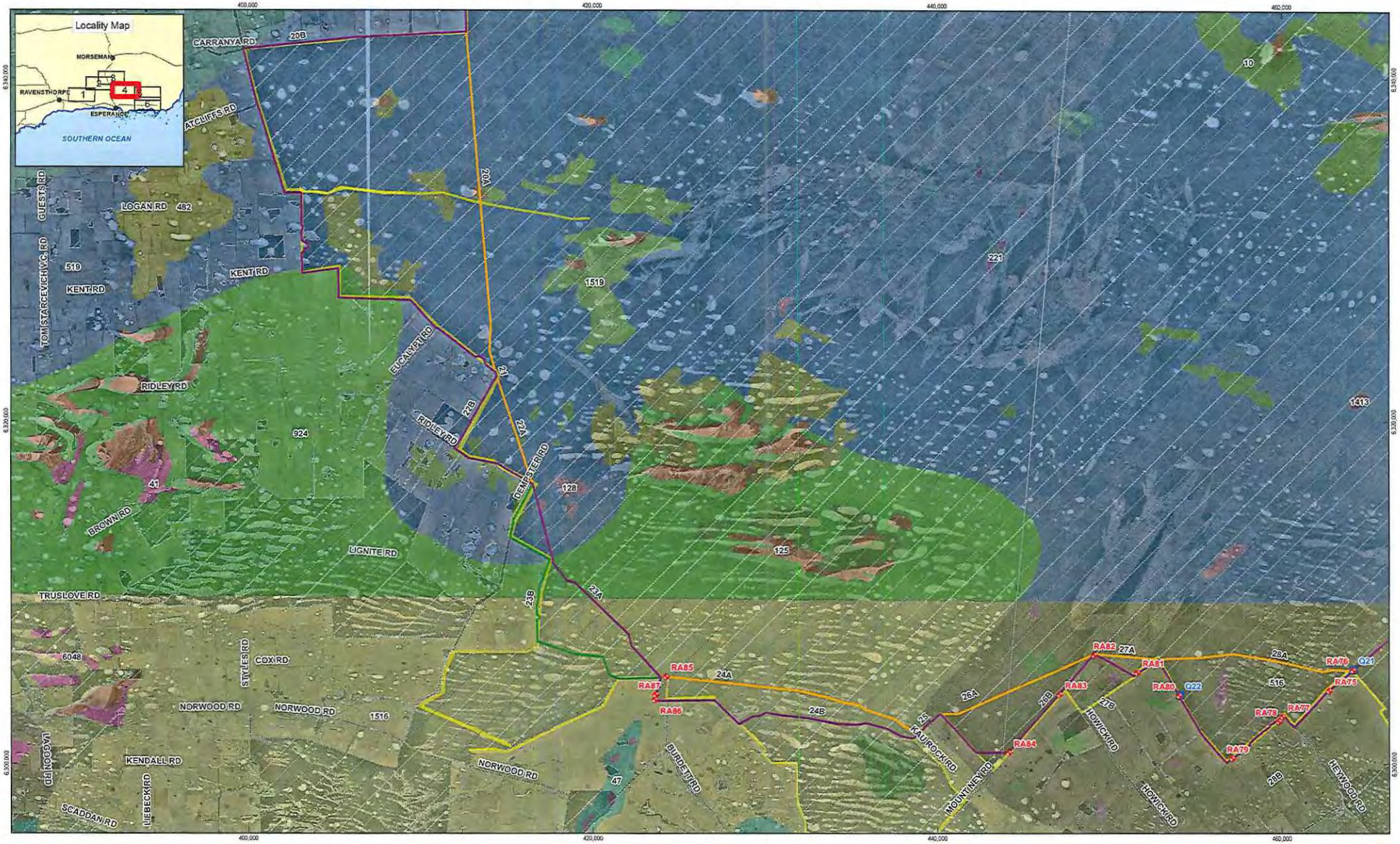

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Vegetation Aspects

Figure 2

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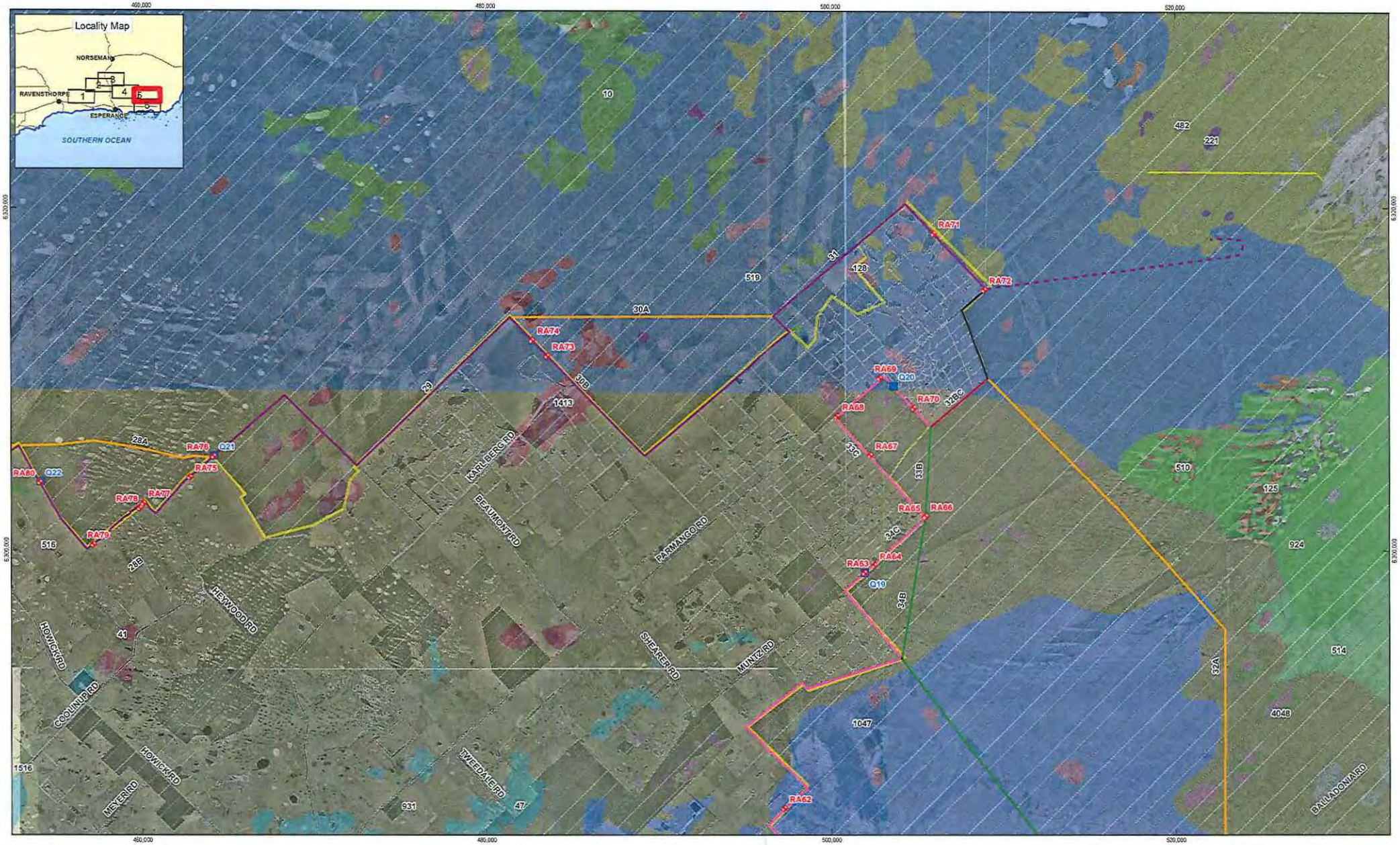

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Vegetation Aspects

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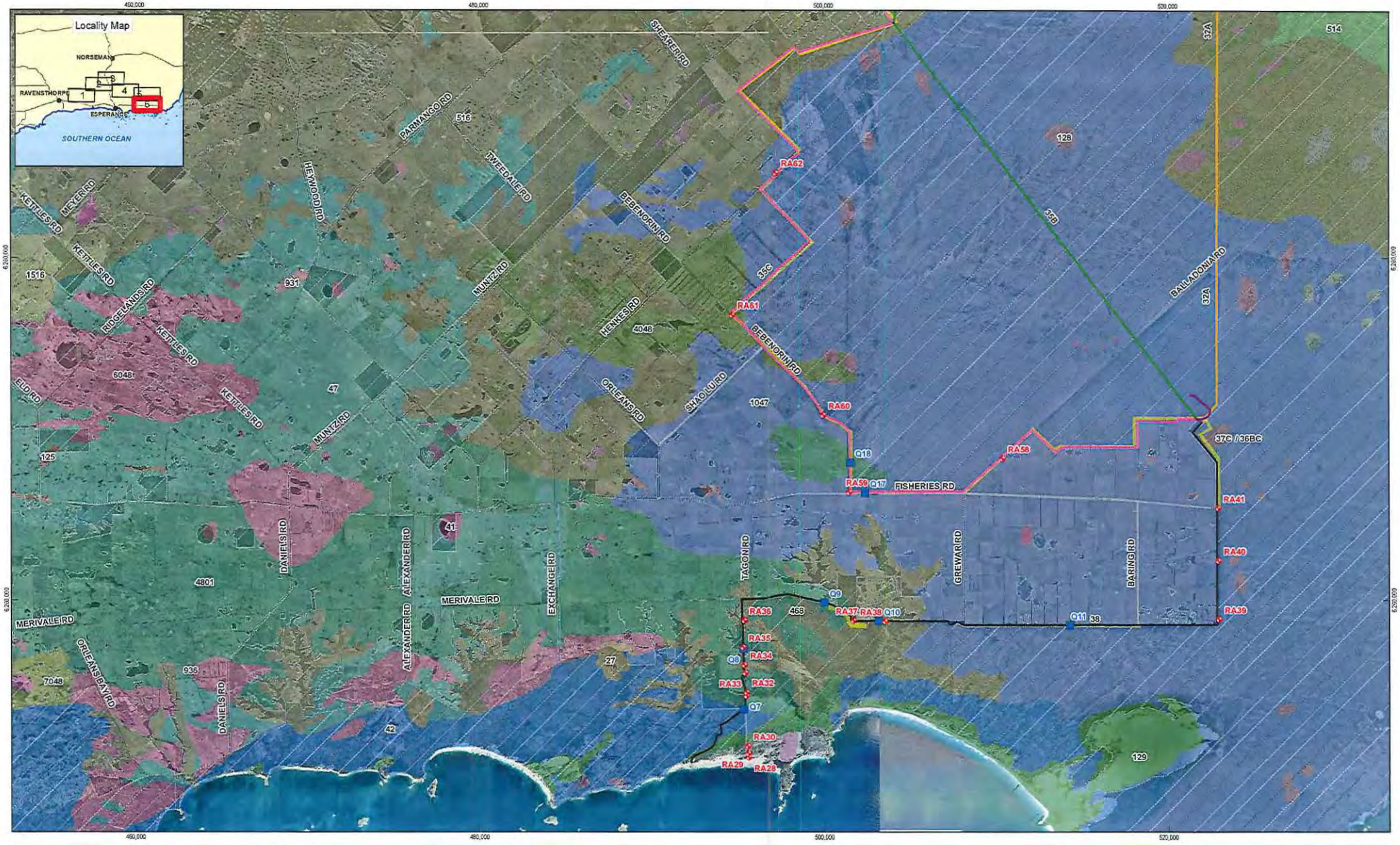

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Vegetation Aspects

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Appendix B

Conservation Categories

Vegetation Condition Rating Scale

EPBC Act Flora and Fauna Conservation Categories

WC Act and DEC Flora Conservation Categories

Declared Plant Control Classes

WC Act Fauna Conservation Codes

DEC Priority Fauna Conservation Codes

Table 7 Vegetation Condition Rating Scale

Vegetation condition rating	Vegetation condition	Description
1	*Pristine or Nearly So.*	No obvious signs of disturbance.
2	*Excellent*	Vegetation structure intact, disturbance affecting individual species, and weeds are non-aggressive species.
3	*Very Good*	Vegetation structure altered, obvious signs of disturbance.
4	*Good*	Vegetation structure significantly altered by very obvious signs of multiple disturbances retains basic vegetation structure or ability to regenerate it.
5	*Degraded*	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not in a state approaching good condition without intensive management.
6	*Completely Degraded*	The structure of the vegetation is no longer intact and the area is completely or almost without native species.

Table 8 Categories and Definitions for EPBC Act Listed Flora and Fauna Species

Conservation Category	Definition
Extinct	Taxa not definitely located in the wild during the past 50 years.
Extinct in the Wild	Taxa known to survive only in captivity.
Critically Endangered	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	Taxa facing a very high risk of extinction in the wild in the near future.
Vulnerable	Taxa facing a high risk of extinction in the wild in the medium-term.
Near Threatened	Taxa that risk becoming Vulnerable in the wild.
Conservation Dependent	Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classified as Vulnerable or more severely threatened.
Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.
Least Concern	Taxa that are not considered Threatened.

Table 9 WC Act and DEC Conservation Codes and Descriptions for Threatened (Declared Rare) and Priority Flora Species.

Code	Conservation Category	Definition
X	Presumed Extinct Flora (Declared Rare Flora – Extinct)	Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such (Schedule 2 under the Wildlife Conservation Act 1950).
T	Threatened Flora (Declared Rare Flora – Extant)	Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such (Schedule 1 under the Wildlife Conservation Act 1950). Threatened Flora are further ranked by the Department according the their level of threat using IUCN Red List criteria: • CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild; • EN: Endangered – considered to be face a very high risk of extinction in the wild; and • VU: Vulnerable – considered to be facing a high risk of extinction in the wild.
P1	Priority 1 – Poorly Known Taxa	Taxa that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes
P2	Priority 2 – Poorly Known Taxa	Taxa that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Taxa may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	Priority 3 – Poorly Known Taxa	Taxa that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Taxa may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.

P4	Priority 4 – Rare, Near Threatened and other taxa in need of monitoring	Rare. Taxa that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands. • Near Threatened. Taxa that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. • Taxa that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	Priority 5 – Conservation Dependent Taxa	Taxa that are not threatened but are subject to a specific conservation program, the cessation of which would result in the taxon becoming threatened within five years.

Table 10 Department of Agriculture and Food Declared Plant Control Classes

Priority Class	Description
P1	Prohibits movement of plants or their seeds within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2	Eradicate infestation to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3	Control infestation in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants.
P4	Prevent the spread of infestation from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.
P5	Infestations on public lands must be controlled.

Listed migratory species

The EPBC Act protects lands and migratory species that are listed under International Agreements.

- Appendices to the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals) for which Australia is a Range State under the Convention;
- The Agreement between the Government of Australia and the Government of the Peoples Republic of China for the Protection of Migratory Birds and their Environment (CAMBA);
- The Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and
- The Agreement between the Government of Australia and the Government of the Republic of Korea on the Protection of Migratory Birds (ROKAMBA).
- other international agreements approved by the Commonwealth Environment Minister.

An action will require approval from the Environment Minister if the action has, will have, or is likely to have a significant impact on a listed migratory species. Note that some migratory species are also listed as threatened species. The criteria below are relevant to migratory species that are not threatened.

An action has, will have, or is likely to have a significant impact on a migratory species if it does, will, or is likely to:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat of the migratory species, or
- result in invasive species that is harmful to the migratory species becoming established* in an area of important habitat of the migratory species, or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of the species.

An area of important habitat is:

1. habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species, or
2. habitat utilised by a migratory species which is at the limit of the species range, or
3. habitat within an area where the species is declining.

Listed migratory species cover a broad range of species with different life cycles and population sizes. Therefore, what is an ecologically significant proportion of the population varies with the species (each circumstance will need to be evaluated).

**Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a migratory species by direct competition, modification of habitat, or predation.*

Table 11 Western Australian *Wildlife Conservation Act 1950* Fauna Conservation Codes

Conservation Code	Description
Schedule 1	"...fauna that is rare or likely to become extinct, are declared to be fauna that is in need of special protection."
Schedule 2	"... fauna that is presumed to be extinct, are declared to be fauna that is in need of special protection."
Schedule 3	"... birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction are declared to be fauna that is in need of special protection."
Schedule 4	"... fauna that is in need of special protection, otherwise than the reasons mentioned [in Schedule 1-3]".

Table 12 DEC Priority Fauna Codes

Conservation Category	Description
Priority 1	Taxa with few, poorly known populations on threatened lands.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown Land , water reserves, etc.
Priority 3	Taxa, which are known from few specimens or sight records, some of which are on lands not under immediate threat of habitat destruction or degradation.
Priority 4	Rare taxa. Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.
Priority 5	Taxa is in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Appendix C

Flora and Vegetation

Table 13 Presence of Low Modified Fuel Buffer (information provided by DEC) and calculations of the size of the area of scrub-cleared and undisturbed vegetation within each section and option of the alignment

Section	Option	Fuel Modified Burnt	Fuel Modified Unburnt	Total area of alignment (ha)	Area of scrub-cleared vegetation (ha)	Area of undisturbed Vegetation (ha)	Comment
1		present	present	97.7941	47.7720	50.022	
2	A	Not present	Not present	31.9345	4.8476	27.087	
2	B	present	present	56.5413	50.0587	6.483	
3		present	Not present	6.5181	6.4987	0.019	
4	A	present	Not present	21.6681	0.3471	21.321	
4	B	present	Not Present	9.8648	0.2187	9.646	
4	BC	present	Not Present	16.2115	7.0692	9.142	
4	C	present	Not present	37.8797	32.2660	5.614	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
5		present	Not present	2.66	1.1315	1.524	
6	A	present	Not present	19.58	0.0049	19.571	
6	B	present	Not present	18.31	0.1234	18.182	
6	C	present	Not present	58.21	18.5157	39.691	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
6	BC	present	Not present	4.38	0.1551	4.225	
7		present	Not present	26.69	25.0825	1.605	
8	A	Not present	Not present	57.78	0.1461	57.630	
8	B	present	not present	28.19	1.6157	26.575	
8	C	Not present	Not present	59.76	8.8308	50.933	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
8	BC	Not present	Not present	63.77	57.0333	6.737	
10		present	Not present	13.87	3.6189	10.248	
11	A	Not present	Not present	9.44		9.440	
	B	Not present	Not present	10.52		10.520	
12		Not present	Not present	7.91		7.910	
13	A	Not present	Not present	20.06		20.060	
13	B	Not present	Not present	13.95		13.950	
13	C	Not present	Not present	82.99		82.990	

Section	Option	Fuel Modified Burnt	Fuel Modified Unburnt	Total area of alignment (ha)	Area of scrub-cleared vegetation (ha)	Area of undisturbed Vegetation (ha)	Comment
13	BC	Not present	Not present	9.46		9.460	
14		Not present	Not present	69.82		69.820	no scrub-rolling here, but a narrow cleared track exists for most of length- could use this as as part of the 10m cleared buffer on one side to reduce clearing amount (this hasn't been calculated)
15	A	Not present	Not present	9.19		9.190	
15	B	Not present	Not present	8.94		8.940	
15	C	Not present	Not present	31.98		31.980	no scrub-rolling here, but a narrow cleared track exists for most of length- could use this as as part of the 10m cleared buffer on one side to reduce clearing amount (this hasn't been calculated)
15	BC	Not present	Not present	0.33		0.330	
16		Not present	present	69.00	11.9519	57.045	
17	A	Not present	Not present	11.60	0.6754	10.924	
17	B	Not present	present	19.98	8.5795	11.402	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
18	A	Not present	present	23.99	2.3753	21.616	
	B	Not present	Not present	31.64	10.2941	21.341	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
19		Not present	present	9.75	4.3349	5.415	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
20	A	present	present	39.91	0.7780	39.129	
	B	Not present	Not present	84.96	50.4470	34.515	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
21		present	Not present	0.46	0.2228	0.238	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
22	A	Not present	Not present	13.30	1.0046	12.299	
22	B	present	not present	19.96	10.4675	9.495	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required

Section	Option	Fuel Modified Burnt	Fuel Modified Unburnt	Total area of alignment (ha)	Area of scrub-cleared vegetation (ha)	Area of undisturbed Vegetation (ha)	Comment
23	A	Not present	Not present	28.18	0.9377	27.243	
23	B	present	not present	38.36	12.6603	25.697	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
24	A	Not present	Not present	31.07	0.7967	30.270	
24	B	present	not present	35.77	4.3569	31.410	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
25		present	Not present	3.46	1.9631	1.499	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
26	A	Not present	Not present	19.40	0.1636	19.232	
26	B	present	Not present	25.16	14.5066	10.651	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required; could alignment be moved to the outside of nature reserve, and thus within an existing firebreak?
27	A	Not present	Not present	7.45	0.3940	7.054	
27	B	present	Not present	8.66	0.3600	8.300	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required;
28	A	Not present	Not present	22.77	0.8404	21.934	
28	B	present	Not present	34.78	16.6720	18.104	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required;
29		present	Not present	47.51	21.6097	25.897	learing line goes the other side - is it possible to follow the clearing line to reduce clearing
30	A	Not present	Not present	30.58	0.3377	30.247	
30	B	present	Not present	47.33	7.9892	39.342	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required;
31		present	no present	46.04	18.0541	27.986	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required; could alignment be moved to the outside of UCL, and thus within scrub-rolled?

Section	Option	Fuel Modified Burnt	Fuel Modified Unburnt	Total area of alignment (ha)	Area of scrub-cleared vegetation (ha)	Area of undisturbed Vegetation (ha)	Comment
32	A	Not present	Not present	90.82	0.4159	90.408	
32	BC	present	not present	8.71	8.7098	0.005	
33	B	Not present	Not present	10.67	0.3102	10.364	If alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required;
33	C	present	not present	31.14	9.3172	21.824	
34	B	Not present	Not present	16.58	0.8652	15.715	
34	C	present	not present	22.87	14.7330	8.137	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
35	B	Not present	Not present	58.11	0.5277	57.585	
35	C	present	not present	132.60	72.7801	59.819	alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required
36	BC	present	Not present	5.162768	1.1146	4.048	
37	C	present	Not present	0.66	0.1037	0.551	
38		present	not present	104.50	9.5138	94.989	small sections of the alignment can be refined to more closely follow scrub-rolled area and thus reduce clearing required

Table 14 Significant Flora Species recorded within approximately 20 km of the SBF Esperance Extension Alignment Options (Source: DEC databases search, *Naturemap Search* (DEC, 2012) and EPBC Act Protected Matters Search (DSEWPaC, 2012)

Family	*Genus*	*Species*	Status	*Naturemap /DEC Search*	EPBC Act Search	Description	Habitat
Apiaceae	*Xanthosia*	*collina*	P3	x		Small perennial, herb, ca 0.06 m high. Fl. white/white & pink, Sep to Oct.	loam or peaty sand, sandy clay over quartzite. Winter-wet areas, swamps, hilltops.
Araliaceae	*Hydrocotyle*	*coraginaensis*	P2	x		Annual, herb.	Grey sand. Seasonally wet flats, granite outcrops.
Araliaceae	*Hydrocotyle*	*decipiens*	P2	x		Small annual, herb.	Along creek edges.
Araliaceae	*Trachymene*	*anisocarpa* var. *trichocarpa*	P3	x		Upright, spreading annual, herb, 0.3-1.5 m high, peduncles up to 140 mm long; distinguished by hairlike bristles on the fruits. Fl. blue-white, Oct to Nov	Sandy soils. Recently disturbed or burnt sites, woodlands, plains.
Asparagaceae	*Thysanotus*	*parviflorus*	P4	x		Perennial, herb, 0.1-0.3 m high. Fl. purple, Oct to Nov.	Grey sand.
Asteraceae	*Haegiela*	*tatei*	P4	x		Ascending to erect annual, herb, 0.02-0.08(-0.2) m high. Fl. white-yellow, Aug to Nov.	Clay, sandy loam, gypsum. Saline habitats.
Asteraceae	*Olearia*	*laciniifolia*	P2	x		Erect, few-stemmed shrub, 0.6-1.2 m high. Fl. blue/purple & white/yellow, May to Sep.	White sand. Around playa lakes.
Casuarinaceae	*Allocasuarina*	*eriochlamys* subsp. *grossa*	P3	x		Dioecious or monoecious shrub, 1-3 m high, bracteoles prominently exceeding cone.	Stony loam, laterite clay. Granite outcrops.
Casuarinaceae	*Allocasuarina*	*globosa*	P1	x		Dioecious shrub, ca 1.5 m high.	Laterite,clay,loam.

Chenopodiaceae	*Atriplex*	*lindleyi* subsp. *conduplicata*	P3	x	Monoecious, short-lived annual or perennial, herb, ca 0.2 m high.	Crabhole plains.
Chenopodiaceae	*Tecticornia*	*indefessa*	P2	x	Prostrate, perennial shrub, 0.05-0.15 m high.	Near the edges of salt lakes.
Dilleniaceae	*Hibbertia*	*hamata*	P3	x	Erect shrub, to 0.5 m high. Fl. yellow, Oct to Dec.	Granite. Inland outcrops.
Droseraceae	*Drosera*	*salina*	P2	x	Erect, flexuose tuberous, perennial, herb, to 0.07 m high. Fl. white, Jul to Sep.	Salt-free white sand. Margins of salt lakes.
Ericaceae	*Andersonia*	*carinata*	P2	x	Erect slender shrub, 0.1-0.45(-0.8) m high. Fl. pink/pink-white/pink-purple, Aug to Oct.	White sand, gravelly lateritic soils. Plains.
Ericaceae	*Astroloma*	sp. Grass Patch (A.J.G. Wilson 110)	P2	x	Multi-stemmed, domed shrub, 0.2-0.4 m high. Fl. red, Jun to Aug.	White/grey sand. Edge od salt lakes.
Ericaceae	*Brachyloma*	*nguba*	P1	x	Erect, compact to spreading, mid-dense shrub, to 0.8 m high, leaves discolorous, usually 2-3 mm long; style 0.2-0.25 mm long; disc truncate. Fl. red, Apr to May.	White to brown sandy clay, shallow sandy loam. Open mallee woodland, mallee scrub, flat plains.
Ericaceae	*Conostephium*	*uncinatum*	P2	x	Erect shrub, 0.5-1.4 m high.	Deep sandy soils. Edges of salt lakes, undulating plains, claypans.
Ericaceae	*Conostephium*	*marchantiorum*	P3	x	Erect, much-branched shrub, 0.4-1.8 m high. Fl. red-purple/brown & yellow, Mar or Jul or Nov.	White/grey sand. Plains, creeklines, edges of salt lakes.
Ericaceae	*Leucopogon*	*apiculatus*	P3	x	Erect, open-branched shrub, 0.3-2 m high. Fl. white/pink, Jul to Nov.	Skeletal sandy or stony soils over quartzite or granite. Granite outcrops & hills, quartzite ridges, rocky slopes.
Ericaceae	*Leucopogon*	*compactus*	P4	x	Much-branched shrub, 0.3-1 m high. Fl. white, Jun to Aug or Dec.	Yellow sand with lateritic gravel, stony clay, loam over granite. Plains, hillslopes.
Ericaceae	*Leucopogon*	*florulentus*	P3	x	Erect slender shrub, 0.3-0.8 m high. Fl. white, Jun to Nov.	White/grey or yellow sand, sandy clay, gravelly lateritic soils. Sandplains, gentle slopes.
Ericaceae	*Leucopogon*	*interruptus*	P2	x	Spreading shrub, to 2 m high.	Grey sand over granite.

Ericaceae	*Leucopogon*	*multiflorus*	P2	x	Erect, sturdy shrub, 0.3-1.5 m high. Fl. white, Jan or Apr or Jul or Nov.	White/grey sand. Rocky slopes, coastal sand dunes, amongst quartzite or granite rocks.
Ericaceae	*Leucopogon*	*remotus*	P1	x	unknown	unknown
Ericaceae	*Leucopogon*	*rotundifolius*	P3	x	Robust shrub, (0.2-)0.5-1.5 m high. Fl. white, Jan or Mar to Aug or Nov.	Skeletal soils. Granite outcrops, steep hillslopes.
Ericaceae	*Leucopogon*	*rugulosus*	P1	x	unknown	unknown
Ericaceae	*Leucopogon*	sp. Bonnie Hill (K.R. Newby 9831)	P1	x	unknown	unknown
Euphorbiaceae	*Beyeria*	*sulcata* var. *truncata*	P3	x	unknown	unknown
Euphorbiaceae	*Ricinocarpos*	*trichophorus*	En / T	x	Erect, openly branching shrub, 0.3-1 m high. Fl. white, May or Aug to Sep.	Sandy clay, loam. Breakaways, among sandstone rocks.
Euphorbiaceae	*Stachystemon*	*vinosus*	P4	x	Compact shrub, to 0.1 m high. Fl. purple-red/white, Sep to Nov.	Fine loamy sand, stony soils. Sandplains, rock crevices on breakaways.
Fabaceae	*Acacia*	*amyctica*	P2	x	Erect, bushy, pungent shrub, 0.7-1.5 m high. Fl. yellow, Aug to Sep.	Sandy loam or clay. Flats.
Fabaceae	*Acacia*	*ancistrophylla* var. *perarcuata*	P3	x	Rounded or obconic shrub, 0.6-1.6 m high, to 6 m wide. Fl. yellow, Aug to Sep.	Red sand, clay loam, loam. Undulating plains
Fabaceae	*Acacia*	*diaphana*	P1	x	Bushy shrub, 1.5-3 m high. Fl. yellow.	Clay, sandy loam. Wet or waterlogged depressions.
Fabaceae	*Acacia*	*dorsenna*	P1	x	Dense, domed shrub, 1-1.6 m high, to 3 m wide. Fl. yellow, Aug to Sep.	(near Salmon Gums) Rocky sandy loam or clay loam. Low rocky hills.
Fabaceae	*Acacia*	*empelioclada*	P4	x	Spindly erect shrub, 0.5-2 m high. Fl. yellow-cream, Jul to Oct.	White sand, gravelly sand, laterite. Rocky hillsides, low rises, moist drainage areas.
Fabaceae	*Acacia*	*euthyphylla*	P3	x	Shrub, 0.7-2 m high. Fl. yellow, Aug to Sep.	Grey/white sand, clay loam. Margins of salt lakes & marshes, seasonal swamps.
Fabaceae	*Acacia*	*glaucissima*	P3	x	Dense, bushy shrub, 0.3-1.5 m high. Fl. yellow.	Sand or clay. Flats, low-lying areas.

Fabaceae	*Acacia*	*nitidula*	P2	x	Spreading shrub, (0.2-)0.6-2(-3) m high. Fl. yellow.	(inland near salmon gums) Granitic sandy gravelly soils. Amongst granite boulders.
Fabaceae	*Acacia*	*truculenta*	P3	x	Spreading, straggly, prickly shrub, 0.7-2.2 m high. Fl. yellow, Aug to Sep.	Sand or loam.
Fabaceae	*Acacia*	*improcera*	P3	x	Spreading, spiny shrub, 0.15-0.4 m high. Fl. yellow, Aug.	Sand, loamy clay, clay. Undulating plains, flats.
Fabaceae	*Acacia*	*singula*	P3	x	Shrub, 0.35-2 m high. Fl. yellow, Aug to Oct.	Gravelly sand over laterite, white or yellow sand. Rises, hilltops.
Fabaceae	*Acacia*	sp. Burdett Road (B.R. Maslin 8218)	P3	x	unknown	unknown
Fabaceae	*Bossiaea*	*arcuata*	P1	x	Erect, divaricately branched superficially leafless shrub, to 1.5 m high. Fl. yellow&red, Mar to Apr or Sep to Oct	Perimeter of salt lakes.
Fabaceae	*Bossiaea*	*aurantiaca*	P1	x	Compact, rounded or spreading, spinescent shrub, to 1.5 m high. Fl. red/yellow, Sep to Oct.	Red sand, red clay loam. Low-lying, winter-damp sites.
Fabaceae	*Bossiaea*	*flexuosa*	P3	x	Compact shrub, to 0.6 m high. Fl. yellow-orange-red-brown, Sep to Nov.	Deep sandy soil.
Fabaceae	*Chorizema*	*circinale*	P1	x	Prostrate, scrambling, wiry shrub, to 0.4 m high. Fl. yellow & orange & red, Sep to Dec.	Yellow sand, sandy clay with gravel. Flats, margin of gravel pit.
Fabaceae	*Daviesia*	*pauciflora*	P2	x	Diffuse, many-stemmed shrub, 0.3-0.8 m high. Fl. yellow & red, Oct to Dec or Jan.	White or grey sand over laterite or limestone. Flats.
Fabaceae	*Daviesia*	*microcarpa*	T	x	Sprawling, tangled shrub, to 0.4 m high, ca 1 m wide. Fl. orange & red, Sep.	north of area) Weathered gravel.
Fabaceae	*Dillwynia*	*acerosa*	P3	x	Shrub, to 0.5 m high. Fl. yellow/red, Sep.	Gravelly clay with laterite.
Fabaceae	*Eutaxia*	*actinophylla*	P3	x	Shrub, to 0.5 m high. Fl. yellow/red, Sep to Oct.	Red-brown clay loam, red clay loam over granite, gravel. Small depressions.

