



# Denison 3D Seismic Survey
# Environmental Scoping Document

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| **Title:** Denison 3D Seismic Survey Environmental Scoping Document | **Job Number:** J04-053 | |
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**Key words:**

Nature Reserve, 3D Seismic Survey, Scoping Document, ARC Energy, Origin Energy, Environmental Management Plan

**Abstract:**

ARC Energy Limited (ARC) and Origin Energy Developments Pty Limited (Origin) are proposing to conduct a 3D seismic survey over tenements L1, L2 and EP413 as part of their ongoing commitment to developing petroleum resources in the Perth Basin. Seismic surveys are a necessary component of petroleum exploration and are required to assist with the planning of exploration drilling activities. ARC and Origin submitted an Environmental Management Plan (EMP) to the Department of Industry and Resources (DoIR) and the Environmental Protection Authority (EPA) on 7 January 2004 as part of their application to carry out this survey. The EPA considered that the proposal warranted formal assessment at the level of Public Environmental Review (PER), with a four week review period under the provisions of the *Environmental Protection Act* 1986 (EP Act). The EPA notified ARC and Origin of the requirement for a PER on 2 March 2004.

Formal assessment under the EP Act requires that a proponent submits an Environmental Scoping Document to the EPA. This document is ARC and Origin's PER Environmental Scoping Document for the Onshore Denison 3D Seismic Survey over an area covered by the L1, L2 and EP413 licences and permits.

This document was prepared for the EPA as a requirement of the PER environmental impact assessment (EIA) process under the EP Act. This Environmental Scoping Document will assist the EPA to determine which environmental factors are relevant and significant to this proposal and aid the formulation of the PER.

**Country:**

Perth Basin, Port Denison, Dongara, Western Australia.

**Reference:**

IRCE 2004. *Denison 3D Seismic Survey Environmental Scoping Document.* Unpublished report prepared by IRC Environment for ARC Energy Limited, Perth, Western Australia.

# Contents

# ABBREVIATIONS

| | |
|---|---|
| 2D | Two Dimensional |
| 3D | Three Dimensional |
| ARC | ARC Energy Limited |
| CALM | Department of Conservation and Land Management |
| DIA | Department of Indigenous Affairs |
| DoIR | Department of Industry and Resources |
| DRF | Declared Rare Flora |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EP | Exploration Permit |
| EP Act | *Environmental Protection Act* 1986 |
| EPA | Environmental Protection Authority |
| EPBC Act | *Environmental Protection and Biodiversity Conservation Act* 1999 |
| FESA | Fire and Emergency Services Authority |
| HPF | Hovea Production Facility |
| L | Production Licence |
| M | million |
| NR | Nature Reserve |
| Origin | Origin Energy Developments Pty Limited |
| PER | Public Environmental Review |
| PL | Pipeline Licence |
| Trace | Trace Energy Services, Inc. |
| UCL | Unallocated Crown Land |
| UHF | Ultra High Frequency |

# 1 INTRODUCTION

## 1.1 Background

ARC Energy Limited (ARC) and Origin Energy Developments Pty Limited (Origin) are companies specialising in oil and gas exploration and production. They are joint venture partners in a number of tenements as well as operating tenements independently.

ARC is the operator of the Production Licenses L1, L2, L4, L5 and L7, Exploration Permit EP368 and Pipeline Licence PL6 in the Perth Basin. It also has interests in L11, EP320, EP413 and TP/15. ARC's production activities are centred around the Hovea Production Facility (HPF) located in L1.

In the immediate area, Origin is the operator of L11, EP320 and EP413. It operates the Beharra Springs Gas Plant (L11) located 40km south-east of Dongara and is currently developing the Jingemia oil field located in the northeast part of EP413. Origin also has interests in L1, L2 and EP368.

As part of their ongoing commitment to develop petroleum resources in the Perth Basin, ARC and Origin propose to conduct a 3D seismic survey over the L1, L2 and EP413 tenements. Seismic surveys are necessary to assist with planning petroleum exploration drilling activities. ARC and Origin submitted an Environmental Management Plan (EMP) to the Department of Industry and Resources (DoIR) and the Environmental Protection Authority (EPA) on 7 January 2004 as part of its application to carry out this survey. The EPA considered that the proposal warranted formal assessment at the level of Public Environmental Review (PER), with a four week review period under the provisions of the *Environmental Protection Act* 1986 (EP Act). The EPA notified ARC and Origin of the requirement for a PER on 2 March 2004.

Formal assessment under the EP Act requires that a proponent submits an Environmental Scoping Document to the EPA. This document is ARC and Origin's Environmental Scoping Document for the Onshore Denison 3D Seismic Survey over the L1, L2 and EP413 tenements.

## 1.2 Purpose of this document

This document was prepared for the EPA as a requirement of the PER environmental impact assessment (EIA) process under the EP Act. This Environmental Scoping Document will assist the EPA to determine which environmental factors are relevant and significant to this proposal and aid the formulation of the PER.

## 1.3 Structure of this report

This Environmental Scoping Document is structured as follows:

*Section 1* Introduction – outlines the background for the Environmental Scoping Document and the proponents involved.

*Section 2* Description of the Seismic Survey – provides a summary of the location and timing of the survey as well as a brief outline of the processes involved.

*Section 3* Alternative Options Considered – considers options other than the proposed 3D survey are outlined in this section.

*Section 4* Justification for Proposal and Selecting Preferred Option – explains the reasoning behind ARC/Origin's choice of option.

*Section 5* Regional Setting of Proposal – summarises the physical, social and economic environments that interact with the proposed survey.

*Section 6* Environmental Impacts and Their Management – presents a summary of the potential environmental impacts, their significance and proposed management responses.

*Section 7* Proposed Studies and Investigations – identifies the studies and investigations that have already been carried out and through a gap analysis highlights further studies and investigations that are necessary.

*Section 8* Environmental Factors Relevant to Proposal – presents a summary relating the environmental factors to the scope of investigations.

*Section 9* Applicable Legislation – presents the legislation applicable to the proposed activity.

*Section 10* Community and Other Stakeholder Consultation Program – outlines the community and stakeholder consultation carried out as part of this proposal.

*Section 11* Project and Assessment Schedule – includes a proposed timetable for undertaking the environmental surveys, investigations, further community and stakeholder consultation and submission of the draft PER to the EPA.

*Section 12* Peer Review – presents a list of organisations and individuals that will perform the peer review of surveys and investigations.

*Section 13* Study Team – identifies the members of the study team and their expertise.

*Section 14* References.

## 1.4 The proponents

The co-proponents of this proposal are ARC Energy Limited and Origin Energy Developments Pty Limited, a wholly owned subsidiary of Origin Energy Limited. ARC is the operator of Licenses L1 and L2 in which it owns 50%.

The nominated proponent contact for this proposal is Andrew Padman, Exploration Manager at ARC Energy Limited.

ARC's contact details are:

ARC Energy Limited
ABN 74 009 204 031
Level 4
679 Murray Street
West Perth, Western Australia, 6005.
Tel: (08) 9486 7333
Fax: (08) 9486 7322

Origin owns the remaining 50% interest in Licenses L1 and L2. ARC is the custodian of this Environmental Scoping Document for Licenses L1 and L2.

Origin is the operator of EP413 in which it owns 49.19%, and is the custodian of this Environmental Scoping Document for this Permit. The other joint venture partners of EP413 are ARC Energy Limited (25.65%), Hardman Oil and Gas Pty Ltd (12.0%), Voyager Energy Limited (6.27%), Victoria Petroleum NL (5.0%), Norwest Energy NL (1.28%), ROC Oil (WA) Pty Limited (0.25%) and John Kevin Geary (0.14%).

Origin's contact details are:

Origin Energy Developments Pty Limited
ABN 43 008 432 479
34 Colin Street
West Perth, Western Australia, 6005.
Tel: (08) 9324 6111
Fax: (08) 9321 5457

**Please note that in the context of the remainder of this Environmental Scoping Document, ARC/Origin is used in reference to ARC for activities in L1 and L2 and, *inter alia*, in reference to Origin for activities in EP413.**

# 2 DESCRIPTION OF THE SEISMIC SURVEY

## 2.1 Background

The information below summarises the description of the activity. More detailed information is presented in Section 2 of the Denison 3D Seismic Survey EMP (ARC 2004). Table 2.1 presents the key characteristics of the proposed survey.

**Table 2.1 Key Characteristics Table**

| Element | Description |
|---|---|
| Type of survey. | 3D seismic. |
| Timing and maximum duration of survey. | 90-120 days. |
| Approximate length of survey (source and receiver lines that impact reserve areas). | Approximately 1.5% of the total survey area will need to be accessed for data acquisition. Of this area about 25% lies within Nature Reserves. |
| Maximum width of line preparation. | 3m plus allowances for vehicle turning points. |
| Approximate number of data acquisition holes (up-holes) required. | Up to 130 up-holes across the survey, up to approximately 50 up-holes in the Nature Reserves. |
| Maximum depth of data acquisition holes (up-holes). | ≤200m . |
| Plant details for survey. | Camp (including office, mess and accommodation blocks), up to 5 truck mounted source vehicles, up to 10 camp based vehicles (including fuel, water and fire trucks), up to 17 seismic line crew vehicles. |
| Approximate number of persons involved. | 80 personnel including sub-contractors. |
| Operation hours. | Daylight hours only, 7 days/week. |

## 2.2 Location and scale of survey

The survey is proposed to provide 3D seismic coverage over a proven oil and gas province that is considered highly prospective. The survey is located entirely onshore and has an aerial extent of upto approximately 394km$^2$ including the township of Dongara and Port Denison, adjacent farmed areas and the Yardanogo, Dongara and Beekeeper Nature Reserves (nature reserves comprise approximately 25% of the total survey area) (Figure 2.1). Of this total survey area, less than 1.5% will be accessed for data acquisition.

## 2.3 Timing of survey

The 3D seismic survey is proposed to commence in September 2004, once regulatory approvals are achieved. It is anticipated that it will take a total of about 90-120 days to conduct the survey. In addition, several weeks of preparatory work will be required. This latter work is primarily to prepare and survey access (line preparation) for the receiver and source lines.