Fabaceae	*Eutaxia*	*endocada*	P1	x	Erect shrub (with sparse ascending branches), 0.2-0.4 m high.	White sand or brown sandy-clay over granite.
Fabaceae	*Kennedia*	*beckxiana*	P4	x	Prostrate or twining shrub or climber. Fl. red, Sep to Dec.	Sand, loam. Granite hills & outcrops.
Fabaceae	*Mirbelia*	*densiflora*	P1	x	Erect or straggling shrub, 0.2-1 m high. Fl. yellow-orange, Oct or Jan.	Stony loam, loamy sand. Small ridges, breakaways, undulating plains.
Fabaceae	*Otion*	*rigidum*	P2	x	Rounded, dense shrub, 0.4-0.8 m high, 0.4-1.5 m wide. Fl. yellow & red, Nov.	Sandy soils. Flats, edges of salt lake.
Fabaceae	*Pultenaea*	*daena*	P3	x	Dense, prostrate, domed shrub, to 0.07 m high. Fl. yellow, Mar.	White to yellow sand or sandy loam, sandy or loamy clay, gravel, limestone, dolomite, laterite. Gently undulating plains, adjacent to salt lakes, in disturbed areas.
Fabaceae	*Pultenaea*	*aduncа*	P3	x	Erect, slender shrub, (0.15-)0.3-1 m high. Fl. yellow & red, Mar or Oct.	White/grey sand.
Fabaceae	*Pultenaea*	*brachyphylla*	P2	x	Erect shrub, to 0.5 m high. Fl. yellow&orange & brown, Sep to Oct.	Pale brown sandy loam, sandy clay, gravel, granite, quartz, laterite. Gently undulating loam.
Frankeniaceae	*Frankenia*	*brachyphylla*	P2	x	Small, decumbent shrub. Fl. white/pink,	Salt lake margins.
Frankeniaceae	*Frankenia*	*drummondii*	P3	x	Prostrate shrub. Fl. white.	Sand. Lake edges.
Goodeniaceae	*Dampiera*	*orchardii*	P2	x	Erect perennial, herb, 0.2-0.4 m high	Sand.
Goodeniaceae	*Dampiera*	*sericantha*	P3	x	Erect, slender perennial, herb, 0.05-0.3(-0.6) m high, stems with blunt angles. Fl. blue, May or Aug to Dec.	Sand, sometimes with gravel. Plains.
Goodeniaceae	*Goodenia*	*laevis* subsp. *laevis*	P3	x	Erect, woody shrub (subshrub), 0.1-0.25 m high, largest leaves 15-25 x 1-3 mm, entire. Fl. yellow, Aug to Dec.	Sandy loam or laterite.
Goodeniaceae	*Goodenia*	*quadriloculariis*	P2	x	Erect, slender, woody perennial, herb, 0.3-1 m high. Fl. yellow, Sep to Dec	Sand dunes, granite slope & outcrops.

Goodeniaceae	*Goodenia*	*turleyae*	P1	x		Annual, herb, 0.03-0.04 m high.	White or grey-brown sand over clay, yellow-brown gravelly clay and granite. Moist sheltered areas, near salt lakes.
Goodeniaceae	*Scaevola*	*archeriana*	P1	x		Erect, resprouting, multi-stemmed, clonal herb, to 0.45 m high.	Sandy and sandy-clay loam soils. Sandplains, road verges.
Gyrostemonaceae	*Gyrostemon*	*ditrigynus*	P4	x		Shrub, 0.4-1.5 m high.	Sand, sandy clay, loam. Plains, low ironstone ridges.
Haemodoraceae	*Anigozanthos*	*bicolor* subsp. *minor*	En / T	x	x	Rhizomatous, perennial, herb, 0.05-0.2 m high. Fl. green&red, Aug to Oct.	Well-watered sites.
Haemodoraceae	*Conostylis*	*lepidospermoides*	En / T	x	x	Rhizomatous, tufted perennial, grass-like or herb, 0.17-0.36 m high. Fl. yellow, Sep to Oct.	Grey or yellow-brown sand over laterite.
Haloragaceae	*Gonocarpus*	*pycnostachyus*	P3	x		Erect annual, herb, 0.1-0.15 m high. Fl. green-red.	Sand or clay soils. Wet depressions, granite rocks.
Haloragaceae	*Myriophyllum*	sp. Mt Arid (L.S.J. Sweedman 6767)	P2	x		unknown	unknown
Haloragaceae	*Myriophyllum*	*petraeum*	P4	x		Aquatic annual, herb, stems 0.15-0.3 m long. Fl. white, Aug to Dec.	Strictly confined to ephemeral rock pools on granite outcrops.
Hemerocallidaceae	*Caesia*	*viscida*	P2	x		Rhizomatous and tuberous, tufted perennial, herb, to 0.3 m high. Fl. white, Nov	Aeolian sand. Low dunes.
Lamiaceae	*Dicrastylis*	*archeri*	P1	x		Erect, spindly shrub, 0.4-1 m high, inflorescence with scale-like indumentum; upper leaf surface glabrous; stamens usually 4. Fl. cream-white, Nov to Dec.	White sand. Open mallee woodland.
Lamiaceae	*Dicrastylis*	*capitellata*	P1	x		Low spreading shrub, 0.2-0.25 m high. Fl. blue-purple, May.	Loamy sand, sandy loam.
Lamiaceae	*Pityrodia*	*chrysocalyx*	P3	x		Erect, branched shrub, 0.3-0.75(-1) m high. Fl. white, Aug to Oct.	Sandy soils.
Lamiaceae	*Prostanthera*	*carrickiana*	P4	x		Erect shrub, to 1 m high. Fl. pink-red, Apr to May.	Sandy clay soils. Granite outcrops.

Malvaceae	*Lasiopetalum*	*maxwellii*	P2	x	Sprawling shrub, 0.25-0.6 m high. Fl. white-cream, Sep to Oct or Jan or Apr.	Sandy soils. Granite slopes.
Malvaceae	*Lasiopetalum*	*parvuliflorum*	P3	x	Erect, spreading shrub, 0.35-1 m high. Fl. green-cream, Sep to Oct.	Sand, gravelly loam. Along creeks, seasonal swamps.
Myrtaceae	*Astartea*	sp. Esperance (A. Fairall 2431)	P1	x	Erect spreading shrub, to 1.5 m high, to 2.5 m wide. Fl. white, Sep to Oct.	Sandy gravel, sandy clay, loam. Saline depressions, near salt pans, lake margins.
Myrtaceae	*Astartea*	sp. Jyndabinbin Rocks (K.R. Newbey 7689)	P2	x	Spreading shrub, 0.3-0.85 m high. Fl. white, Sep.	Grey sand, granitic sandy loam. Aeolian dunes, flat plains.
Myrtaceae	*Astus*	*duomilius*	P1	x	Shrub.	Orange sand, somewhat saline. Gentle slope of a lake dune.
Myrtaceae	*Baeckea*	sp. Gibson (K.R. Newbey 11084)	P1	x	Spreading, erect, mid-dense shrub, to 2 m high. Fl. pink, Jun or Nov to Dec.	Brown sandy loam over laterite & granite. Moderately exposed hills, cleared bushland.
Myrtaceae	*Cyathostemon*	sp. Dowak (J.M. Fox 86/271)	P1	x	Rounded, decumbent shrub, to 2 m high. Fl. white, Oct	Sand. Margins of salt lakes.
Myrtaceae	*Cyathostemon*	sp. Salmon Gums (B. Archer 769)	P3	x	Erect, compact shrub, to 3 m high. Fl. white, May or Oct to Nov.	Orange sand, white sand or sandy clay over granite, light brown clay with gypsum, saline soils. Flats, dry river beds, near claypans.
Myrtaceae	*Darwinia*	*luehmannii*	P1	x	Dense, spreading shrub, 0.1-0.5 m high. Fl. white & green, May or Sep or Nov.	White sand, sandy loam. Flat depressions, base of granite rocks.
Myrtaceae	*Darwinia*	*polycephala*	P4	x	Diffuse shrub, 0.1-0.5 m high. Fl. red-purple, Mar or May to Jul or Sep	Sand, clay. Flats, near salt lakes.
Myrtaceae	*Darwinia*	sp. Mt Baring (K.R. Newbey 9775)	P1	x	Shrub, ca 0.5 m high. Fl. red, Aug.	White sand. Hill crest.
Myrtaceae	*Darwinia*	sp. Mt Burdett (N.G. Marchant 80/42)	P4	x	Many-stemmed shrub, to 0.5 m high. Fl. red & white, Mar or Aug.	White to cream sand, clay to clay-loam, laterite. Flats, near clay pans & salt lakes, hillcrests, road verges.

Myrtaceae	*Darwinia*	sp. Mt Heywood (R. Davis 11066)	T	x	unknown	unknown
Myrtaceae	*Darwinia*	sp. Mt Ney (M.A. Burgman & S. McNee 1274)	P1	x	Low, spreading shrub, ca 0.3 m high. Fl. white, May.	White sand. Slight slope.
Myrtaceae	*Darwinia*	sp. Mt Ragged (S. Barrett 663)	P2	x	Spreading, much-branched shrub, to 0.7 m high. Fl. green-white/cream. Jul or Dec.	Brown loamy sand, quartzite, granite. Outcrops, steep ridges, rocky slopes.
Myrtaceae	*Eucalyptus*	*balanopelex*	P1	x	Mallee, 3-4(-6) m high, bark smooth, grey.	Grey sand, sandy loam. Low wet areas.
Myrtaceae	*Eucalyptus*	*brockwayi*	P3	x	Tree, 5-20 m high, bark smooth. Fl. white-cream, Mar to Jun.	(north) Gravelly sandy loam. Low rocky hills & slopes.
Myrtaceae	*Eucalyptus*	*creta*	P3	x	Tree, 3-15 m high, bark smooth. Fl. cream-yellow, May.	Sandy clay or loam. Calcareous plains.
Myrtaceae	*Eucalyptus*	*famelica*	P3	x	Mallee, 1.5-4 m high, bark smooth. Fl. white, Apr to Jul.	White/grey sand. Wet areas, sometimes slightly brackish.
Myrtaceae	*Eucalyptus*	*jimberlanica*	P1	x	Mallee or tree, 4-10 m high, bark smooth.	Loam. Valley edges.
Myrtaceae	*Eucalyptus*	*ligulata* subsp. *ligulata*	P4	x	Mallee, 1-4 m high, bark smooth grey; stems pinkish-grey. Fl. white-cream, Mar or Jun or Oct.	Sand, sandy clay, rocky loam, granite. Near large coastal granite domes.
Myrtaceae	*Eucalyptus*	*litorea*	P2	x	Mallee, 2-6 m high, bark rough at base, smooth above.	(Cape Arid) Calcareous sand, sandy clay loam & stones. Leeward of primary dunes, around salt lakes.
Myrtaceae	*Eucalyptus*	*platydisca*	T	x	Mallee, 2-4 m high, bark smooth.	Granitic soils, clay. Stony hills.
Myrtaceae	*Eucalyptus*	*pterocarpa*	P4	x	Tree, to 15 m high, bark smooth throughout, becoming ribbony,light grey over salmon cream.	(north) Red-brown sandy loam, yellow-brown silty loam. Creek edges, rocky slopes.
Myrtaceae	*Eucalyptus*	*semiglobosa*	P3	x	Mallee, to 6 m high, bark smooth grey over tan. Fl. cream-white-yellow, May or Oct to Dec or Jan.	White sand over laterite, silty sand on edge of granite shelf, limestone. Hillslopes, gullies, cliffs.
Myrtaceae	*Eucalyptus*	sp. Esperance (M.E. French 1579)	P1	x	Mallee, to 5 m high, bark smooth grey over light grey & cream, shedding in ribbons.	Grey sandy loam, red-brown loam, grey-brown calcareous loam. Flats.

Myrtaceae	*Eucalyptus*	*sweedmaniana*	P2	x		unknown	unknown
Myrtaceae	*Eucalyptus*	*dolichorhyncha*	P4	x		Mallee or tree, 1-5 m high. Fl. yellow, Jan to Mar or May.	Sandy clay or clay. Flats.
Myrtaceae	*Eucalyptus*	*goniantha* subsp. *goniantha*	P4	x		Mallee or tree (rarely), 1.5-10 m high, bark smooth, shedding. Fl. cream-white, Sep or Nov to Dec or Jan to Feb.	Sand, sandy clay, often over weathered granite & laterite. Coastal areas.
Myrtaceae	*Eucalyptus*	*merrickiae*	En / T	x	x	Mallee, 2-4(-6) m high, bark rough, flaky. Fl. pink/cream-white, Aug to Nov.	Sandy clay, grey sand. Near salt lakes.
Myrtaceae	*Eucalyptus*	*misella*	P1	x		Mallee, 1-3 m high, bark smooth. Fl. cream, Nov.	White, yellow or grey sand. Low-lying sandplains.
Myrtaceae	*Eucalytpus*	*stoatei*	P4	x		Slender tree, 2-7.5 m high, bark smooth. Fl. yellow, Jul to Aug or Oct to Dec or Jan to Feb.	Gravelly sand or clay, sandy loam. Flats, rises.
Myrtaceae	*Hypocalymma*	sp. Cascade (R. Bruhn 20896)	P2	x		Shrub, 0.4-0.6 m high, crowded, decussate leaves; flowers axillary, 2 cm wide. Fl. pink, Aug.	Sandy loam.
Myrtaceae	*Kunzea*	*salina*	P2	x		unknown	unknown
Myrtaceae	*Melaleuca*	*coccinea*	P3	x		Much branched shrub, 1.5-2.6 m high, leaf blade elliptic to ovate, 1.5-2.2 times as long as wide. Fl. red, Sep to Nov or Jan.	Sandy loam over granite. Granite outcrops, sandplain, river valleys.
Myrtaceae	*Melaleuca*	*dempta*	P3	x		Shrub, (0.2-)0.6-2(-3) m high. Fl. white-cream, Aug	
Myrtaceae	*Melaleuca*	*eximia*	P2	x		Erect shrub, 2-3 m high, leaf blade subulate to linear-elliptic, 8-14 times as long as wide. Fl. red, Oct to Nov or Jun	Gravelly sand or gravelly clay. Granite outcrops.
Myrtaceae	*Melaleuca*	*fissurata*	P4	x		Shrub, 0.5-2(-4) m high. Fl. white/yellow, Jul to Aug.	White/grey sand, sandy loam. Samphire flats, salt pans.
Myrtaceae	*Melaleuca*	*incana* subsp. *tenella*	P3	x		Bushy shrub, 0.6-2 m high. Fl. white-cream-yellow, Aug to Oct.	Grey/brown sand. Swamps & depressions.
Myrtaceae	*Melaleuca*	*viminea* subsp. *appressa*	P2	x		Spreading shrub, 1.3-4.5 m high. Fl. white-cream, Sep to Oct.	Shallow sand over clay. Near creeks or wet depressions.
Myrtaceae	*Melaleuca*	*similis*	P1	x		Shrub, to 0.6 m high. Fl. pink, Nov.	Grey sand. Margins of saline drainage lines.

Myrtaceae	*Micromyrtus*	*elobata* subsp. *scopula*	P3	x	Erect shrub, 0.1-0.4(-1) m high.	Deep aeolian sand, grey or white sand, white sandy clay. Undulating plains, dunes, hill crests.
Myrtaceae	*Micromyrtus*	*papillosa*	P1	x	Erect or low, spreading shrub, 0.4-1.2 m high. Fl. white, Apr or Aug to Oct.	Sandy or clay soils, ironstone, granite. Rocky sites, outcrops, on hills from base to summit.
Myrtaceae	*Verticordia*	*verticordina*	P3	x	Spreading to prostrate shrub, 0.1-0.3 m high. Fl. green/white & red/brown, Aug to Oct or Dec.	Sand, clay
Orchidaceae	*Caladenia*	*cristata*	P1	x	Tuberous, perennial, herb, 0.18-0.4 m high. Fl. green & red, Aug to Sep	Sandy rise above salt flats, freshwater.
Orchidaceae	*Paracaleana*	*parvula*	P2	x	Perennial, herb, to 0.18 m high. Fl. yellow/green, Oct to Nov. Deep white sands	Deep white sands. Plains.
Orchidaceae	*Pterostylis*	sp. Ongerup (K.R. Newbey 4874)	P4	x	Upright annual, herb, to 0.12 m high	Sheltered slopes, base of cliffs and valley floors, in soil pockets.
Orchidaceae	*Pterostylis*	sp. Striped sepal greenhood (G. Brockman Gbb355)	P2	x	Herb, to 0.08 m high.	Clay loam, ironstone, granite. At the base of boulders, broken outcrops.
Orchidaceae	*Rhizanthella*	*gardneri*	T; CE	x	Tuberous, perennial, herb, flowers develop under the surface and break through as they mature; flowers c. 6 mm long, 5 mm wide. Fl. pink-purple, May to Jul.	Sand. Grows in association with Melaleuca uncinata.
Poaceae	*Austrostipa*	*pycnostachya*	P1	x	Shortly rhizomatous, tufted perennial, grass-like or herb, 0.15-0.6 m high. Fl. green-purple, Oct.	Sand, clay, loam, frequently saline. Salt lakes, swamps, coastal dunes.
Polygalaceae	*Comesperma*	*calcicola*	P3	x	Soft perennial, herb, to 0.3 m high. Fl. pink, Oct to Dec or Jan.	Calcareous or semi-saline clay loams, limestone. Areas around saline water.
Proteaceae	*Adenanthos*	*ileticos*	P4	x	Diffuse, lignotuberous shrub, 0.7-2(-3) m high. Fl. pink & cream/yellow, Mar or Jul to Oct or Dec.	(far inland) White, yellow or brown sand.
Proteaceae	*Banksia*	*lullfitzii*	P3	x	Lignotuberous shrub, 0.8-2 m high. Fl. yellow-orange/orange-brown, Mar to May.	Yellow sand. Sandplains.
Proteaceae	*Banksia*	*prolata* subsp. *prolata*	P3	x	Erect, non-lignotuberous shrub, 1-3 m high. Fl. yellow, Jun to Oct.	Sand or sandy loam over granite. Slopes.

Proteaceae	*Grevillea*	*baxteri*	P4	x	Erect to spreading shrub, 0.8-3.6 m high. Fl. green-yellow-orange-brown-red, Feb or May to Jul or Sep to Dec.	Sand. Sandplains.
Proteaceae	*Grevillea*	*phillipsiana*	P1	x	Shrubs, 0.5–1.5 m high. Branchlets not glaucous. *Leaves* simple, 12–30 mm long overall.	Amongst medium trees, or tall (sclerophyll) shrubland, or low (sclerophyll) shrubland; in rocky or stony soil, or loam; occupying rock fissures.
Proteaceae	*Grevillea*	*aneura*	P4	x	Dense, prickly shrub, 0.5-2.8 m high. Fl. red, Jun or Aug to Dec or Jan.	Sand, sandy clay, gravel.
Proteaceae	*Grevillea*	*festigiata*	P4	x	Shrub, 0.9-1.3 m high. Fl. red, Jan.	Red clay, granite.
Proteaceae	*Hakea*	*tuberculata*	P3	x	Erect, slender, columnar shrub, to 2 m high. Fl. white, Mar to Apr or Jul.	Shallow red loam over ironstone. Winter-wet flats.
Proteaceae	*Isopogon*	*alcicornis*	P3	x	Low, lignotuberous shrub, 0.3-0.5 m high, up to 0.6 m wide. Fl. yellow/white/pink, Oct to Dec or Feb.	Sandy soils, skeletal loam on granite. Sandhills, salt lakes, sandplains.
Proteaceae	*Persoonia*	*cymbifolia*	P3	x	Erect, spreading shrub, 0.2-0.6(-1) m high. Fl. yellow, Dec or Jan.	Sandy soils. On flats or in rock crevices.
Proteaceae	*Persoonia*	*scabra*	P3	x	Erect, spreading, lignotuberous shrub, 0.3-0.9 m high. Fl. yellow, Nov to Dec or Jan.	White sand or sandy loam.
Proteaceae	*Persoonia*	*spathulata*	P2	x	Erect, spreading shrub, 0.2-0.6 m high. Fl. yellow, Dec or Jan.	Sand.
Proteaceae	*Synaphea*	*platyphylla*	P3	x	Caespitose shrub. Fl. yellow, Sep to Oct.	Sandy loam
Rhamnaceae	*Spyridium*	*mucronatum* subsp. *multiflorum*	P2	x	Erect or spreading shrub, 0.15-0.6 m high. Fl. white-cream-yellow, Oct to Dec or Jan.	Gravelly loam or clay.
Rubiaceae	*Opercularia*	*rubioides*	P3	x	Perennial, herb or shrub, 0.04-0.45 m high. Fl. green-cream-white, Sep to Nov.	White/grey sand, gravelly sandy clay, sandy loam. Floodplains, stony hills, flat plains.
Rutaceae	*Boronia*	*baeckeacea* subsp. *patula*	P1	x	Slender or straggling shrub, 0.2-1 m high, leaves simple or triofoliolate, more or less spreading, broadly elliptic to obovate, 4-7 mm long. Fl. pink & white, Mar to Sep or Nov to Dec.	Clay loam. Mallee.

Rutaceae	*Boronia*	*scabra* subsp. *attenuata*	P3	x		Erect shrub, 0.3-0.6 m high, flowers 4- and 5-merous, sepals strongly hirsute, staminal filaments smooth. Fl. pink/red, Sep to Nov.	Sandy skeletal soils over granite. Among granite rocks.
Rutaceae	*Philotheca*	*apiculata*	P2	x		Erect shrub, 0.5-1.5 m high. Fl. white-pink, Aug to Nov.	Stony clay loam. Rocky outcrops, hillsides.
Rutaceae	*Philotheca*	*gardneri* subsp. *globosa*	P1	x		Rounded shrub, 0.25-0.5 m high, leaves globular, 1.5-2 mm long; petals c. 6 mm long. Fl. white, May to July	Sandy soils. Heathland.
Scrophulariaceae	*Eremophila*	*purpurascens*	P3	x		Erect, bushy shrub, 0.3-1.5 m high. Fl. pink & purple/red, Aug to Oct.	(north) Sandy clay, stony loam over greenstone.
Scrophulariaceae	*Eremophila*	*serpens*	P4	x		Prostrate, creeping, forming large patches shrub, 0.03-0.4 m high, forming large patches to 2 m wide. Fl. green/yellow-green, Sep to Dec or Mar to May.	White/grey sand, alluvium, loam. Winter-wet depressions, sub-saline flats, drainage lines, salt lakes.
Scrophulariaceae	*Eremophila*	*chamaephila*	P3	x		Low, dome-shaped shrub, 0.1-0.25 m high, 0.2-0.8 m wide. Fl. blue-purple, Nov to Dec.	White sand, clay. Sandplains, disturbed road verges.
Scrophulariaceae	*Eremophila*	*compressa*	P3	x		Erect, often spindly shrub, (0.5-)0.7-2 m high. Fl. white-cream, Oct to Dec or Mar.	Red brown clay or clay loam, sandy loam. Undulating plains.
Scrophulariaceae	*Eremophila*	*denticulata* subsp. *denticulata*		x	x	Erect, open shrub, 0.5-2.5 m high. Fl. pink-orange/yellow-orange-red, Aug to Dec or Jan to Feb.	, sand, sandy clay loam. River beds & plains, laterite breakaways.
Scrophulariaceae	*Eremophila*	*denticulata* subsp. *trisulcata*	En / T		x	Compact shrub, to 2 m high. Fl. pink-orange-red, May or Sep.	Sand or loam over limestone.
Scrophulariaceae	*Eremophila*	*lactea*	En / T		x	Erect spindly or compact shrub, (0.3-)0.8-3.5 m high. Fl. blue-purple, Sep to Nov.	White sandy clay loam. Open disturbed road verge.
Scrophulariaceae	*Eremophila*	*racemosa*	P4	x		Erect shrub, 0.5-1.7 m high. Fl. purple-pink-red/white, Mar or Aug to Dec.	Sandy or stony loam, clay loam. Undulating plains, roadsides.
Scrophulariaceae	*Eremophila*	*subteretifolia*	T	x	x	Prostrate shrub, 0.04-0.15 m high, to 2.5 m wide. Fl. orange, Nov to Dec	Grey sand, loam. Edges of salt lakes, sub-saline flats.
Scrophulariaceae	*Myoporum*	*turbinatum*	En / T	x	x	Erect shrub, 0.5-3 m high. Fl. white, Jan or Apr to May or Aug to Dec.	Sandy soils. In moist areas: along creeks & rivers, near pools, margins of saline depressions.

Scrophulariaceae	*Myoporum*	*velutinum*	T	x	Shrub, 1-2 m high. Fl. white, Sep.	Sandy soils. Creek banks.
Stylidiaceae	*Stylidium*	*pulviniforme*	P3	x	Caespitose perennial, herb, 0.01-0.05 m high, forming dense flat-topped cushions. Fl. white, Sep to Nov.	White sand. Winter-wet areas.
Thymelaeaceae	*Pimelea*	*halophila*	P2	x	Dwarf, cushion-like shrub, 0.015-0.15 m high. Fl. white-cream, Aug to Oct.	White/grey sand. Salt lake.

Legend

P Priority

T Threatened (listed as DRF under the WC Act)

EN Endangered (under the EPBC Act)

Fl. Flowers

Quadrat Data Recorded During Field Survey

RA Data Recorded During Field Survey

Flora Species List Recorded During Field Survey (with reference to Quadrat and RA locations)

Appendix D

Fauna

Table 15 Fauna Species recorded within approximately 20 km of the SBF Esperance Extension Alignment Options (Source: *Naturemap Search* (DEC, 2012); EPBC Act Protected Matters (PM) Search (DSEWPaC, 2012) and opportunistic records from the field survey

**invertebrate species and solely marine species have been excluded

Family	Genus	Species	Common Name	Status	Field Survey	*Nature Map Search*	EPBC PM Search
Birds							
Acanthizidae	*Acanthiza*	*apicalis*	Inland Thornbill			x	
Acanthizidae	*Acanthiza*	*chrysorrhoa*	Yellow-rumped Thornbill			x	
Acanthizidae	*Acanthiza*	*uropygialis*	Chestnut-rumped Thornbill			x	
Acanthizidae	*Pyrrholaemus*	*brunneus*	Redthroat			x	
Acanthizidae	*Sericornis*	*frontalis*	White-browed Scrubwren			x	
Acanthizidae	*Smicrornis*	*brevirostris*	Weebill			x	
Accipitridae	*Accipiter*	*fasciatus fasciatus*	Brown Goshawk			x	
Accipitridae	*Aquila*	*audax*	Wedge-tailed Eagle		x	x	
Accipitridae	*Circus*	*approximans*	Swamp Harrier			x	
Accipitridae	*Circus*	*assimilis*	Spotted Harrier			x	
Accipitridae	*Haliaeetus*	*leucogaster*	White-bellied Sea-Eagle	Mi		x	x
Aegothelidae	*Aegotheles*	*cristatus*	Australian Owlet-nightjar			x	
Anatidae	*Anas*	*castanea*	Chestnut Teal			x	
Anatidae	*Anas*	*gracilis*	Grey Teal			x	
Anatidae	*Anas*	*rhynchotis*	Australasian Shoveler			x	
Anatidae	*Anas*	*superciliosa*	Pacific Black Duck			x	
Anatidae	*Biziura*	*lobata*	Musk Duck			x	
Anatidae	*Cereopsis*	*novaehollandiae* subsp. *grisea*	Cape Barren Goose	Vu (EPBC Act); S1-Vu		x	
Anatidae	*Chenonetta*	*jubata*	Australian Wood Duck			x	
Anatidae	*Cygnus*	*atratus*	Black Swan			x	
Anatidae	*Malacorhynchus*	*membranaceus*	Pink-eared Duck			x	
Anatidae	*Oxyura*	*australis*	Blue-billed Duck			x	
Anatidae	*Tadorna*	*tadornoides*	Australian Shelduck			x	

Family	Genus	Species	Common Name	Status	Field Survey	Nature Map Search	EPBC PM Search
Apodidae	*Apus*	*pacificus*	Fork-tailed Swift	Mi		x	x
Ardeidae	*Ardea*	*pacifica*	White-necked Heron		x	x	
Ardeidae	*Ardea*	*alba*	Great Egret				x
Ardeidae	*Ardea*	*ibis*	Cattle Egret	Mi			x
Ardeidae	*Botaurus*	*poiciloptilus*	Australasian Bittern	En (EPBC Act); S1-En			x
Artamidae	*Artamus*	*cinereus*	Black-faced Woodswallow		x	x	
Artamidae	*Artamus*	*cyanopterus*	Dusky Woodswallow			x	
Artamidae	*Cracticus*	*nigrogularis*	Pied Butcherbird			x	
Artamidae	*Cracticus*	*tibicen*	Australian Magpie		x	x	
Artamidae	*Cracticus*	*torquatus*	Grey Butcherbird		x	x	
Artamidae	*Strepera*	*versicolor*	Grey Currawong		x	x	
Cacatuidae	*Calyptorhynchus*	*latirostris*	Carnaby's Cockatoo	En (EPBC Act); S1-En	x	x	
Campephagidae	*Coracina*	*novaehollandiae*	Black-faced Cuckoo-shrike			x	
Caprimulgidae	*Eurostopodus*	*argus*	Spotted Nightjar			x	
Casuariidae	*Dromaius*	*novaehollandiae*	Emu		x	x	
Charadriidae	*Charadrius*	*ruficapillus*	Red-capped Plover			x	
Charadriidae	*Pluvialis*	*fulva*	Pacific Golden Plover	Mi		x	
Charadriidae	*Pluvialis*	*squatarola*	Grey Plover			x	
Charadriidae	*Thinornis*	*rubricollis*	Hooded Plover	P4		x	
Charadriidae	*Vanellus*	*miles*	Masked Lapwing			x	
Charadriidae	*Vanellus*	*tricolor*	Banded Lapwing			x	
Climacteridae	*Climacteris*	*rufa*	Rufous Treecreeper			x	
Columbidae	*Ocyphaps*	*lophotes*	Crested Pigeon			x	
Columbidae	*Phaps*	*chalcoptera*	Common Bronzewing		x	x	
Columbidae	*Phaps*	*elegans*	Brush Bronzewing			x	
Columbidae	*Streptopelia*	*senegalensis*	Laughing Turtle-Dove	*		x	
Corvidae	*Corvus*	*bennetti*	Little Crow			x	
Corvidae	*Corvus*	*coronoides*	Australian Raven		x	x	
Cuculidae	*Cacomantis*	*flabelliformis* subsp. *flabelliformis*	Fan-tailed Cuckoo			x	

Family	Genus	Species	Common Name	Status	Field Survey	Nature Map Search	EPBC PM Search
Cuculidae	*Cacomantis*	*pallidus*	Pallid Cuckoo			x	
Cuculidae	*Chalcites*	*lucidus* subsp. *plagosus*	Shining Bronze Cuckoo			x	
Dicaeidae	*Dicaeum*	*hirundinaceum*	Mistletoebird			x	
Diomedeidae	*Diomedea*	*exulans*	Wandering Albatross	Vu (EPBC Act); ; S1-Vu; Mi			x
Diomedeidae	*Thalassarche*	*chrysostoma*	Grey-headed Albatross	En (EPBC Act); S1-Vu; Mi		x	
Diomedeidae	*Thalassarche*	*cauta*	Shy Albatross	Vu (EPBC Act); ; S1-Vu; Mi			x
Diomedeidae	*Thalassarche*	*chlororhynchos*	Yellow-nosed Albatross	Vu (EPBC Act); ; S1-Vu; Mi			x
Diomedeidae	*Thalassarche*	*melanophris*	Black-browed Albatross	Vu (EPBC Act); ; S1-Vu; Mi			x
Estrildidae	*Stagonopleura*	*oculata*	Red-eared Firetail			x	
Eupetidae	*Cinclosoma*	*castanotum*	Chestnut Quail-thrush			x	
Falconidae	*Falco*	*berigora* subsp. *berigora*	Brown Falcon			x	
Falconidae	*Falco*	*cenchroides*	Australian Kestrel			x	
Falconidae	*Falco*	*longipennis*	Australian Hobby			x	
Falconidae	*Falco*	*peregrinus*	Peregrine Falcon	S4		x	
Haematopodidae	*Haematopus*	*fuliginosus*	Sooty Oystercatcher		x	x	
Haematopodidae	*Haematopus*	*longirostris*	Australian Pied Oystercatcher			x	
Halcyonidae	*Todiramphus*	*sanctus*	Sacred Kingfister			x	
Hirundinidae	*Cheramoeca*	*leucosternus*	White-backed Swallow			x	
Hirundinidae	*Hirundo*	*neoxena*	Welcome Swallow			x	
Hirundinidae	*Petrochelidon*	*nigricans*	Tree Martin		x	x	
Laridae	*Chroicocephalus*	*novaehollandiae* subsp. *novaehollandiae*	Silver Gull			x	
Laridae	*Hydroprogne*	*caspia*	Caspian Tern	Mi		x	x
Laridae	*Larus*	*pacificus* subsp. *georgii*	Pacific Gull			x	
Maluridae	*Malurus*	*leucopterus subsp.*	White-winged Fairy Wren			x	

Family	Genus	Species	Common Name	Status	Field Survey	Nature Map Search	EPBC PM Search
		leuconotus					
Maluridae	*Malurus*	*pulcherrimus*	Blue-breasted Fairy-wren			x	
Maluridae	*Stipiturus*	*malachurus*	Southern Emu-wren			x	
Megapodiidae	*Leipoa*	*ocellata*	Malleefowl	Vu (EPBC Act); ; S1-Vu; Mi			x
Meliphagidae	*Acanthagenys*	*rufogularis*	Spiny-cheeked Honeyeater			x	
Meliphagidae	*Acanthorhynchus*	*superciliosus*	Western Spinebill			x	
Meliphagidae	*Anthochaera*	*chrysoptera*	Little Wattlebird			x	
Meliphagidae	*Anthochaera*	*lunulata*	Western Wattlebird			x	
Meliphagidae	*Epthianura*	*albifrons*	White-fronted Chat			x	
Meliphagidae	*Glyciphila*	*melanops*	Tawny-crowned Honeyeater			x	
Meliphagidae	*Lichenostomus*	*cratitius*	Purple-gaped Honeyeater			x	
Meliphagidae	*Lichenostomus*	*leucotis subsp. novaenorciae*	White-eared Honeyeaters			x	
Meliphagidae	*Lichenostomus*	*ornatus*	Yellow-plumed Honeyeater			x	
Meliphagidae	*Lichenostomus*	*virescens*	Singing Honeyeater			x	
Meliphagidae	*Lichmera*	*indistincta* subsp. *indistincta*	Brown Honeyeater			x	
Meliphagidae	*Manorina*	*flavigula*	Yellow-throated Miner		x	x	
Meliphagidae	*Melithreptus*	*brevirostris* subsp. *leucogenys*	Brown-headed Honeyeater			x	
Meliphagidae	*Phylidonyris*	*novaehollandiae*	New Holland Honeyeater		x	x	
Meliphagidae	*Purnella*	*albifrons*	White-fronted Honeyeater			x	
Meropidae	*Merops*	*ornatus*	Rainbow Bee-eater	Mi		x	x
Monarchidae	*Grallina*	*cyanoleuca*	Magpie-Lark		x	x	
Monarchidae	*Myiagra*	*inquieta*	Restless Flycatcher			x	
Motacillidae	*Anthus*	*australis*	Australasian Pipit			x	
Neosittidae	*Daphoenositta*	*chrysoptera* subsp. *pileata*	Varied Sittella			x	
Otididae	*Ardeotis*	*australis*	Australian Bustard	P4		x	

Family	Genus	Species	Common Name	Status	Field Survey	Nature Map Search	EPBC PM Search
Pachycephalidae	*Colluricincla*	*harmonica* subsp. *rufiventris*	Grey Shrike-thrush			x	
Pachycephalidae	*Pachycephala*	*inornata*	Gilbert's Whistler			x	
Pachycephalidae	*Pachycephala*	*pectoralis* subsp. *fuliginosa*	Golden Whistler			x	
Pachycephalidae	*Pachycephala*	*rufiventris*	Rufous Whistler			x	
Pardalotidae	*Pardalotus*	*punctatus* subsp. *xanthopyge*	Spotted Pardalote			x	
Pardalotidae	*Pardalotus*	*striatus* subsp. *westraliensis*	Striated Pardalote			x	
Pelecanidae	*Pelecanus*	*conspicillatus*	Australian Pelican			x	
Petroicidae	*Drymodes*	*brunneopygia*	Southern Scrub-robin			x	
Petroicidae	*Eopsaltria*	*griseogularis*	Western Yellow Robin			x	
Petroicidae	*Melanodryas*	*cucullata*	Hooded Robin			x	
Petroicidae	*Microeca*	*fascinans* subsp. *assimilis*	Jacky Winter			x	
Petroicidae	*Petroica*	*goodenovii*	Red-capped Robin			x	
Phalacrocoracidae	*Phalacrocorax*	*carbo*	Great Cormorant			x	
Phalacrocoracidae	*Phalacrocorax*	*fuscescens*	Black-faced Cormorant			x	
Phalacrocoracidae	*Phalacrocorax*	*sulcirostris*	Little Black Comorant			x	
Phalacrocoracidae	*Phalacrocorax*	*varius*	Pied Comorant			x	
Phasianidae	*Columix*	*pectoralis*	Stubble Quail			x	
Podargidae	*Podargus*	*strigoides*	Tawny Frogmouth			x	
Podicipedidae	*Podiceps*	*cristatus*	Great Crested Grebe			x	
Podicipedidae	*Poliocephalus*	*poliocephalus*	Hoary-headed Grebe			x	
Podicipedidae	*Tachybaptus*	*novaehollandiae*	Australasian Grebe			x	
Procellariidae	*Ardenna*	*carneipes*	Fleshy-footed Shearwater	Mi		x	x
Procellariidae	*Ardenna*	*tenuirostris*	Short-tailed Shearwater	Mi		x	x
Procellariidae	*Halobaena*	*caerulea*	Blue Petrel	Vu (EPBC Act)			x
Procellariidae	*Macronectes*	*halli*	Northern Giant Petrel	Vu (EPBC		x	x

Family	*Genus*	*Species*	Common Name	Status	Field Survey	*Nature Map Search*	EPBC PM Search
				Act); Mi			
Procellariidae	*Macronectes*	*giganteus*	Southern Giant Petrel	Vu (EPBC Act); ; S1-Vu; Mi			x
Procellariidae	*Pterodroma*	*macroptera*	Great-winged Petrel	Mi		x	
Procellariidae	*Pterodroma*	*mollis*	Soft-plumaged Petrel	Vu (EPBC Act), Mi			x
Procellariidae	*Puffinus*	*assimilis* subsp. *assimilis*	Little Shearwater			x	
Psittacidae	*Barnardius*	*zonarius* subsp. *zonarius*	Australian Ringneck		x	x	
Psittacidae	*Cacatua*	*roseicapilla*	Galah		x	x	
Psittacidae	*Glossopsitta*	*porphyrocephala*	Purple-crowned Lorikeet			x	
Psittacidae	*Neophema*	*petrophila*	Rock Parrot			x	
Psittacidae	*Pezoporus*	*wallicus* subsp. *flaviventrus*	Ground Parrot	En (EPBC Act); S1 - CR; Mi		x	
Psittacidae	*Platycercus*	*icterotis*	Western Rosella			x	
Psittacidae	*Psephotus*	*varius*	Mulga Parrot			x	
Rallidae	*Fulica*	*atra*	Eurasian Coot			x	
Rallidae	*Porzana*	*fluminea*	Australian Spotted Crake			x	
Recurvirostridae	*Cladorhynchus*	*leucocephalus*	Banded Stilt			x	
Recurvirostridae	*Himantopus*	*himantopus*	Black-winged Stilt			x	
Recurvirostridae	*Recurvirostra*	*novaehollandiae*	Red-necked Avocet			x	
Rhipiduridae	*Rhipidura*	*leucophrys*	Willie Wagtail		x	x	
Scolopacidae	*Arenaria*	*interpres*	Ruddy Turnstone	Mi		x	
Scolopacidae	*Calidris*	*acuminata*	Sharp-tailed Sandpiper	Mi		x	
Scolopacidae	*Calidris*	*alba*	Sanderling	Mi		x	
Scolopacidae	*Calidris*	*ruficollis*	Red-necked Stint			x	
Scolopacidae	*Calidris*	*tenuirostris*	Great Knot			x	
Scolopacidae	*Gallinago*	*megala*	Swinhoe's Snipe	Mi			x
Scolopacidae	*Gallinago*	*stenura*	Pin-tailed Snipe	Mi			x
Scolopacidae	*Limosa*	*lapponica*	Bar-tailed Godwit			x	
Scolopacidae	*Numenius*	*minutus*	Little Curlew	Mi			x
Scolopacidae	*Tringa*	*nebularia*	Common Greenshank	Mi		x	

Family	Genus	Species	Common Name	Status	Field Survey	*Nature Map Search*	EPBC PM Search
Spheniscidae	*Eudyptula*	*minor* subsp. *novaehollandiae*	Little Penguin			x	
Strigidae	*Ninox*	*novaeseelandiae*	Boobook Owl			x	
Threskiornithidae	*Platalea*	*flavipes*	Yellow-billed Spoonbill			x	
Threskiornithidae	*Threskiomis*	*molucca*	Australian White Ibis			x	
Threskiornithidae	*Threskiomis*	*spinicollis*	Straw-necked Ibis			x	
Timaliidae	*Zosterops*	*lateralis* subsp. *gouldi*	Grey-breasted White-eye			x	
Mammals							
Burramyidae	*Cercartetus*	*concinnus*	Western Pygmy-possum			x	
Canidae	*Vulpes*	*vulpes*	Red Fox	*	x	x	
Dasyuridae	*Dasyurus*	*geoffroii*	Chuditch	Vu (EPBC Act); S1-Vu		x	x
Dasyuridae	*Sminthopsis*	*crassicaudata*	Fat-tailed Dunnart			x	
Leporidae	*Oryctolagus*	*cuniculus*	Rabbit	*	x	x	
Macropodidae	*Macropus*	*eugenii* subsp. *derbianus*	Tammar Wallaby (WA subsp.)	P5		x	
Macropodidae	*Macropus*	*fuliginosus*	Western Grey Kangaroo		x		
Muridae	*Mus*	*musculus*	House Mouse	*		x	
Muridae	*Notomys*	*mitchellii*	Mitchell's Hopping Mouse			x	
Muridae	*Rattus*	*fuscipes*	Western Bush Rat			x	
Muridae	*Rattus*	*rattus*	Black Rat	*		x	
Peramelidae	*Isoodon*	*obesulus* subsp. *fusciventer*	Quenda	P5		x	
Tarsipedidae	*Tarsipes*	*rostratus*	Honey Possum			x	
Vespertilionidae	*Chalinolobus*	*gouldii*	Gould's Wattled Bat			x	
Vespertilionidae	*Chalinolobus*	*morio*	Chocolate Wattled Bat			x	
Vespertilionidae	*Nyctophilus*	*timoriensis* subsp. *timoriensis*	Greater Long-eared Bat			x	
Reptiles						x	
Agamidae	*Amphibolurus*	*norrisi*	Mallee Tree Dragon			x	

Family	Genus	Species	Common Name	Status	Field Survey	*Nature Map Search*	EPBC PM Search
Agamidae	*Ctenophorus*	*cristatus*	Bicycle Dragon			x	
Agamidae	*Ctenophorus*	*maculatus* subsp. *griseus*	Spotted Military Dragon			x	
Agamidae	*Ctenophorus*	*ornatus*	Ornate Crevice Dragon			x	
Agamidae	*Ctenophorus*	*reticulatus*	Western Netted Dragon			x	
Agamidae	*Ctenophorus*	*salinarum*	Salt Pan Dragon			x	
Agamidae	*Moloch*	*horridus*	Thorny Devil			x	
Agamidae	*Pogona*	*minor* subsp. *minor*	Western Bearded Dragon			x	
Agamidae	*Tympanocryptis*	*cephalus*	Pebble Dragon			x	
Boidae	*Morelia*	*spilota* subsp. *imbricata*	Carpet Python	S4 - P4		x	
Carphodactylidae	*Nephrurus*	*milii*	Barking Gecko			x	
Diplodactylidae	*Crenadactylus*	*ocellatus* subsp. *ocellatus*	Clawless Gecko			x	
Diplodactylidae	*Lucasium*	*maini*	Main's Ground Gecko			x	
Diplodactylidae	*Strophurus*	*spinigerus* subsp. *inornatus*	Soft Spiny-tailed Gecko			x	
Elapidae	*Drysdalia*	*mastersii*	Master's Snake			x	
Elapidae	*Echiopsis*	*curta*	Bardick			x	
Elapidae	*Elapognathus*	*coronatus*	Crowned Snake			x	
Elapidae	*Neelaps*	*bimaculatus*	Black-naped Snake			x	
Elapidae	*Parasuta*	*gouldii*	Gould's Snake			x	
Elapidae	*Pseudonaja*	*affinis* subsp. *affinis*	Dugite			x	
Elapidae	*Pseudonaja*	*nuchalis*	Gwardar			x	
Elapidae	*Rhinoplocephalus*	*bicolor*	Square-nosed Snake			x	
Elapidae	*Simoselaps*	*bertholdi*	Jan's Banded Snake			x	
Gekkonidae	*Christinus*	*marmoratus*	Marbled Gecko			x	
Gekkonidae	*Gehyra*	*variegata*	Tree Dtella			x	
Gekkonidae	*Heteronotia*	*binoei*	Bynoe's Gecko			x	
Pygopodidae	*Delma*	*australis*	Marble-faced Legless Lizard			x	
Pygopodidae	*Delma*	*fraseri*	Fraser's Legless Lizard			x	

Family	Genus	Species	Common Name	Status	Field Survey	Nature Map Search	EPBC PM Search
Pygopodidae	*Pygopus*	*lepidopodus*	Common Scaly Foot			x	
Scincidae	*Cryptoblepharus*	*buchananii*	Common Fence Skink			x	
Scincidae	*Ctenotus*	*catenifer*	Chain-striped Heath Ctenotus			x	
Scincidae	*Ctenotus*	*impar*	Odd-striped Ctenotus			x	
Scincidae	*Ctenotus*	*labillardieri*	Red-legged Skink			x	
Scincidae	*Ctenotus*	*schomburgkii*	Barred Wedgesnout Ctenotus			x	
Scincidae	*Ctenotus*	*uber* subsp. *uber*	Spotted Ctenotus			x	
Scincidae	*Cyclodomorphus*	*melanops* subsp. *elongatus*	Slender Bluetongue			x	
Scincidae	*Egernia*	*kingii*	King's Skink			x	
Scincidae	*Egernia*	*napoleonis*	Napoleon Skink			x	
Scincidae	*Egernia*	*richardi*	Richard's Skink			x	
Scincidae	*Hemiergis*	*initialis* subsp. *initialis*	Five-toed Earless Skink			x	
Scincidae	*Hemiergis*	*peronii* subsp. *peronii*	South Coast Earless Skink			x	
Scincidae	*Lerista*	*distinguenda*	Southwest Four-toed Skink			x	
Scincidae	*Lerista*	*dorsalis*	Southern Slider			x	
Scincidae	*Lerista*	*microtis* subsp. *intermedia*	South-western Slider			x	
Scincidae	*Lerista*	*picturata*	Southern Robust Slider			x	
Scincidae	*Menetia*	*greyii*	Common Dwarf Skink			x	
Scincidae	*Morethia*	*butleri*	Butler's Skink			x	
Scincidae	*Morethia*	*obscura*	Southern Pale-flecked Morethia			x	
Scincidae	*Tiliqua*	*occipitalis*	Western Bluetongue			x	
Scincidae	*Tiliqua*	*rugosa* subsp. *rugosa*	Western Bobtail			x	
Typhlopidae	*Ramphotyphlops*	*australis*	Southern Blindsnake			x	
Typhlopidae	*Ramphotyphlops*	*bituberculatus*	Prong-snouted Blindsnake			x	
Varanidae	*Varanus*	*gouldii*	Gould's Monitor			x	
Varanidae	*Varanus*	*rosenbergi*	Heath Monitor			x	
Amphibians						x	

Family	*Genus*	*Species*	Common Name	Status	Field Survey	*Nature Map Search*	EPBC PM Search
Hylidae	*Litoria*	*cyclorhyncha*	Spotted-thighed Frog			x	
Limnodynastidae	*Limnodynastes*	*dorsalis*	Western Banjo Frog			x	
Limnodynastidae	*Neobatrachus*	*pelobatoides*	Humming Frog			x	
Myobatrachidae	*Pseudophryne*	*occidentalis*	Western Toadlet			x	
Myobatrachidae	*Crinia*	*pseudinsignifera*	Bleating Froglet			x	
Myobatrachidae	*Pseudophryne*	*occidentalis*	Western Toadlet			x	

Legend

Mi Migratory (DSEWPaC, 2012)

Vu Vulnerable

En Endangered

S Schedule (under the WC Act)

P Priority

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
	M Toner / M Dilly	A Napier				

Appendix H

Dieback Report

Great Southern Bio Logic –
Environmental solutions

Great Southern Bio Logic

environmental solutions

A Desktop Assessment of *Phytophthora* Dieback Distribution and Risk Assessment for the State Barrier Fence – Esperance Extension

May 2012

Prepared for:

GHD
10 Victoria Street
Bunbury
WA, 6230

Report Date: 12 June 2012
Project Ref: GSBL070-Desktop dieback assessment_State Barrier Fence_Esperance ext_V1

Written and Submitted By

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RECORD OF DISTRIBUTION

No. of copies	Report File Name	Report Status	Date	Prepared for:	Initials
2	GSBL070-Desktop dieback assessment_State Barrier Fence_Esperance Ext_V1	V1	12 June 2012	GHD	JS
1	GSBL070-Desktop dieback assessment_State Barrier Fence_Esperance Ext_V1	V1	12 June 2012	Great Southern Bio Logic	JS

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EXECUTIVE SUMMARY

The Department of Agriculture and Food Western Australia (DAFWA) requires a Scoping Study to determine the optimum alignment for the Esperance Extension to the State Barrier Fence (SBF). *Phytophthora* dieback has been identified as a potential issue for consideration in the scoping study being undertaken by GHD, and preliminary alignments for the proposed fence extension have been provided as a focus for the scoping study. Great Southern Bio Logic have been engaged by GHD to undertake the required *Phytophthora* desktop dieback assessment and develop the associated disease distribution and potential risk report.

The desktop assessment involved a review of relevant data sets providing information relating to rainfall, vegetation composition, disease distribution and potential disease vectors. The project area for the assessment has been defined as a 10km corridor following the proposed alignments.

The accepted range of *Phytophthora* across Western Australia is restricted to the southern and western regions where average annual rainfall is greater than 600mm, however, it can persist and have significant impact under favourable conditions within the 400mm to 600mm rainfall zone. All sections of the alignment that fall outside the accepted range of *Phytophthora* are considered to be at negligible risk of infestation and basic hygiene principles are considered suitable for management in these regions.

Two sections of the proposed alignment are considered potentially susceptible to infestation, and are defined as areas of proposed alignment that are located within the 400mm - 600mm rainfall zone. The first section extends from the existing barrier fence in a north easterly direction for approximately 80km, where the alignment intersects with Neds Corner Road. The second section extends from the 400mm isohyet, located just north of Mt Ridley, approximately 220km in a generally south east direction to the eastern termination of the SBF extension at Cape Arid. The vegetation in these areas is classified as either:

- Uninterpretable due to significant disturbance or a lack of susceptible species;
- Requiring survey if the vegetation comprises susceptible species and there is no known *Phytophthora*; or
- Infested if previous assessment has identified *Phytophthora* within the vegetation.

A review of the known distribution of *Phytophthora* across the project area identified 16 positive recoveries of *Phytophthora* from soil and tissue samples and strategic mapping of infestations associated with the western side of the Cape Arid National Park. Of the positive sample results, 1 is located within 700m of the proposed alignment and 6 are located within 100m of the proposed alignment. This indicates that there are infestations of *Phytophthora* intersecting with the alignment and operational hygiene will be required during project planning, construction and maintenance.

Areas that contain susceptible vegetation within the accepted range of the disease are considered to be at risk of infestation by *Phytophthora* and will require appropriate management to mitigate this risk. These areas will require a detailed field assessment for the presence of *Phytophthora* and to demarcate disease and hygiene category boundaries in the

field. There is approximately 400km of proposed alignment that requires field assessment however this distance will be significantly reduced with the selection of a single alignment.

Areas that have been assessed as uninterpretable and that are located within the accepted range of the disease should be further assessed using detailed field based floristic survey data to qualify the uninterpretable classification. Areas that are confirmed as uninterpretable will require no further assessment and basic vehicle hygiene will be appropriate for the mitigation of risk. Any areas that are considered to contain susceptible vegetation will require a field based assessment.

1 INTRODUCTION

1.1 Background

The Department of Agriculture and Food Western Australia (DAFWA) requires a Scoping Study to determine the optimum alignment for the Esperance Extension to the State Barrier Fence (SBF) and to quantify cost items to enable a detailed costing for construction of the proposed fence extension. The proposed Esperance Extension to the existing SFB is intended to provide protection to the Esperance and Ravensthorpe farming communities from wild dog attack and emu damage.

A preliminary alignment for the proposed fence extension has been determined, however, there is a need to assess in greater detail the optimum alignment with consideration for protection efficiency, costs for construction and maintenance, and the need to minimise environmental and social impacts. *Phytophthora* dieback has been identified as a potential issue for consideration in the scoping study and, as defined in the request for quote (RFQ), dieback mapping is to be presented for the alignment options with recommendations related to managing dieback for the preferred alignment option.

Great Southern Bio Logic was engaged by GHD to undertake the required *Phytophthora* desktop dieback assessment and develop the associated disease distribution and potential risk report.

1.2 Disease Characteristics

Phytophthora dieback is an introduced soil borne plant pathogen that affects up to 50% of native plant species within Western Australia. While a soil borne water mould, the pathogen behaves similarly to fungi, thriving in warm, moist conditions. It has a split phase lifecycle with active and dormant phases. The active phase of the lifecycle involves motile zoo-spores which actively attack the root systems of susceptible plant species, cutting off plant internal transport systems and resulting in rapid death. When environmental conditions are not conducive, the pathogen will produce dormant chlamydospores which may persist in the soil for long periods of time, waiting for suitable conditions to re-establish.

The accepted range of *Phytophthora* across Western Australia is restricted to the southern and western regions where average annual rainfall is greater than 600mm, however, due to the dormant phase of its lifecycle, the disease can persist and have significant impact within the 400mm to 600mm rainfall zone where seasonal rainfall events in combination with topography result in ephemeral water bodies and streams which, together with high soil temperatures, provide prime conditions for the spread of *Phytophthora*. As a result, short periods of optimal conditions for *Phytophthora* spread are interspersed with long periods where soil moisture and temperature are not conducive to the spread of the disease. This results in a disease pattern reflecting high rates of spread for short periods followed by long periods of dormancy with no apparent spread.

Phytophthora dieback is introduced to an area in a variety of ways but most commonly via transportation of infested soil on vehicles, machinery and equipment. Once introduced to an area *Phytophthora* dieback will spread autonomously through soil via water movement and root to root contact resulting in infestations with significant impact upon native vegetation

communities. There is currently no practical method for eradication of the pathogen once introduced.

1.3 Objective

The outcome of the scoping study as defined in the RFQ is to identify a preferred alignment for the State Barrier Fence, Esperance Extension that provides optimum and cost-effective vermin control with minimal impact upon environment and heritage values of the region.

It is understood that the information contained in this disease distribution and risk assessment report will be used to inform the scoping study produced by GHD. Accordingly, the objectives of the desktop *Phytophthora* dieback assessment are to:

- Determine the current known extent of *Phytophthora* across the project area:
- Identify areas where the introduction of *Phytophthora* to the project area are likely to result in detrimental impact to the vegetation and associated ecological communities, both within the project area and also surrounding areas; and
- Develop management and planning recommendations for effective management of *Phytophthora* across the project area to mitigate the risk of introducing the disease to currently uninfested areas.

1.4 Scope of Works

The scope of works undertaken to achieve the project objectives included:

1. Assessment and comparison of relevant GIS data sets to determine the likely extent of known *Phytophthora* infestations potentially influencing the proposed alignments;
2. Assessment and analysis of relevant GIS data sets to identify the extent of potentially susceptible vegetation across the project area
3. Development of maps illustrating the known distribution of *P. cinnamomi* infestations and the extent of potentially susceptible areas across the project area; and
4. Development of management recommendations to mitigate and appropriately manage potential environmental impacts. All management recommendations shall be developed in accordance with the *Phytophthora cinnamomi* and the disease caused by it. Volume 1 – Management Guidelines (CALM 2003).

1.5 Project Area

Several potential alignments have been provided for assessment as shown in Figure 1. In order to capture all potential risks and environmental values that may be influenced by the proposed fence extension, a 10km corridor was applied to the alignment. This area has been used to define the project area, which extends from the terminal of the existing Barrier Fence situated approximately 25km to the east of Ravensthorpe in a north easterly direction to Salmon Gums, and then in a south easterly direction where it terminates on the coast immediately west of Cape Arid.

1.5.1 Climate

The climate across the project area can be described as semi-arid with warm, dry summers and cold winters. Average annual rainfall across the area varies from approximately 550mm to below 350mm, however, the area can be subject to large annual variation as a result of periodic weather events including decaying tropical low pressure systems. These systems can result in single events that provide significant rainfall in short periods, often during the summer months.

Phytophthora distribution is closely related to rainfall, and as such the average annual rainfall is an important statistic because it defines the accepted range of *Phytophthora* occurrence.

2 METHOD

The desktop *Phytophthora* dieback assessment of the project area was performed by a Department of Environment and Conservation (DEC) accredited interpreter. The methodology for the assessment used relevant datasets as supplied by DAFWA and the DEC and is summarised below:

- A buffer of 10km, extending 5km either side, was applied to the provided alignments to form the project area of the desktop assessment;
- Areas receiving less than 400mm annual average rainfall were deemed to be beyond the accepted range of *Phytophthora cinnamomi* within Western Australia;
- All areas receiving greater than 400mm annual rainfall were assessed for susceptibility through analysis of the provided Pre-European Vegetation dataset and the current vegetation extent dataset;
- The distribution of all known threatened and priority flora was assessed to identify the location of any susceptible species that may require specific management;
- The known distribution of *Phytophthora* dieback was assessed using the Department of Environment & Conservation VHS positive *Phytophthora* recovery data and a review of the Dieback Information Delivery Management System (DIDMS)(SCNRM);
- Road networks and hydrography datasets were then overlaid to assess the potential for disease spread via these potential vectors; and
- Management recommendations were developed with reference to the *Phytophthora cinnamomi and the disease caused by it. Volume 1 – Management Guidelines (CALM 2003).*

3 ASSESSMENT CRITERIA

3.1 Disease Distribution

The currently accepted range of *Phytophthora* dieback is defined by the 400mm isohyet with the pathogen occurring only in areas with an average annual rainfall in excess of 400mm. There have been no positive identifications of the pathogen below this range, however, it should be noted that the survey effort in those regions is limited.

DEC guidelines identify three potential disease categories based on presence/absence of the disease, and the interpretability of an area, being:

Infested – Areas of vegetation, identified and assessed by an accredited disease interpreter, that show visible signs of infestation through the presence of associated susceptible plant deaths in a pattern consistent with *Phytophthora*. Evidence of the infestation may be supported by positive recoveries of *Phytophthora* via laboratory analysis.

Uninfested - Areas of vegetation, identified and assessed by an accredited disease interpreter, that are free from the disease. Uninfested areas must contain susceptible species in numbers that would allow detection of the disease if it were present.

Uninterpretable – Areas within the study area that cannot be determined to be infested or uninfested. Such areas may:

- consist of vegetation that does not contain susceptible species;
- have been recently burnt, removing all evidence of disease symptoms; or
- be areas of cleared land, recently disturbed areas or areas of non-native vegetation (also referred to as "unmappable".

The current desktop assessment utilised existing survey effort data to indicate known disease distribution which does not include on ground field interpretation. Limitations to this methodology include the paucity of historic survey effort in the project area, and lack of sampling effort supporting negative recoveries of disease. For this reason, the absence of disease across the project area cannot be confirmed and therefore the uninfested disease category cannot be applied. Further, while infested areas can be identified, their current extent cannot be quantified.

Therefore, for the purposes of the Desktop analysis of disease distribution and potential risk the following disease categories have been applied:

Infested – Areas of vegetation assessed as infested by previous studies. Evidence of the infestation may be supported by positive recoveries of *Phytophthora* from soil and tissue samples via laboratory analysis. Where there are no positive samples to support the infested classification, the disease distribution information shall be classified as low confidence.

Uninterpretable – Areas within the study area that cannot be determined to be either infested or uninfested as they consist of vegetation communities that do not include susceptible species as defined by the Pre-European vegetation dataset.

Survey Required – Areas where the Pre-European Vegetation dataset indicates susceptible vegetation occurs, that have not been previously classified as infested.

This category has also been applied where previous survey effort has identified the area as being uninfested, but where the interpretive information was derived through strategic planning rather than field interpretation, or where field interpreted data has exceeded the prescribed three year time frame for use. This time frame is applied to all operational interpretation, as new or enhanced *Phytophthora* dieback infestations may occur or spread since previous assessment.

Unmappable – Areas where native vegetation appears to be significantly degraded or cleared. Classification of unmappable areas has been based on analysis of the current Native Vegetation Extent dataset.

3.2 Disease Risk

As defined Section 1.2 the most common method of disease introduction is via the transportation of infested soil on vehicles, machinery and equipment. Once introduced to an area the disease may spread via further human vectoring and/or by autonomous spread. Autonomous spread is defined as the movement of the disease without the aid of external influence and occurs via movement of zoospores in soil water and by root to root contact.

For the purposes of this assessment the risk of disease introduction into currently uninfested areas is considered to be via human vectoring as a part of planning, construction and maintenance works for the project. Accordingly, the entire alignment is to be considered at risk of infestation. However, as the alignment traverses areas beyond the accepted range for *Phytophthora* and through areas where the vegetation is classified as uninterpretable, the degree of risk is varied and so the following risk categories have been developed for application.

Negligible Risk – Areas of alignment that occur north of the 400mm isohyet and are therefore beyond the accepted range of *Phytophthora*. It is considered unlikely that *Phytophthora* would survive in these areas.

Low Risk – Areas of alignment that traverse uninterpretable vegetation occurring in areas receiving greater than 400mm of annual rainfall. While *Phytophthora* may survive in these areas the disease will not significantly impact the vegetation structure of these communities as they contain few or no susceptible species. It is, however, likely that small areas of susceptible vegetation may occur within these areas, having not been identified at the high scale mapping available for the desktop assessment. Further, low risk areas may provide a source of dieback to be vectored into susceptible areas.

Moderate to High Risk – Areas of the alignment receiving greater than 400mm annual rainfall that traverse susceptible vegetation, as identified by the Pre-European Vegetation dataset. If introduced to these areas, *Phytophthora* dieback will alter native vegetation communities, with the level of impact being influenced by rainfall, soil type and topography.

In all areas where Threatened and Priority flora and fauna have been identified, there is an increased threat due to the degradation of ecological structure with the associated impacts to the species they support. The distribution of threatened flora and fauna are presented in Figure 3.

4 RESULTS AND DISCUSSION

The potential range of *Phytophthora*, its known distribution and potential risk of infestation have been assessed using the methodology described in Section 2. Detailed potential range distribution and susceptibility information for the project area is presented in Figures 1, 2 & 3.

4.1 Potential Range

As previously discussed, *Phytophthora* dieback occurrence is typically restricted to an accepted range defined by the 400mm rainfall isohyet. Figure 1 indicates the potential distribution of *Phytophthora* within the project area to be at the western and eastern ends of the SBF. While there is a risk that *Phytophthora* may be introduced to areas beyond its accepted range, this risk is considered negligible and no further survey effort is required in those areas.

The potential distribution of *Phytophthora* within the project area is summarised below:

- Ravensthorpe East - extending from the existing barrier fence in a north easterly direction, approximately 80km, where the alignment intersects with Neds Corner Road;
- Mt Ridley to Cape Arid - the 400mm isohyet is located just north of Mt Ridley and the area of potential distribution of *Phytophthora* extends from this point approximately 220km in a generally south east direction to the eastern termination of the SBF extension at Cape Arid.

4.2 Infested Areas - Current Extent of Known Distribution

As previously discussed there has been very limited survey effort for the presence of *Phytophthora* across the project area. Data relating to the current known distribution has been sourced from the DIDMS database (SCNRM) and the Department of Environment & Conservation VHS laboratory database. The available disease distribution information for the project area is summarised below and the VHS sample data is presented in Figure 2.

4.2.1 Dieback Information Delivery and Management System – Strategic Mapping

Strategic dieback mapping from the DIDMs database (SCNRM) has been developed using operational mapping, positive sample recoveries and estimated rate of spread predictions to show projected disease distribution information. A review of the internet dataset reveals:

- A large area of infestation is located at Cape Arid. This area is not intersecting the project area however introduces the potential for disease to be vectored from this area into the project area.
- Several positive sample recoveries located at the western end of Yokinup Bay, associated with Thomas River. These samples are located within the project area but are not on the proposed alignment.

4.2.2 DEC VHS Sample Database

The DEC maintains the VHS database which has recorded *Phytophthora* sample results since the late 1980's. A review of the VHS database (Figure 2) shows the distribution of positive sample recoveries as summarised below.

- There have been multiple positive recoveries of *Phytophthora* across the eastern Great Southern Region with recoveries up to 50km from the coast and in rainfall areas approaching the 400mm limit of *Phytophthora* distribution.
- Two positive recoveries are located on the South Coast Highway approximately 6.8km from the junction of the existing and proposed alignments.
- There are seven positive recoveries within the project area where it traverses remnant vegetation situated to the west of Cape Arid National Park, north of Balladonia Road. One of these positive recoveries is situated within 700 meters of the proposed alignment.
- There are nine positive recoveries within the project area where it follows Merivale Road immediately north of the Cape Arid National Park, near Thomas River. Six of these are within 100m of the proposed alignment.

4.3 Survey Required

As defined in Section 3.2 the activities associated with the planning, construction and maintenance of the proposed SBF extension introduce the risk of vectoring *Phytophthora* along the entire alignment. However there is negligible risk of infestation in areas that are beyond the accepted range of the disease. Therefore survey is required within all mappable areas that receive greater than 400mm of average annual rainfall.

Much of the alignment in this rainfall zone is classified as uninterpretable as analysis of the Pre-European Vegetation and Vegetation Extent datasets have indicated that either no susceptible vegetation communities occur or the areas are unmappable as the vegetation has been significantly altered or cleared. The unmappable areas will be excluded from further survey while the uninterpretable areas should be subject to a further review of field based vegetation assessment to determine the actual extent of uninterpretable vegetation. Uninterpretable vegetation is considered to have a low risk of impact by infestation with *Phytophthora*.

All susceptible vegetation communities within the project area will require detailed field based survey to enable the development of appropriate hygiene protocols for application during operational activities. The distribution of the susceptible vegetation along the alignment where field survey is required is presented in Figures 2 and 3, and a detailed description of the susceptible vegetation associations, as described by the Pre-European Vegetation dataset, is provided as Appendix A. All susceptible vegetation communities are considered to have a moderate to high risk of impact by *Phytophthora*. A summary of the areas where further survey is required is provided below:

- Approximately 400km of proposed alignment includes susceptible vegetation communities at risk of infestation by *Phytophthora*. These areas will require further field based interpretation;

- Approximately 30km of the alignment requiring further field assessment for susceptible vegetation is situated in the area defined as Ravensthorpe East (Section 4.1); and
- Approximately 370km of the alignment requiring further field assessment for susceptible vegetation is situated in the area defined as Mt Ridley to Cape Arid (Section 4.1). This section includes several potential alignments that all fall within potentially susceptible vegetation.

4.4 Hydrography

In addition to areas situated within the project area, the desk top assessment has also assessed major river systems that will act as vectors to downstream areas should *Phytophthora* be introduced. There are five main river systems that cross the proposed alignments and an additional two rivers that would be potentially affected should *Phytophthora* be introduced into the river catchments, which intersect the alignment. These Rivers are shown on Figure 2.

There are currently no known infestations within the project area that could potentially influence these rivers, with the exception of the Thomas River at the termination of the SBF.