## 2.4 General seismic plan and activities

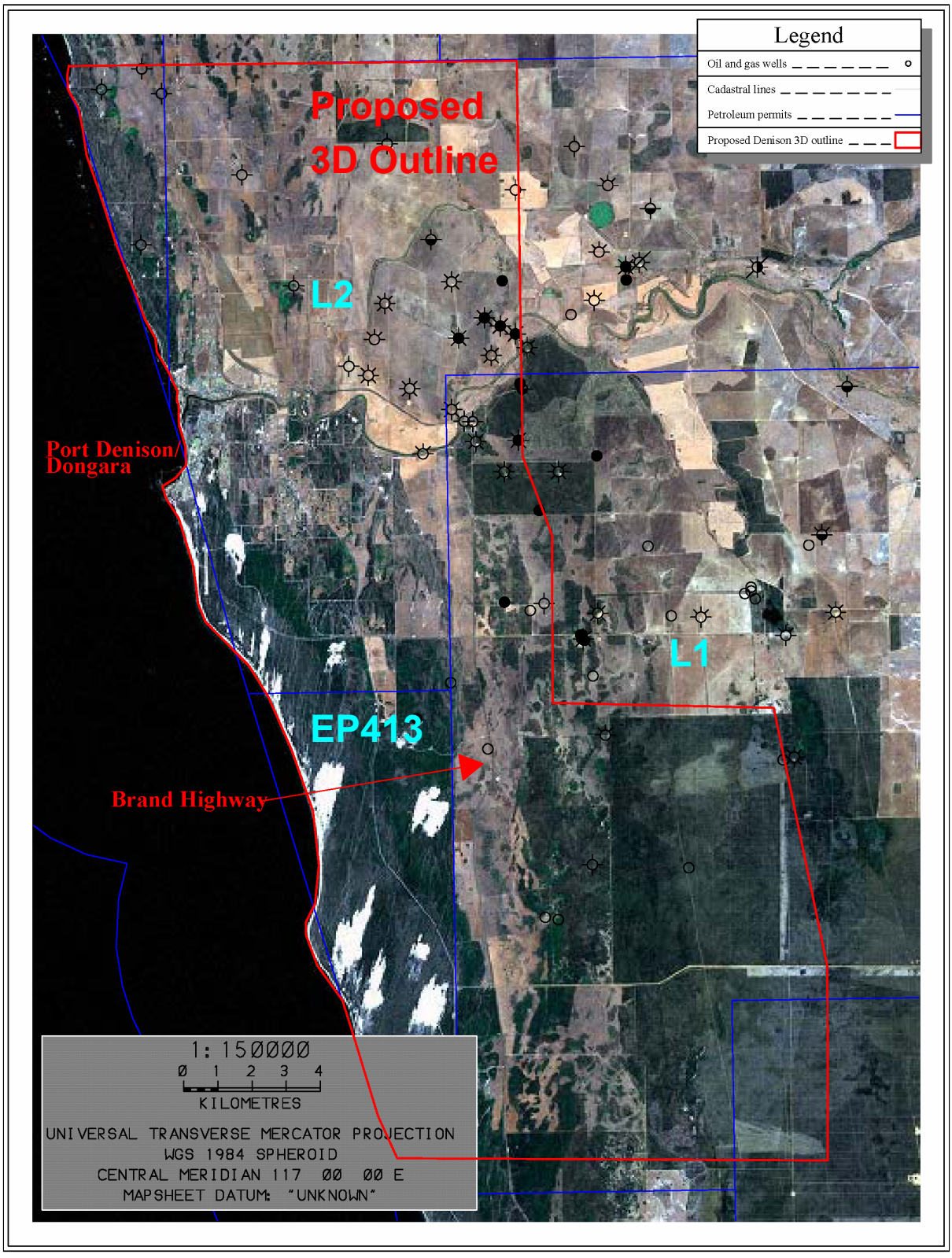
Specialised geophysical contractors, Trace Energy Services (Trace), who have experience in acquiring seismic data in the area, will conduct the survey under the direct supervision of ARC/Origin personnel. The proposed survey comprises a rectangular grid (generally 480m x 240m, but reducing to 240m x 240m in areas where there are data quality issues such as across limestone ridges). The survey is an extension of the prior Hovea and Hibbertia 3D surveys acquired in 2001, which were acquired to the east of the proposed Denison 3D survey using the same parameters.

The primary objectives of the seismic program is to define prospects for future drilling and thus enable oil and gas production from the companies' permit areas to be maintained and to ensure obligations to the DoIR are satisfied.

Activities to be conducted include:

- Initial establishment of a base camp and ongoing provision of supplies;
- Preparation of survey grid (access line preparation and surveying);
- Drilling of boreholes (for up-hole logging necessary to the survey);
- Data acquisition (vibroseis and up-hole); and
- Demobilisation and rehabilitation (refer to Denison 3D Seismic Survey EMP).

**Figure 2.1 Landsat image showing the proposed Denison 3D Seismic Survey outline (in red)**



# 3 ALTERNATIVE OPTIONS CONSIDERED

## 3.1 Background

Three alternatives to undertaking the Denison 3D Seismic Survey were considered by ARC/Origin:

1. No survey;
2. Conducting a series of 2D seismic surveys over a longer timeframe; and
3. Conducting a series of smaller scale 3D seismic surveys.

Sections 3.2 to 3.4 describe these alternative options. Section 4 provides the rationale for selecting the preferred option described in Section 2.

## 3.2 Option 1 – no survey

The seismic method is the only tool available that adequately images and explores the subsurface to the detail necessary to effectively explore for hydrocarbons prior to drilling exploration and/or development wells. There are currently no alternative tools that can replace the seismic method. Absence of seismic survey data would impose a prohibitively wasteful, expensive and environmentally undesirable requirement of pattern drilling to explore for hydrocarbons.

## 3.3 Option 2 – 2D surveys

2D surveys have historically been used in the Perth Basin since the 1950s, with several areas being explored with 2D seismic in the past ten years. 2D surveys suffer from inadequate sub-surface coverage and resolution to adequately define drilling targets. This results in misplaced drill-holes and higher drilling risks. Historically, there is always a need to increase 2D line coverage to resolve key prospect risks and uncertainties. This has resulted in almost annual acquisition programs.

## 3.4 Option 3 – smaller scale 3D surveys

Small scale 3D surveys are an inefficient means of acquiring properly imaged data that is useful in the exploration of hydrocarbons. On any seismic survey or line, the outer ‘halo’ or fringe is inevitably ‘under-sampled’ and incorrectly imaged. Depending upon the depth of the primary targets this sub-optimal zone of the data is typically at least 2km wide. Thus, a 6km by 6km square survey (i.e. 36km$^2$) will only have about 4km$^2$ (11%) of well imaged information versus a 20km by 20km square survey with 256km$^2$ out of 400km$^2$ (64%) being well imaged. In order to achieve proper coverage of the subsurface, this under-sampled halo would have to be overlapped by the next, adjacent 3D survey (as is required where the

proposed Denison 3D Seismic Survey overlaps the pre-existing Hovea 3D seismic survey), doubling the access requirements (and environmental impact of these survey lines).

Further, a patchwork of small surveys acquired over successive years does not allow the regional geology to be interpreted in a timely manner, degrading the efficiency and effectiveness of the exploration process.

# 4 JUSTIFICATION FOR PROPOSAL AND SELECTING PREFERRED OPTION

## 4.1 Justification for proposal

The 3D seismic survey program is required for the ongoing development of petroleum resources in the Perth Basin. Development of these resources is required to ensure security of supply of hydrocarbon resources and provides economic benefits to the State of Western Australia through providing employment and petroleum royalties. The proposed survey methodology has been developed to reduce the overall environmental impacts of petroleum exploration as detailed in Section 4.2.

The Perth Basin is a strategic supply source for gas to the Perth market as it is currently the only alternative to the Northwest Shelf for southwest Western Australian gas customers. Approximately 8% of Western Australia's oil consumption is presently met from resources from the area covered by, or in the immediate vicinity of, the Denison 3D Seismic Survey.

## 4.2 Basis for selecting preferred option

The criteria used to compare options was based on economic, environmental, logistical and safety issues.

The acquisition of a larger scale 3D seismic survey compared to alternative options, satisfies the subsurface sampling needs of the exploration program, which means there will be no need to re-visit the area for seismic acquisition in the foreseeable future (at least 10 to 15 years), minimising environmental impact in the region.

The location of the 3D seismic survey is dictated by the distribution of prospectivity, which is the result of the interpretation of all the existing data (both local and more regional) and including fields, wells and 2D seismic. Location of the 3D survey outside of the prospective area would be pointless.

There are many alternative and variously complex seismic acquisition geometries (line patterns) technically capable of acquiring adequate data over the area of the survey. The survey pattern chosen (perpendicular source and receiver lines) achieves the required subsurface sampling density, and also:

- Is the most simple and efficient geometry when access is constrained by environmental considerations to along the lines only. (ie no cross-country access);
- Minimises the amount of manual handling of phones and cables (ie vehicular traffic) improving the rate of data acquisition; and
- Will enable a seamless join onto the pre-existing surveys which employed the same acquisition geometry.

Buggy mounted vibrators are proposed as the seismic source for this survey. Dynamite was considered as an alternative, but safety (handling explosives), environmental (noise and intensity of vibrations) and data quality issues (previously shown to be inferior in this area) caused this option to be rejected. The vibrators (whilst large, heavy vehicles) allow rapid, safe data acquisition, less intense vibration of the ground near the source (to minimise ground disturbance and structural damage) and have been shown to acquire better data.

# 5 REGIONAL SETTING OF PROPOSAL

This section provides a summary of the physical, biological and social environment in which the proposal is situated. A detailed description of the environment was presented in the Denison 3D Seismic Survey EMP (ARC 2004).

## 5.1 Physical environment

### 5.1.1 Climate

The region has a Mediterranean-type climate characterised by seasonal patterns of hot, dry summers and mild, wet winters. The area is subject to high wind speeds, dust storms and lightning storms. The nearest Bureau of Meteorology stations are at Geraldton (63km north of Dongara) and Mingenew (52km east of Dongara). Temperature ranges from 18-36°C in January and February to 7-20°C in August.

Annual rainfall is approximately 460mm. There is dominant winter rainfall with approximately 55% of annual rainfall occurring between June and August. During the summer months rain occurs only rarely, resulting in a seasonal drought lasting from November through to February. Rainfall in these months averages less than 20mm/month.

Geraldton wind data for the period 1990-2002 shows the wind to be predominantly from a southerly direction with a daily land and sea breeze pattern of strong winds (20-40km/hr) from the SSE and SSW respectively. Gales (wind speed >60km/hr) occur in every month of the year and are particularly common in mid-winter and mid-summer.

### 5.1.2 Geology and geomorphology

The proposed Denison 3D Seismic Survey is located entirely in the Geraldton Sandplains Biogeographical Region (Environment Australia, 2000). The area incorporates an area of sand dunes (both stabilised and mobile) and dense coastal scrub nearer the coast and large areas of cleared agricultural land particularly in the northern and eastern parts of the project area. Within this region three broad physiographical units are recognised; the Swan Coastal Plain, the Arrowsmith Region and the Dandaragan Plateau.

The Swan Coastal Plain forms an elongated strip approximately 40km wide of the western margin of the Northern Perth Basin. It is bounded to the east by the Gingin Scarp and to the west by the Indian Ocean. The region is typically a low lying, gently undulating area covered by quaternary coastal dunes and marine deposits. Alluvial deposits are common adjacent to scarps and are also deposited in valley floors, typically in close proximity to river systems.

The Arrowsmith Region lies between the Swan Coastal Plain and Dandaragan Plateau. The region is bounded by the Dandaragan and Gingin Scarps. It comprises undulating sandy regions with laterite breakaways occurring at the crest of hills.

The Dandaragan Plateau is characterised by flat to undulating, often un-dissected sand and laterite capped plateau. When present, valleys are typically deep and V shaped. Deep yellow sands are common in the uplands, with deep red and yellow sands common in the valley floors.