5 OPERATIONAL HYGIENE RECOMMENDATIONS

The results of the desktop *Phytophthora* dieback survey identified 12 locations where *Phytophthora* is known to exist within the project area. While there may be additional infestations within the project area that are yet to be identified, it is likely that the majority of the project area is uninfested by *Phytophthora* and is therefore at risk of infestation due to SFB project activities. However, as much of the project area is outside the accepted range of *Phytophthora* or within areas classified as either unmappable or uninterpretable, the risks of infestation have been scaled.

In order for the SBF extension to be constructed and maintained in a manner that mitigates the risk of infesting the final alignment with *Phytophthora*, the following management recommendations are provided.

5.1 Negligible Risk Areas

Areas of Negligible Risk are defined as areas of proposed alignment situated in areas with less than 400mm of average annual rainfall. While these areas are beyond the accepted range of *Phytophthora*, there is a minimal risk of introducing the disease into microclimates that may support the pathogen and potentially act as a source of disease to be vectored into more susceptible locations.

Accordingly the following basic disease hygiene principle should be applied in these areas:

- All machinery, vehicles, equipment and materials must be effectively cleaned down prior to accessing the alignment at any time to avoid potentially importing infested soil or water.

5.2 Low Risk Areas

Areas of Low Risk are defined as sections of alignment that traverse uninterpretable vegetation occurring in areas receiving greater than 400mm of annual rainfall. While these areas are unlikely to be impacted by the disease, the pathogen may survive and provide a source of disease to be vectored into more susceptible locations.

Project areas determined to be uninterpretable should be re-assessed using detailed vegetation data developed from associated on-ground floristic surveys, to determine actual interpretability of these areas.

Should the further assessment of vegetation data support the classification of uninterpretable for these areas then the following basic disease hygiene principles should be applied:

- All machinery, vehicles, equipment and materials must be effectively cleaned down prior to accessing the alignment at any time to avoid potentially importing infested soil or water.
- All machinery, vehicles, equipment and materials must be effectively cleaned down prior to leaving Low Risk areas along the alignment. Cleandown should be conducted within the low risk uninterpretable area, on well drained firm surfaces situated low in the topographic profile.

- Undertaking works in dry soil conditions will minimise much of the necessary cleandown requirements, as dry soil will not readily adhere to machinery, vehicles, equipment and materials.

5.3 Moderate to High Risk Areas

Areas of Moderate to High Risk are defined as sections of the alignment that traverse susceptible vegetation in areas receiving greater than 400mm of annual rainfall (see Figure 2). These areas are likely to be detrimentally impacted by *Phytophthora* if it is introduced. They may also harbour unknown infestations that could provide a source of disease that would be vectored along the alignment during project works. Accordingly, these areas will require further detailed field interpretation to determine disease distribution along the final proposed SBF alignment.

Accordingly, recommendations for the areas considered to be of Moderate to High Risk are:

- A detailed on-ground *Phytophthora* assessment should be undertaken within a 100m corridor of the proposed final alignment to demarcate in the field actual disease distribution boundaries and associated hygiene management categories. The assessment should be undertaken by a DEC accredited interpreter with relevant experience in identifying *Phytophthora* within vegetation associations of the South Coast and Great Southern regions. The assessment should be performed in accordance with "*Phytophthora cinnamomi and the disease caused by it- Volume 2: Interpreters Guidelines for Detection, Diagnosis and Mapping, (CALM, 2001)*";
- Information developed during the on-ground assessment should be used to develop an operational hygiene management plan to be implemented during all phases of project planning, construction and maintenance. The operational hygiene plan should be developed in accordance with *Phytophthora cinnamomi and the disease caused by it. Volume 1 – Management Guidelines (CALM 2003).*

5.4 Effective Clean Down Standards

Effective cleandown should occur within infested or unmappable areas at well drained locations where effluent will not flow towards external, uninfested or uninterpretable areas. They should be situated as close to the disease category boundaries as practical. Effective clean down involves the removal of all soil and plant material from machinery, vehicles, equipment, tools and footwear to prevent transportation into uninfested or uninterpretable areas. Attention needs to be given to removing soil and plant material from under vehicles and machinery, especially from running boards, belly plates, spare tyres and wheels.

If operations are conducted in dry soil conditions the requirements for clean down are reduced as the soil material does not readily adhere, and clean down can be performed using a stiff brush or compressed air.

Mud and soil should be removed from footwear with a stick or brush, and the amount of water used should be minimised. All mud/soil should be collected in a bag/bucket and disposed of in a site that is already infested. Drainage from cleandown areas must be controlled so that effluent from clean down operations does not drain into uninfested or uninterpretable areas.

Hand held equipment, tools and footwear can be sterilised using methylated spirits mixed with water 70:30. Decant into an appropriately labelled spray bottle, spray to cover all surfaces and allow a few minutes for the disinfectant to soak surfaces. Other equipment can be sterilised by soaking in a disinfectant such as bleach (active ingredient sodium hypochlorite). Dilute the bleach (1 part bleach to 10 parts water), soak the tools for a few minutes then rinse, following the manufacturer's safety instructions.

Water can be sterilised by adding 6ml of sodium hypochlorite (bleach or pool chlorine) to every 10L of water. Safety instruction should be followed.

5.5 Dry Soil Conditions

Dry soil conditions are defined as when soil moisture content of open ground or on unsealed roads is not high enough to allow soil material to adhere to vehicles, machinery equipment and footwear. The level of soil moisture required for soils to be classified as dry varies between soil types, however, a general rule commonly applied is that greater than 5mm of rainfall over a 24 hour period will result in moist soil conditions.

5.6 Green Card

Please be aware that the Department of Environment & Conservation recommends that all staff and contractors working in the South Coast region undertake Green Card training provided through the Albany South Coast regional office. The induction is designed to raise aware of the environmental consequences of operational activities and provide principles to mitigate environmental impact. The training highlights values and environmental threats in the region, with a particular focus upon the threat of *Phytophthora* dieback. It is compulsory for those undertaking works on DEC managed lands.

6 REFERENCES

Bureau of Meteorology (BoM) (2012): http://www.bom.gov.au/climate/data/

Department of Conservation and Land Management (CALM) (2001): *Phytophthora cinnamomi and disease caused by it, Volume two Interpreter Guidelines for Detection, Diagnosis and Mapping*, CALM July 2001.

Department of Environment and Conservation (CALM) (2003): *Phytophthora cinnamomi and disease caused by it, Volume 1, management guidelines*, CALM 2003.

Project Dieback (2012): *Dieback Information Delivery and Management System*, South Coast Natural Resource Management 2012

7 LIMITATIONS

This report was prepared for GHD for the purposes set out in the scope of works and it is not intended that any other person use or rely on the contents of this report.

Whilst the information contained in the Report is accurate to the best of our knowledge and belief, Great Southern Bio Logic and its agents cannot guarantee the completeness or accuracy of any of the descriptions or conclusions based on the information supplied to it or obtained during the site investigations, site surveys, visits and interviews. Furthermore, field and/or regulatory conditions are subject to change over time, and this should be considered if this report is to be used after any significant time period after its issue.

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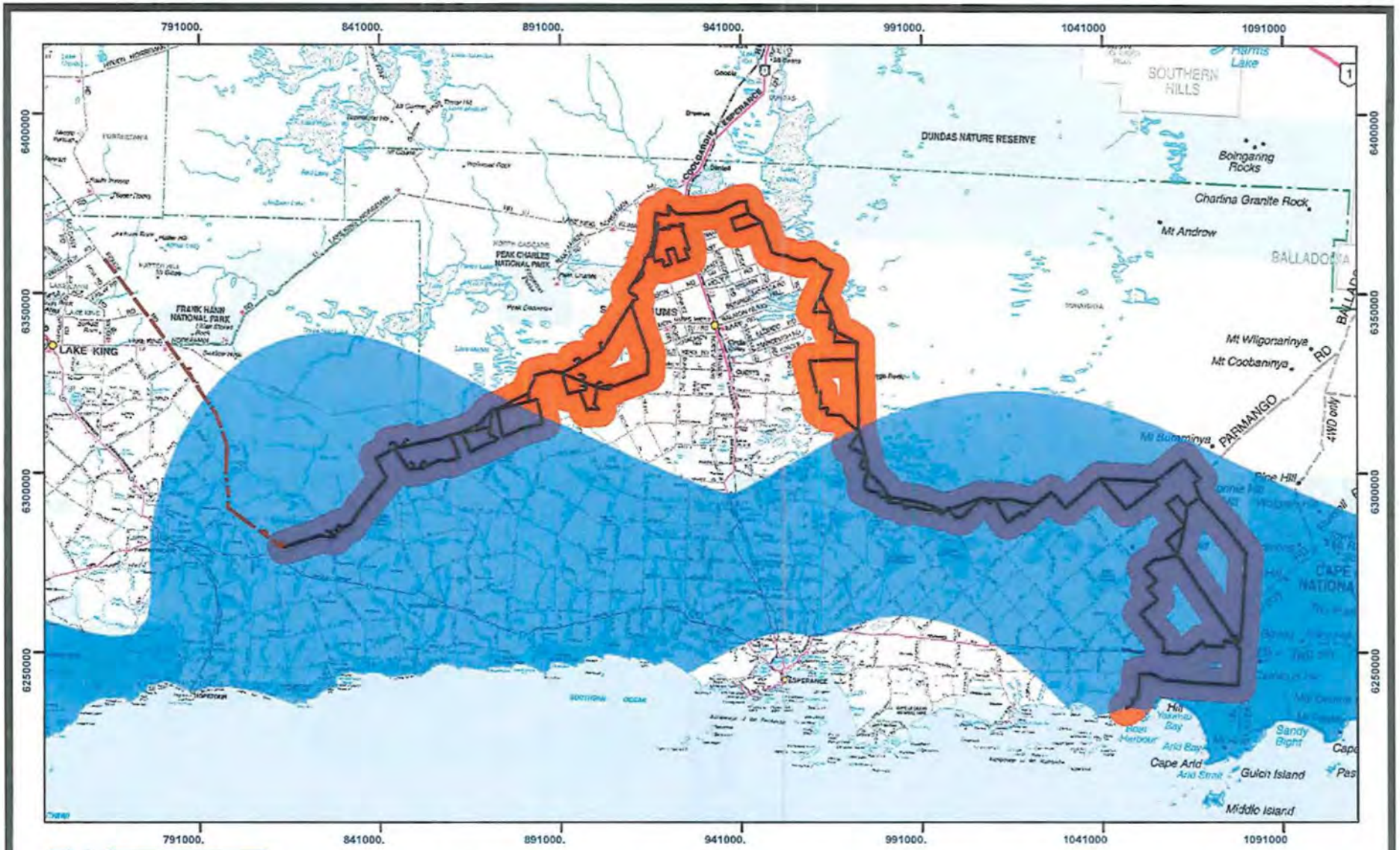
This report must be read, copied, distributed and referred in its entirety.

Figures

A Desktop Assessment of *Phytophthora* Dieback Distribution and Risk Assessment for the State Barrier Fence – Esperance Extension



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Ref: GSBL070
Date: 11/06/2012
Image Source: Landgate Travellers Atlas 2009
Source Data: WA Agriculture Authority

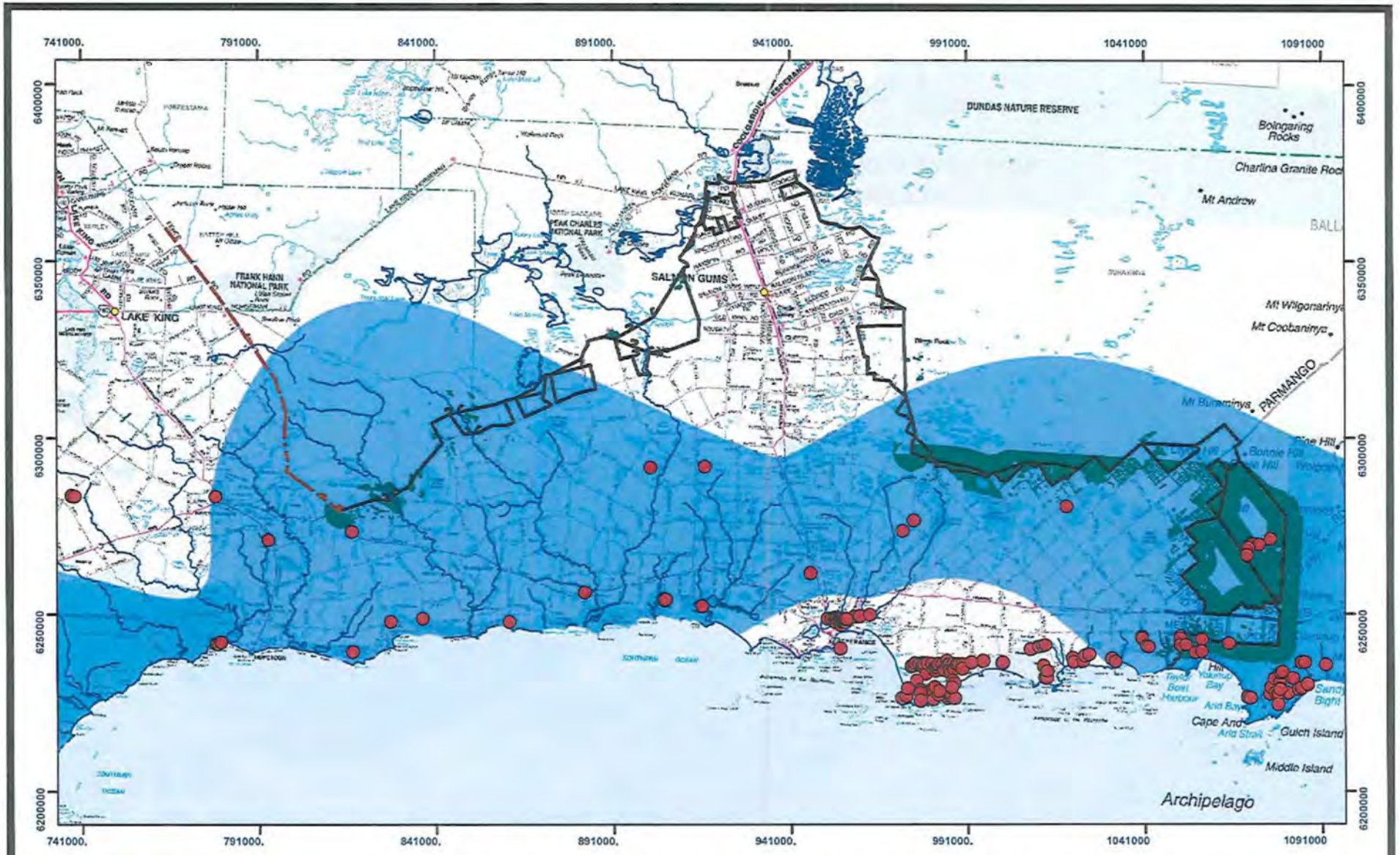
Figure 1: Project Area showing 400-600mm Rainfall zone

A Desktop Assessment of Phytophthora dieback Distribution and Risk Assessment for the State Barrier Fence - Esperance extension
Prepared for GHD

Legend
- State Barrier Fence
- Proposed Alignment sections
- Project Area
- WA Rainfall 400-600mm (BOM)

N

1:1,500,000
Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator
0 50 Kilometers



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Ref: GSBL070
Date: 12/06/2012
Image Source: Landgate Travellers Atlas 2009
Source Data: WA Agriculture Authority
Dept Environment & Conservation, VHS

Figure 2: Current known Disease Distribution and areas of susceptible vegetation in relation to the Proposed Alignments

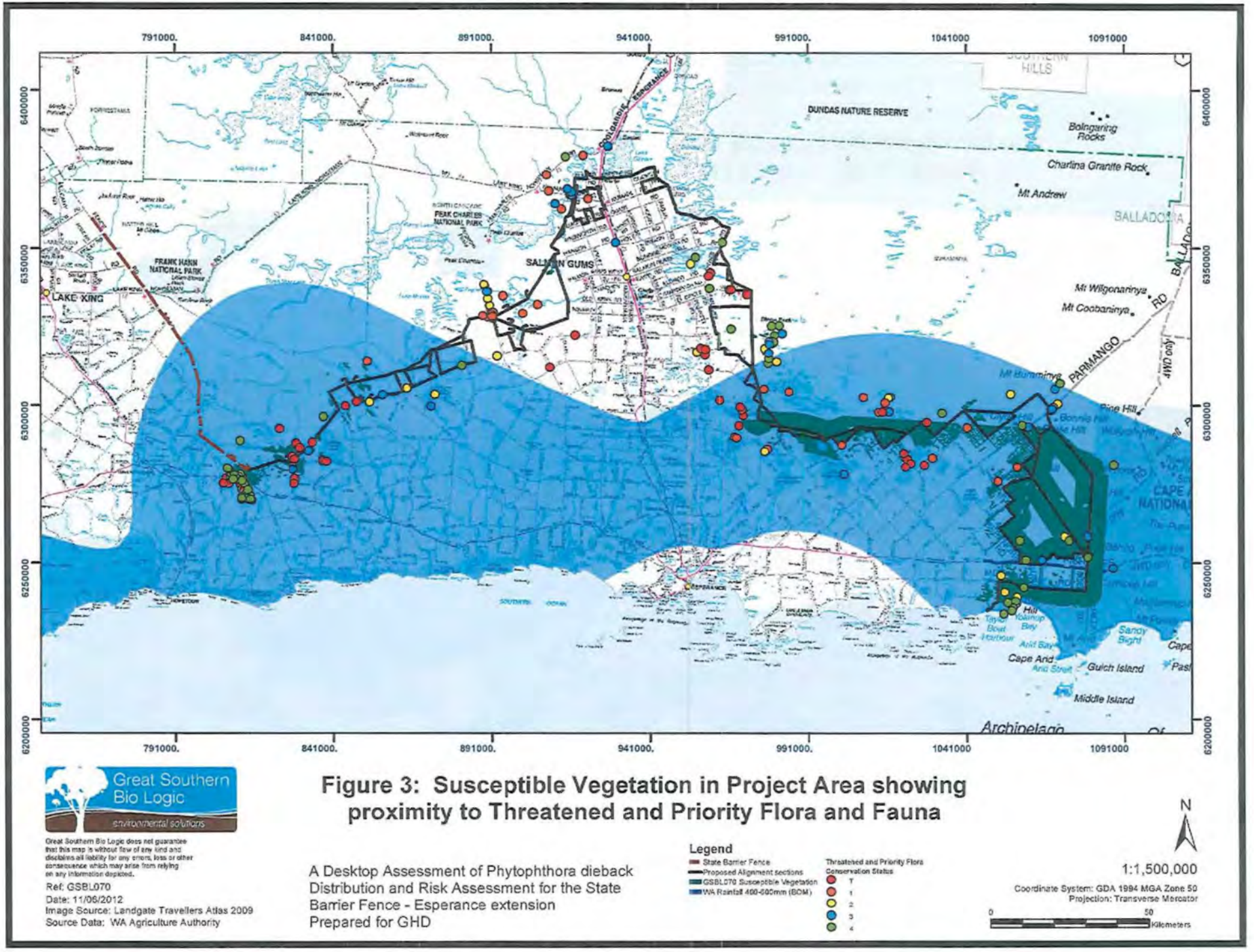
A Desktop Assessment of Phytophthora dieback Distribution and Risk Assessment for the State Barrier Fence - Esperance extension
Prepared for GHD

Legend
- Positive recoveries of Phytophthora
- State Barrier Fence
- Proposed Alignment sections
- Susceptible Vegetation
- WA Rainfall 400-600mm (BOM)
- Hydrography

1:1,500,000

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

0 50 Kilometers



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Ref: GSBL070
Date: 11/06/2012
Image Source: Landgate Travellers Atlas 2009
Source Data: WA Agriculture Authority

Figure 3: Susceptible Vegetation in Project Area showing proximity to Threatened and Priority Flora and Fauna

A Desktop Assessment of Phytophthora dieback Distribution and Risk Assessment for the State Barrier Fence - Esperance extension
Prepared for GHD

Legend

- State Barrier Fence
- Proposed Alignment sections
- GSBL070 Susceptible Vegetation
- WA Rainfall 400-600mm (BOM)

Threatened and Priority Flora Conservation Status

- T
- 1
- 2
- 3
- 4

N

1:1,500,000

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

0 50 Kilometers

Appendix A

Pre-European Vegetation data for susceptible vegetation associations

SA CODE	SOURCE CODE	SOURCE DESCRIPTION	L2 STRUCTURAL FORMATION	L6 SUB ASSOCIATION	ENVIRONMENTAL DESCRIPTION
47	47_1	Shrublands; tallerack mallee-heath	Open mallee shrubland	U1+Eucalyptus tetragona, Eucalyptus sp.\mallee\5\i;M1 Banksia sp., Calothamnus sp., Lambertia inermis, Dryandra sp., Eucalyptus sp.\shrub,mallee\4\i;M2 Acacia sp., Adenanthos sp., Banksia sp., Allocasuarina humilis, Hakea corymbosa\shrub\3\i;G1 Andersonia	GENERAL
47.1	47.1_1	Shrublands; tallerack mallee-heath	Open mallee shrubland	U1+Eucalyptus tetragona,+Eucalyptus incrassata\mallee\5\i;M1 Lambertia inermis, Banksia baueri, Calothamnus quadrifidus, Dryandra longifolia,^Eucalyptus tetraptera\shrub,mallee\4\c;M2 Acacia sp. aff. cupularis, Adenanthos cuneatus, Banksia	ESPERANCE
47.2	47.2_1	Shrublands; tallerack mallee-heath	Open mallee shrubland	U1+Eucalyptus tetragona, Eucalyptus leptopoda, Eucalyptus forrestiana\mallee\5\i;M1 Grevillea excelsior, Banksia elderiana, Grevillea incrassata, Hakea corymbosa, Callitris preissii\shrub\4\c;G1 Micromyrtus imbricata\shrub\2\c	LAKE HOPE
47.3	47.3_1	Shrublands; tallerack mallee-heath	-9999	-9999	RIDLEY
514	514_1	Shrublands; mallee scrub, white mallee (Eucalyptus cooperiana)	Open mallee shrubland	U1+Eucalyptus cooperiana, Eucalyptus sp.\mallee\5\i;M1 Callitris roei\shrub\4\r;M2 Templetonia retusa, Acacia sp., Dryandra longifolia, Eriostemon sp., Grevillea sp.\shrub\3\c	GENERAL
516.1	516.1_1	Shrublands; mallee scrub, black marlock	Open mallee shrubland	U1+Eucalyptus uncinata,+Eucalyptus redunca,^Eucalyptus goniantha\mallee\5\i;M1 Banksia media, Callitris sp., Phymatocarpus maxwellii\shrub\4\r;M2 Melaleuca sp.\shrub\4\r	ESPERANCE
516.2	516.2_1	Shrublands; mallee scrub, black marlock	Open mallee shrubland	U1+Eucalyptus redunca,+Eucalyptus uncinata,^Eucalyptus dielsii,^Eucalyptus annulata, Eucalyptus leptocalyx\mallee\5\i;M1 Banksia media, Callitris preissii, Hakea laurina, Callitris roei\shrub\4\c;M2 Acacia glaucoptera, Bossiaea leptacantha, Hakea cinerea,	RIDLEY
516.3	516.3_1	Shrublands; mallee scrub, black marlock	Open mallee shrubland	U1+Eucalyptus uncinata, Eucalyptus redunca, Eucalyptus flocktiniae, Eucalyptus incrassata, Eucalyptus conglobata\mallee\6\i;M1 Banksia calyei, Hakea laurina, Hakea crassifolia, Hakea coymbosa\shrub\4\i;M2 Melaleuca uncinata, Melaleuca thymoides, Melaleuca	QUALUP
1047.1	1047.1_1	Shrublands; Eucalyptus incrassata mallee-heath	Open mallee shrubland	U1+Eucalyptus incrassata, Eucalyptus uncinata, Eucalyptus redunca, Eucalyptus goniantha, Eucalyptus cooperiana\mallee\5\i;M1 Grevillea hookeriana, Lambertia inermis, Hakea cinerea, Isopogon buxifolius, Hakea corymbosa\shrub\4\c;M2 Agonis linearifolia, All	ESPERANCE

1413.1	1413.1_1	Shrublands; acacia, casuarina & melaleuca thicket	Shrubland	U1 Eucalyptus grossa, Callitris preissii\mallee,shrub\5\r;M1+Allocasuarina campestris, Acacia fragilis, Melaleuca uncinata, Calothamnus quadrifidus\shrub\4\c;M2 Astartea ambigua, Verticordia preissii\shrub\3\c	RIDLEY
1516.1	1516.1_1	Shrublands; mallee scrub, black marlock & Forrest's marlock	Open mallee shrubland	U1+Eucalyptus redunca,+Eucalyptus uncinata,^Eucalyptus forrestiana, Eucalyptus leptocalyx, Eucalyptus incrassata\mallee\5\i;M1 Banksia media, Callitris preissii, Hakea laurina, Callitris roei\shrub\4\c;M2 Acacia glaucoptera, Hakea cinerea, Melaleuca scabr	RIDLEY
1519.1	1519.1_1	Shrublands; mallee scrub, Eucalyptus eremophila & banksia	Open mallee shrubland	U1+Eucalyptus eremophila,^Eucalyptus goniantha\mallee\5\i;M1 Banksia media, Phymatocarpus maxwellii, Phebalium sp.\shrub\4\c;G1 Baeckea sp., Calytrix stipulosa\shrub\2\c	RIDLEY
2048	2048_1	Shrublands; scrub-heath in the Mallee Region	Open shrubland	U1 Acacia sp., Allocasuarina acutivalvis, Adenanthos argyreus, Calothamnus lateralis\shrub\4\r;M1 Acacia sp., Allocasuarina campestris, Melaleuca sp., Hakea sp., Leptopspermum erubescens\shrub\4\i;M2 Verticordia sp., Dryandra sp., Melaleuca sp., Baeckea s	GENERAL
2048.1	2048.1_1	Shrublands; scrub-heath in the Mallee Region	Shrubland	U1 Acacia fragilis, Acacia multispicata, Grevillea excelsior, Hakea falcata, Leptospermum erubescens\shrub\4\c;M1 Adenanthos argyreus, Acacia fragilis, Banksia sphaerocarpa, Calothamnus lateralis, Dryandra cirsioides\shrub\3\c;G1 Acacia acanthoclada, Baec	HYDEN
2048.2	2048.2_1	Shrublands; scrub-heath in the Mallee Region	Open shrubland	U1^Eucalyptus leptopoda,^Eucalyptus burracoppinensis, Allocasuarina acutivalvis\mallee,shrub\5\r;M1 Acacia beauverdiana, Banksia audax, Grevillea excelsior, Hakea multilineata, Santalum acuminatum\shrub\4\i;M2 Acacia coolgardiensis, Anthotium rubriflorum,	SKELETON ROCK
4048.1	4048.1_1	Shrublands; scrub-heath in the Esperence Plains including Mt Ragged scrub-heath	Open mallee shrubland	U1^Eucalyptus incrassata, Eucalyptus conglobata, Eucalyptus leptocalyx, Eucalyptus lucasii,^Nuytsia floribunda\mallee,tree,shrub\5\i;M1^Dryandra quercifolia,^Lambertia inermis, Adenanthos cuneatus, Agonis obtusissima, Baeckea uncinella\shrub,mallee,cycad\	GENERAL

4801.1	4801.1_1	Shrublands; heath with scattered Nuytsia floribunda on sandplain	Shrubland	U1 Eucalyptus sp.,^Nuytsia floribunda\mallee,tree\5\r;M1+Lambertia inermis, Hakea sp.,^Xanthorrhoea preissii\shrub\4\c	ESPERANCE
6048.1	6048.1_1	Shrublands; banksia scrub-heath on sandplain in the Esperence Plains Region	Open shrubland	U1 Eucalyptus incrassata, Nuytsia floribunda, Eucalyptus conglobata, Eucalyptus leptocalyx, Eucalyptus lucasii\mallee,tree\5\i;M1+Banksia speciosa, Banksia media\shrub\4\i;M2^Lambertia inermis, Dryandra quercifolia, Isopogon buxifolius, Eucalyptus tetrapt	ESPERANCE

Appendix I

Heritage Report

Brad Goode & Associates

Consulting Anthropologists & Archaeologists

REPORT OF A DESKTOP ABORIGINAL HERITAGE SURVEY OF THE STATE BARRIER (VERMIN) FENCE - ESPERANCE EXTENSION IN THE GREAT SOUTHERN REGION, WESTERN AUSTRALIA

A report prepared for GHD Pty Ltd on behalf of The Department of Agriculture and Food Western Australia (DAFWA)

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HERITAGE SURVEY

ACKNOWLEDGEMENTS

The authors would like to thank the following organisations and individuals who helped with the management of the heritage survey.

- Ms Fionnuala Hannon - GHD Pty Ltd (Principal Environmental Consultant)
- Ms Orla O'Donnell - GHD Pty Ltd (Environmental Scientist)
- Ms Erin Rice - GHD Pty Ltd (GIS Analyst)
- Dr Peter Gifford - Brad Goode & Associates Pty Ltd (Ethno-historian)
- Mr Ashley Zanotti - Brad Goode & Associates Pty Ltd (Researcher)

DISCLAIMER

All of the information contained in this report is believed to be correct and accurate at the time it was recorded. The author does not take responsibility or accept any liability for errors or omissions contained in the report based upon information supplied by others.

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GLOSSARY OF TERMS

The Proponent – DAFWA – The Department of Agriculture and Food Western Australia
The Consultant – Brad Goode & Associates Pty Ltd
AHA – Western Australian Aboriginal Heritage Act (1972)
DIA – Department of Indigenous Affairs
ACMC – Aboriginal Cultural Material Committee
SWALSC – South West Aboriginal Land and Sea Council
GLSC – Goldfields Land and Sea Council
SBF – State Barrier Fence
GHD – GHD Pty Ltd

EXECUTIVE SUMMARY

The Department of Agriculture and Food Western Australia (DAFWA) is considering a number of proposed alignments to erect an extension to the State Barrier vermin control fence (State Barrier Fence). The project as currently proposed runs for approximately 400km in length in the Esperance region of WA.

This extension is proposed to link the existing State Barrier Fence about 13 kilometres north of the South Coast Highway near Jerdacuttup (Ravensthorpe) with the coast approximately 95 kilometres east of Esperance in a circuitous route which borders existing agricultural farmland to the east of Esperance. A number of alternative routes are proposed within the overall scope of work (see Figure 1: Location map).

A search of the DIA Aboriginal Sites Register conducted on the 28th May 2012 revealed 10 Aboriginal heritage sites/places to be located within the 100m survey corridor; 6 being Registered Aboriginal sites and 4 are Other Heritage places (see Figure 2: Location map of Aboriginal Sites/Places; Appendix 1: Sites Register Search).

Site ID 2642 'Boyatup Hill 1-5' is a highly significant site and is listed as being a 'Protected Area' (PA #31, W561.1-5) under section 19 of the AHA. The ACMC assessed this site under section 5(a) of the AHA at a meeting held on 9th February 1994 (Resolution No. 94/021).

It is recommended that this site be avoided and that the proponent seek to alter their proposed fence line so that it does not impact upon the extent of this protected site.

It is further recommended that an archaeological inspection and research be conducted in relation to this site (ID 2642) if development is required in the area. A protected area has special status in relation to the AHA; ministerial consent to affect such an area would be unlikely to succeed.

Site ID 2396 'Reserve Stone Arrangement' could potentially be affected by the proposed alignment. This is a 'closed' site and would require permission from the site informants to access the site file to further define the extent of this site. Consultation and field verification will be required should work proceed in the vicinity of this site.

Sites ID 1647 'Coujinup Surface Scatter' and ID 2641 'Thomas River Station' have the potential to be impacted by the proposed State Barrier Fence and further archaeological verification may be required should work proceed in the vicinity of this site.

For mythological sites ID 26265 'Oldfield River and ID 26264 'Young River' consultation with the sites informants followed by an application under Section 18 of the AHA will be required for any crossings of these rivers.

Heritage Places DIA 2393 and 2394 'Mt Ridley Salt Lakes' relevant files/records were unable to be located at the DIA and will require further research and field verification by an archaeologist should work proceed within the vicinity of these places.

In relation to heritage places DIA 2681 'Hawes Hill' and DIA 17991 'Granite Outcrop south of Hawes Hill' further archaeological verification is recommended and an application under Section 18 of the AHA may be required should the site extent be affected.

There are no other Aboriginal heritage sites or places affected by the state barrier fence proposal as it is currently planned.

As a result of this Desktop Aboriginal Heritage Survey of the State Barrier Fence Esperance Extension, the following recommendations can be made:

It is recommended that specific recommendations for each site identified to be intersected by the State Barrier Fence Esperance Extension proposal is given consideration and enacted upon should the proposal proceed to construction (see Table 4 in Outcomes of Archival Research).

In terms of the general project the following recommendations are made:

It is recommended that previously recorded archaeological sites where the actual extent is not defined and where options intersect the DIA buffered extent should be verified in the field by a qualified Archaeologist in order that the proponents remain compliant with all obligations under the AHA.

Once the actual extent has been verified, **it is recommended** that the fence be redesigned to avoid these areas. If avoidance is not possible, ministerial consent notice will be required to be lodged under Section 18 of the AHA for consent to use the land that may contain an Aboriginal heritage site.

In relation to ethnographic Aboriginal heritage sites, **it is recommended** that where the DIA buffered extent is intersected by the proposed alignments that consultations are conducted with the named DIA site informants and Native Title Claimants (see Native Title Claims Extant over the Project Area, page 21-22) in order that the heritage values of these places are accurately determined. Should avoidance not be possible (i.e. river crossings) ministerial consent notice will be required to be lodged under Section 18 of the AHA for consent to use the land that may contain an Aboriginal heritage site.

In terms of the general survey area, several sections of the State Barrier Fence Esperance Extension proposal are yet to be subject to rigorous archaeological and ethnographic enquiries and as such **it is recommended** that these areas are inspected by a qualified Archaeologist and that these areas are subject to consultation with the appropriate representative bodies and/or Native Title Claim groups in order to ascertain if a full ethnographic survey is required.

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Report of a Desktop Aboriginal Heritage Survey of the State Barrier (Vermin) Fence - Esperance Extension in the Great Southern Region, Western Australia

ISSUE

The Department of Agriculture and Food Western Australia (DAFWA) is considering a number of proposed alignments to erect an extension to the State Barrier vermin control fence (State Barrier Fence). The project as currently proposed runs for approximately 400km in length in the Esperance region of WA.

This extension is proposed to link the existing State Barrier Fence about 13 kilometres north of the South Coast Highway near Jerdacuttup with the coast approximately 95 kilometres east of Esperance in a circuitous route which borders existing agricultural farmland to the East of Esperance. A number of alternative routes are proposed within the overall scope of work.

In order to remain compliant with all obligations under the Western Australian Aboriginal Heritage Act (1972) [AHA], GHD Pty Ltd have commissioned Brad Goode and Associates (The Consultant) to conduct a desktop Aboriginal heritage survey of the proposed routes, including a 100m buffer zone, to determine whether any sites of significance as defined by section 5 of the AHA will be affected by the proposal.

REPORT OBJECTIVES

To report on archival research in order to determine if any previously recorded Aboriginal Heritage sites/places will be impacted upon by the proposed State Barrier Fence Esperance Extension.

To provide an overview of significant Aboriginal heritage sites/places located within the proposed corridor of the State Barrier Fence Esperance Extension.

To provide recommendations with regards to further research and issues relating to sites of significance and their future management in accordance with the AHA.

To identify all traditional owner groups, protocol and processes required to engage with such groups should Section 18 consent notices be required.

BACKGROUND

On 7th May 2012, Ms Fionnuala Hannon, Principal Environmental Consultant from GHD commissioned Brad Goode and Associates to conduct a Desktop Heritage Aboriginal Survey of the Proposed State Barrier Fence Esperance Extension.

The Department of Agriculture and Food Western Australia (DAFWA) proposes to construct an Esperance extension to the existing State Barrier Fence (SBF) to provide protection to the Esperance and Ravensthorpe farming properties from vermin, primarily wild dog attack and damage caused by emu invasion. The State Government has allocated Royalties for Regions funding through DAFWA for materials to construct the fence and has proposed a preliminary alignment for an approximately 400km long fence extension.

The State Barrier Fence (SBF) has been established for 111 years and was previously known as the Rabbit Proof Fence. It was constructed to protect Western Australia's agricultural resources from vermin including rabbits, emus, kangaroos, wild dogs and foxes.

The existing fence runs from the Zuytdorp Cliffs north of Kalbarri and borders the perimeter of the agricultural region south to Jerdacuttup in the Ravensthorpe Shire, covering more than 1100km. Despite considerable advances in pest and vermin control in the agricultural and bio-security sectors, it remains an integral barrier to help protect modern day agriculture.

A proposed Esperance Extension fence line to the existing SBF has been determined and is expected to cover a distance of approximately 400km, depending on the actual final alignment.

The Consultants have been engaged to assess in greater detail the potential Aboriginal cultural and heritage impacts in relation to the proposed fence extension and identifies Aboriginal heritage sites/places and previous Aboriginal heritage surveys that have been conducted within the 100m survey corridor.

LOCATION

DESCRIPTION

The proposed alignment of the Esperance Fence Extension begins on the south coast 95km east of Esperance approximately 10km west of Thomas River Beach situated on a large rock feature. It heads in a north-north east direction for about 4.5km then turns north through undulating coastal woodland scrub for about 6.4km (see Figure 1).

The proposed alignment corridor intersects Aboriginal heritage place ID 17991 'Granite Outcrop South of Hawes Hill' and approximately 1km north of this artefact scatter, the survey corridor intersects heritage place ID 2685 'Hawes Hill.'

Heading in a northerly direction bordering open (cleared) pastoral land and undulating bush scrub, the survey corridor then heads east following the alignment of Merivale Road, nearing Registered Aboriginal Site ID 2641 'Thomas River Station.' About 20km further east, the proposed alignment deviates north to a point about 11kms east of Boyatup where different alignments are proposed.

The most western of these alignments is a 21km section which crosses Registered Aboriginal Heritage Site ID 2642 'Boyatup Hill 1-5' approximately 7kms west of Boyatup. The alignment proceeds to head N/NW, skirting cleared agricultural pastoral land to the east of Beaumont.

A second proposed alignment heads in N/NW direction for 30km across undulating coastal scrub.

The third alignment heads due north for approximately 24km to a point 14km east of Cape Arid before heading N/NW to connect with the other two proposed alignments East of Beaumont. It mainly traverses flat, semi-arid sandy country largely devoid of vegetation.

Alternating in a SW to NW direction the alignment follows a path of cleared agricultural paddocks passing to the North of Mount Ney through hilly, wooded areas. 24kms west, it transects Registered Aboriginal Site ID 2396 'Reserve Stone Arrangement.'

Approximately 10kms NW, two alignments are proposed, the more western of which crosses the boundary of heritage place ID 2394 'Mt Ridley Salt Lake.' The alignment then heads north

of Esperance at Mt Ridley with an approximately 50km deviation skirting paddocks further west and an alternative 32km alignment heading due north through hilly scrubland.

The proposed route then joins up to pass South of Lake Gilmore, intersects the Coolgardie and Esperance Highway then encompassing pastoral land 22km due west of Salmon Gums. A number of further deviations are proposed approximately 10km north of Cascade, all passing south of Pyramid Lake. Some encompass agricultural paddocks while others deviate further north through arid scrubland.

From here, the proposed fence crosses the Young River, a Registered Aboriginal Heritage site ID 26264. Approximately 30km further S/SW, the fence crosses the Oldfield River, a Registered site ID 26265. Proceeding onwards, 16kms north of Jerdacuttup, the alignment is planned to head 3km north of the South Coast Highway, heading in a NW direction.

The proposed corridor runs adjacent to Registered Aboriginal site ID 1647 'Coujinup Surface Scatter' and then continues on for approximately 65km in a NW direction to connect with the existing State Barrier Fence.

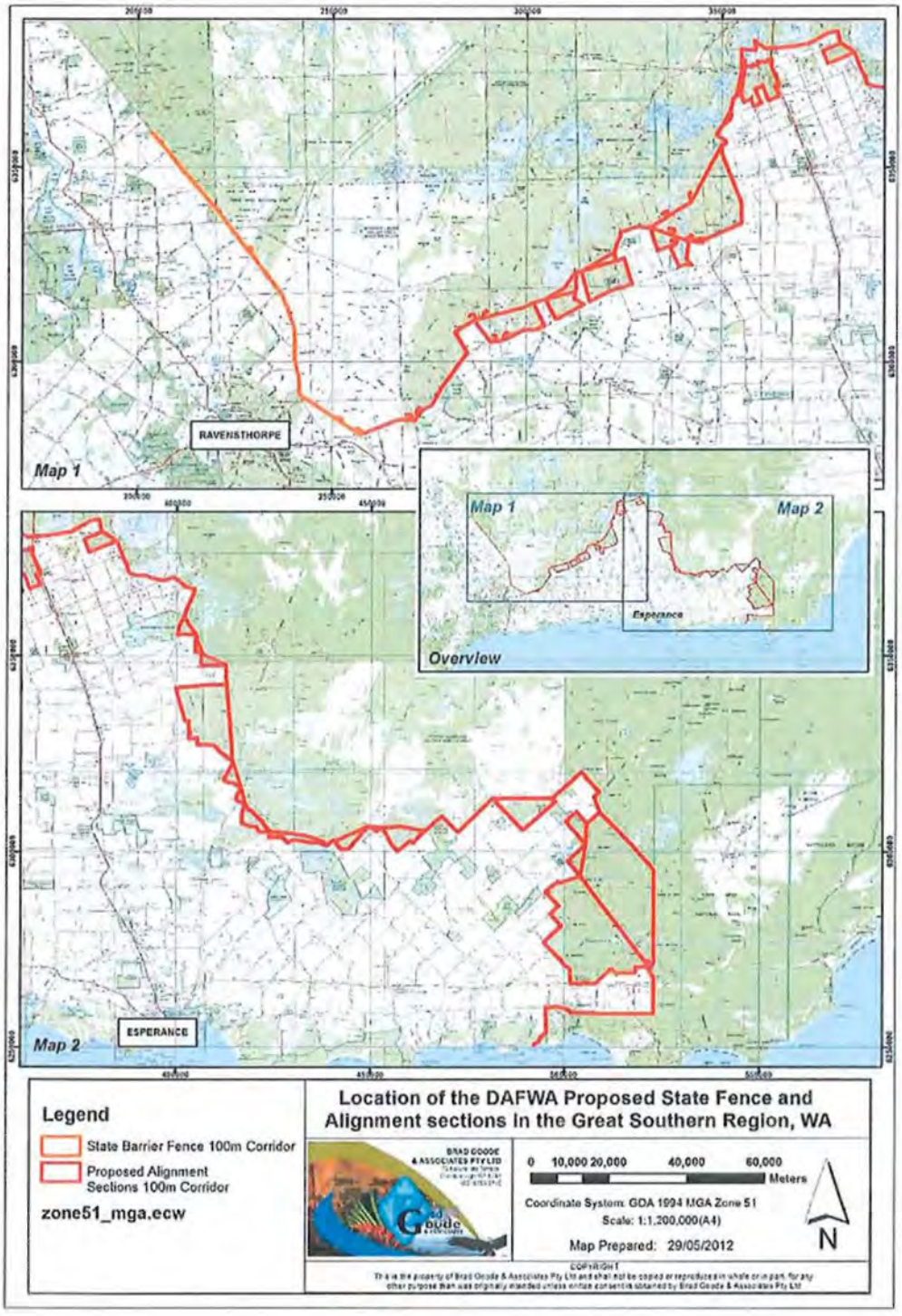

Figure 1: Location of the survey area.

ARCHIVAL RESEARCH

Archival research involved an examination of the DIA Sites Register, a review of any relevant site files and a review of any unpublished ethnographic reports that relate to the proposed development tract for the Esperance Extension of the State Barrier Fence, in the Great Southern Region of Western Australia.

SITES REGISTER SEARCH

The DIA Aboriginal Sites Register categorises places reported to be of importance and significance to Aboriginal people into two separate categories.

The first category contains sites classified as **'Registered',** which have been assessed by the ACMC as meeting the definition of section 5 of the AHA and are fully protected in law. Disturbance to land that contains such sites requires a section 18 application for ministerial consent should proponents wish to use the land that contain these sites.

'Other Heritage Places' is the second category within the Aboriginal sites register. This category includes reported sites both 'Lodged' and awaiting ACMC assessment, and 'Information Assessed' by the ACMC, however awaiting a final decision on the places status. Also there are places where the ACMC have determined there is 'Insufficient' information for these places to be fully 'Registered' under the AHA, however there is enough information to warrant their temporary protection. Within the category of 'Other Heritage Places' sites that are awaiting assessment or are lodged are protected by the provisions of the AHA, until assessed and their final status determined. Other heritage places that have been assessed and fail to meet the definition of section 5 of the AHA are classified as 'Stored Data'. Places in this category are not sites under the AHA as they have failed to meet the definition of section 5.

In relation to this survey a search of the DIA Aboriginal Sites Register was conducted for this project on the **28th May, 2012**, in order to determine if there were any previously recorded Aboriginal heritage sites/places that would be affected by the project proposal (see Appendix 1: Sites Register Search).

This site search identified nineteen (19) Aboriginal heritage sites/places within the survey area. A GIS analysis was conducted through Arc-Map V10 which further refined the survey corridor to the exact 100m buffer either side of the proposed alignments.

This refined search revealed a total of ten (10) Aboriginal heritage sites/places located within the survey corridor.

Of these ten (10) Aboriginal heritage sites/places, **six (6)** are 'Registered' Aboriginal sites and **four (4)** are 'Other Heritage places' (see Table 1).

Site ID 2642 'Boyatup Hill 1-5' is a highly significant site and is listed as being a 'Protected Area' (PA #31, W561.1-5). **It is recommended** that this site be avoided and that the proponent seek to alter their proposed fence line so that it does not impact upon the extent of this protected site. **It is further recommended** that an archaeological inspection and research be conducted in relation to this site if development is required in the area. A protected area has special status in relation to the AHA, ministerial consent to affect such an area would unlikely succeed.

Site ID 2396 'Reserve Stone Arrangement' could potentially be affected by the proposed alignment. This is a 'closed' site and would require permission from the site informants to access the site file to further define the extent of this site. Consultation and field verification will be required should work proceed in the vicinity of this site.

Sites ID 1647 'Coujinup Surface Scatter' and ID 2641 'Thomas River Station' have the potential to be impacted by the proposed State Barrier Fence and further archaeological verification may be required should work proceed in the vicinity of this site.

For mythological sites ID 26265 'Oldfield River and ID 26264 'Young River' consultation with the sites informants followed by an application under Section 18 of the AHA will be required for any crossings of these rivers.

Heritage Places DIA 2393 and 2394 'Mt Ridley Salt Lakes' relevant files/records were unable to be located at the DIA and will require further research and field verification by an archaeologist will be required should work proceed within the vicinity of these places.

In relation to heritage places DIA 2681 'Hawes Hill' and DIA 17991 'Granite Outcrop south of Hawes Hill' further archaeological verification is recommended as the actual location of these places is imprecise.

There are no other Aboriginal heritage sites or places affected by the state barrier fence proposal as it is currently planned.

Table 1: Summary of Aboriginal heritage sites within project area

Site ID	Name	Status	Access	Restriction	Location (GDA94 Zone 50)* mE	mN	Site Type
Registered Aboriginal Sites							
1647	Coujinup Surface Scatter	R	O	N	245133	6305157	Artefacts/ Scatter
2396	Reserve Stone Arrangement	R	C	N	N/A	N/A	Ceremonial Myth, Manmade Structure
2641	Thomas River Station	R	O	N	502837	6259406	Artefacts/ Scatter
2642	Boyatup Hill 1-5	R	O	N	504247	6267121	Painting/ Artefacts/ Scatter
26264	Young River	R	O	N	315933	6279194	Myth
26265	Oldfield River	R	O	N	278067	6282070	Myth
Other Heritage Places							
2393	Mt Ridley Salt Lake	L	O	N	416637	6310656	Artefacts/ Scatter
2394	Mt Ridley Salt Lake	L	O	N	416637	6310656	Artefacts/ Scatter
2685	Hawes Hill	I	O	N	495438	6255556	Artefacts/ Scatter
17991	Granite Outcrop South of Hawes Hill	L	O	N	495737	6254805	Artefacts/ Scatter

* Please note: Coordinates are indicative locations that represent the centre of sites as shown on maps produced by the DIA – they may not necessarily represent the true centre of all sites.

LEGEND

R – Registered Site, **I** - Insufficient Information, **S** - Stored Data, **L** - Lodged awaiting assessment, **IA** - Information Assessed, **O** – Access Open, **C** - Closed Access, **N** – File Not Restricted.

REVIEW OF RELEVANT SITE FILES

Site ID 1647 Coujinup Surface Scatter

Site ID 1647 'Coujinup Surface Scatter' (Field Code W01551) was recorded by Kirkby in 1980 during a Western Australian Museum field expedition at Coujinup Creek. This site is described as a scatter of quartz and quartzite artefacts identified in an area recorded on map sheet SI 51-5 Grid Reference 32-87. Kirkby's field notes report that approximately 93 artefacts were collected and identified SW of Coujinup Creek and were distributed over a large area. No further details regarding the specific location of this site were available in the site file.

Site ID 1647 'Coujinup Surface Scatter' is a Registered Aboriginal site that has been assessed by the ACMC as a site under Section 5(a) and 39.2(c) of the AHA (Resolution Number 00088). This is an open site with no restrictions and the coordinates recorded in the site file are 245135mE 6305156mN (MGA Zone 51).

The DIA extent of this site is recorded as a 10km square. The southern portion of the existing barrier fence runs along the western boundary of the site. No actual location and extent of the site could be determined from the site file. Should development proceed within the DIA extent **it is recommended** that an inspection by an archaeologist takes place in order to make sure that no artefacts are affected by fencing at this location.

Site ID 2396 Reserve Stone Arrangement

Site ID 2396 'Reserve Stone Arrangement' (W00805) is described as a site complex with stone arrangements within a 2km x 2km extent. As this site is 'Closed' the site file was unable to be viewed. It is **therefore recommended** that the site informants be contacted to gain access to the site file and that an archaeologist inspects the area where fencing is proposed within the DIA extent.

Site ID 2396 'Reserve Stone Arrangement' has been assessed as a 'Registered' site by the ACMC at a meeting held on 9th February 1994 (Resolution Number 94/021).

In relation to the proposed State Barrier Fence both Option A and Option B pass through the DIA extent of this site.

Site ID 2396 'Reserve Stone Arrangement' could potentially be affected by the proposed alignment.

Site ID 2641 Thomas River Station

Site ID 2641 'Thomas River Station' (W00560) is an artefact scatter that was recorded in 1978 by Dr Moya Smith, conducting a preliminary archaeological survey on behalf of the University of Western Australia. This site is a 'Registered' Aboriginal site recorded at 502837mE 6259406mN where three (3) main artefact scatters were visible at the time of recording, and it was noted that existing vegetation and crops might obscure other artefact scatters.

Scatter 1 is located on the west bank of Thomas River opposite/east of a homestead (contact period settlement). The artefacts were predominantly secondarily retouched chert and located within an area of 50m x 5m consisting of Eucalypts.

Scatter 2 comprises approximately 50 flakes, fragments of chert, some with secondary retouch and utilisation marks. The scatter is located on the eastern side of the hill overlooking the homestead and surrounded by thick grass and Eucalypts. No extent was noted however a field map gave an indicative extent of the scatter (see Appendix 2: Maps of Aboriginal Sites).

Scatter 3 is a sparse scatter of chert flakes were identified along an embankment of Thomas River. The artefacts were located within brown soil (not sandy) in an area clear of trees and the vegetation consisted of wheat/barley crops and Eucalypts.

DIA have spatially captured these scatters as three separate circles with a radius of 200m. Scatter 1 and 2 have overlapping circles and are located approximately 1km NW of Scatter 3.

Site ID 2641 'Thomas River Station' has been assessed by the ACMC as a site under section 5(a) and section 39.2(c) of the AHA.

Scatter 3 is located close to Merivale Road and has the potential to be impacted by the proposed alignment. The indicative site extent is located within the 100m corridor of the alignment and it **is recommended** that further archaeological inspection be conducted to verify the extent of this site before fencing proceeds.

Site ID 2642 Boyatup Hill 1 -5

Site ID 2642 'Boyatup Hill 1-5' (W00561) is a painting, artefacts scatter, rock-shelter and water source site that was recorded in 1978 by Dr Moya Smith, during a preliminary archaeological survey on behalf of the University of Western Australia. This site is a 'Registered' Aboriginal site recorded at 504247mE 6267121mN.

The location of this site is described as 116km east of Esperance along Fisheries Road on Crown Land. The Boyatup site complex contains four (4) artefact scatter/occupation sites and an art site comprised of a small rock shelter with red ochre hand stencils. The artefacts identified comprise chert and quartz chips and flake stone scraping tools lying on or embedded in shallow moss-like ground cover on top of a granite hill, topped by a trig tower survey point. The artefacts were reported to be scattered either side of and underneath the tower.

There is a granite-based depression to the south-east of the hill which acts as a temporary water catchment and artefacts are reported to occur near this depression and a quarry is located to the south east.

At the time of recording, considerable disturbance was noted as a result of construction works associated with cementing the tower on top of Boyatup Hill.

DIA have spatially encapsulated this site as a 680m x 1310m polygon that overlays 4 key areas within the extent, specifically a pool, overhangs, a depression and a quarry. AMG coordinates listed within the site file were plotted and differed from the DIA Sites Register GIS polygon. As a result this 'actual extent' intersects with the Proposed State Barrier alignment (see Appendix 2: Map of Site ID 2642 Boyatup Hill 1-5).

Site ID 2642 'Boyatup Hill 1-5' is a highly significant site and is listed as being a 'Protected Area' (PA #31, W561.1-5) under section 19 of the AHA. The ACMC assessed this site under section 5(a) of the AHA at a meeting held on 9th February 1994 (Resolution No. 94/021).

It is recommended that this site be avoided and that the proponent seek to alter their proposed fence line so that it does not impact upon the extent of this protected site.

It is further recommended that an archaeological inspection and research be conducted in relation to this site if development is required in the area. A protected area has special status in relation to the AHA, ministerial consent to affect such an area would unlikely succeed.

Site ID 26264 Young River

The Young River commences north of Munglinup and travels in a NW/SE direction through Yerritup before entering the ocean at Stokes Inlet. The Young River in its entirety inclusive of all tributaries (Lort River, Yerritup Creek and Cascade Creek) has been reported as a mythological site in association with the eagle and the crow which was recorded by Mr Brad Goode in 2009.

The centre coordinate has been recorded at the area visited during the 2005 survey at 329133mN and 6263028mN.

Both Option A and Option B fence alignments cross the river (see Appendix 2: Maps showing both options). **It is recommended** that Ministerial consent under Section 18 of the AHA be sought for this river crossing, as the entire river and its extent is registered as a mythological site of significance.

Site ID 26265 Oldfield River

The Oldfield River is located NE of Ravensthorpe and commences NW of Munglinup and runs in a NW/SE direction before entering the ocean at the Oldfield Estuary on the South Coast. During the survey in 2005, the Oldfield River centre coordinate was recorded at the site the river was inspected along the South Coast Highway at 283905mE and 6271832mN. The Oldfield River in its entirety including all tributaries (Munglinup River and Dallinup Creek) has been reported as a site of mythological significance in association with the *Norrun* which was recorded by Mr Brad Goode in October, 2009.

Site ID 26265 'Oldfield River' has been assessed by the ACMC and registered as a site under Section 5(b) and Section 39.2(b) and (c) of the AHA at a meeting held on 27th January 2009 (Resolution ID 4310 No. 5969).

It is recommended that application be made under Section 18 of the AHA in relation to proposed crossings of this river as the entire river is a 'Registered' site.

REVIEW OF RELEVANT HERITAGE PLACES

DIA 2393 Mt Ridley Salt Lake

Heritage Place ID 2393 (W0802) Mt Ridley Salt Lake is an artefact scatter that has a 'Lodged' status on the DIA Sites Register which means the information has been lodged and is awaiting assessment. The file in relation to this record could not be located at DIA.

DIA have spatially captured this site within a 1km x 1km polygon which is intersected by the proposed State Barrier Fence in the south eastern corner of the extent. Aerial imagery shows this polygon overlay a number of salt lakes.

Further archaeological research and field verification is recommended should work proceed within the DIA extent.

DIA 2394 Mt Ridley Salt Lake

Heritage Place ID 2394 (W0803) Mt Ridley Salt Lake is an artefact scatter that has the same extent and status as DIA 2393. The file was unable to be located at DIA.

Further archaeological research and field verification is recommended should work proceed within the DIA extent.

DIA 2685 Hawes Hill

Heritage Place ID 2685 Hawes Hill (W0550) is defined by a 300m radius circle with a central location 495438mE 625556mN. This heritage place was reported by Dr Moya Smith in 1978. Status is 'Interim' due to insufficient information, Open access.

This heritage place is located on the western boundary of Cape Arid National Park and is approximately 104km east of Esperance, located off Lower Fisheries Road, approximately half way between the coast and Merrivale Road. This heritage place is described as artefact scatters on top of a granite hill with chert flakes scattered to the north of the hilltop and a high

concentration of chert and quartz artefacts and a fragment of dolerite (artefacts washed together). An overhang is described on the NW side of the hill with granite dome depressions that contain water on the southern side of the hill (as per field map).

DIA 2685 'Hawes Hill' has been assessed by the ACMC as having insufficient information at a meeting held on 13th June 2000 (Resolution ID 444, No. 00/088).

The proposed State Barrier fence (outermost fence alignment option) intersects the DIA extent of this heritage place ID 2685 'Hawes Hill' however it appears to border the hill where the overhang and depression are recorded.

Further archaeological research and field verification is recommended should work proceed within the DIA extent.

DIA 17991 Granite Outcrop South of Hawes Hill

This heritage place was recorded by Dr Moya Smith in 1978 in a Report of a Preliminary Archaeological Survey of the Thomas River Region in Western Australia. It is identified as an Artefact scatter on the south edge of granite outcrop within a landscape consisting of mixed Mallee, scrub Heath and Nyutsia. This heritage place is located on the western boundary of Cape Arid National Park.

DIA 17991 'Granite Outcrop south of Hawes Hill' is 'Lodged' and awaiting assessment by the ACMC on the DIA Sites Register. The file access is 'Open.'

DIA have spatially captured this heritage place as a circle with a radius of 500m located at 495737mE 6254805mN (MGA Zone 51). The file noted that a probability radius of 500m was necessary for lack of detail and map being very poor as it was a very old photocopy. The field map that was included in the file shows an irregular polygon defining the key features of this granite outcrop which appears to extend approximately 180m east of the currently mapped DIA extent (see Appendix 2: Maps).

Further archaeological research and field verification is recommended should work proceed within the DIA extent.

PREVOUS ABORIGINAL HERITAGE SURVEYS CONDUCTED IN THE SURVEY AREA

A GIS download sourced on 30th May 2012 from Mr Simon Keenan; Heritage Officer at DIA was able to provide details of Aboriginal heritage surveys previously conducted within the proposed Station Barrier Fence and Alignment areas. The following table identifies surveys that intersect the proposed survey corridor, in relation to Aboriginal heritage sites and places.

Table 2: Previous Aboriginal Heritage Surveys conducted within the Survey area.

Aboriginal Heritage Surveys			Section of Proposed State Barrier Fence that have previously been surveyed
Report ID	**Author/Year**	**Report Title**	
102182	O'Connor, R 1995	*Report on an Ethnographic Survey of the Proposed Lake King to Cascades Road*	State Barrier Fence - No. 1 South (ID 69)
20322	de Gand, D 2002	*Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim area (Sambo Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in WA.*	Section 14
20323	de Gand, D 2002	*Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim area (Donaldson Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in WA.*	Section 14
20254	O'Connor, R 2002	*Ethnographic Survey of Bullenbuk-Noongar Section of Kambalda to Esperance Gas Pipeline Route*	Section 14 Section 13 Option C
17057	Quartermaine, G 1990	*Report on the Archaeological Component of the Aboriginal Site Survey of the Perth to Adelaide optic fibre cable route - Ceduna to Eastern Goldfields to South Coastal and South Coastal to South Western Sections*	None
17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*	Section 24 Option A and Option B Section 23 Option A and Option B Section 35 Option C Section 38
18775	Smith, M 1978	*Report of a Preliminary Archaeological Survey of the Thomas River Region of Western Australia*	Section 35 Option C Section 38
18706	Wolfe-Okongwu, W 1978	*Aboriginal Art of the South-West of Western Australia*	
106482	O'Connor, R 1990	*Report on an Ethnographic Survey of the Proposed Perth to Adelaide optic fibre cable route*	Section 33 Option C Section 31

Table 3: Previous surveys associated with identified Aboriginal heritage sites/places.

Aboriginal Heritage Site/Place	Aboriginal Heritage Surveys		
	Report ID	Author/Year	Report Title
Site ID 1647 Coujinup Surface Scatter	None		
Site ID 2396 Reserve Stone Arrangement	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
Site ID 2641 Thomas River Station	18775	Smith, M 1978	*Report of a Preliminary Archaeological Survey of the Thomas River Region of Western Australia*
	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
Site ID Boyatup Hill 1-5	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
	18706	Wolfe-Okongwu, W 1978	*Aboriginal Art of the South-West of Western Australia*
	18775	Smith, M 1978	*Report of a Preliminary Archaeological Survey of the Thomas River Region of Western Australia*
Site ID 26264 Young River	102182	O'Connor, R 1995	*Report on an Ethnographic Survey of the Proposed Lake King to Cascades Road*
Site ID 26265 Oldfield River	None		
DIA 2393 Mt Ridley Salt Lake	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
DIA 2394 Mt Ridley Salt Lake	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
DIA 2685 Hawes Hill	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
	18775	Smith, M 1978	*Report of a Preliminary Archaeological Survey of the Thomas River Region of Western Australia*
DIA 17991 Granite Outcrop South of Hawes Hill	17221	Smith, M 1993	*Recherche a L'Esperance: A Prehistory of the Esperance Region of South-Western Australia*
	18775	Smith, M 1978	*Report of a Preliminary Archaeological Survey of the Thomas River Region of Western Australia*

REVIEW OF RELEVANT ABORIGINAL HERITAGE REPORTS

Smith, M 1978, *Report of a Preliminary Archaeological Survey of the Thomas River region of Western Australia,* Masters Preliminary Dissertation, Anthropology Department, UWA

This report (ID 18775) was prepared by Dr Moya Smith in 1978 for the Anthropology Department of the University of Western Australia, and identified 26 sites within a large area. The survey area was bounded by Taylor Boat Harbour to the West, Cape Arid to the East and north to Latitude 83, just north of Fisheries Road. The sites recorded are predominantly artefact scatters of varying extent and density.

This report was a regional survey which consisted of ethno-historical research, and site identification within the Thomas River region of Western Australia. Dr Smith's ethnohistorical research revealed that the Njunga/Wudjari tribal group occupied a coastal zone extending approximately 40 miles inland between Doubtful Bay and Israelite Bay (Smith 1978:6).

The field survey was undertaken over a four week timeframe and river systems, swamps, lakes, high sandhills, coastal dunes and granite outcrops were inspected for the possible existence of sites. Thirty one sites were identified to be artefact scatters of varying extent and density; one was a painting site (Site ID 2642 Boyatup 1-5). Rock art was located at this painting site in one of the three overhangs on the east side of Boyatup Hill and over ten hand stencils in red ochre were noted. Dr Smith observed that the interpretation of these hand stencils could possibly be betrothal contracts, calling cards, indications of traveling directions, the mark of spirit ancestors, appeasement of the spirits of deal relatives, personal identification, an indication of a nearby burial, a population tally or an Aboriginal variation of graffiti (Ibid:34). No source of red ochre was known for this area however burnt laterite could have been used as a substitute.

In relation to the proposed State Barrier Fence, sites ID 2642 'Boyatup Hill 1-5', ID 2641 'Thomas River Station' and heritage places DIA 2685 'Hawes Hill,' and DIA 17991 'Granite Outcrop south of Hawes Hill' were identified within this report.

O'Connor, R 1990, *Report on an Ethnographic Survey of the Proposed Perth to Adelaide Optic Fibre Cable Route,* unpublished report prepared for Telecom Australia.

This report (ID 106482) was prepared by Mr Rory O'Connor in 1990 for Telecom Australia. The survey area for the proposed Perth to Adelaide Optic Fibre Cable route overlays the current survey area for the State Barrier Fence. However the four sites that were identified by O'Connor in 1990 were W1538 'Galgalanganya' ', W1537 'Gurajininya', W1546 'Breeboorinia' and W1545 'Deralinya' and are located to the east of the current survey area. These sites are not likely to be affected by the current proposed alignment.

Quartermaine, G 1990, *Report on the Archaeological Component of the Aboriginal Site Survey of the Perth to Adelaide Optic Fibre Cable Route - Ceduna to Eastern Goldfields, Eastern Goldfields to South Coastal and South Coastal to South Western Sections,* unpublished report prepared for Telecom Australia.

This report (ID 17057) was prepared by Mr Gary Quartermaine in April 1990 for an Aboriginal Site Survey of the proposed South Coastal and South Western Sections of the Perth to Adelaide Optic Fibre Cable Route proposed by Telecom Australia.

There were 31 previously recorded sites, 14 newly recorded archaeological sites and 18 isolated finds reported. These were mostly artefact scatters but also included a flint quarry and rock holes and Gnamma holes associated with artefacts. The artefact scatters were mainly small, low density sites with quartz or chalcedony as the main lithology. One field site was an extensive,

dense artefact scatter and another was a flint quarry that had been extensively utilised. It was proposed that Telecom avoid these sites in their Optic Fibre Cable Route.

The field survey identified 18 isolated finds mainly located along creeks, riverine, saltpan and lake margins which fit the predicted pattern of site distribution. Other possible site locations were noted to be granite outcrops that may contain Gnamma holes or archaeological material.

Smith, M 1993, *Recherche A L'Esperance: A Prehistory of the Esperance Region of South Western Australia,* Thesis presented for the degree of Doctor of Philosophy of the University of Western Australia, Department of Anthropology.

Dr Moya Smith prepared this thesis (ID 17221) in 1993 for the Department of Anthropology at UWA and identifies 32 sites in a large area from Esperance to Mt Ridley, extending east to Israelite Bay. An analysis of excavated material from three rockshelters 'Cheetup,' 'Cape le Grand' and 'Barndi Caves' and data from 214 archaeological sites within the coastal and inland regions between Esperance and Israelite Bay were reported on in this thesis. Mt Ridley (Site 21) was a site that comprised 500-1000 artefacts and located within a granite landscape. Mt Ridley is believed to have been the location of an important gathering centre for people from different linguistic groups and is one of the rare South West art sites. Paintings are found on several 2m to 5m granite boulders near the Western base of the hill and some artefacts occur on the sandy clay to the west. The main artefact scatter identified was located within Eucalypt woodland NE of the hill near a water source. In relation to our current survey of the State Barrier Fence, this site (ID 2882 'Mt Ridley') is located approximately 4.5km N/NE of heritage places DIA 2393 and 2394 'Mt Ridley Salt Lake.' No mention however is made in this report of these salt lakes. Further research is recommended to locate the details regarding these heritage places.

de Gand, D M 2002, *Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim Area (Sambo Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in W.A.,* unpublished report prepared for Worley Pipelines and Terminals Pty Ltd.

This Aboriginal Heritage Assessment report (ID 20322) identifies six sites in relation to the proposed Kambalda (West) to Esperance Gas Pipeline, prepared by Mr Daniel de Gand in June 2002. These sites/places are DIA 165 'Pluto,' DIA 497 'Milbari Nidjuru,' DIA 2919 'Lake Cowan,' DIA 3151 'Kambalda Stone Arrangement,' DIA 18700 'Dordie Rockhole' and DIA 19180 'Kambalda Site.' The survey area for the report prepared for Worley Pipelines and Terminals Pty Ltd overlays the current survey area for the State Barrier Fence. However the sites/places identified in this 2002 report are not located within the current survey area and will not be affected by the proposed alignment.

de Gand, D M 2002, *Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim Area (Donaldson Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in W.A.,* unpublished report prepared for Worley Pipelines and Terminals Pty Ltd.