### 5.1.3 Soils

Three broad soil-landscape systems are present in the proposed Denison 3D Seismic Survey area; the Quindalup system (coastal sand plain and dune systems), the Tamala system (yellow, red and black sands on limestone) and the Irwin system (alluvial valley systems).

### 5.1.4 Surface water and drainage

The Irwin River valley is the only major drainage channel within the proposed survey area. The porous and permeable coastal limestones and dune systems tend to allow rainwater to infiltrate to the water table rather than running off the land surface, giving rise to the lack of defined watercourses in much of the survey area. There are, however, no known caves in the survey area. A number of swamps surrounded by dense scrub, frequent limestone outcrops and the occasional laterite outcrop are the other major features in the region, but these mainly fall outside the survey area.

### 5.1.5 Groundwater

Shallow groundwater lenses are located within the Tamala Limestone and most probably occur within the survey area, forming an unconfined aquifer in which the groundwater is mainly recharged from local rainfall. There is no known economic use of the shallow groundwater resource in the survey area.

## 5.2 Vegetation

The survey area can be grouped into broad categories discussed individually under the following categories: farmland incorporating re-growth/native vegetation, built-up areas and nature reserves (refer to the Denison 3D Seismic Survey EMP (ARC 2004) for further details).

### 5.2.1 Farmland vegetation

Part of the proposed survey area covers cleared farmland with both large and small stands of remnant native vegetation, often degraded by stock. Cleared paddocks are mostly utilised for cropping and grazing. Crops commonly grown in the area are wheat, oats and lupins. In the poorer soils, hay cutting and grazing is often the only farming land use. Some remnants of uncleared or regrowth native vegetation exist as ‘islands’ within farmland (Table 5.2). Typically, remnant native vegetation in farmland areas is degraded to varying degrees by

partial clearing, burning, weed invasion and/or grazing. In addition, reserves have been impacted by road works and weeds.

### 5.2.2 Built-up area vegetation

The proposed survey area includes built-up areas. Disturbance levels in these areas are typically high due to high levels of clearing and accordingly the native vegetation in these areas is significantly compromised.

### 5.2.3 Nature Reserve vegetation

Beekeepers Nature Reserve, Dongara Nature Reserve and Yardanogo Nature Reserve all have some proportion of their area covered by the proposed seismic survey (Table 5.1). These are discussed individually in the following sections.

**Table 5.1 Nature Reserves in proposed survey area**

| Reserve | Area (ha) | Proportion of Nature Reserve within proposed Seismic Survey | Designation |
|---|---|---|---|
| Beekeepers Nature Reserve | 67,900 | 7% | Protection of flora |
| Dongara Nature Reserve | 52 | 100% | Conservation of flora and fauna |
| Yardanogo Nature Reserve | 6,591 | 100% | Conservation of flora and fauna |

**Beekeepers Nature Reserve**

The Beekeeper Nature Reserve occurs on part of the Quindalup dune and soil system. The vegetation in the area is limited and ranges from virtually no cover on dune blow-outs to low scrub land on shallow sand over limestone to dense thickets of tall shrubs in sheltered areas.

**Dongara Nature Reserve**

The Dongara Nature Reserve occurs on part of the Quindalup dune and soil system. The vegetation is similar to that in the Beekeepers Nature Reserve and comprises coastal thicket and heath on typically white sands over limestone. The dominant species in the reserve is the black wattle (*Acacia rostilifera*) with pockets of mallee (*Eucalyptus obtusiflora*). One declared rare flora (DRF) species, *Wurmbea tubulosa*, may occur in the area.

**Yardanogo Nature Reserve**

In the proposed survey area, the Yardanogo Nature Reserve occurs on part of the Tamala soil system. Physiographically the survey area incorporates part of the Spearwood dune system and at the surveys easterly extent, the westerly edge of the Eneabba sandplain. The vegetation is dominated by limestone heath.

Three DRF species may occur in the proposed survey area of the Yardanogo Reserve. However, only *Stawellia dimorphantha* has been recorded on previous botanical surveys. Although declared rare, the species was reported in many sites during the Beharra and Hibbertia 3D Seismic Surveys, typically on sand and in low lying areas.

**Table 5.2 Typical native vegetation types of survey region**

| Region | Geomorphic region | Substrate | Vegetation community description |
|---|---|---|---|
| **Farmland** | Swale | Sand and limestone (Quindalup soil system) | *Acacia* and *Melaleuca* thicket, most of the swales cleared for farming. |
| | Dune | Sand and limestone (Quindalup / Tamala soil system | Sand heath 0.5-1.5m high – Low Banksias dominant, *Melaleuca* in low lying areas, scattered tall shrubs inc. *Xylomelum angustiflorum, Eucalyptus todtiana, Nutyisa floribunda.* |
| | Dune | Sand and laterite (Quindalup / Tamala soil system) | Low heath 0.5-1m high – *Hakea, Dryandra* and *Petrophile* species dominant, some *Allocasuarina* in low on laterite, trees are typically low and sparse including *Eucalyptus todtiana* and some mallee trees. |
| | Alluvial plain | Grey clay and loam (Irwin soil system) | *Eucalyptus loxophleba, Eucalyptus camadulenis.* |
| **Beekeeper Nature Reserve** | Swale | Shallow calcareous sand over limestone (Quindalup soil system) | *Acacia rostellifera* and *lasiocarpa, Melaleuca huegelli, systena* and *cardiophylla, Santalum acuminatum, Exocarpos sparteus, Gompholobium tomentosum, Rhagodia preissii, Olearia dampieri, Scaveola thesoiides, Anthocercis intricata,* limited *Lepidosprema squamatum* and *Acanthocarpus preissi.* |
| | Swale (low lying) | Marl (Quindalup soil system) | Saltbush, samphire, stunted *Casuarina obesa*, *Frankenia pauciflora.* |
| | Dune | Shallow calcareous sand over limestone (Quindalup soil system) | *Acacia rostellifera* dominant. |
| | Lees of dunes | Shallow calcareous sand over limestone (Quindalup soil system) | Thickets of *Acacia rostellifera.* |
| | Coastal dunes | Shallow calcareous sand over limestone (Quindalup soil system) | Perennial grassed to seaward side, *Olearia axillaris.* |
| | Other | Limestone hills (Quindalup soil system) | Local areas of dense Dongara mallee (*Eucalyptus obtusiflora*). |
| | Trees | Varied (Quindalup soil system) | Trees overall are rare and occur in low-lying areas and inland and including mallees, *Meleleuca lanceolata,* and *Eucalyptus petrensis.* |
| **Yardanogo Nature** | Dune and swale | Brown, grey or yellow sand (Quindalup / Tamala soil system) | *Acacia spathulata* and *rostelliferea, Dryandra sessilis, Jacksonia hakeoides, Melaleuca huegelii, banksias leptophylla.* |

| Region | Geomorphic region | Substrate | Vegetation community description |
|---|---|---|---|
| **Reserve** | Eneabba Sandplain | White, yellow or grey sand (Quindalup / Tamala soil system) | 1-1.5m shrubs *Banskia attenuate* and *hookeriana*, Rare trees including *Banksia menziessi,* scattered *Xylomelum angustiflorum, Eucaplytus todtiana* and *Nutysia floribunda.* |
| **Dongara Nature Reserve** | Dune | Shallow calcareous sand over limestone (Quindalup soil system) | Thickets of *Acacia rostellifera* and heath. |
| | Swale | Sand and limestone (Quindalup soil system) | Pockets of mallee (*Eucalyptus obtusiflora*). |

**Table 5.3 Declared Rare and Priority flora species potentially occurring in the survey area**

| Region | Species | Status |
|---|---|---|
| **Farmland** | *Tricoryne robusta* | Priority 2 |
| | *Acacia telmica* | Priority 3 |
| | *Calytrix eneabbenis* | Priority 3 |
| | *Grevillea hirtella* | Priority 3 |
| | *Grevillea tenuiloba* | Priority 3 |
| | *Hakea polyanthema* | Priority 3 |
| | *Hypocalymma tetrapterum* | Priority 3 |
| | *Leucopogon glaucifolius* | Priority 3 |
| | *Stylidium drummondianum* | Priority 3 |
| | *Eucalyptus ebbanoensis photina* | Priority 4 |
| | *Eucalyptus zopherophloia* | Priority 4 |
| | *Gastrolobium callistachys* | Priority 4 |
| **Beekeepers Nature Reserve** | *Anthocercis intricata* | Priority 3 |
| | *Eucalyptus zopherophloia* | Priority 4 |
| | *Haloragis foliosa* | Priority 3 |
| | *Acacia latipes licina* | Priority 3 |
| | *Anthocercis intricata* | Priority 3 |
| | *Astroloma microcalyx* | Priority 3 |

| Region | Species | Status |
|---|---|---|
| | *Eucalyptus foecunda coolimba* | Priority 3 |
| | *Eucalyptus zopherophloia* | Priority 4 |
| | *Grevillae olivacea* | Priority 4 |
| | *Grevillae stenomera* | Priority 2 |
| | *Haloragis foliosa* | Priority 3 |
| | *Walteranthus erectus* | Priority 2 |
| **Yardanogo Nature Reserve** | *Conostylis micrantha* | Declared rare |
| | *Wurmbea tubulosa* | Declared rare |
| | *Stawellia dimorphantha* | Declared rare |
| | *Eremaea acutifolia* | Priority 2 |
| | *Verticordia blepharophylla* | Priority 2 |
| | *Geleznowia verrucosa formosa* | Priority 3 |
| | *Hemigenia saligna* | Priority 3 |
| | *Isopogon tridens* | Priority 3 |
| | *Isopogon tridens* | Priority 3 |
| | *Olax scalariformis* | Priority 3 |
| | *Banksia elegans* | Priority 4 |
| | *Thysanotus glaucus* | Priority 4 |
| | *Eucalyptus macrocarpa elacantha* | Priority 4 |
| **Dongara Nature Reserve** | *Wurmbea tubulosa* | Declared rare |

## 5.3 Fauna

### 5.3.1 Native fauna

A fauna survey conducted in the Beekeeper's Nature Reserve for the Denison 3D Seismic Survey EMP indicated that 10 species of frog, 65 species of reptile, 182 species of birds, 16 native species of mammals (including 5 bats) and 7 introduced or feral mammal species are likely to be found in this area. A large number of birds are predicted as the survey area includes the Irwin River, a habitat for many species of waterbirds.

Rare species listed by the *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act) are limited to two Schedule 1 species and one Schedule 4 species (Table 5.4). One Priority 2 species, two Priority 3 species and two Priority 4 species have been recorded in the area. Field personnel will be on the lookout for the mallee fowl nesting mounds during line preparation. Lines will be deviated around existing nesting mounds.