This report (ID 20323) was prepared by Mr Daniel de Gand in June 2002. In addition to the sites identified in the previous report by de Gand (2002), 3 other sites were included in this report, namely DIA 844 'Maluri Rockholes,' DIA 3007 'Mt Burges' and DIA 3152 'Mt Morgan.' This report was in relation to the Donaldson Family Native Title claim area and resulted in two ethnographic sites being recorded during the consultations held with Aboriginal representatives of the Donaldson Family. Mythological information was reported in relation to these two sites DIA 20608 'Jarjuru Tjukurpa' and DIA 20609 'Yundarnie Rocks' and it was recommended that a 200m buffer zone be recorded as their extent. These sites/places are located approximately 115km north of the current study area for the State Barrier Fence and will not be impacted by the proposed alignment.

O'Connor, R 2002, *Ethnographic Survey of Bullenbuk-Noongar Section of Kambalda-Esperance Gas Pipeline Route,* unpublished report prepared for Esperance Pipeline Company Pty Ltd.

This report (ID 20254) was prepared by Mr Rory O'Connor in November 2002 for the Esperance Pipeline Company Pty Ltd. The survey area comprised the road reserve and proposed pipeline route between Esperance in the south, as far north to Beete, north of Salmon Gums.

Five aboriginal sites were identified in the search area, DIA 1407 'Helm's Arboretum,' DIA 1459 'Red Lake,' DIA 1644 'Bukenarup Road,' DIA 1710 'Bilyarup' also known as Pink Lake and DIA 2881 'Tommy Windich's Grave.'

As a result of this survey it was established that the Kambalda to Esperance Gas Pipeline route would not affect these identified Aboriginal heritage sites/places however it was recommended that Aboriginal monitoring take place during any ground disturbance occurring at Truslove Nature Reserve and Lake Warden. It was also requested by the Aboriginal representatives consulted that the site associated with the former Salmon Gums Aboriginal Reserve not be disturbed (DIA 20605 'Esperance Pipeline 2'). As a result it was a recommendation in this report that all ground disturbance in the Salmon Gums Township be restricted to the close vicinity of the railway and not extend into the bushland to the east.

A former Aboriginal camping ground was reported on during this survey, located at a large prominent sand dune, north of the junction of Fisheries Road and Coolgardie-Esperance Highway (DIA 20603 'Esperance Pipeline 1').

In relation to the current survey for the State Barrier Fence, DIA 20603 'Esperance Pipeline 1' and DIA 20607 'Lake Warden' are located close to the Esperance Township, approximately 55km from the proposed alignment. The Truslove Nature Reserve is approximately 22km west of the alignment, and DIA 20605 'Esperance Pipeline 2' is approximately 27km west of the alignment. These identified sites/places will not be affected by the current proposed alignment.

Glendenning, W 2003, *A Report of an Archaeological and Ethnographic Survey undertaken as part of a Section 18 Application to disturb Howick Hill, near Condingup,* unpublished report prepared for the Shire of Esperance.

This report (ID 20635) was prepared by Mr Wayne Glendenning for an Aboriginal survey of a proposed Telstra CDMA tower construction project that the Shire of Esperance was managing. The CDMA tower was planned to be constructed on top of Howick Hill and a power supply cable was planned to be installed along the western side of Howick Hill. No new Aboriginal sites were identified within the survey area and previously recorded artefact scatters were not relocated during the survey. Two lizard traps were located within the proposed path of the power supply cable and this report recommended that the proponent alter their plans to avoid impacting these sites. Aboriginal monitoring of the construction phase was also requested to ensure that these sites were not disturbed.

One ethnographic site was reported during the survey and the Esperance Nyoongar representatives consulted stated that the area within a 1km radius from the top of Howick Hill should be reported as a camping and hunting site. No mythology was reported in relation to this site. As the area had previously been disturbed by farming activities and the construction of an existing radio tower, the Aboriginal representatives found no impediments to the Telstra project proceeding.

In relation to the current survey for the State Barrier Fence, the sites identified within this report are located approximately 24km west of the alignment at Boyatup, and will not be affected by the current proposed works.

OUTCOMES OF ARCHIVAL RESEARCH

A search of the DIA Sites Register conducted on the 28th May 2012 revealed ten (10) Aboriginal heritage sites/places to be located within the 100m survey corridor, **six (6)** being 'Registered' Aboriginal sites and **four (4)** 'Other Heritage places.'

The following table details the outcomes from archival research:

Table 4: Outcomes of Archival Research relating to specific Aboriginal Heritage Sites/Places

Aboriginal Heritage Site/Place	Type	Outcomes*
Site ID 1647 'Coujinup Surface Scatter'	Artefact Scatter	No specific location could be defined from the site file. Further archaeological verification recommended.
Site ID 2396 'Reserve Stone Arrangement'	Closed site	Permission from site informants is required to access this site file. This course of action is recommended to define the actual extent, Further archaeological verification recommended.
Site ID 2641 'Thomas River Station'	Artefact Scatters	Scatter 3 has the potential to be affected by the proposed alignment. Archaeological verification recommended.
Site ID 2642 'Boyatup Hill 1-5'	Painting, Artefact Scatters, highly significant site listed as being a 'Protected Area' (PA#31)	Avoidance recommended. Further archaeological inspection and research recommended. Ministerial consent to affect a protected area would likely be unsuccessful.
Site ID 26264 'Young River'	Mythological site	Consultations to be held with site informants and Native Title Claimants. Application recommended under Section 18 of the AHA.
Site ID 26265 'Oldfield River'	Mythological site	Consultations to be held with site informants and Native Title Claimants. Application recommended under Section 18 of the AHA.
DIA 2393 and 2394 'Mt Ridley Salt Lakes'	Artefact Scatters	These heritage places are located within the same recorded extents. DIA could not locate the relevant files/records. Further research is and field verification recommended.
DIA 2681 'Hawes Hill'	Artefact Scatters	Further research is and field verification recommended.
DIA 17991 'Granite Outcrop South of Hawes Hill'	Artefact Scatters	Further research is and field verification recommended..

*These specific recommendations pertain to areas of land within DIA recorded polygons only (see Appendix 2: Maps).

NATIVE TITLE CLAIMS EXTANT OVER THE PROJECT AREA

Currently lodged with the Register of Native Title Claims and the Schedule of Applications, held by the Commonwealth Native Title Tribunal, there are **three registered** Native Title applications that overlay the project area, and **two registered** Native Title applications that are adjacent to the proposed State Barrier Fence. The Schedule of Applications includes registered applications, unregistered applications and applications still undergoing the registration test (see Table 5 and 6; Map of Native Title Claim Application area, Figure 2).

Table 5: Native Title Claim Applications overlaying survey area.

Native Title Claim Application	Applicants	Representative	Section of Proposed State Barrier Fence NTC application overlays
Ngadju WC99/2 WAD6020/98	Mr Jack Schultz, Mr John Walter Graham, Ms Katie Ray, Mr Sonny Graham, and six other applicants, names withheld for Cultural Reasons.	Ms Wendy Gong, Goldfields Land & Sea Council Level 1, 63 Adelaide Terrace EAST PERTH WA 6004 Phone: (08) 9263 8711 Fax: (08) 9218 9449	Section 1 South (ID 69) and Proposed Alignment sections 8-16.
Ballardong People WC00/7 WAD6181/98	Mr Reg Yarran (Jnr), Mr Murray Yarran, Ms Fay Slater, Ms Carol Holmes, Mr Alan Jones, Ms Dianne Taylor, Mr Doug Nelson, Mr Reg Hayden, Mr Ricky Nelson, Mr Tim Riley, Ms Winnie McHenry	Maryse Aranda, South West Aboriginal Land & Sea Council (SWALSC) PO Box 585 CANNINGTON WA 6987 Phone: (08) 9358 7400 Fax: (08) 9358 7499	Section 1 South (ID 69)
The Esperance Nyungar's WC96/64 WAD6097/98	Ms Elaine Bullen, Ms Jenny Woods, Ms Diane Clinch, Ms Veronica Williams-Bennell, Mr Jarman Jamieson, Mr Graham Tucker	Ms Sophie Kilpatrick, Goldfields Land & Sea Council Level 1, 63 Adelaide Terrace EAST PERTH WA 6004 Phone: (08) 9263 8711 Fax: (08) 9218 9449	All sections of the fence, excluding a northern portion of Section 1 South (ID 69)

Two registered Native Title Applications that are approximately 9m west of the Proposed State Barrier Fence, but are inclusive in the 100m survey corridor are listed in the following table:

Table 6: Native Title Claim Applications adjacent to survey area.

Native Title Claim Application	Applicants	Representative	Section of Proposed State Barrier Fence NTC application overlays
Southern Noongar WC96/109 WAD6134/98	Mr Aden Eades, Mr Allan Bolton, Mr Cedric Roberts, Mr Dallas Coyne, Mr Glen Colbung, Ms Joyce Winsley and Ms Rita Dempster	Mr Simon Blackshield, SWALSC PO Box 585 CANNINGTON WA 6987 Phone: (08) 9358 7400 Fax: (08) 9358 7499	West of Section 1 South
Wagyl Kaip WC98/70 WAD6286/98	Mr Allan Bolton, Mr Cedric Roberts, Mr Glen Colbung, Mr Ken Colbung, Mr Kevin Miller, Mr Mark Smith, Mr Sam Miller, Ms Hazel Brown, Ms Marlene Ware, Ms Mingli Wanjurri-Nungala, Ms Rita Dempster and Ms Rose Pickett	Ms Maryse Aranda, SWALSC PO Box 585 CANNINGTON WA 6987 Phone: (08) 9358 7400 Fax: (08) 9358 7499	West of Section 1 South

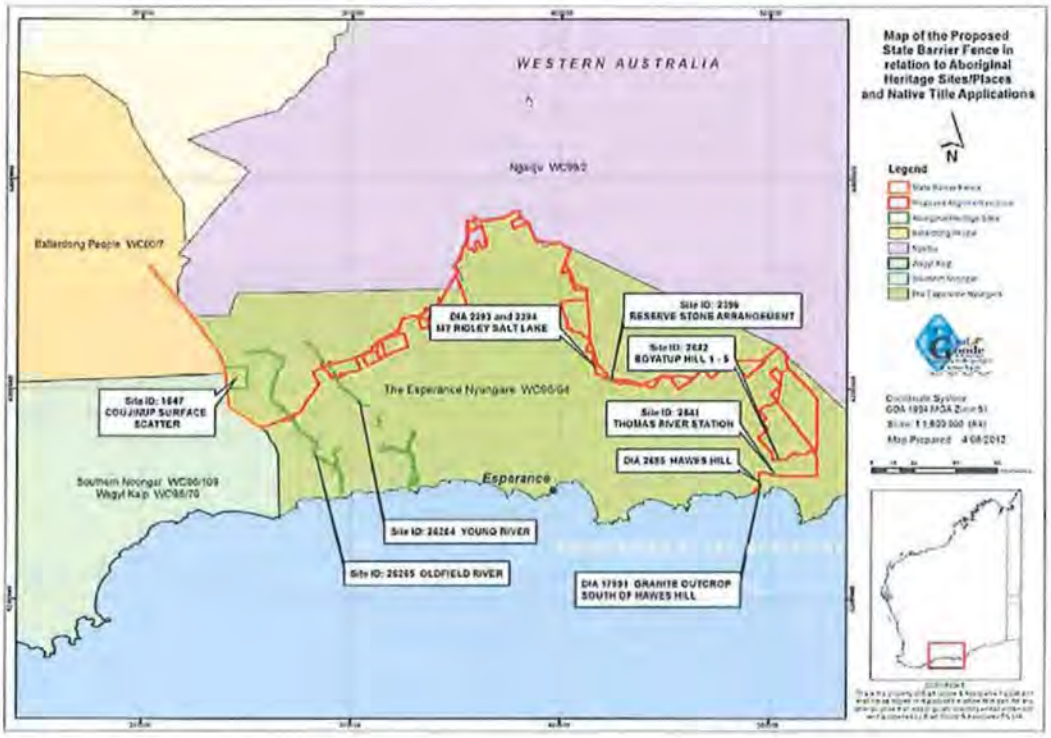

Figure 2: Location of Proposed State Barrier Fence Esperance Extension in relation to Aboriginal heritage Sites/Places and Native Title Claim Applications.

NAMED SITE INFORMANTS FOR DIA SITES WITHIN THE PROPOSED ALIGNMENT

Site ID 2396 'Reserve Stone Arrangement'

This site is mythological and ceremonial in nature and as it is a 'Closed' site, written permission from the site informants is required by the DIA before access can be given to any restricted file. The following people listed were consulted for this site; they may or may not be the site informants:

Listed Site Informants: Mr Bill Bennell, Mr Gordon Harris, Ms Theresa Holmes, Ms Veronica Williams, Ms Angie Bullen, Ms Dianne Bullen, Mr Jimmy Dimer, Mrs. Bullen, Mr Terry Yorkshire, Mr Warren Yorkshire

Contact:
Church Officials.
Department of CALM.
Landowners and holders of mining interests from the Mitchell Plateau.

Site ID 26264 'Young River' and Site ID 26265 'Oldfield River'

Listed Site Informants: Mr Alan Bullen, Mr Henry Samuel Dabb, Mr Eddy Dimer, Mr Doc Reynolds, Mr Errol Williams and Mr Terry Yorkshire.

Contact: Kepa Kurl Aboriginal Eco-Tours Corporation
PO Box 1754
ESPERANCE WA 6450
Ph: (08) 9072 1688

RECOMMENDATIONS

As a result of this Desktop Aboriginal Heritage Survey of the State Barrier Fence Esperance Extension, the following recommendations can be made:

It is recommended that specific recommendations for each site identified to be intersected by the State Barrier Fence Esperance Extension proposal is given consideration and enacted upon should the proposal proceed to construction (see Table 4 in Outcomes of Archival Research).

In terms of the general project the following recommendations are made:

It is recommended that previously recorded archaeological sites where the actual extent is not defined and where options intersect the DIA buffered extent should be verified in the field by a qualified Archaeologist in order that the proponents remain compliant with all obligations under the AHA.

Once the actual extent has been verified, **it is recommended** that the fence be redesigned to avoid these areas. If avoidance is not possible, ministerial consent notice will be required to be lodged under Section 18 of the AHA for consent to use the land that may contain an Aboriginal heritage site.

In relation to ethnographic Aboriginal heritage sites, **it is recommended** that where the DIA buffered extent is intersected by the proposed alignments that consultations are conducted with the named DIA site informants and Native Title Claimants (see Native Title Claims Extant over the Project Area, page 21-22) in order that the heritage values of these places are accurately determined. Should avoidance not be possible (i.e. river crossings) ministerial consent notice will be required to be lodged under Section 18 of the AHA for consent to use the land that may contain an Aboriginal heritage site.

In terms of the general survey area, several sections of the State Barrier Fence Esperance Extension proposal are yet to be subject to rigorous archaeological and ethnographic enquiries and as such **it is recommended** that these areas are inspected by a qualified Archaeologist and that these areas are subject to consultation with the appropriate representative bodies and/or Native Title Claim groups in order to ascertain if a full ethnographic survey is required.

BIBLIOGRAPHY

de Gand, D M 2002, *Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim Area (Sambo Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in W.A.*, unpublished report prepared for Worley Pipelines and Terminals Pty Ltd.

de Gand, D M 2002, *Report on an Aboriginal Heritage Assessment in the Central West Native Title Claim Area (Donaldson Family) of the Proposed Kambalda (West) to Esperance Gas Pipeline in W.A.*, unpublished report prepared for Worley Pipelines and Terminals Pty Ltd.

Glendenning, W 2003, *A Report of an Archaeological and Ethnographic Survey undertaken as part of a Section 18 Application to disturb Howick Hill, near Condingup*, unpublished report prepared for the Shire of Esperance.

O'Connor, R 1990, *Report on an Ethnographic Survey of the Proposed Perth to Adelaide Optic Fibre Cable Route*, unpublished report prepared for Telecom Australia.

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Smith, M 1993, *Recherche A L'Esperance: A Prehistory of the Esperance Region of South Western Australia*, Thesis presented for the degree of Doctor of Philosophy of the University of Western Australia, Department of Anthropology.

APPENDIX 1: SITES REGISTER SEARCH

Search Criteria

19 sites in a search polygon. The polygon is formed by these points (in order):

MGA Zone 51	
Northing	Easting
6387342	380793
6367498	405796
6367697	405102
6347258	413833
6323842	415421
6312134	418000
6305983	424350
6303998	438936
6306975	449254
6309554	468304
6307570	472273
6314317	481203
6321064	503924
6315508	509877
6295664	523966
6257524	524363
6257722	496979
6253158	495986
6250380	492811
6250976	492613
6254151	494796
6260302	495391
6302371	495391
6298799	457093
6301577	422564
6308126	413436
6330748	401332
6366982	389921
6367181	366704
6333843	355592

6324318	343090
6303681	293679
6300506	285245
6283638	272347
6280265	256670
6291179	240795
6315984	236033
6358846	203687
6329279	229484
6317373	238017
6307848	241589
6292370	243177
6283043	258258
6308443	280284
6313999	289214
6341185	334061
6367379	351127
6382976	353806
6387342	380793

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Legend

Restriction

N	No restriction
M	Male access only
F	Female access

Access

C	Closed
O	Open
V	Vulnerable

Coordinate Accuracy

Accuracy is shown as a code in brackets following the site coordinates.

[Reliable]	The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
[Unreliable]	The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L - Lodged		ACMC Decision Made
Information lodged, awaiting assessment	→	R - Registered Site I - Insufficient information S - Stored Data

Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code "closed" or "vulnerable". Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.

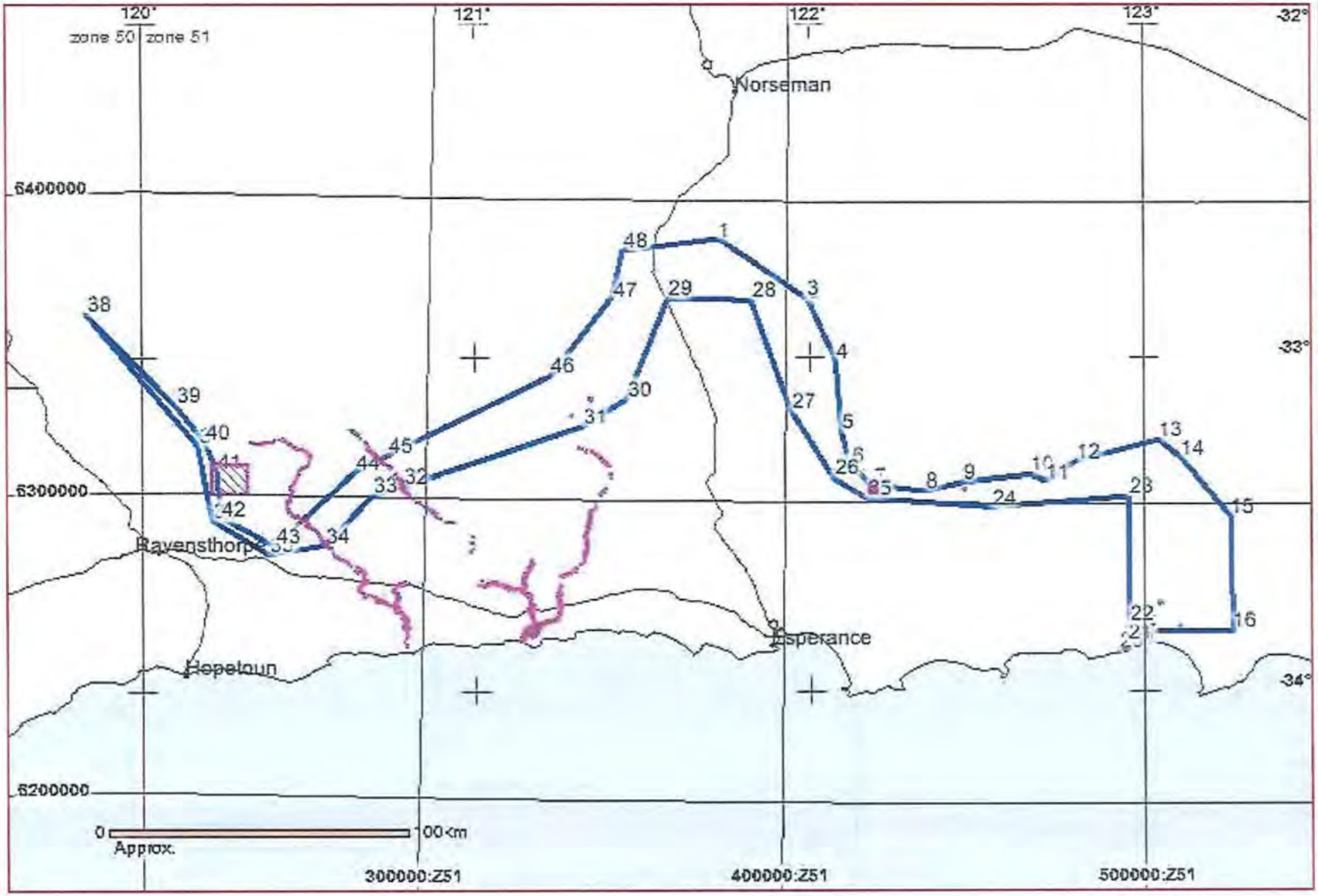
Sites Shown on Maps

Site boundaries may not appear on maps at low zoom levels

List of 12 Registered Aboriginal Sites with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
1647	R	O	N	Coujinup Surface Scatter	Artefacts / Scatter			245133mE 6305157mN Zone 51 [Unreliable]	W01551
1757	R	O	N	Mt Ney	Artefacts / Scatter			449837mE 6304756mN Zone 51 [Unreliable]	W01445
2158	R	O	N	The Cups.	Artefacts / Scatter	Water Source		345637mE 6333656mN Zone 51 [Unreliable]	W01086
2396	R	C	N	Reserve Stone Arrangement.	Ceremonial, Mythological, Man-Made Structure, Artefacts / Scatter	Water Source, [Other: PA 32]		Not available for closed sites	W00805
2641	R	O	N	Thomas River Station	Artefacts / Scatter			502837mE 6259406mN Zone 51 [Reliable]	W00560
2642	R	O	N	Boyatup Hill 1 - 5.	Painting, Artefacts / Scatter	Rockshelter, Water Source, [Other: PA 31, W561.1-5]		504247mE 6267121mN Zone 51 [Reliable]	W00561
2646	R	O	N	Boyatup Hill Depessn.	Artefacts / Scatter			504138mE 6267156mN Zone 51 [Unreliable]	W00565
2647	R	O	N	Washpool	Artefacts / Scatter			509773mE 6259000mN Zone 51 [Unreliable]	W00566
2686	R	O	N	Chert Outcrop	Quarry, Artefacts / Scatter			494637mE 6251656mN Zone 51 [Unreliable]	W00551

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
26264	R	O	N	Young River	Mythological		*Registered Informant names available from DIA.	315933mE 6279194mN Zone 51 [Reliable]	
26265	R	O	N	Oldfield River	Mythological		*Registered Informant names available from DIA.	278067mE 6282070mN Zone 51 [Reliable]	
26266	R	O	N	Lort River	Mythological	[Other: weir type fishtraps]	*Registered Informant names available from DIA.	342857mE 6285855mN Zone 51 [Reliable]	



Legend

Selected Heritage Sites

Registered Sites

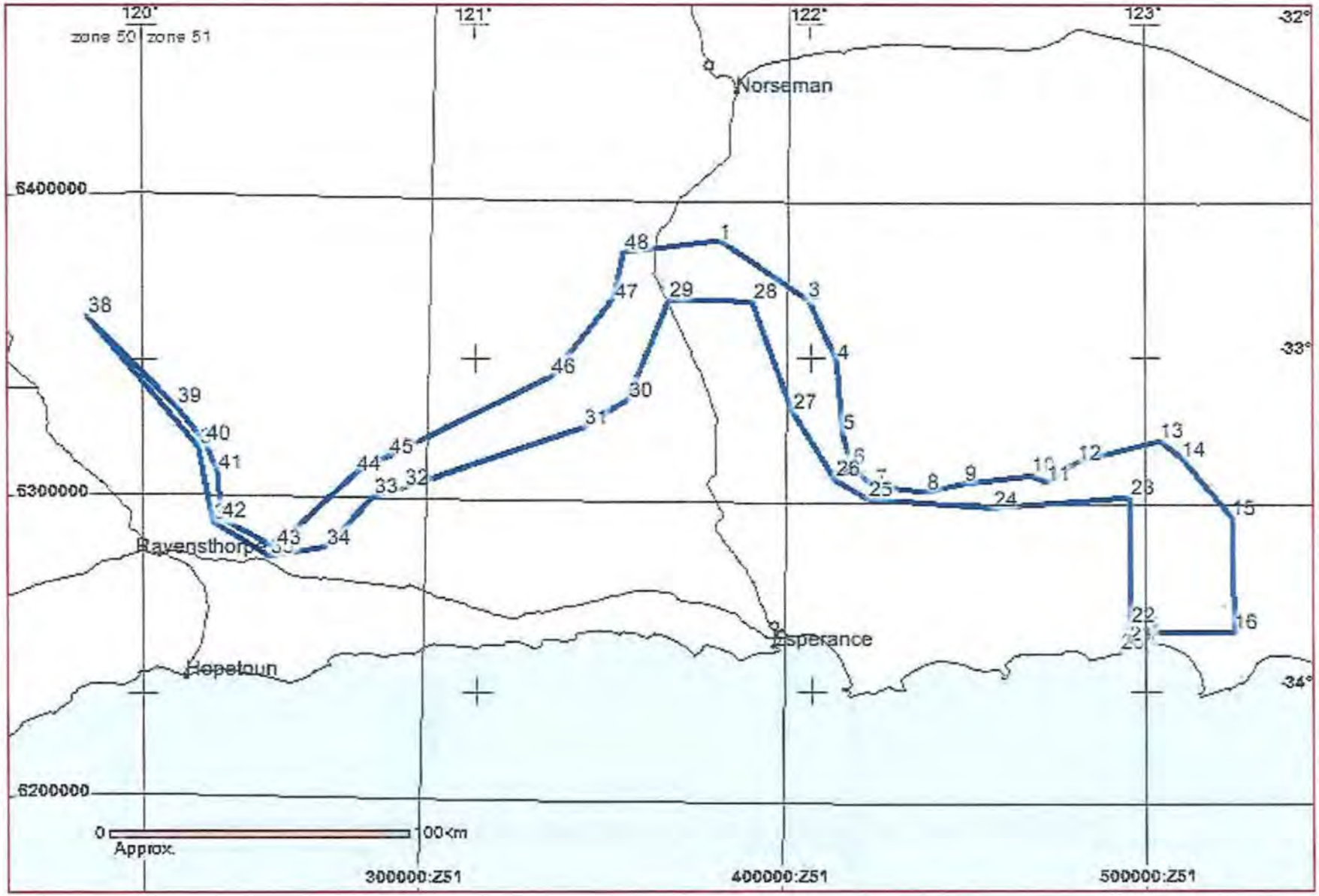
Town

Map Area

Search Area

List of 7 Other Heritage Places with Map

Site ID	Status	Access	Restriction	Site Name	Site Type	Additional Info	Informants	Coordinates	Site No.
2393	L	O	N	Mt Ridley Salt Lake	Artefacts / Scatter			416637mE 6310656mN Zone 51 [Unreliable]	W00802
2394	L	O	N	Mt Ridley Salt Lake	Artefacts / Scatter			416637mE 6310656mN Zone 51 [Unreliable]	W00803
2580	I	O	N	Willbe 1	Artefacts / Scatter			521438mE 6266156mN Zone 51 [Reliable]	W00608
2640	I	O	N	Thomas River Station	Artefacts / Scatter			502638mE 6259656mN Zone 51 [Unreliable]	W00559
2685	I	O	N	Hawes Hill	Artefacts / Scatter			495438mE 6255556mN Zone 51 [Unreliable]	W00550
2918	I	O	N	Salmon Gums.	Man-Made Structure, Artefacts / Scatter	Camp, [Other: FOSSIL REMAINS?]		365122mE 6371211mN Zone 51 [Unreliable]	W00302
17991	L	O	N	Granite Outcrop South Of Hawes Hill	Artefacts / Scatter			495737mE 6254805mN Zone 51 [Unreliable]	



Legend

Selected Heritage Sites

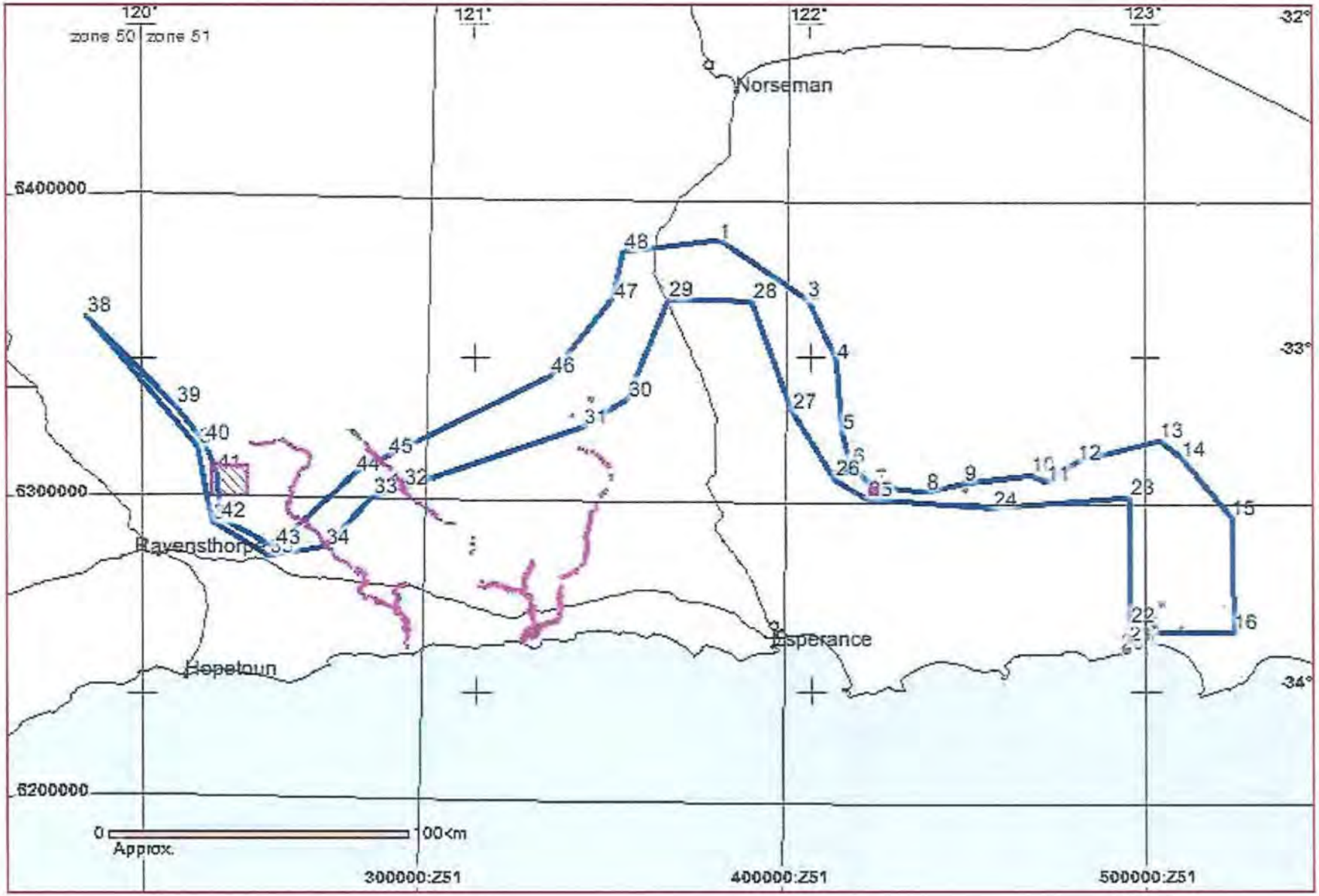
Other Heritage Places

Town

Map Area

Search Area

Map Showing Registered Aboriginal Sites and Other Heritage Places



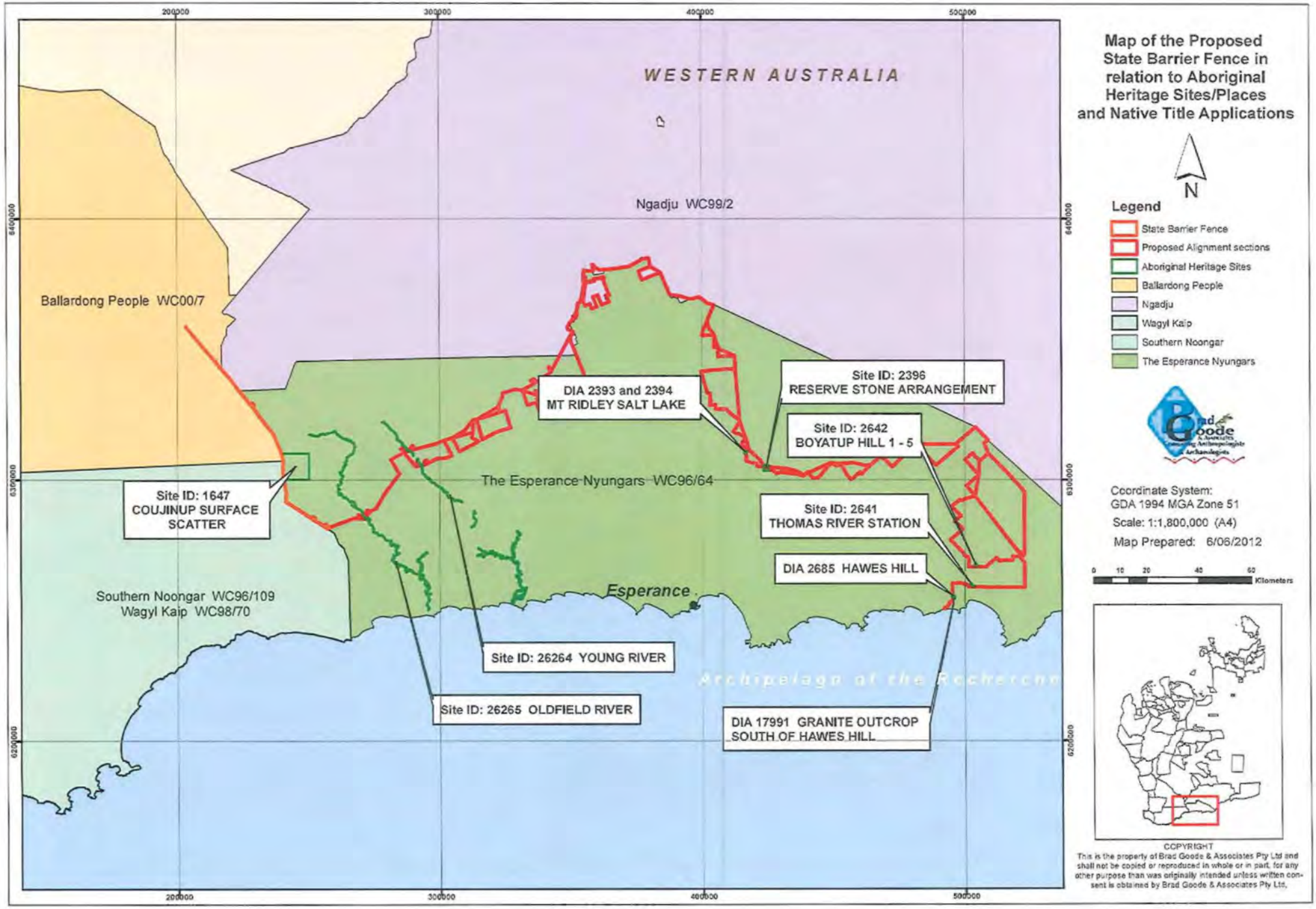
Legend

Selected Heritage Sites

- Registered Sites
- Other Heritage Places
- Town
- Map Area
- Search Area

APPENDIX 2: MAPS OF THE PROJECT AREA IN RELATION TO ABORIGINAL HERITAGE SITES/PLACES

Table 7: Table of Maps



Map of the Proposed State Barrier Fence in relation to Aboriginal Heritage Sites/Places and Native Title Applications