**Table 5.4 Rare and priority fauna species**

| Common Name | Scientific Name | Status |
|---|---|---|
| Carnaby's Black-Cockatoo | *Calyptorhynchus latirostris* | Schedule 1 |
| Malleefowl | *Leipoa ocellata* | Schedule 1 |
| Peregrine Falcon | *Falco peregrinnus* | Schedule 4 |
| Stick-insect | *Phasmodes jeeba* | Priority 2 |
| Cricket | *Hemisaga vepreculae* | Priority 3 |
| Native bee | *Hyaleus globuliferus* | Priority 3 |
| Bush Stonecurlew | *Burhinus grallarius* | Priority 4 |
| Rufous Fieldwren | *Calamanthus campestris montanellus* | Priority 4 |

### 5.3.2 Feral animals

There are seven feral or introduced species reported in the area including the house mouse (*Mus musculus*), black rat (*Rattus rattus*), red fox (*Vulpes vulpes*), pig (*Sus scrofa*), European rabbit (*Oryctolagus cunuculus*), goat (*Capra hircus*), and house cat (*Felis catus*). These species may have a significant impact on the native fauna either by competition for food and/or resources or by predation.

## 5.4 Social and economic environment

The survey area is located within a sparsely populated region (approximately 2,500 in the town of Dongara/Port Denison) that has limited settlement, transport and communications infrastructure.

The significant economic activities in the survey area include oil, gas and mineral (sand mining) production, mining of gypsum and lime sand/limestone, crayfishing and broad

hectare cropping and grazing activities. Early settlement in the Dongara region was by pastoralists, however mining and agriculture are now important components of the regional economy.

The total value generated from the mining and oil and gas industries in the Shire of Irwin for the 2002/03 financial year was over $48M, of which a significant amount was contributed by the petroleum industry. The value of the contribution made by petroleum production is expected to be over $100M in the current financial year (ARC 2004). Royalties paid by ARC to the Government of Western Australia totalled $2.4M for the last six months of 2003.

There has been extensive exploration for, and development of oil and gas in the area. Currently there are seven fields in production in the onshore north Perth Basin; Dongara, Yardarino, Mt Horner, Woodada, Beharra Springs, Beharra Springs North and Hovea. Eremia and Jingemia are/have been producing under extended production permits with a view to commissioning permanent facilities in the near future.

The bushland areas of the region support seasonal honey production and commercial wildflower harvesting.

Through the permitting process 248 landholders in the survey area have been approached and access agreements either negotiated (245) or are in progress (3).

## 5.5 Aboriginal heritage and Native Title

An archaeological investigation for Aboriginal heritage significance in the area of the proposed Denison 3D Seismic Survey was conducted in October 2003. The archaeological work involved a review of previous research in the area, a field program to sample the designated survey area and the recording of any archaeological sites discovered within the project area.

As a result of previous surveys and independent research it was established that ten Aboriginal sites have been recorded and registered with the Department of Indigenous Affairs (DIA) within or approximate to the project area. Six registered archaeological sites are within the project area. These are made up of three burial sites, two artefact sites and one shell midden. Most of these are situated along the margins of the Irwin River. Two other registered sites may be within the project area but the recorded information is insufficient to determine their exact location.

An additional ethnographic survey has been conducted in the north-western portion of the L1/L2 survey area in land that has not been previously surveyed with the registered Mullewa Wadjari Native Title Claimant Group (Registration WC96/93) and the Pandawn Group. No additional sites with the exception of the Irwin River have been identified during this survey. Recognised representatives from both Aboriginal groups have signed approval forms for the survey to proceed.

# 6 ENVIRONMENTAL IMPACTS AND THEIR MANAGEMENT

The potential environmental impacts associated with conducting the Denison 3D Seismic Survey were described in detail in the EMP (ARC 2004). A risk assessment workshop was conducted that included representatives from a range of government and non-government organisations' project engineers and environmental scientists (ARC 2004). The combined experience of the workshop team ensured that all key environmental issues were identified, their significance assessed and appropriate management measures put in place to ensure that the environmental impacts will be managed appropriately. Table A1.1 (Attachment 1) presents a summary of the risk assessment that was carried out for the Denison 3D Seismic Survey; full details of the results of the risk assessment workshop are provided in the Denison 3D Seismic Survey EMP (Section 4).

The risk assessment considered impacts on the biological, physical and social environment and identified 35 hazards associated with routine activities and six hazards associated with non-routine activities or events (ARC 2004). Of the 35 hazards arising from routine activities, 57% were found to be a low risk, 37% were found to be a low/medium risk, 3% were found to be a medium risk and 3% were not assessed as they were considered to be safety risks rather than environmental risks.

Of the six risks arising from non-routine activities, five (83%) were considered to be low risk and one (17%) was considered to be a medium risk. There were no hazards that were considered to be of high risk.

Based on the findings of the risk assessment workshop presented in Attachment 1, Table 6.1 shows the levels of risk on environmental factors for various activities to be undertaken in the 3D seismic survey. They were assessed as having greatest effect at the local and regional levels.

Preliminary discussions on additional management measures with the DoIR (the decision-making authority for petroleum permits) and Department of Conservation and Land Management (CALM) (the decision-making authority for Nature Reserves) have included:

- Discussions during preparation of the EMP;
- Consultations and attendance at the environmental risk assessment workshop (for the EMP); and
- Discussions during preparation of this Environmental Scoping Document.

**Table 6.1 Environmental risks categorised by environmental factors and activity for the Denison 3D Seismic Survey**

| Environmental Factors | Activity | | | | | | |
|---|---|---|---|---|---|---|---|
| | Line preparation | Line preparation (river crossing) | Line preparation (dune areas) | Campsite preparation | Mobilisation | Daily movement to and from camp | Waste management |
| Biodiversity | L/M | | | | | | |
| Flora | L/M & M | L | L/M | L | | | |
| Fauna | L | | L | L | | | |
| Conservation Areas | L | | | | | | |
| Weeds | L & L/M | | | | | L/M | |
| Dieback | L | | | | | | |
| Revegetation/ Rehabilitation | L/M | | | | | | |
| Wetlands (Irwin River) | | L | L/M | | | | |
| Land (soil) | L/M | L | L/M | L | | | |
| Land (caves) | | | L | | | | |
| General Waste | | | | | | | L/M |
| Hazardous Waste | | | | | | | L |
| Noise | L | | | | | | |
| Cultural heritage | L | | L | | | | |
| Fire | | | | | L | | |
| Infrastructure and Services | L & L/M | | | | | | |

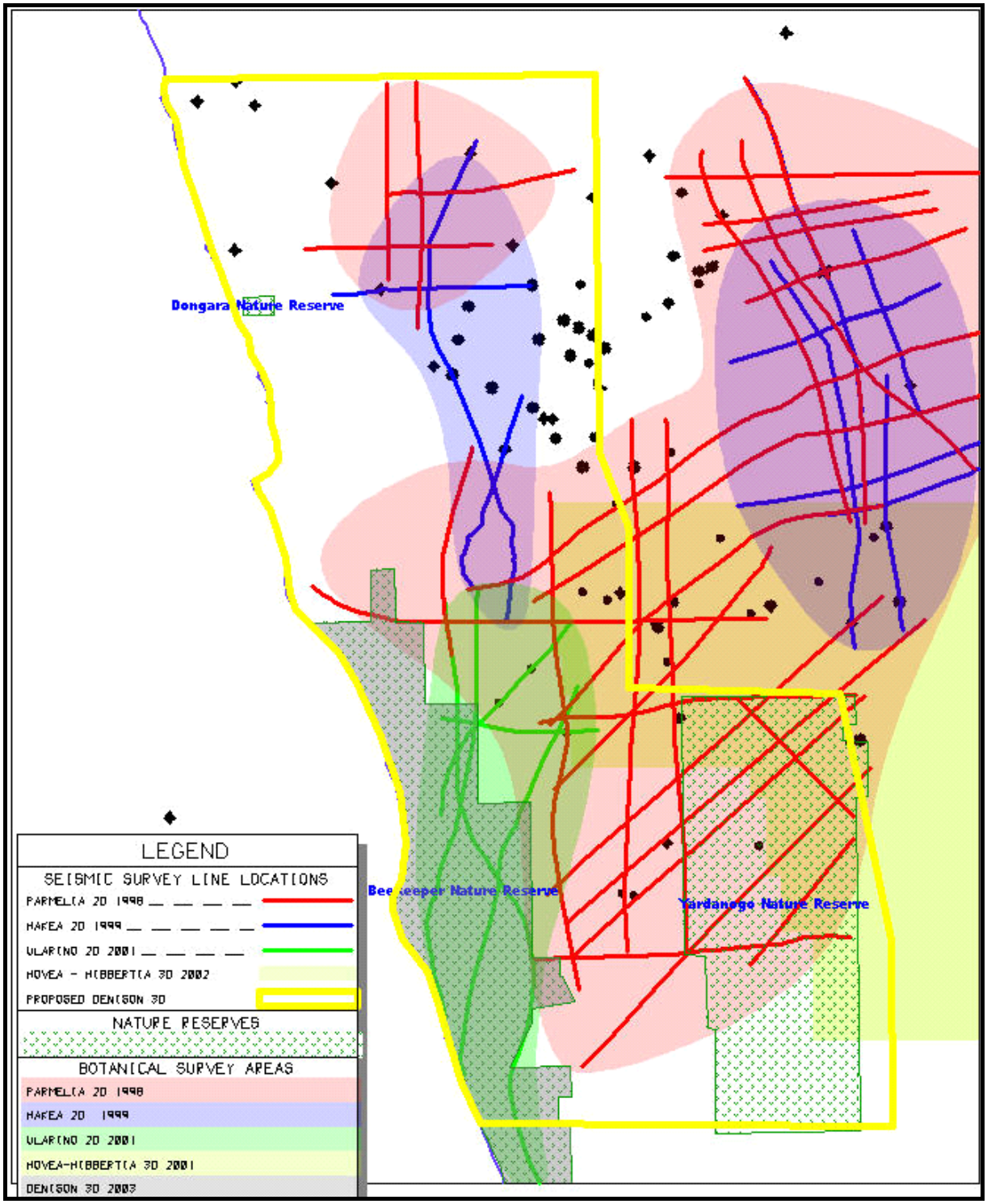
L: Low Risk; L/M : Low to Medium Risk; M: Medium Risk

# 7 PROPOSED STUDIES AND INVESTIGATIONS

Table A2.1 (Attachment 2) identifies the studies and investigations that ARC/Origin have carried out in relation to each of the environmental issues assessed in Section 6. Table A2.1 also identifies further studies and investigations that ARC/Origin proposes to carry out where further information may be required to ensure that the risks are managed using best practice measures. A summary of the vegetation and flora surveys carried out in the region, is illustrated in Figure 7.1. Proposed additional studies include:

- Desktop review of the entire survey area using aerial photography and field observations to produce a map of areas of high conservation significance (in consultation with CALM);
- Determine seismic line plan through the overlay of the identified high conservation areas with the proposed lines with field verification in conjunction with CALM;
- Detailed flora surveys in areas of high conservation significance that will be affected by seismic lines and activities. Section 11 outlines the timing of the proposed survey (if survey activities are delayed, ARC/Origin will conduct the flora survey in spring); and
- Walk-through of lines that intersect high conservation areas, deviating as required to avoid individual flora. This survey would be conducted just prior to the mobilisation of survey vehicles and equipment. If survey activities are delayed, ARC/Origin will conduct the walk-through survey in spring.