N

Legend

- State Barrier Fence
- Proposed Alignment sections
- Aboriginal Heritage Sites
- Ballardong People
- Ngadju
- Wagyl Kaip
- Southern Noongar
- The Esperance Nyungars

Coordinate System:
GDA 1994 MGA Zone 51

Scale: 1:1,800,000 (A4)

Map Prepared: 6/06/2012

0 10 20 40 60 Kilometers

Map of Previous Aboriginal Heritage Surveys

Legend

- Proposed_Alignment_sections
- StateBarrierFence
- Aboriginal Heritage Surveys
- Aboriginal Heritage Surveys

N

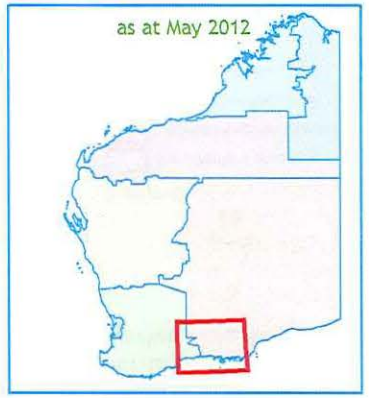
1:1,800,000

0 10 20

Kilometers

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

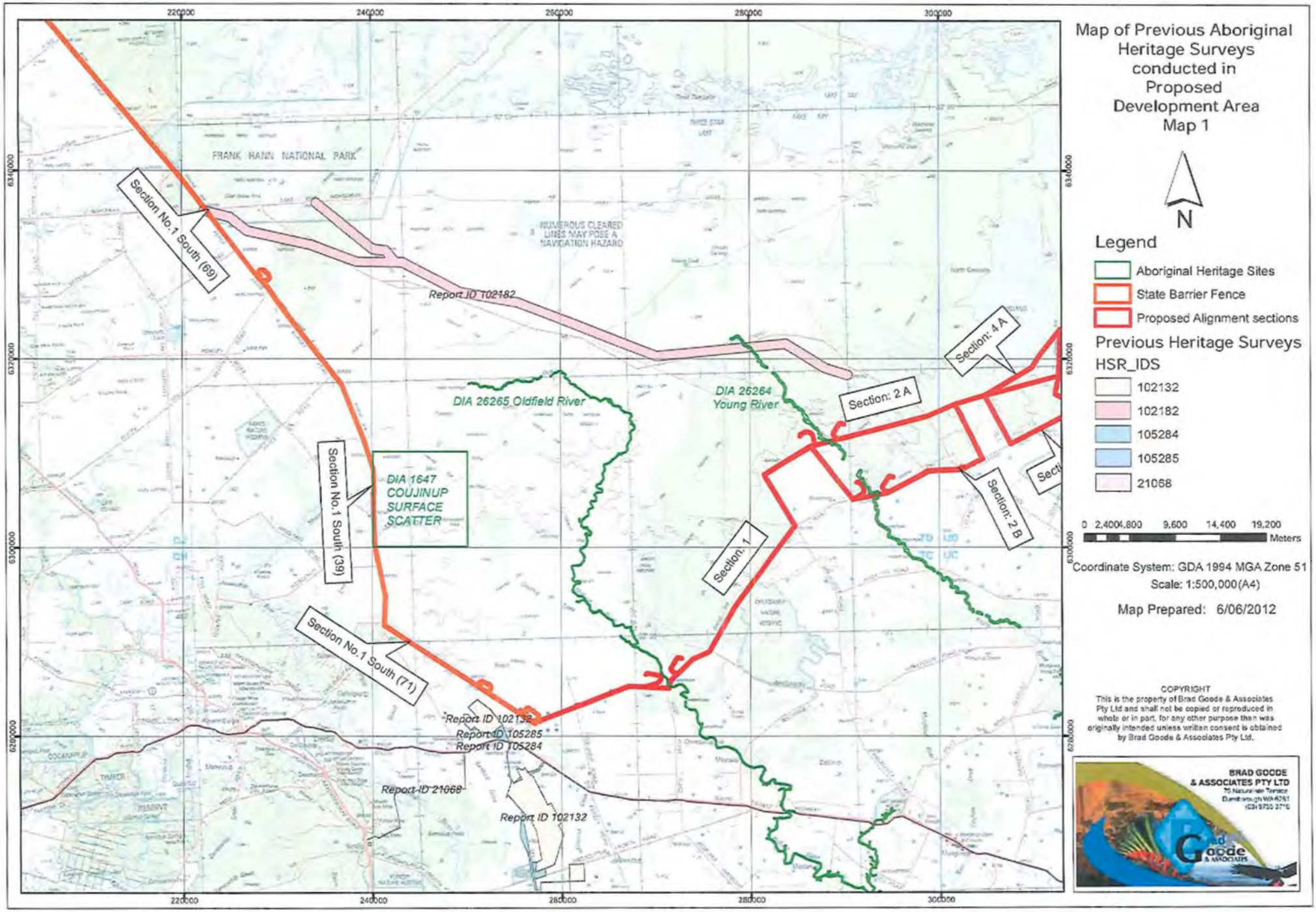
Survey Intersections overview



Government of Western Australia
Department of Indigenous Affairs

Drawn by: simon.keenan

\\PDCFIL01\UserData$\Restricted_MOEUserLibraries\simon.keenan\Documents\ArcGIS\Chichester MEtals May 2012 Wunna Nyipap map.mxd


Map of Previous Aboriginal Heritage Surveys conducted in Proposed Development Area Map 1
N
Legend
Aboriginal Heritage Sites
State Barrier Fence
Proposed Alignment sections
Previous Heritage Surveys
HSR_IDS
102132
102182
105284
105285
21068
0 2,400 4,800 9,600 14,400 19,200
Meters
Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:500,000(A4)
Map Prepared: 6/06/2012
FRANK HANN NATIONAL PARK
NUMEROUS CLEARED LINES MAY POSE A NAVIGATION HAZARD
Section No.1 South (69)
Report ID 102182
DIA 26265 Oldfield River
DIA 26264 Young River
Section: 4 A
Section: 2 A
Section: 2 B
Section. 1
Section No.1 South (39)
DIA 1647 COUJINUP SURFACE SCATTER
Section No.1 South (71)
Report ID 102132
Report ID 105285
Report ID 105284
Report ID 21068
Report ID 102132
220000
240000
260000
280000
300000
6340000
6320000
6300000
6280000
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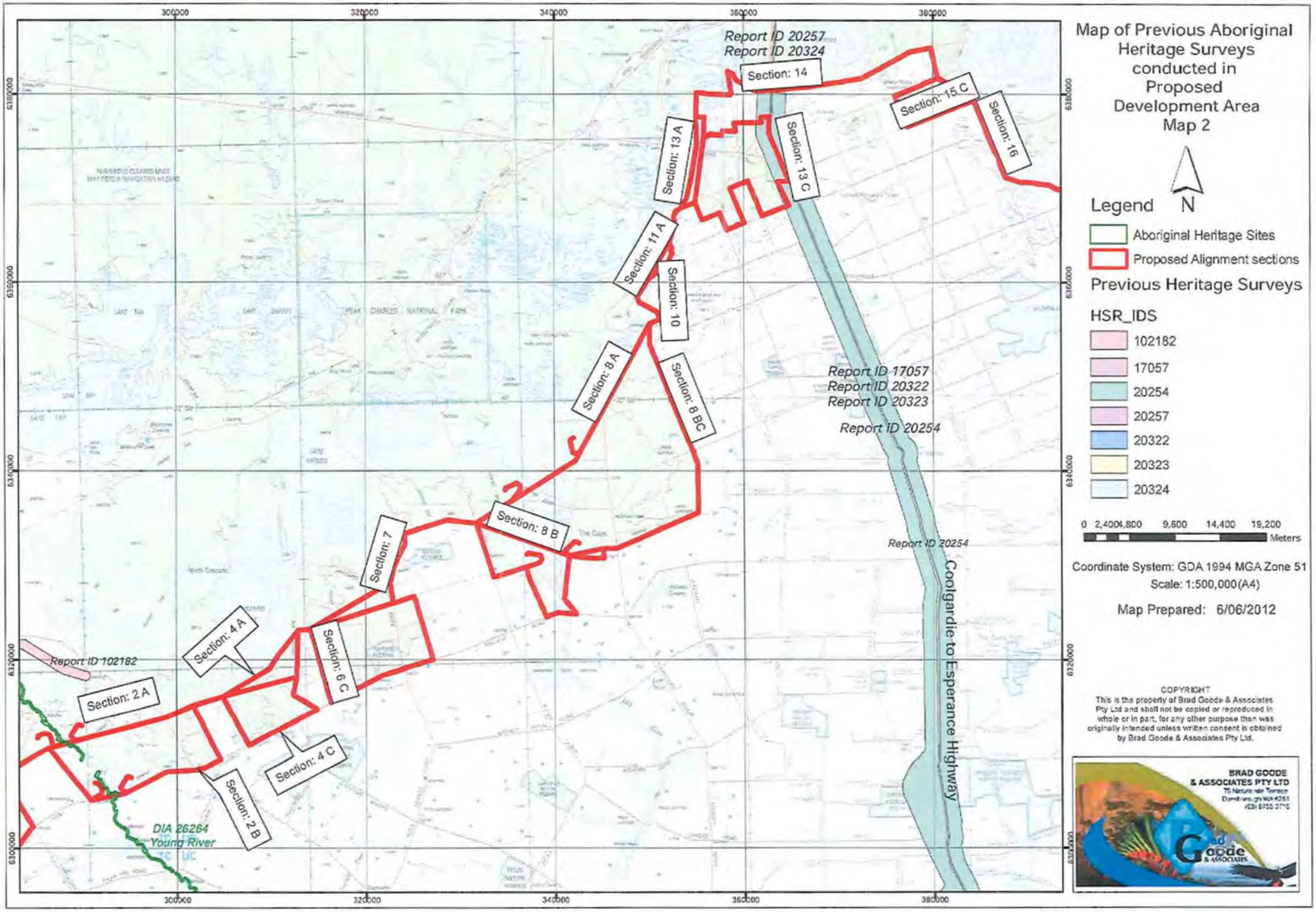
Report ID 20257
Report ID 20324
Section: 14
Section: 15 C
Section: 16
Section: 13 A
Section: 13 C
Section: 11 A
Section: 10
Section: 8 A
Section: 8 BC
Section: 8 B
Section: 7
Section: 6 C
Section: 4 A
Section: 4 C
Section: 2 A
Section: 2 B
Report ID 102182
Report ID 17057
Report ID 20322
Report ID 20323
Report ID 20254
Report ID 20254
Coolgardie to Esperance Highway
DIA 26264
Young River
Map of Previous Aboriginal Heritage Surveys conducted in Proposed Development Area Map 2
N
Legend
Aboriginal Heritage Sites
Proposed Alignment sections
Previous Heritage Surveys
HSR_IDS
102182
17057
20254
20257
20322
20323
20324
0 2,400 4,800 9,600 14,400 19,200
Meters
Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:500,000(A4)
Map Prepared: 6/06/2012
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Map of Previous Aboriginal Heritage Surveys conducted in Proposed Development Area Map 4
N
Legend
Aboriginal Heritage Sites
Proposed Alignment sections
Previous Heritage Surveys
HSR_IDS
106482
17057
17221
17230
17231
17600
18775
0 1,700 3,400 6,800 10,200 13,600
Meters
Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:350,000(A4)
Map Prepared: 6/06/2012
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BRAD GOODE & ASSOCIATES PTY LTD
Report ID 17230
Report ID 17057
Report ID 106482
Report ID 17221
Report ID 17600
Report ID 18775
Report ID 17231
Section: 33 C
Section: 34 B
Section: 35 B
Section: 35 C
Section: 32 A
Section: 38
DIA 2642 BOYATUP HILL 1 - 5.
DIA 2641 THOMAS RIVER STATION
DIA 2685 HAWES HILL
DIA 17991 GRANITE OUTCROP SOUTH OF HAWES HILL
YOKINUP BAY
SANDY
480000
500000
520000
540000
6300000
6280000
6260000

Legend

- Aboriginal Heritage Sites State Barrier
- State Barrier Fence 100m Corridor
- StateBarrierFence

Aerial Imagery supplied by GHD:

6128161_Moolyall08_Coujinup MGA51_20120529.ers

Map of Proposed State Barrier Fence in relation to Site ID 1647 Coujinup Surface Scatter

BRAD GOODE & ASSOCIATES PTY LTD
79 Naturaliste Terrace
Bunbury WA 6230
(08) 9755 3710

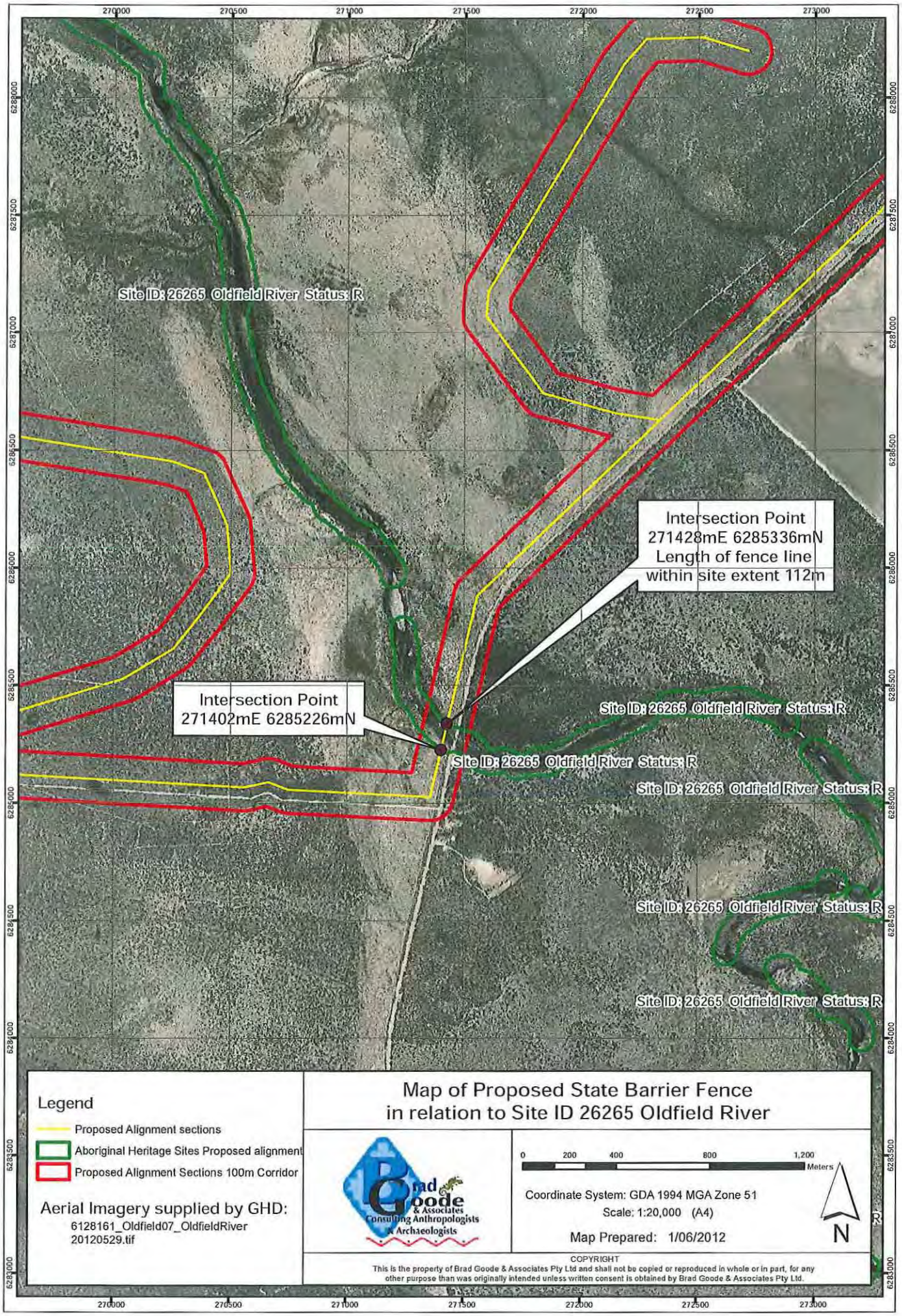
0 500 1,000 2,000 3,000 Meters

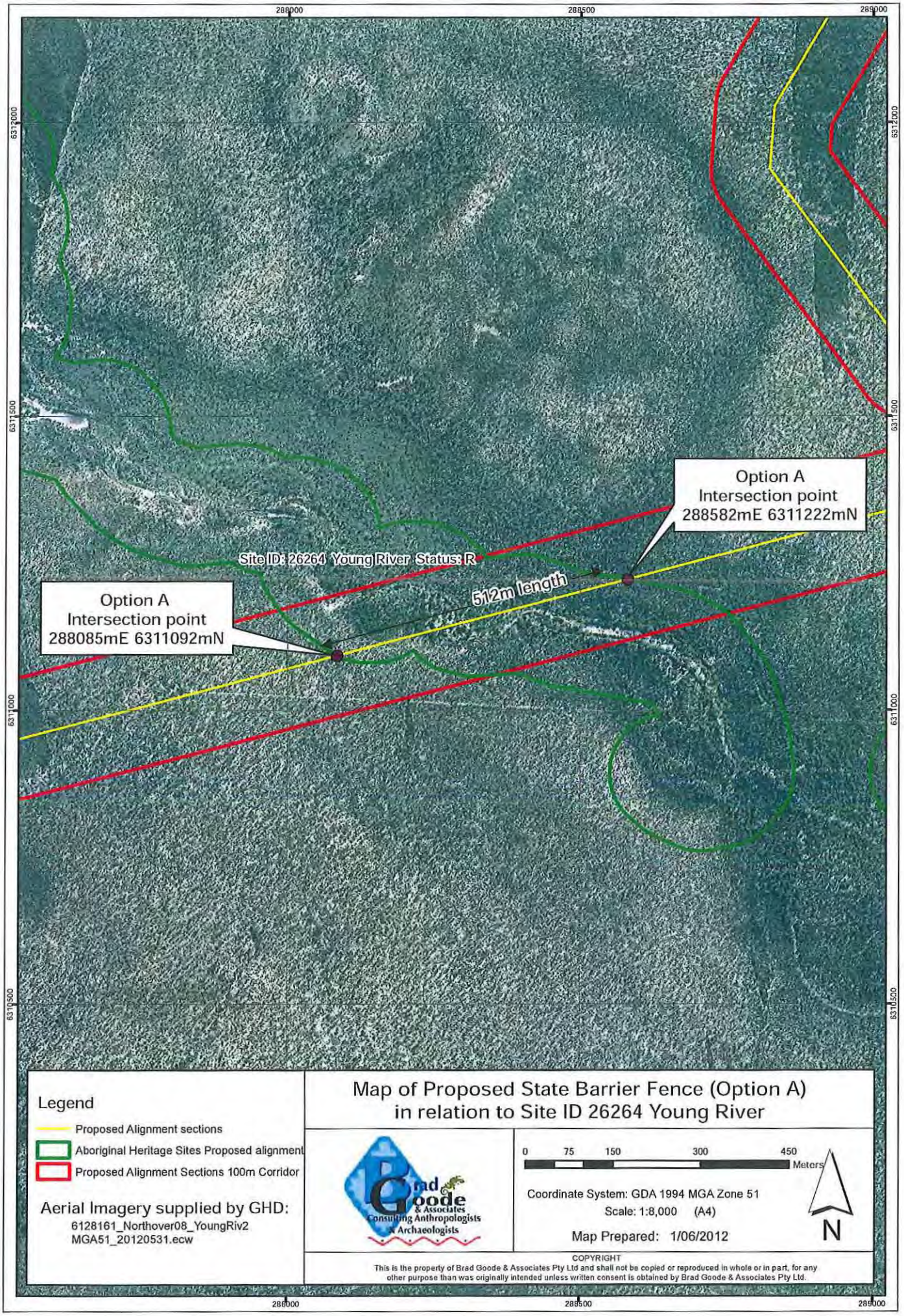
Coordinate System: GDA 1994 MGA Zone 51

Scale: 1:60,000 (A4)

Map Prepared: 31/05/2012

N




288000
288500
289000
6312000
6311500
6311000
6310500
Option A
Intersection point
288582mE 6311222mN
Site ID: 26264 Young River Status: R
512m length
Option A
Intersection point
288085mE 6311092mN
Legend
Proposed Alignment sections
Aboriginal Heritage Sites Proposed alignment
Proposed Alignment Sections 100m Corridor
Aerial Imagery supplied by GHD:
6128161_Northover08_YoungRiv2
MGA51_20120531.ecw
Map of Proposed State Barrier Fence (Option A)
in relation to Site ID 26264 Young River
Brad Goode & Associates
Consulting Anthropologists & Archaeologists
0 75 150 300 450
Meters
Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:8,000 (A4)
Map Prepared: 1/06/2012
N
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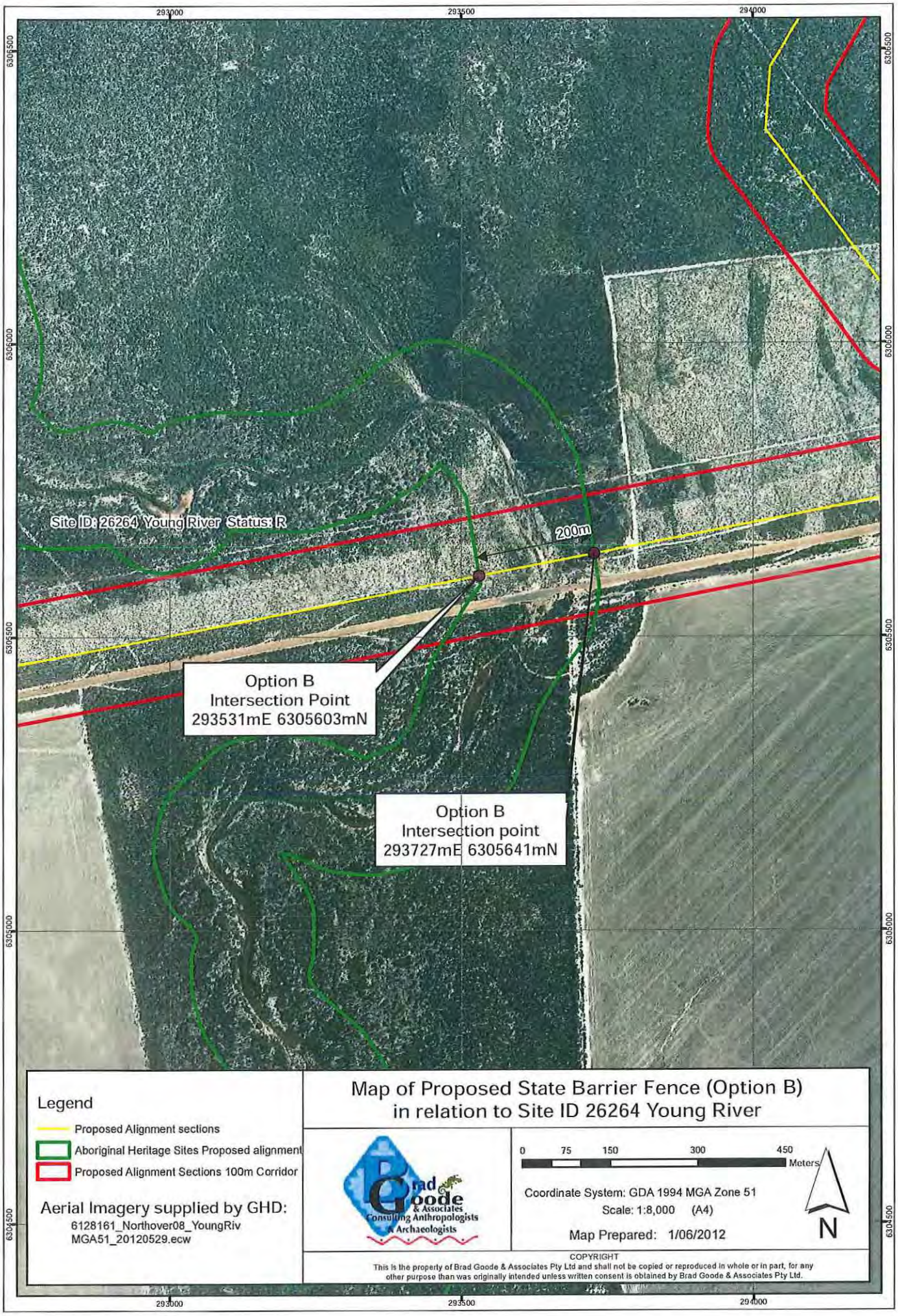


Legend

Proposed Alignment sections

Aboriginal Heritage Sites Proposed alignment

Proposed Alignment Sections 100m Corridor

Aerial Imagery supplied by GHD:
6128161_Northover08_YoungRiv
MGA51_20120529.ecw

Map of Proposed State Barrier Fence (Option B) in relation to Site ID 26264 Young River

Brad Goode & Associates
Consulting Anthropologists & Archaeologists

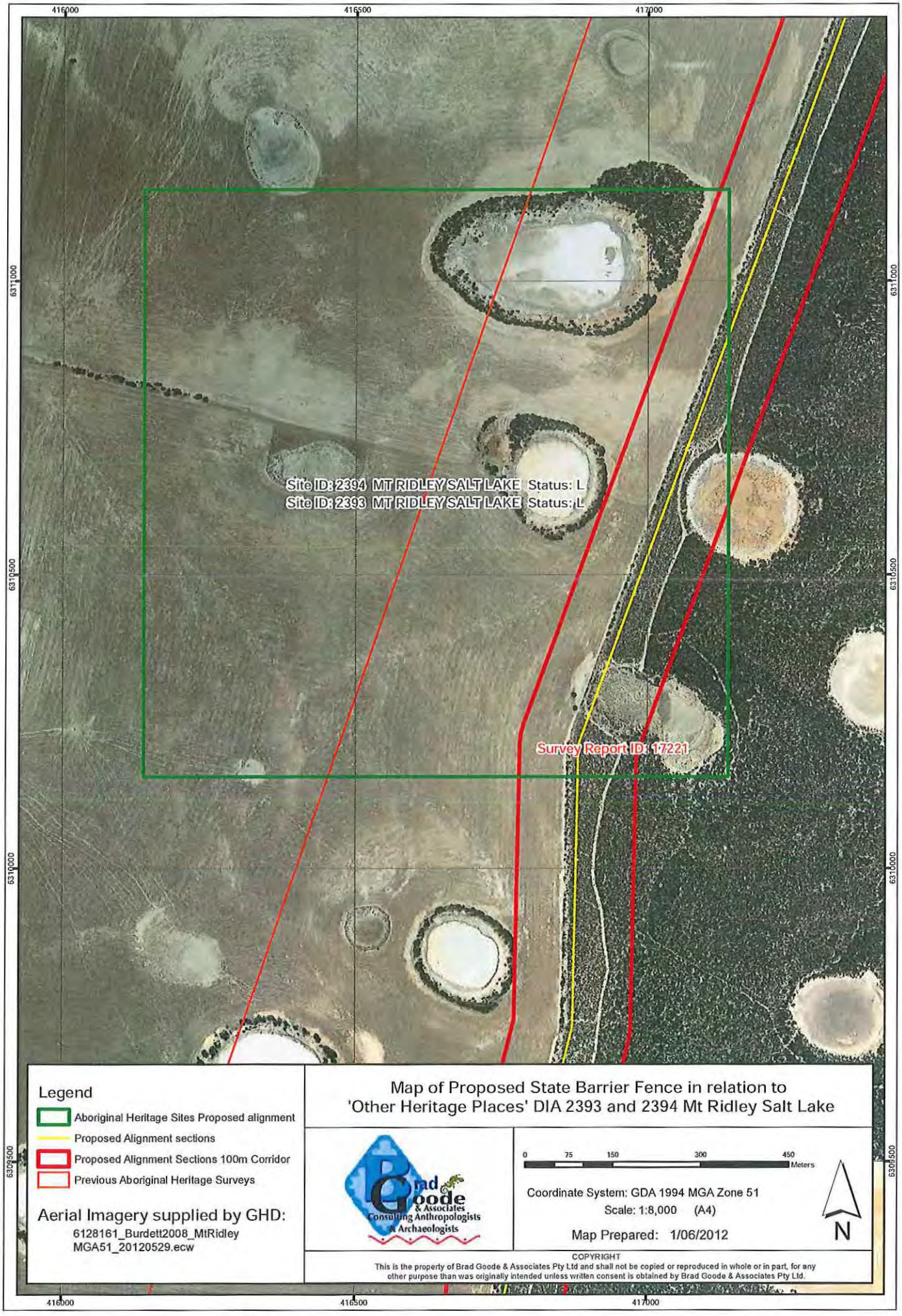
0 75 150 300 450 Meters

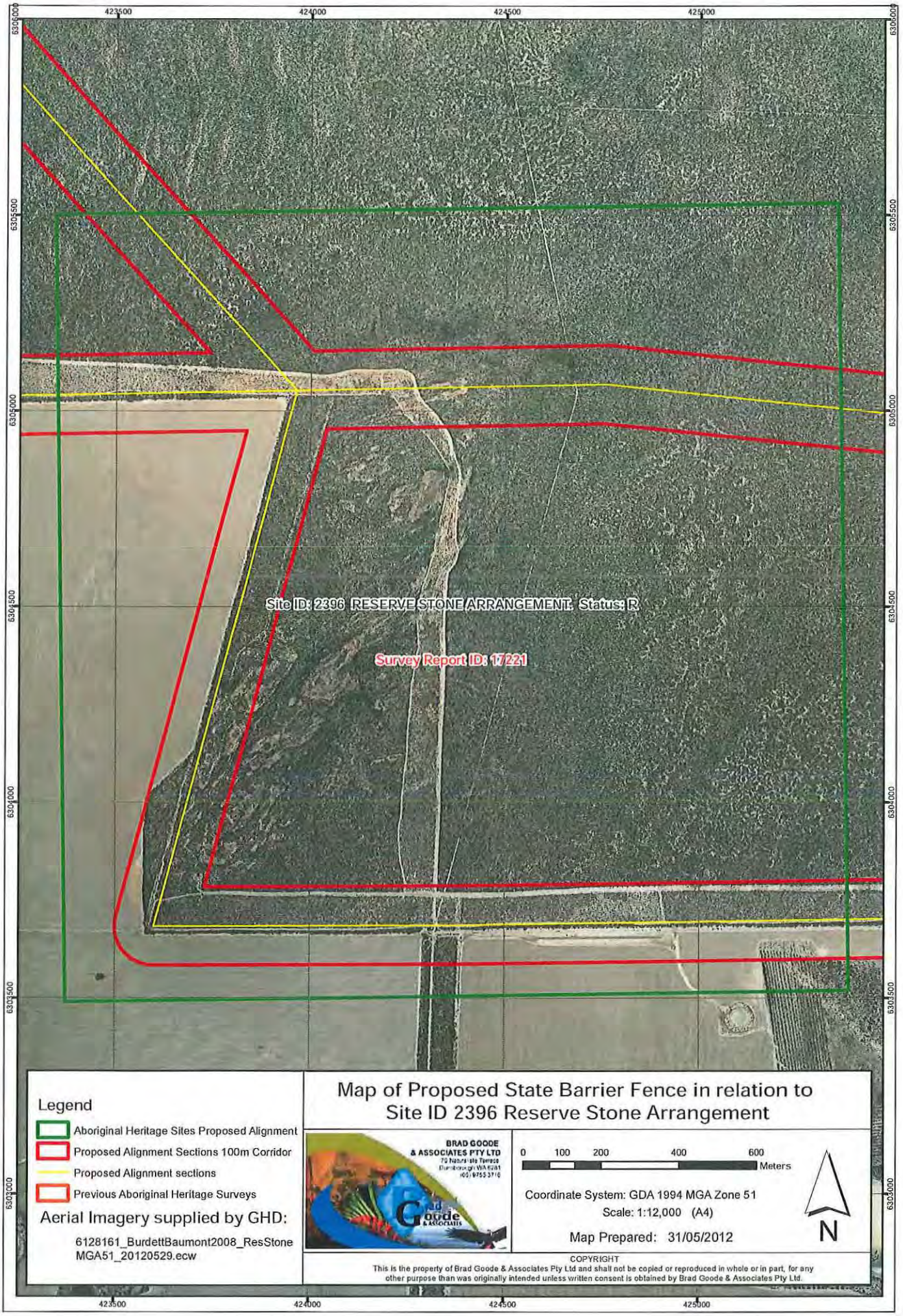
Coordinate System: GDA 1994 MGA Zone 51

Scale: 1:8,000 (A4)