**Figure 7.1 Locations of previous environmental surveys in L1, L2 and EP413**



# 8 ENVIRONMENTAL FACTORS RELEVANT TO PROPOSAL

Following from discussions of the identification of potential environmental impacts, their management responses and the outline of the scope of studies and investigations to be undertaken, Table 8.1 presents a summary table relating environmental factors with scopes of additional studies and investigations. This table specifically identifies the key environmental factors where additional work has been identified as part of the PER process.

**Table 8.1 Environmental factors and scope of investigations**

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Biodiversity | Nature Reserves. | No loss of population of DRF or listed Priority species. | Loss of biodiversity and habitat. | Further consultation with CALM is planned to determine if further surveys are required and in which locations additional surveys need to be carried out. | • Identify endangered populations and minimise clearing where possible. |
| Flora | Nature Reserves and remnant habitats. | Minimise effects of the physical presence of the lines and camp site to sensitive areas (habitat, soil types, fauna or protected areas), discrete colonies of rare plants and other significant species (including priority, undescribed species and important structural species and long lived species eg | Sensitive or protected areas are cleared resulting in impact on significant values.<br>Damage to discrete colonies of rare plants and other significant species (including priority, undescribed species and important structural species and long lived species eg | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to ensure that no DRF, Priority or EPBC Act-listed flora are encountered in areas of agreed high conservation value, and will deviate the lines to avoid these flora as | • The site selection process will be based on criteria designed to minimise impact including: making use of existing tracks and firebreaks, avoidance of low lying areas; avoidance of slow growing species (*Xanthorrhea, Zamia* etc) avoidance of larger trees, avoiding sensitive sites (eg sites prone to erosion).<br>• The site selection process will include the use of aerial photos with the location of known DRFs, known significant vegetation stands and communities and other sensitive sites identified. CALM will be consulted in the process of line selection in sensitive areas. The ARC/Origin Field Botanist/s will be provided with copies of the marked up aerial photos.<br>• An ecological appraisal will be carried out before rolling to identify all sensitive areas including protected areas (reserves), habitats, location of protected and priority species (flora and fauna) and avoid choosing site locations that impact on these areas. Chaining maps are prepared based on the ecological appraisal. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | grasstrees). | grasstrees). | required. This survey would also identify other significant features such as fauna burrows, significant weed areas, wetlands, dunes, and areas of high erosion potential (see specific factors listed below).<br><br>The alignment of the lines will chosen with agreement from CALM. Advice has and will be sought from CALM on the requirement for additional flora surveys for lines located in Nature Reserves. | • The specialist engaged to survey the proposed line alignments will be familiarised with DRF and Priority flora prior to the survey, through a flora identification session in the field.<br>• A field herbarium will be compiled to aid in the identification of DRF and Priority flora.<br>• Confirmation that activity unlikely to have impact on significant areas through desktop review and discussions with CALM regional office.<br>• ARC/Origin will identify and locate Declared Rare Flora and Priority Flora and report to CALM on the standard forms using GPS locations.<br>• The same environmental protection management measures will be used in all areas of good quality native vegetation on private property and in the Nature Reserves.<br>• Allocation of space for the camp will be minimised.<br>• Camp rules, including the requirement not to interfere with wildlife and flora will be covered by the induction.<br>• Walk-through botanical surveys will be undertaken on lines that intersect areas of agreed high conservation value, just prior to the mobilisation of survey vehicles and equipment.<br>• Line selection planning will include aerial photo mapping of significant vegetation communities, stands of significant species, important habitat and wetland areas and any other areas with high conservation values.<br>• The White Point beach ridge area in EP413 covers an area of about 3km x 0.5km close to the coastline and contains high quality vegetation and landforms located in the Beekeepers Nature Reserve. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | | | | It is considered an area of high value conservation. ARC/Origin commit to the following mitigation measures:<br>• All personnel are advised that non authorised vehicles be prohibited from travelling in area.<br>• Receiver crews will hand carry equipment in the area.<br>• Source access lines will not enter the area other than along any existing tracks in consultation with CALM.<br>• A pre-clearing botanical survey will be done to identify and mark the boundary of the area.<br>• In addition, the following measures will be implemented in Nature Reserves:<br>• An ARC/Origin Field Botanist will walk ahead of the line preparation/rolling equipment in identified priority areas as agreed to with CALM.<br>• Qualifications of the ARC/Origin Field Botanist will be provided to CALM prior to work commencing.<br>• No DRF has been identified in the Beekeepers Nature Reserve. The nine Priority Flora species that are potentially present and three Priority Flora species that have been identified are listed in Table 5.3.<br>• There is known DRF in the Yardanogo Nature Reserve. Advice from CALM will be sought regarding occupation of previous survey lines.<br>• Lines will be deviated to avoid sensitive sites. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | | | | • Checklist to be prepared for the ARC/Origin Field Botanist identifying significant features.<br>• Build a mitigation strategy for high conservation value areas in consultation with CALM.<br>• New lines will be checked for DRF/Priority Flora and other features requiring management before they are rolled.<br>• Vegetation to be rolled so as not to disturb the topsoil and leave the vegetation in place to reduce rutting by tyres. |
| Fauna | Nature Reserves and remnant habitats. | Minimise effects of the physical presence of the lines and camp site to sensitive species, discrete colonies of rare species plants and other significant species (including priority, undescribed species and important structural species and long lived species eg grasstrees). | Destruction of fauna habitat leading to the loss of faunal populations.<br>Dust from 4WDs affects wildlife, residents and other land users. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to ensure that no animal burrows or nesting areas (eg Mallee Fowl mounds) are encountered in areas of agreed high conservation value, and will deviate lines to avoid burrows as required. | • Allocation of space for the camp will be minimised.<br>• No pets and no animals to be allowed on site.<br>• Camp rules, including the requirement not to interfere with wildlife and flora will be covered by the induction.<br>• Driver education regarding speed during induction.<br>• Induction to be carried out prior to start to educate on environmental issues as per the EMP risk assessment.<br>• Chaining maps available.<br>• Water truck available for dust suppression. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Conservation areas | Nature Reserves. | Minimise effects of the physical presence of the lines and camp site to sensitive areas (habitat, soil types, fauna or protected areas), discrete colonies of rare plants and other significant species (including priority, undescribed species and important structural species and long lived species eg grasstrees). | Degradation of conservation areas by habitat destruction and introduction of pest species. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to ensure that no DRF, Priority or EPBC Act-listed flora are encountered in areas of agreed high conservation value, and will deviate the lines to avoid these flora as required. | • Ensure all equipment is cleaned and inspected for soil, plant material and pest animal contamination before mobilisation to minimise risk of introducing exotic species. Location not to be near DRF.<br>• Pre-planning using aerial photos.<br>• Lines can be deviated to avoid sensitive and uncleared areas. Procedure ARC-PR-324 will be implemented to identify and agree on specific sensitive vegetation to be avoided / managed.<br>• Rolling is done to preserve the rootstock.<br>• Mallee fowl nesting mounds to be looked out for by ARC/Origin Field Botanist and avoided by the crew.<br>• Walk-through botanical surveys will be undertaken on lines that intersect areas of agreed high conservation value, just prior to the mobilisation of survey vehicles and equipment.<br>• Lines can be deviated to avoid sensitive and uncleared areas.<br>• Limited width of lines.<br>• Sand tyres are used on vehicles.<br>• Vehicles not to cross any dunes, except on existing tracks or following consultation with the ARC/Origin Environmental Field Officer.<br>• Rehabilitation commitments (see below). |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Weeds | All areas. | Minimise risk of introducing exotic species into region. | Exotic species could become invasive if introduced, with unpredictable consequences for native species.<br><br>Rolling Equipment and support vehicles introduce weed species from outside the survey area, or between areas of the survey.<br><br>Spread of weeds either by line preparation vehicles and wind or natural processes, or by subsequent public access along the seismic lines. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to ensure that no areas heavily infested with weeds are encountered in areas of agreed high conservation value, and will deviate the lines to avoid weeds as required. | • Maps are available to show weed distribution and clean down locations.<br>• If advised by the ARC/Origin Field Botanist to clean-down - only scheme water or water treated with chlorine will be used for all wash down activities.<br>• Induction to include personnel movement and implications of spread of weed and communicate that personnel are to lookout for and remove any soil and any organic material adhering to equipment.<br>• Supervisor to be allocated and communicate Quarantine Management/hygiene responsibilities.<br>• Monitor and dispose of exotic species returned through auditing and inspection program.<br>• All vehicles and machinery to be cleaned and inspected for soil, plant material and pest animal contamination prior to mobilisation to site.<br>• Cleandown areas to be defined with advice from the ARC/Origin Field Botanist.<br>• Daily planning to minimise all vehicle and line rolling activities in weed infected areas and movement from weed affected.<br>• Agriculture Department confirmed that there is “no Skeleton Weed or quarantine properties in the seismic survey area L1,L2 and EP413. Weeds such as thistle and Patterson's curse are no longer listed as declared plants”, however best practice is to be applied to ensure the survey does not significantly contribute to the spread of these weeds into areas currently free of these plants. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Revegetation / rehabilitation | All areas. | To ensure, as far as practicable, that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values. | Loss of topsoil and erosion from wind and water if sites are not adequately rehabilitated.<br>Loss of habitat cover and species diversity in disturbed areas.<br>Introduction of weeds, disease and species inconsistent with the surrounding landscape. | Evaluation of previous rehabilitation/ recovery survey results following vegetation clearing and/or disturbance activities.<br>Investigate and agree on completion criteria for areas of agreed high conservation value with CALM. | • All audit and close out reports will be provided to both CALM and DoIR to ensure good communications.<br>• Locations in reserves will be selected in consultation with CALM.<br>• All rubbish and other items will be removed once the work is completed.<br>• Ensure rehabilitation of areas disturbed is successful (as guided by rehabilitation completion criteria, set in conjunction with CALM).<br>• On completion of the project the entrances to the lines will be mulched where required. ARC/Origin will employ best endeavours to close lines within 2 weeks of last use by the seismic crew or ancillary activities (survey, uphole etc), and are committed to effect closure within 1 month. Particular attention will be paid to the lines with potential for future unauthorised access to the beach.<br>• Proponents to liaise with CALM and Fire and Emergency Services Authority (FESA) to resolve issues such as which tracks are to remain open on Unallocated Crown Land (UCL) to service the wildflower picking industry and to provide guidance on the interaction with the wildflower picking industry. This will be done with CALM as CALM has management responsibility for the flora industry on UCL. Licence conditions prevent flora pickers from driving on "seismic lines" which have been recently created.<br>• Signs and fences will be avoided because they tend to “invite” access.<br>• ARC/Origin has an ongoing commitment to inspection and remedial actions. These are detailed in the Denison 3D Seismic Survey EMP, Section 7. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | | | | • ARC/Origin will carry out any rehabilitation work necessary at the completion of the survey, including closing off the track entrances and using controlled fires to promote regeneration - but only in consultation with CALM and FESA and using CALM approved procedures.<br>• Audits will take place within 2 weeks of the end of the survey and after the first anniversary with attention paid to third party access issues including the presence of introduced weeds and disease.<br>• Identify seismic lines with potential for third party access. Conduct tri-monthly inspections until closure with CALM to ensure that lines are disguised using scrub and mulch to beyond line of sight. Follow up monitoring is to be determined after consultation with CALM.<br>• Inspections of rehabilitated areas will be undertaken (in consultation with CALM and DoIR) following the second anniversary of the survey and then annually thereafter for 5 years or until closed-out by CALM.<br>• If rehabilitation were considered adequate at this time CALM would close-out the survey.<br>• If not, further rehabilitation procedures will be agreed between ARC/Origin and CALM, with close-out when rehabilitation is adequate.<br>• Any lines with authorised third party access would be exempt from rehabilitation requirements.<br>• Communications with CALM will be through both the Perth and regional offices. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | | | | • Recontouring and brushing in dogleg areas where rutting has occurred near public access points or where vehicles have been bogged to be stabilised with priority. |
| Wetlands (Irwin River) | Irwin River | Minimise erosion of river banks via vegetation and soil damage. | Erosion of river banks via vegetation and soil damage. | Aerial photographs will be used to plan the alignment of the surveys lines. The lines will be planned to avoid significant wetland features.<br><br>Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to ensure that no new river crossings are made in areas of agreed high conservation value and that all crossings in these areas preferentially use existing roads and tracks. | • No new crossings. Use existing roads and track crossing points only.<br>• Reference will be made to key documents such as the Batavia Coast Strategy, Dec. 2001, section 6.9, page 63.<br>• Source Lines – stop outside Riparian zone.<br>• Receiver Lines – hand clearing only within bank to river edge.<br>• No line clearing of native vegetation in areas of agreed high conservation value will be carried out without botanical supervision. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Land (soil) | All areas. | Minimise erosion of steep dune slopes and sharp crests. | Soil lost through water and wind erosion, increased groundwater salinity.<br><br>Steep dune slopes; sharp crests subject to blowout if soil and vegetation disturbed. Not suitable for vehicular traverse.<br><br>Lines cut / rolled along dune slopes and obliquely across dune crests resulting in blowout if soil & vegetation disturbed. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments to check for significant features (e.g. areas of high erosion potential) in areas of agreed high conservation value and will deviate the lines to avoid significant features if they are encountered. | • No clearing of native vegetation will be carried out for the camp construction. Geo-heritage to be one of several criteria to determine suitability of site. Field check to be completed to ensure no remnant vegetation in site.<br>• Follow previous survey (Hovea and Hibbertia) rehabilitation practices.<br>• The campsite preparation method will be the same as the previously accepted procedure of removing and stockpiling topsoil and using limestone marl.<br>• Receiver lines: Vegetation will be rolled in valleys and only hand cutting/carrying will be done over the steep dune slopes and sharp crests.<br>• Any line preparation work for a vehicle crossing of a longitudinal dune can only be done after consultation with the ARC/Origin Environmental Field Officer.<br>• Access plan in consultation with CALM.<br>• No line clearing of native vegetation in areas of agreed high conservation value will be carried out without botanical supervision.<br>• In the Beekeepers Nature Reserve line clearing will not occur within 150m from the high tide mark or cut the first or secondary dune sets. Line clearing will not extend to the beach so that tracks are not opened.<br>• The ARC/Origin Field Botanist checklist will be prepared including reference to potential for extended areas of no rolling in areas on low vegetation height. (H&S issue for crew when planting geophones). |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| | | | | | • Roll approximately NNE/SSW oriented source lines along dune swales.<br>• Where dunes obstruct source lines, detailed air photo and on ground analysis will be conducted to avoid steep or unstable slopes, and to deviate source lines to paths of least disturbance. Cross at lowest point of saddles. Rolling of vegetation. |
| Cultural heritage | All areas. | No damage/loss of archaeological / ethnographic values. | Damage / loss of archaeological / ethnographic value. | Assessment of heritage areas in consultation with Shire Engineer. | • In the event that any archaeological material, including human skeletal material is uncovered as a result of line preparation, the development will be immediately reported to the relevant authorities.<br>• All work stops immediately and the area is isolated.<br>• Refer "Report on an Archaeological Investigation for Aboriginal Sites Denison 3D Seismic Programme" Quartermaine Consultants, November 2003, page 17<br>• The induction will include the requirement under the WA *Aboriginal Heritage Act* 1972, Section 17, that it is an offence to knowingly interfere with Aboriginal sites. |

| Environmental Factor | Relevant Area | Environmental Objective | Potential Impacts | Additional Investigations | Potential Management |
|---|---|---|---|---|---|
| Infrastructure and services | Farmland and populated areas. | Closed access lines are not used by unauthorised vehicles | Damage to roads pipes, drains, buildings, services.<br>Soil lost through erosion by vehicles from turns.<br>Damage to paddocks.<br>Disturbance to livestock.<br>Generation of litter<br>Degradation of visual amenity. | Further consultation with the Shire Engineer is planned. | • Consultation with Shire Engineer to ensure compatibility of equipment and infrastructure.<br>• Pre-planning.<br>• Prior experience in area.<br>• Public consultation.<br>• Compliance with Australian Standards on vibration of structures.<br>• Control of drive levels to remain within limits. |

# 9 APPLICABLE LEGISLATION

Activities occurring within tenements L1, L2 and EP 413 are regulated under State jurisdiction although there are Commonwealth Acts and industry codes of practice that also apply (Table 9.1).

In the event of conflict between these and other mentioned legislation in the list, DoIR shall be properly notified and consulted for resolution.

**Table 9.1 Legislation and industry codes applying to the area of operations**

| Jurisdiction | Legislation |
|---|---|
| **State Legislation** | • *Aboriginal Heritage Act* 1972<br>• *Conservation and Land Management Act* 1984<br>• *Country Areas Water Supply Act* 1947<br>• *Environmental Protection Act* 1986<br>• *Heritage of Western Australia Act* 1990<br>• *Land Administration Act* 1997<br>• *Petroleum Act* 1967<br>• *Schedule of Onshore Petroleum Exploration and Production Requirements* 1991<br>• *Petroleum Act* 1967<br>• *Petroleum Pipelines Act* 1969<br>• *Pollution of Waters by Oil and Noxious Substances Act* 1987<br>• *Prevention of Pollution of Water by Oil Act* 1960<br>• *Wildlife Conservation Act* 1950-1980 |
| **Commonwealth Legislation** | • *Aboriginal and Torres Strait Islander Heritage Protection Act* 1984<br>• *Australian Heritage Commission Act* 1975<br>• *Environment Protection and Biodiversity Conservation Act* 1999<br>• *Native Title Act* 1993 (Not applicable to the production licences) |
| **Industry codes of practices** | • Code of Environmental Practice (APPEA, 1996) |

# 10 COMMUNITY AND OTHER STAKEHOLDER CONSULTATION PROGRAM

Consultation through local communities and stakeholders is an ongoing process. Since September 2003, ARC/Origin has provided dedicated resources to landowner liaison for the proposed Denison 3D Seismic Survey. A summary of stakeholder consultation is presented in Table 10.1.

**Table 10.1 Summary of stakeholder consultation, key issues and outcomes.**

| Stakeholder | Key Issues | Outcomes of Consultation |
|---|---|---|
| **FESA**<br>Chief Fire Officer<br>Peter Summers | Fire Risk | • Seismic crew well prepared and fire risk considered low. |
| **Department of Agriculture**<br>(Geraldton) | Fire Risk<br>Weeds | • Rehabilitation of farmland, crops and scarifying;<br>• Soil stability;<br>• Develop soil risk amelioration advice for landowners; and<br>• Cleandown protocol incorporated into ARC/Origin EMP and inductions. |
| **Shire of Irwin** | Community disturbance<br>Noise | • Restrict seismic source to non-urban areas to Australian Standards for intensity of vibration; and<br>• Monitor noise and heritage buildings to Australian Standards. |
| **Land Owners** | Erosion<br>Gates, fences etc.<br>Operational footprint<br>Weeds | • All landowners consulted (approximately 250);<br>• Discussion of erosion;<br>• Discussion on the management of gates, fences to ensure no adverse impact to land owners;<br>• Discussion on the area of footprint on aerial photographs; and<br>• Discussion of the distribution of weeds. |
| **Conservation Council**<br>Graeme Rundle<br>Rachel Siewert | Access to public<br>Heritage Buildings<br>Weeds | • Discussion of how to restrict access to public once acquisition has been completed; and<br>• Heritage buildings will be monitored to Australian Standards for intensity of vibration. |

| Stakeholder | Key Issues | Outcomes of Consultation |
|---|---|---|
| **Wildflower Society**<br>Brian Moyle<br>Janet Atkins | Access to public<br>Vegetation disturbance<br>Weeds | • Discussion of how to restrict access to public once acquisition has been completed;<br>• Lines and roads will be diverted to avoid slow growing species;<br>• Discussion on rolling process; and<br>• Weed eradication program ahead of equipment entering area to reduce the opportunity for seeds to spread. |
| **CALM**<br>Norm Caporn<br>Daniel Coffey<br>Rebecca Carter | Access to public<br>Caves<br>Line placement<br>Rehabilitation<br>Weeds | • Field Trip carried out with CALM on 17 November 2003;<br>• Ongoing consultation with CALM regarding access to Nature Reserves;<br>• Discussion of how to restrict access to public once acquisition has been completed;<br>• Surveys have indicated no evidence of caves;<br>• Preplotting of lines before ground truthing and modification;<br>• Funding of burn program to increase rehabilitation;<br>• Weed eradication program ahead of equipment entering area to reduce the opportunity for seeds to spread, particularly along railway line; and<br>• Funding of CALM staff and administration costs that relate to the administration/regulation of the survey. |
| **EPA**<br>Tim Gentle<br>Nick Woolfrey | Access to public<br>Best practice<br>Cultural Heritage<br>Weeds | • Discussion of how to restrict access to public once acquisition has been completed;<br>• Discussion on best practice for environmental care;<br>• Discussion on ethno-graphic and archaeological surveys and consultation with local Aboriginal groups; and<br>• Weed eradication program ahead of equipment entering area to reduce the opportunity for seeds to spread. |
| **DoIR**<br>Graham Cobby<br>Craig McLernan | Fire Risk<br>Rehabilitation<br>Weeds | • Weed eradication program ahead of equipment entering area to reduce the opportunity for seeds to spread. |

Consultation as part of ethnographic and archaeological studies have also been undertaken. Heritage, archaeological and anthropological surveys are being assessed independently of the Denison 3D Seismic Survey EMP.