Map Prepared: 1/06/2012

N





Legend

- Aboriginal Heritage Sites Proposed Alignment
- Proposed Alignment Sections 100m Corridor
- Proposed Alignment sections
- Previous Aboriginal Heritage Surveys

Aerial Imagery supplied by GHD:

6128161_BurdettBaumont2008_ResStone MGA51_20120529.ecw

Map of Proposed State Barrier Fence in relation to Site ID 2396 Reserve Stone Arrangement

BRAD GOODE & ASSOCIATES PTY LTD
70 Naburnie Terrace
Dunsborough WA 6281
(08) 9755 3710

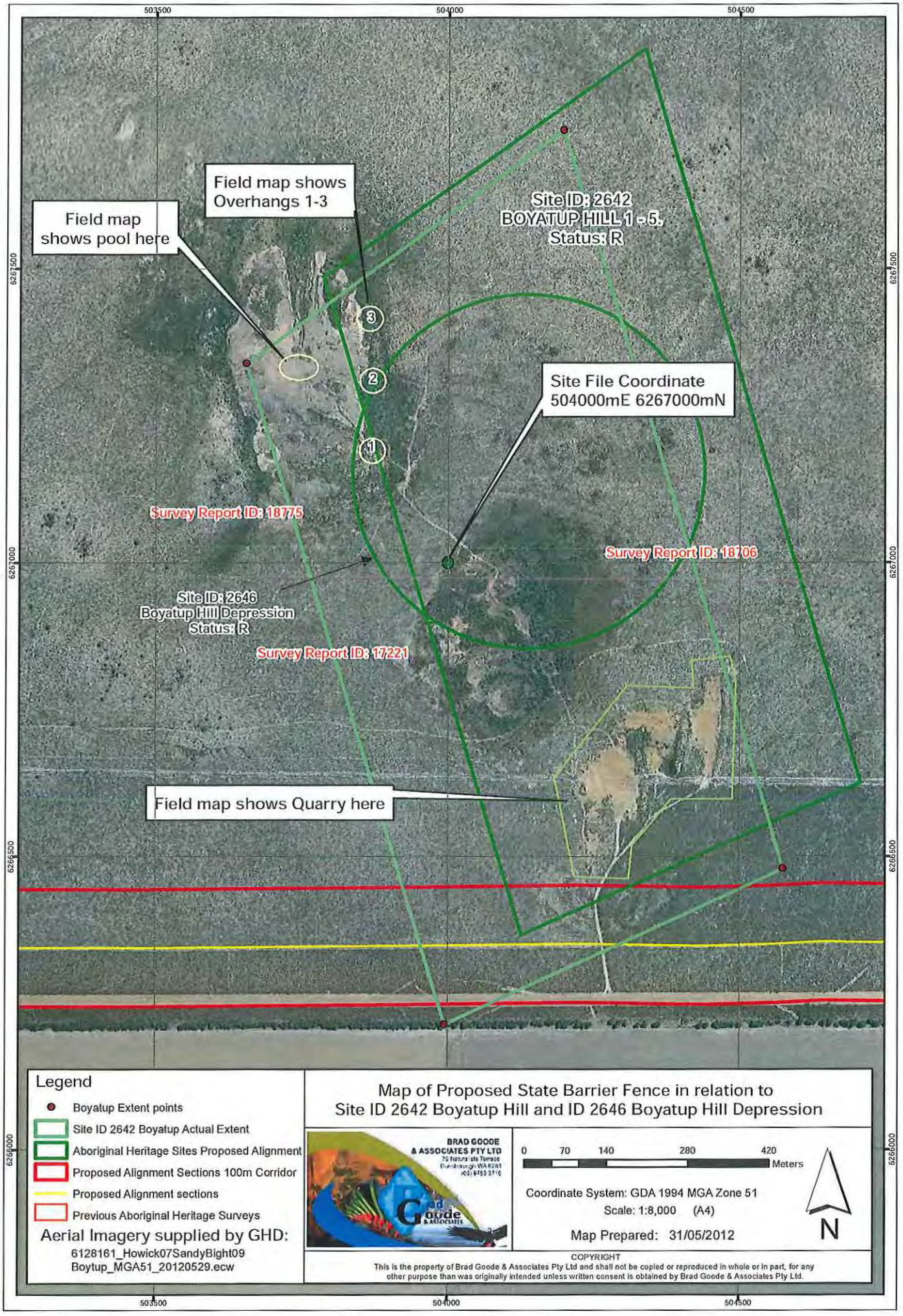
0 100 200 400 600 Meters

Coordinate System: GDA 1994 MGA Zone 51

Scale: 1:12,000 (A4)

Map Prepared: 31/05/2012

N



Legend

- Boyatup Extent points
- Site ID 2642 Boyatup Actual Extent
- Aboriginal Heritage Sites Proposed Alignment
- Proposed Alignment Sections 100m Corridor
- Proposed Alignment sections
- Previous Aboriginal Heritage Surveys

Aerial Imagery supplied by GHD:
6128161_Howick07SandyBight09
Boytup_MGA51_20120529.ecw

Map of Proposed State Barrier Fence in relation to Site ID 2642 Boyatup Hill and ID 2646 Boyatup Hill Depression

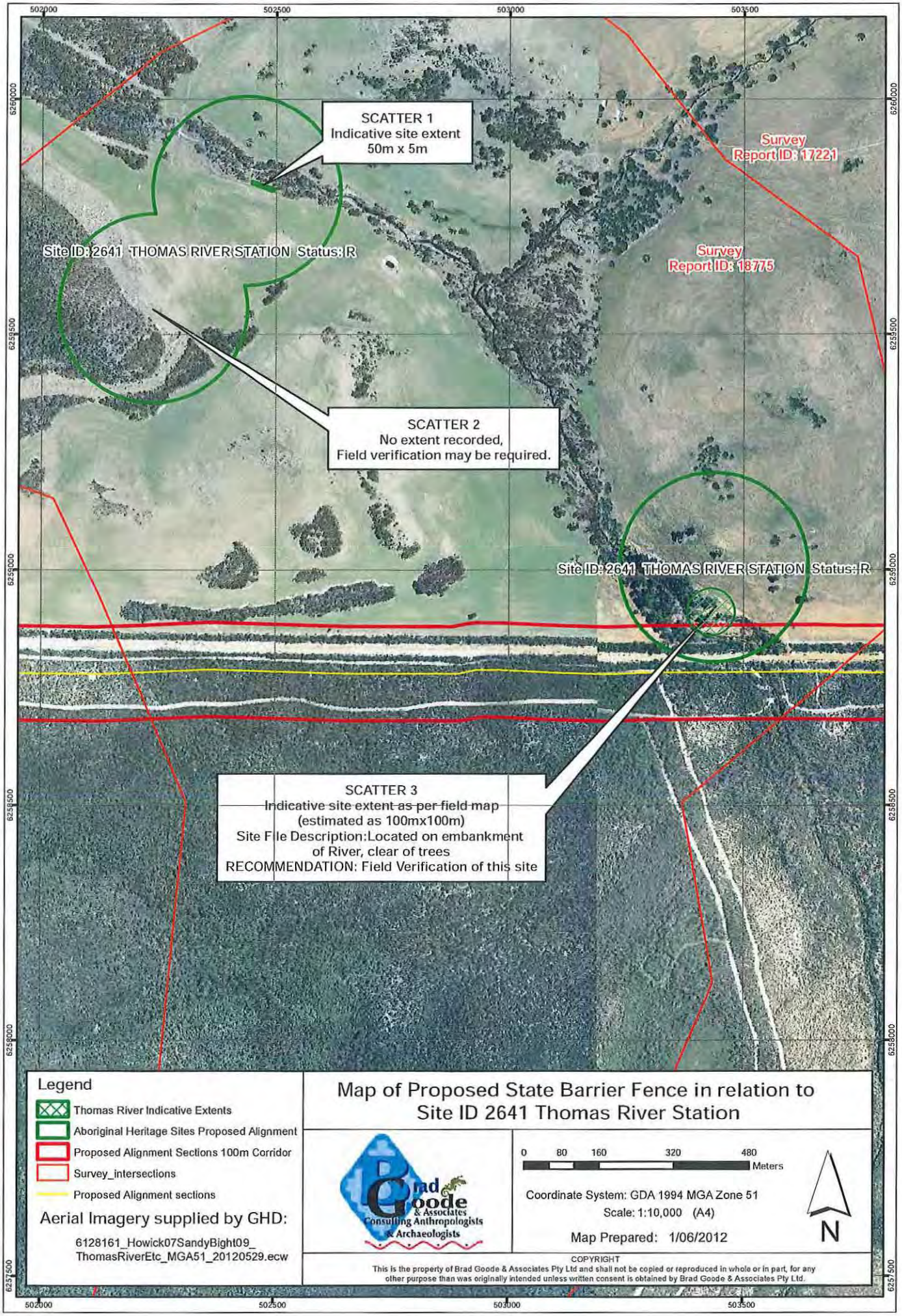
BRAD GOODE
& ASSOCIATES PTY LTD

0 70 140 280 420 Meters

Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:8,000 (A4)

Map Prepared: 31/05/2012

N



Legend

- Thomas River Indicative Extents
- Aboriginal Heritage Sites Proposed Alignment
- Proposed Alignment Sections 100m Corridor
- Survey_intersections
- Proposed Alignment sections

Aerial Imagery supplied by GHD:

6128161_Howick07SandyBight09_
ThomasRiverEtc_MGA51_20120529.ecw

Map of Proposed State Barrier Fence in relation to Site ID 2641 Thomas River Station

Brad Goode & Associates
Consulting Anthropologists & Archaeologists

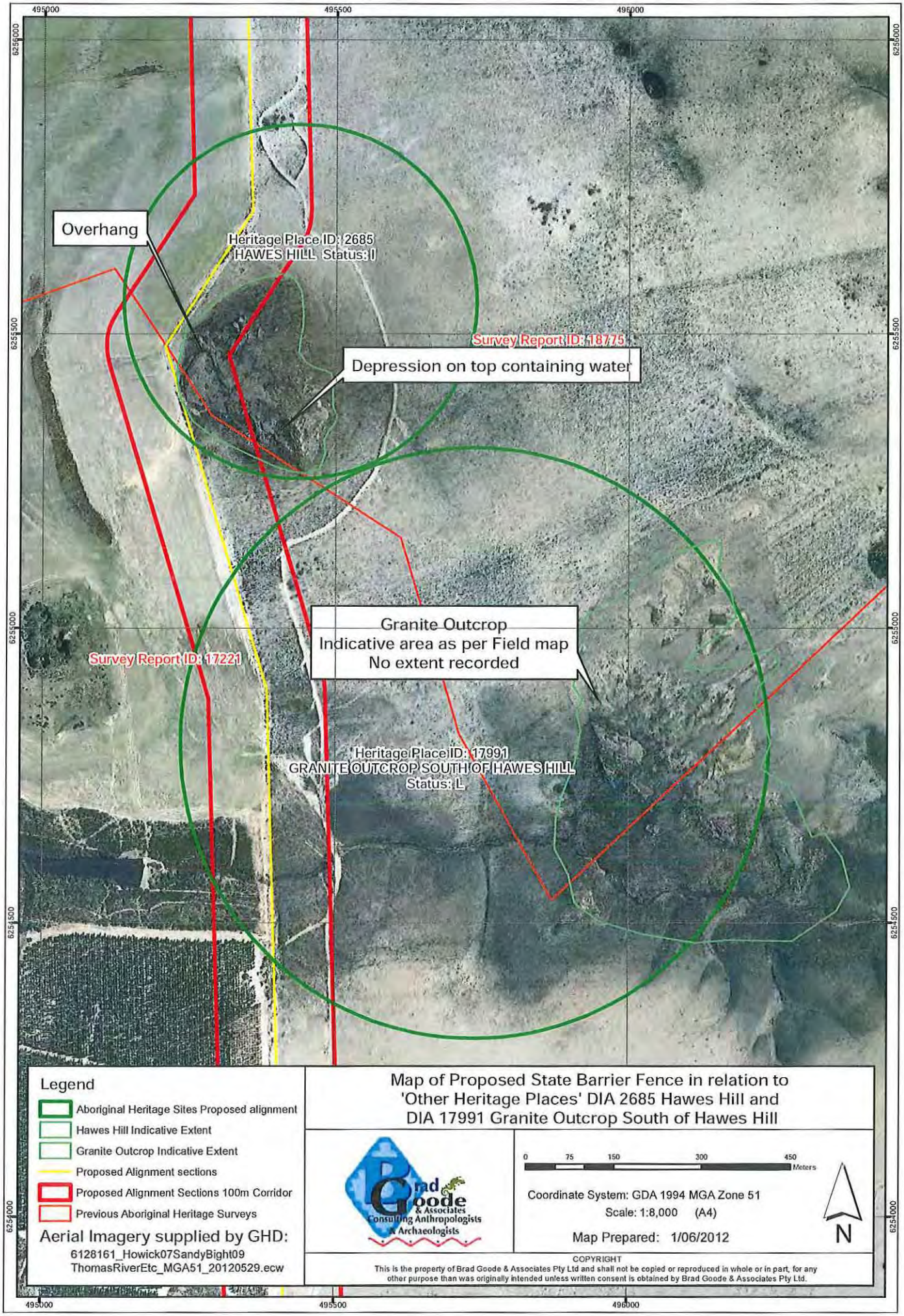
0 80 160 320 480 Meters

Coordinate System: GDA 1994 MGA Zone 51

Scale: 1:10,000 (A4)

Map Prepared: 1/06/2012

N



Legend

- Aboriginal Heritage Sites Proposed alignment
- Hawes Hill Indicative Extent
- Granite Outcrop Indicative Extent
- Proposed Alignment sections
- Proposed Alignment Sections 100m Corridor
- Previous Aboriginal Heritage Surveys

Aerial Imagery supplied by GHD:
6128161_Howick07SandyBight09
ThomasRiverEtc_MGA51_20120529.ecw

Map of Proposed State Barrier Fence in relation to 'Other Heritage Places' DIA 2685 Hawes Hill and DIA 17991 Granite Outcrop South of Hawes Hill

Brad Goode & Associates
Consulting Anthropologists & Archaeologists

0 75 150 300 450 Meters

Coordinate System: GDA 1994 MGA Zone 51
Scale: 1:8,000 (A4)
Map Prepared: 1/06/2012

N

Appendix J

Constraints Table

GHD

Alignment		Physical						Social and Planning				Aboriginal Heritage Sites		Dieback			Risk from Lack of Information	Alignment of least constraint options highlighted in blue
Section	Option	Waterway crossing	Geology	Soft ground	Access	90° angle	Length	Conservation Area	Distance <100m	ESA < 100m	Roads present	Registered	Other	Positive recovery within 100m of alignment	Susceptible Vegetation	Risk		
1		Oldfield River			Mostly good, could not access West Point Rd during survey (road closed) so some areas unknown	1	50	Cheadanup Nature Reserve	57.81	1883					Present	Moderate to High		
2	A	Young River			Unable to access		18.42					Young River (ID26264) Oldfield River (ID 26265)			Present	Moderate to High		
2	B	Young River			Good access	2	30.87				Cascade rd	Young River (ID26264) Oldfield River (ID 26265)			Present	Moderate to High		
3					Good access		3.26									Low		
4	A	unnamed			Unable to access		10.8									Low		
4	B				Unable to access		8.1											
4	BC				Good access		4.9											
4	C				Good access		18.9											Altered to follow main public and decrease the sharp angle
5					Good access		1.33											
6	A				Unable to access		9.79											
6	B				Unable to access		9.15											
6	C		Quartz area		Good access for most, one part could not be accessed this survey	2	2.19	un-named	0		Neds Corner rd					Low		Recommend altering route slightly to avoid reserve and granite outcrop
6	BC				Potential to access (was not accessed this survey)		29.11									Negligible		
7					Good access		13.35				Neds Corner rd, field rd & Pyramid rd				Present	Negligible		
8	A	Lort River			Unable to access		35.24				Cups rd					Negligible		
8	B	Lort River		present	Unable to access		17.9								Present	Negligible		
8	C	Lort River			Good access	4	34.43									Negligible		Recommend use of wind
8	BC	Lort River			Unable to access	33.7	34.49	Un-named						Present	Negligible			
10				present	Unable to access	1	6.94									Negligible		
11	A			Peak Charles	Unable to access		4.72									Negligible		
11	B			present	Unable to access		5.26									Negligible	Issues unknown	
12				present	Unable to access this survey		3.96									Negligible		
13	A			Kumarl Lake King	Unable to access most of this section this survey		10.03									Negligible		
13	B			Kumarl Lake King	Unable to access		6.98									Negligible		
13	C			Kumarl Lake King	Good access	9	4.73				Gimlet rd					Negligible		
13	BC			Kumarl Lake King	Unable to access		41.52									Negligible		
14		Drainage Line		Kumarl Lake King,Salt lake	Good access	1	34.92	Un-named	21.27837111		Beete & Fuller rd and Coolgardie-Esperance Highway					Negligible		
15	A			present	Unable to access		4.59									Negligible		
15	B			present	Unable to access		4.47									Negligible		Shorter route. Less road corssings.
15	C				Good access for most, one part could not be accessed this survey	2	0.16				Unnamed track					Negligible		
15	BC				Good access		15.99									Negligible		
16				Salmon Gums	Good access for most, one part could not be accessed this survey		34.5									Negligible		Recommend reassess the alignment and determine whether it is possible to follow the boundary of the UCL more
17	A			present	Unable to access		5.8									Negligible		
17	B			present	Unable to access the majority	1	9.99									Negligible		
18	A			present	Unable to access		12									Negligible		
18	B				Unable to access the majority	1	15.82			2742						Negligible		
19					Unable to access this survey		4.88				unnamed track					Negligible		
20	A				Unable to access		19.95								Present	Negligible		
20	B				Did not access the majority this survey	3	42.49				Eucalypt rd					Negligible		
21					Unable to access this survey		0.23									Low		
22	A			Lake Halbert	Unable to access		6.652				Dempster rd					Low		
22	B			Lake Halbert	Unable to access	1	9.98				Dempster rd					Low		
23	A			Lake Halbert	Unable to access		14.091				unnamed rd				Present	Moderate to High		
23	B			Lake Halbert	Unable to access		19.18				unnamed rd		Mt Ridley Salt Lake (ID2393 and ID2394)		Present	Moderate to High		
24	A			Lake Halbert	Did not access the majority this survey		15.53					Reserve stone arrangement (ID2396)			Present	Moderate to High		
24	B			Lake Halbert	Did not access the majority this survey	1	17.87				Bronzewing rd	Reserve stone arrangement (ID2396)			Present	Moderate to High		
25					Unable to access this survey		1.73								Present	Moderate to High		
26	A				Unable to access		9.7								Present	Moderate to High		
26	B				Good access		12.58	Mount Ney Nature Reserve	89.18489782						Present	Moderate to High		
27	A				Unable to access		3.72								Present	Moderate to High		
27	B				Good access		4.33	Mount Ney Nature Reserve	28.974648						Present	Moderate to High		
28	A				Unable to access		11.39								Present	Moderate to High		
28	B				Good access	2	17.39	Beaumont Nature Reserve	9.99		Heywood rd				Present	Moderate to High		
29					Unable to access	1	23.76	Beaumont Nature Reserve	10.03						Present	Moderate to High		
30	A				Unable to access		15.29								Present	Moderate to High		
30	B				Unable to access	2	23.69	Clyde Hill Nature Reserve	9.99		Clyde road				Present	Moderate to High		

Alignment		Physical						Social and Planning				Aboriginal Heritage Sites		Dieback			Risk from Lack of Information	Alignment of least constraint options highlighted in blue
Section	Option	Waterway crossing	Geology	Soft ground	Access	90° angle	Length	Conservation Area	Distance <100m	ESA < 100m	Roads present	Registered	Other	Positive recovery within 100m of alignment	Susceptible Vegetation	Risk		
31			Rocky area		Good access for most, one part could not be accessed this survey		23.02				Parmango rd				Present	Moderate to High		
31B					Unable to access		14.073									Low		
31W					Unable to access		2.8									Low		Reducing costs by using the Diversion wing and path
32	A				Unable to access		45.41		Cape Arid						Present	Moderate to High		
32	BC				Unable to access		4.35								Present	Moderate to High		
33	B	Drainage Line			Unable to access		5.34								Present	Moderate to High		Altered to follow chain pulled and avoid granite.
33	C		Granite outcrop		Good access		15.57				Parmango rd				Present	Moderate to High		
34	B				Unable to access		8.29								Present	Moderate to High		
34	C				Good access	1	11.44	Nibbick Nature Reserve	88.28						Present	Moderate to High		
35	B				Unable to access		29.06				Belladonia				Present	Moderate to High		
35	C		Granite outcrop		Good access for the majority, some parts could not be accessed	7	66.31				Belladonia	Boystup Hill 1-5			Present	Moderate to High		
35	BC				Unable to access		2.58								Present	Moderate to High		
37	C				Unable to access		0.33								Present	Moderate to High		
38		Thomas river, Kennedy creek & Unknown drainage line	Granite outcrop	present	Good access for the majority, the last part could not be accessed		52.26	Cape Arid National Park			Fisheries and Merivale road	Thomas River Station (ID2641)	Hawes Hill (ID2685) Granite outcrop south of Hawes Hill (ID17991)	6	Present	Moderate to High		
				Legend:														
					Alignment of least constraint													

Appendix K

DEC statement

Department of Environment and Conservation

Hi Emily

I'm away in Mandurah attending a DEC Senior Managers Conference but I offer the following response to your request.

The DEC South Coast Region's preference has always been for any new State Barrier fence to follow as close as possible to the existing UCL –agricultural interface route (the innermost option).

As this is now a government endorsed initiative I won't get into the merits or long term value of having such a fence erected. I also acknowledge that any longer distances involved will significantly increase the cost of the project.

Obviously some consideration may have to be allowed for, to permit some minor deviations to address localised issues associated with landform practicalities, cultural heritage issues, declared rare fauna locations, etc.

However purely from a DEC management perspective, following the current interface minimises disruptions to this departments existing fire mitigation program and offers the easiest and safest option for implementing any bushfire suppression strategy. From a conservation perspective it also minimises impact on native fauna as it quite obviously considerably lessens the impact associated with interfering with, or isolating and removing wildlife corridor conductivity.

At present DEC maintains a low fuel modified buffer strip most recently installed in 1990's by the then Bush Fires Board (now FESA) almost entirely around the same corresponding length of UCL/farmland interface.

Where practical DEC utilise any existing roads (e.g. Rollond Road in the Cascades area) as the innermost edge of this buffer and where such a road or track does not exist maintain a cleared 10 metre mineral earth access track adjacent to private property. Using this as a base we and respective local Esperance Bush Fire Brigades then maintain a low fuel zone comprising of a fuel modified/ scrub rolled vegetation strip varying, but averaging up to 50 metre in depth.

A fuel reduction burn of any accumulative vegetation material laid down is then undertaken preferably within the same or following year. It may then not be retreated for another decade depending upon risk to key infrastructure, private property assets, vegetation type, seed maturity cycles and viability, fuel loads, etc.
However the access tracks innermost to the agricultural lands still needs to be maintained, either by grading or chemical application.

Should, due to cost considerations, a large proportion of the outermost route be chosen for the future fence alignment it may have considerable management consequences for DEC in regards to the direction of, and capability of any future fire mitigation work to be undertaken within the adjoining UCL.

In this instance, unless the government makes available new funding, DEC would not have the financial resources available, nor for that matter really want to, to pursue any farming community expectations to create any new low fuel buffers to directly protect the entire length of the State Barrier Fence extension. I wouldn't however rule out that DEC might not then utilise any such outermost fence alignment as part of a boundary to undertake a prescribed fuel reduction block burn to the south. DEC does however not see it as its responsibility to maintain the 10 metre break adjoining any part of the fence alignment.

The farming community should also not expect DEC to directly respond to any bushfire event threatening any part of the State Barrier fence where it utilises the outermost alignment, as under the Bush Fires Act fire suppression work is initially the primary responsibility of the local government authority (and brigades) of that district. Any outermost fence alignment

could be deemed to be in No Mans Land with limited safe egress options available to fire crews in the event of a major bushfire.
The risk associated in trying to protect any outermost alignment from a severe bushfire therefore significantly increases the risk to fire fighters while conversely lessening an Incident Controllers preparedness to commit any resources to any such removed site.

As mentioned above from a fire mitigation perspective we would prefer the fence to closely follow the UCL-agricultural interface as this would cause less disruption to our existing established firebreak system. This could effectively also mean that DEC might not be required to undertake any further significant new fuel modification/ scrub rolling work within the Great Western Woodland as part of its pre-bushfire fire mitigation strategy.

As I suspect that any new State Barrier Fence extension will not utilise existing farmland boundary fences DEC preference would be to have a 10 metre wide vegetation free track on both sides of the fence (this could utilise existing roads like Rollond Road). Therefore we would expect a gap of say 10 metre between the private property boundaries and the cleared fence area, and then a further 10 metre cleared immediately adjacent to and north of the fence (this equates to a 20 metre fence reserve).

DEC would then on a rotational basis maintain its existing low fuel buffer system on a needs be basis, and utilise the existing outer section of the fuel modified / scrub rolled buffer. That is, the loss of 10 metres of the buffer, where the existing buffer was already 50 metre wide would not necessary require an additional 10 metre of standing bush to be scrub rolled. However some additional 5-10 metre of scrub rolling may be required where the existing buffer is already significantly smaller than the desired 40 – 50 metre. However we are talking about an additional 5-15 metre of new scrub rolling (over time when deemed necessary) to compensate as required, not an additional 50 metre (as most of this buffer is already in existence – apart from area near and north of Salmon Gums).

This could potentially be accommodated and would most likely be acceptable providing DEC were given written permission/ permits by DAFWA (or it could be enshrined in the vesting order) that DEC had access rights along this new State Barrier Fence Extension for the express purpose of undertaking fire mitigation works. I mention this as I understand that some existing fence service tracks have access restrictions applied to them.

Access through the fence via gate options for access to undertake fire mitigation or bushfire suppression work would also need to be considered/ arranged between DAFWA and DEC/ LGA's.

Due to its location on the outer boundary of cleared agricultural farmland and potential public access restrictions I would think that the visual impact concerns will be minimal v/s a biological controversy in relation to a new outermost alignment.

I trust the above is useful and of assistance to you.

Regards

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Appendix L

Cost Components

Length, Road and River Crossings, Geology and Gates

Cost Component Assessment

Alignment	Gates		River Crossings	Granite Outcrops
Section and Option	10 km	Road Intersections	(Number)	
1	6	1	1	
2A	1	1	1	
2B	4	1	1	
4A	2			
4B	1			
4C	2			
6A	1			
6BC	1			
6C	3	2		
7	1	3		
8A	4	1	1	
8B	1		1	
8BC	3	1		
8C	4		1	
10	1			
11A	1			
12	1			
13A	1	1		
13B	1	1		
13C	5	2		
14	1	4		
15B	1			
15C	1	2		
16	3			
17B	1			
18A	2			
18B	1			
19	1			
20A	2			
20B	4	1		
22A	1	1		
22B	1	1		
23A	2	1		
23B	2			
24A	1			
24B	1	1		
25	1			
26A	1			
26B	1			
27A	1			
28A	1			
28B	2	1		
29	3			
30A	1			
30B	3	1		
31	2	1		
32A	4	1		

Cost Component Assessment

Alignment	Gates		River Crossings	Granite Outcrops
Section and Option	10 km	Road Intersections	(Number)	
33B	1			
33C	1			Present
34B	1			
34C	1			
35B	3	1		
35C	6	1		Present
36BC	1			
38	6	1	2	Present

Legend
A
B
C
BC
Least Constrained Alignmnet

Note: Option colours are linked to those in Figure 1a

Alignment Section	Option	Length (km) Shortest Possible Route	Longest Possible Alignment	Alignment of Least Constraint	Alignment of Least Constraint
1		48.90	50	50	
2	A	15.97	18.42		
2	B	12.35	30.87	30.87	
3		3.26	3.26	3.26	
4	A	10.8			
4	B				
4	BC		4.9	4.9	
4	C		18.9	18.9	
5		1.33	1.33	1.33	
6	A	9.79			
6	B				
6	BC		2.19	2.19	
6	C		29.11	29.11	
7		13.35	13.35	13.35	
8	A	28.89			
8	B				
8	BC		34.49	34.49	Recommend use of wing
8	C		16.83	16.83	
10		6.94	6.94	6.94	
11	A	4.72		4.72	
11	B		5.26		
12		3.96	3.96	3.96	
13	A	10.03			
13	B			6.98	
13	BC		4.73	4.73	
13	C		41.52		
14		34.92	34.92	34.92	
15	A	4.59			
15	B			4.47	Shorter route. Less road crossings.
15	BC		0.16	0.16	
15	C		15.99	15.99	
16		34.5	34.5	34.5	Recommend reassessing the alignment and determine whether it is possible to follow the boundary of the UCL more
17	A	5.8			
17	B		9.99	9.99	
18	A	12			
18	B		15.82	15.82	
19		4.88	4.88	4.88	
20	A	19.95			
20	B		42.49	42.49	
21		0.23	0.23	0.23	
22	A	6.652			
22	B		9.98	9.98	
23	A	14.091		14.091	
23	B		19.18		
24	A	15.53			
24	B		17.87	17.87	
25		1.73	1.73	1.73	
26	A	9.7			
26	B		12.58	12.58	
27	A	3.72			
27	B		4.33	4.33	
28	A	11.39			
28	B		17.39	17.39	
29		23.76	23.76	23.76	
30	A	15.29			
30	B		23.69	23.69	
31		23.02	23.02	23.02	
31	B	14.07		14.07	
31	W	2.6		2.6	
32	A				
32	BC		4.35		
33	B				
33	C		15.57		
34	B				
34	C		11.44		
35	B				
35	C		66.31		
36	BC		2.6		
37	C		0.33		
38			52.26		
Total Length (m)		428.71	751.03	560.74	
% Longest Alignment		57%	100%	74.66%	

Table of Road Crossings

Section	Option	Feature	Length	Road name	Zone	Zone Title	Alignment of Least constraint
1			12049		NO ZONE	Minor Road	Chosen
1		Ww	3826.2		NO ZONE	Minor Road	Chosen
1		S	4480.3		NO ZONE	Minor Road	Chosen
1			32366	WEST POINT ROAD	NO ZONE	Minor Road	Chosen
2	A		12758		IMPORTANT LOCAL ROAD	Minor Road	
2	B		17196	CASCADE ROAD		Minor Road	Chosen
2	B	We	2747.2	WEST POINT ROAD		Minor Road	Chosen
2	B	S	3927.5	WEST POINT ROAD		Minor Road	Chosen
2	B	Ww	2789.5	WEST POINT ROAD	NO ZONE	Minor Road	Chosen
2	B		7149	WEST POINT ROAD	NO ZONE	Minor Road	Chosen
4	C		18944	ROLLOND ROAD		Minor Road	Chosen
6	BC		2190	NEDS CORNER ROAD		Minor Road	Chosen
6	C		29107	NEDS CORNER ROAD		Minor Road	
7			13345	NEDS CORNER ROAD		Minor Road	Chosen
8	C	S	15661	ROLLOND ROAD		Minor Road	Chosen
13	C		41515	COOLGARDIE-ESPERANCE HIGHWAY	STATE HIGHWAY	Major Road	
14			34915			Minor Road	Chosen
14			34915	COOLGARDIE-ESPERANCE HIGHWAY		Major Road	Chosen
22	A		6651.8	DEMPSTER ROAD		Minor Road	
22	B		9982.2	RIDLEY ROAD		Minor Road	Chosen
23	A		14091	DEMPSTER ROAD		Minor Road	Chosen
23	B		19182	DEMPSTER ROAD		Minor Road	
24	B		17887	BURDETT ROAD		Minor Road	Chosen
26	A		9697.7	MOUNT NEY ROAD		Minor Road	
26	B		12579	MOUNT NEY ROAD		Minor Road	Chosen
27	A		3724.2	MOUNT NEY ROAD		Minor Road	
27	B		4330.3	MOUNT NEY ROAD		Minor Road	Chosen
28	B		17392	HEYWOOD ROAD		Minor Road	Chosen
30	B		23668	CLYDE ROAD		Minor Road	Chosen
31			23022	PARMANGO ROAD		Minor Road	Chosen
31	B		######				Chosen
31	W		2600				Chosen
33	C		15573	PARMANGO ROAD		Minor Road	
34	C		11436	MUNTZ ROAD		Minor Road	
35	C		66311	BEBENORIN ROAD		Minor Road	
38			52256	FISHERIES ROAD	RURAL UNSETTLED	Minor Road	

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	Orla O'Donnell	P.Murphy		F.Hannon		4/07/12
0	F. Hannon	P. Murphy		F. Hannon		3-9-2012.