Other agencies, individuals and organisations that have been consulted and/or approached, in order to present the information in the Denison 3D Seismic Survey EMP include:

- Hart, Simpson and Associates – Roz Hart, Cate Tauss
- Museum of Western Australia
- Speleological Research Group of Western Australia – Norman Poulter
- Department of Agriculture (Geraldton) – Mike Clark and Peter Metcalf
- Trace Energy Services: Steve Tobin, Andy Brett

ARC/Origin conducted an environmental risk assessment workshop on 24 November 2003. The workshop was well attended by a cross-section of stakeholders. A list of attendees and minutes of the meeting are presented in the Denison 3D Seismic Survey EMP. Further to the workshop, participants were invited to comment on the minutes of the workshop as well as the assessment of risk conducted on completion of the workshop. It is envisaged that further meetings with these parties will be undertaken as part of the PER process.

# 11 PROJECT AND ASSESSMENT SCHEDULE

ARC/Origin's proposed timeline for the PER process is outlined in Table 11.1.

**Table 11.1 Project and assessment timeline**

| Task | 2004 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D |
| Stakeholder consultation | | | | | | | | | | | | |
| ARC/Origin submits Environmental Scoping Document to EPA | | | | | | | | | | | | |
| EPA agrees to Environmental Scoping Document as basis for PER | | | | | | | | | | | | |
| ARC/Origin prepares PER | | | | | | | | | | | | |
| • *Flora surveys* | | | | | | | | | | | | |
| EPA authorises PER for public review (4 weeks) | | | | | | | | | | | | |
| Public review period (4 weeks) - receipt of submissions during public review period. | | | | | | | | | | | | |
| ARC/Origin responds to submissions | | | | | | | | | | | | |
| EPA undertakes assessment and reports to Minister | | | | | | | | | | | | |
| Minister publishes EPA Report | | | | | | | | | | | | |
| ARC/Origin commence preparatory works following approval from EPA | | | | | | | | | | | | |

# 12 PEER REVIEW

The extensive stakeholder consultation during the preparation of the EMP provided an excellent peer review process for the concepts and management plans developed. The EMP was also reviewed by DoIR, EPA and CALM as part of the peer review process. Details of this consultation are provided in the EMP (ARC 2004) and are summarised in Section 10 of this document.

In addition CALM will provide peer review throughout the additional flora and fauna investigations, with programs developed using botanical consultants (eg Woodman Environmental Consulting) in close consultation with CALM. Technical experts (eg environmental scientists at IRC Environment) will review each investigation report.

# 13 STUDY TEAM

The study team, their roles and expertise are summarised in Table 13.1.

**Table 13.1 Study Team**

| Company/ Organisation | Role | Expertise | Key Personnel |
|---|---|---|---|
| ARC | Primary proponent and supplier of key information relevant to the proposal. | Development of onshore oil and gas resources. | Andrew Padman (Exploration Manager, Proponent Contact). |
| Origin | Co-proponent and supplier of key information relevant to the proposal. | Development of onshore and offshore oil and gas resources. | Dean Powell (Senior Geophysicist – Exploration and Production); and<br>Justin Hayes (HSE Advisor). |
| IRC Environment | Preparation of Environmental Scoping Document and PER. | Environmental regulatory approvals, preparation of environmental approvals documentation. | John Nielsen (Principal Environmental Scientist, Project Manager);<br>Tony Heynen (Environmental Engineer);<br>Anthony McMullen (Principal Environmental Consultant); and<br>Peter Jernakoff (Principal Environmental Consultant). |
| Woodman Environmental Consulting | Project botanical services. | Biological surveys, dieback assessment. | Greg Woodman (Project Botanist). |
| Hart Simpson and Associates | Project botanical services. | Biological surveys, dieback assessment. | Rosalind Hart (Microbiologist). |

# 14 REFERENCES

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# ATTACHMENTS

# Attachment 1
# Summary of potential environmental impacts and their management

**Table A1.1 Activities, risks and management actions classified according to environmental factors**

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| **INTEGRATION** | | | | |
| Biodiversity | See Biophysical sections below. | | | |
| **BIOPHYSICAL** | | | | |
| Flora | Preparation of seismic lines, access roads and camp sites. | Activity located in protected areas (reserves) or other sensitive areas (habitat, soil types). | Sensitive or protected areas are cleared resulting in impact on significant values: Damage to discrete colonies of rare plants and other significant species (including priority, undescribed species and important structural species and long lived species eg grasstrees). | • The site selection process will be based on criteria designed to minimise impact including: making use of existing tracks and firebreaks, avoidance of low lying areas; avoidance of slow growing species (*Xanthorrhea, Zamia* etc) avoidance of larger trees, avoiding sensitive sites (eg sites prone to erosion).<br>• The site selection process will include the use of aerial photos with the location of known DRFs, known significant vegetation stands and communities and other sensitive sites identified. CALM will be consulted in the process of line selection in sensitive areas. The ARC/Origin Field Botanist/s will be provided with copies of the marked up aerial photos.<br>• An ecological appraisal will be carried out before rolling to identify all sensitive areas including protected areas (reserves), habitats, location of protected and priority species (flora and fauna) and avoid choosing site locations that impact on these areas. Chaining maps are prepared based on the ecological appraisal.<br>• The specialist engaged to survey the proposed line alignments will be familiarised with DRF and Priority flora prior to the survey, through a flora identification session in the field.<br>• A field herbarium will be compiled to aid in the identification of DRF and Priority flora.<br>• Confirmation that activity unlikely to have impact on significant areas through desktop review and discussions with CALM regional office.<br>• ARC/Origin will identify and locate Declared Rare Flora and Priority Flora and report to CALM on the standard forms using GPS locations.<br>• The same environmental protection management measures will be used in all areas of good |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | | | quality native vegetation on private property and in the Nature Reserves.<br>• Allocation of space for the camp will be minimised.<br>• Camp rules, including the requirement not to interfere with wildlife and flora will be covered by the induction.<br>• Walk-through botanical surveys will be undertaken on lines that intersect areas of agreed high conservation value, just prior to the mobilisation of survey vehicles and equipment.<br>• Line selection planning will include aerial photo mapping of significant vegetation communities, stands of significant species, important habitat and wetland areas and any other areas with high conservation values.<br>• The White Point beach ridge area in EP413 covers an area of about 3km x 0.5km close to the coastline and contains high quality vegetation and landforms located in the Beekeepers Nature Reserve. It is considered an area of high value conservation. ARC/Origin commit to the following mitigation measures:<br>  • All personnel are advised that non authorised vehicles be prohibited from travelling in area.<br>  • Receiver crews will hand carry equipment in the area.<br>  • Source access lines will not enter the area other than along any existing tracks in consultation with CALM.<br>  • A pre-clearing botanical survey will be done to identify and mark the boundary of the area.<br>• In addition, the following measures will be implemented in Nature Reserves:<br>  • An ARC/Origin Field Botanist will walk ahead of the line preparation/rolling equipment in identified priority areas as agreed to with CALM.<br>  • Qualifications of the ARC/Origin Field Botanist will be provided to CALM prior to work |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | | | commencing.<br>• No DRF has been identified in the Beekeepers Nature Reserve. The nine Priority Flora species that are potentially present and three Priority Flora species that have been identified are listed in Table 5.3.<br>• There is known DRF in the Yardanogo Nature Reserve. Advice from CALM will be sought regarding occupation of previous survey lines.<br>• Lines will be deviated to avoid sensitive sites.<br>• Checklist to be prepared for The ARC/Origin Field Botanist identifying significant features.<br>• Build a mitigation strategy for high conservation value areas in consultation with CALM.<br>• New lines will be checked for DRF/Priority Flora and other features requiring management before they are rolled.<br>• Vegetation to be rolled so as not to disturb the topsoil and leave the vegetation in place to reduce rutting by tyres. |
| Fauna | Preparation of seismic lines, access roads and camp sites. | Removal of native vegetation and potential habitat.<br><br>Dust from 4WDs. | Destruction of fauna habitat.<br><br>Dust from 4WDs affects wildlife, residents, other land users. | • Allocation of space for the camp will be minimised.<br>• No pets and no animals to be allowed on site.<br>• Camp rules, including the requirement not to interfere with wildlife and flora will be covered by the induction.<br>• Driver education regarding speed during induction.<br>• Induction to be carried out prior to start to educate on environmental issues as per the EMP risk assessment.<br>• Chaining maps available.<br>• Water truck available for dust suppression. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| Conservation areas | Preparation of seismic lines, access roads and camp sites. | Rolling of vegetation may lead to: Long-term decrease in size of population by reduction of; fragmentation of; or other adverse effects on occupancy area such that the modification, destruction, removal, isolation or decreased availability of habitat results in the species being likely to decline.<br><br>Interference with the recovery of species. | Potential for significant impact to nationally threatened species or priority/ undescribed species | • Ensure all equipment is cleaned and inspected for soil, plant material and pest animal contamination before mobilisation to minimise risk of introducing exotic species. Location not to be near DRF.<br>• Pre-planning using aerial photos.<br>• Lines can be deviated to avoid sensitive and uncleared areas. Procedure ARC-PR-324 will be implemented to identify and agree on specific sensitive vegetation to be avoided / managed.<br>• Rolling is done to preserve the rootstock.<br>• Mallee fowl nesting mounds to be looked out for by ARC/Origin Field Botanist and avoided by the crew.<br>• Walk-through botanical surveys will be undertaken on lines that intersect areas of agreed high conservation value, just prior to the mobilisation of survey vehicles and equipment.<br>• Lines can be deviated to avoid sensitive and uncleared areas.<br>• Limited width of lines.<br>• Sand tyres are used on vehicles.<br>• Vehicles not to cross any dunes, except on existing tracks or following consultation with the ARC/Origin Environmental Field Officer.<br>• Rehabilitation commitments (see below). |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| Weeds | Plant and personnel mobilisation. | Introduction of exotic species to the camp environment from beyond survey area.<br><br>Leaving defined weed infected areas resulting in the introduction of exotic species. | Exotic species could become invasive if introduced, with unpredictable consequences for native species.<br><br>Rolling Equipment and support vehicles introduce weed species from outside the survey area, or between areas of the survey.<br><br>Spread of weeds either by line preparation vehicles and wind or natural processes, or by subsequent public access along the seismic lines. | • Maps are available to show weed distribution and clean down locations.<br>• If advised by the ARC/Origin Field Botanist to clean-down - only scheme water or water treated with chlorine will be used for all wash down activities.<br>• Induction to include personnel movement and implications of spread of weed and communicate that personnel are to lookout for and remove any soil and any organic material adhering to equipment.<br>• Supervisor to be allocated and communicate Quarantine Management/hygiene responsibilities.<br>• Monitor and dispose of exotic species returned through auditing and inspection program.<br>• All vehicles and machinery to be cleaned and inspected for soil, plant material and pest animal contamination prior to mobilisation to site.<br>• Cleandown areas to be defined with advice from the ARC/Origin Field Botanist.<br>• Daily planning to minimise all vehicle and line rolling activities in weed infected areas and movement from weed affected.<br>• Agriculture Department confirmed that there is “no Skeleton Weed or quarantine properties in the seismic survey area L1, L2 and EP413. Weeds such as thistle and Patterson's curse are no longer listed as declared plants”, however best practice is to be applied to ensure the survey does not significantly contribute to the spread of these weeds into areas currently free of these plants. |
| Dieback | Line preparation. | Spread of disease by line preparation vehicles, feral animals or stock, or by | Introduction of disease such as dieback into reserves. | • There is no known dieback in the survey area.<br>• Clean-down areas to be defined with advice from the ARC/Origin Field Botanist and in consultation with CALM.<br>• If advised by the ARC/Origin Field Botanist to clean-down - only scheme water or water treated with chlorine will be used for all wash down activities. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | subsequent public access along the seismic lines. | | • Maps are available to show the known location of dieback that is outside of the survey area. The induction is to include the requirement that this area is "off limits".<br>• Quarantine Management/Hygiene procedures will be implemented.<br>• Quarantine Management/Hygiene procedures to be included in the induction.<br>• Limestone soil that covers the bulk of the survey area is hostile to dieback.<br>• Map high dieback risk areas (eg wetlands) for the purposes of monitoring.<br>• Mandatory clean down for vehicles if they carry mud.<br>• Chaining maps showing location of gates.<br>• Gates to be managed to prevent the escape of stock. |
| Revegetation / rehabilitation | Line rehabilitation. | Potential for lines to be poorly rehabilitated. | Loss of topsoil and erosion from wind and water if sites are not adequately rehabilitated. Loss of % cover and species diversity at the sites.<br>Introduction of weeds and disease (eg by seismic crew or third parties). | • All audit and close out reports will be provided to both CALM and DoIR to ensure good communications.<br>• Locations in reserves will be selected in consultation with CALM.<br>• All rubbish and other items will be removed once the work is completed.<br>• Ensure rehabilitation of areas disturbed is successful (as guided by rehabilitation completion criteria, set in conjunction with CALM).<br>• On completion of the project the entrances to the lines will be mulched where required. ARC/Origin will employ best endeavours to close lines within 2 weeks of last use by the seismic crew or ancillary activities (survey, uphole etc), and are committed to effect closure within 1 month. Particular attention will be paid to the lines with potential for future unauthorised access to the beach.<br>• Proponents to liaise with CALM and FESA to resolve issues such as which tracks are to remain open on UCL to service the wildflower picking industry and to provide guidance on the interaction with the wildflower picking industry. This will be done with CALM as CALM |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | | | has management responsibility for the flora industry on UCL. Licence conditions prevent flora pickers from driving on "seismic lines" which have been recently created.<br>• Signs and fences will be avoided because they tend to “invite” access.<br>• ARC/Origin has an ongoing commitment to inspection and remedial actions. These are detailed in the Denison 3D Seismic Survey EMP, Section 7.<br>• ARC/Origin will carry out any rehabilitation work necessary at the completion of the survey, including closing off the track entrances and using controlled fires to promote regeneration - but only in consultation with CALM and FESA and using CALM approved procedures.<br>• Audits will take place within 2 weeks of the end of the survey and after the first anniversary with attention paid to third party access issues including the presence of introduced weeds and disease.<br>• Identify seismic lines with potential for third party access. Conduct tri-monthly inspections until closure with CALM to ensure that lines are disguised using scrub and mulch to beyond line of sight. Follow up monitoring is to be determined after consultation with CALM.<br>• Inspections of rehabilitated areas will be undertaken (in consultation with CALM and DoIR) following the second anniversary of the survey and then annually thereafter for 5 years or until closed-out by CALM.<br>• If rehabilitation were considered adequate at this time CALM would close-out the survey.<br>• If not, further rehabilitation procedures will be agreed between ARC/Origin and CALM, with close-out when rehabilitation is adequate.<br>• Any lines with authorised third party access would be exempt from rehabilitation requirements.<br>• Communications with CALM will be through both the Perth and regional offices. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | | | • Recontouring and brushing in dogleg areas where rutting has occurred near public access points or where vehicles have been bogged to be stabilised with priority. |
| Wetlands<br>(Irwin River) | Line preparation (river crossing). | Vehicles crossing Irwin River.<br>Running cables across river. | Erosion of river banks via vegetation and soil damage. | • No new crossings. Use existing roads and track crossing points only.<br>• Reference will be made to key documents such as the Batavia Coast Strategy, Dec. 2001, section 6.9, page 63.<br>• Source Lines – stop outside Riparian zone.<br>• Receiver Lines – hand clearing only within bank to river edge.<br>• No line clearing of native vegetation in areas of agreed high conservation value will be carried out without botanical supervision. |
| Land (soil) | Selection and preparation of seismic lines, drill sites, access roads and camp sites. | Removal of native vegetation and potential habitat.<br>Receiver lines E-W will traverse dunes almost at right angles; N-S lines will run parallel to dune ridges. | Soil lost through water and wind erosion, increased groundwater salinity.<br>Steep dune slopes; sharp crests subject to blowout if soil and vegetation disturbed. Not suitable for vehicular traverse.<br>Lines cut/rolled along dune slopes and obliquely across dune crests resulting in blowout if soil and | • No clearing of native vegetation will be carried out for the camp construction. Geo-heritage to be one of several criteria to determine suitability of site. Field check to be completed to ensure no remnant vegetation in site.<br>• Follow previous survey (Hovea and Hibbertia) rehabilitation practices.<br>• The campsite preparation method will be the same as the previously accepted procedure of removing and stockpiling topsoil and using limestone marl.<br>• Receiver lines: Vegetation will be rolled in valleys and only hand cutting/carrying will be done over the steep dune slopes and sharp crests.<br>• Any line preparation work for a vehicle crossing of a longitudinal dune can only be done after consultation with the ARC/Origin Environmental Field Officer.<br>• Access plan in consultation with CALM.<br>• No line clearing of native vegetation in areas of agreed high conservation value will be carried out without botanical supervision.<br>• In the Beekeepers Nature Reserve line clearing will not occur within 150m from the high tide |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | | vegetation disturbed. | mark or cut the first or secondary dune sets. Line clearing will not extend to the beach so that tracks are not opened.<br>• The ARC/Origin Field Botanist checklist will be prepared including reference to potential for extended areas of no rolling in areas on low vegetation height. (H&S issue for crew when planting geophones).<br>• Roll approximately NNE/SSW oriented source lines along dune swales.<br>• Where dunes obstruct source lines, detailed air photo and on ground analysis will be conducted to avoid steep or unstable slopes, and to deviate source lines to paths of least disturbance. Cross at lowest point of saddles. Rolling of vegetation. |
| Land (caves) | Line preparation. | Potential presence of cavernous or Karst porosity.<br>Potential presence of Stygofauna and/or bats. | Vibration causing collapse of caverns & holes.<br>Stygofauna and/or bats affected by cave collapse. | • Extensive previous seismic in the area.<br>• There are no known karst related habitats for bats or other cave-dwelling fauna in the survey area.<br>• Consultation with Speleological Research Group of WA.<br>• No identified/known caves, no surface openings.<br>• If caves are detected the ARC/Origin supervisor will be notified and he/she will determine if lines need to be re-aligned. Location of significant caves will be reported to Norman Poulter of Speleological Research Group of Western Australia.<br>• Extensive previous seismic in the area.<br>• No identified/known caves, no surface openings.<br>• Consultation with Speleological Research Group of WA |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| **POLLUTION MANAGEMENT** | | | | |
| General waste | Generation and handling of waste. | Generation of waste/ industrial and domestic wastes produced associated with the survey, including drilling and camp activities, which may contaminate the receiving environment. | Soil and groundwater may be contaminated by contact with wastes. | • Ensure that wastes are effectively managed according to Trace management procedures and treatment systems.<br>• Consultation with Irwin Shire Council regarding camp planning and construction.<br>• Waste disposal objectives to be included in the induction.<br>• Minimise the volume of wastes generated over the duration of the seismic program.<br>• All domestic wastes (food scraps/galley wastes) and industrial and solid wastes to be disposed of according to the Irwin Shire Council requirements.<br>• Grey-water, sewage disposed of by septic tank or as otherwise directed by the Irwin Shire Council.<br>• Wind and vermin proof waste bins.<br>• Regular clean ups on camp.<br>• Housekeeping standards to be included in the induction.<br>• All rubbish to be brought back to camp each day for correct disposal. |
| Hazardous waste *(non-routine incidents)* | Storage and handling of hazardous material. | Small quantities of hazardous associated with the survey stored on-site are spilled/ released.<br>Spill of | Soil and groundwater may be contaminated by contact with hazardous materials.<br>Soil and groundwater may be contaminated by contact with wastes | • Hazardous materials to be stored separately and clearly identified.<br>• Ensure that hazardous materials handling is in strict accordance with the Trace dangerous goods procedures.<br>• Ensure personnel are adequately trained in the storage and handling of hazardous materials<br>• Spill kits in place.<br>• Daily inspections of drip trays. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | hazardous materials (hydrocarbons) - Hose breaks during refuelling (50 litres or less). | resulting in ground water contamination.<br>Mortality of fauna and flora directly impacted by oil. | • Remove contaminated soil or use bio-remedial product "Enretech' or "Envirosorb" to digest hydrocarbons in sensitive environments.<br>• No refuelling of light vehicles in Nature Reserves. No refuelling of heavy equipment in Nature Reserves unless approved by ARC/Origin Environmental Officer. Requirement included in induction.<br>• Refuelling procedures (to include watchman present at all times) in place.<br>• Auto shut-off taps during refuelling; main valves to be shut off during night. |
| Noise | Vehicle movement. | Noise from 4WDs, seismic equipment. | Noise from 4WDs affects wildlife, residents, other land users. | • Driver education regarding speed during induction.<br>• Induction to be carried out prior to start to educate on environmental issues as per risk assessment.<br>• Chaining maps available. |
| **SOCIAL, CULTURAL AND ECONOMIC** | | | | |
| Cultural heritage | General activities. | Potential to uncover and disturb any archaeological material, including human skeletal material as a result of line preparation. | Damage/loss of archaeological/ ethnographic value. | • In the event that any archaeological material, including human skeletal material is uncovered as a result of line preparation, the development will be immediately reported to the relevant authorities.<br>• All work stops immediately and the area is isolated.<br>• Refer "Report on an Archaeological Investigation for Aboriginal Sites Denison 3D Seismic Programme" Quartermaine Consultants, November 2003, page 17<br>• The induction will include the requirement under the WA *Aboriginal Heritage Act* 1972, Section 17, that it is an offence to knowingly interfere with Aboriginal sites. |
| Fire *(non-routine incidents)* | Vehicle movement. | Source of ignition: vehicle exhaust, | Grass fires and bush fires in uncleared areas from sources | • No smoking outside of vehicles.<br>• Spark arresters on all vehicles. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| | | smokers, sparks from stones, intentional fire by crew. | of ignition introduced by the survey. Loss of vegetation. | • Vehicles contain rakes, extinguishers and backpacks.<br>• Crew training - use of fire extinguishers.<br>• FESA fire broadcast regarding machinery bans.<br>• Measures to avoid littering with broken glass or plastic to prevent ignition sources.<br>• Regular vehicle inspections (remove grass build up around hot components).<br>• Ultra-high frequency (UHF) radios.<br>• FESA, CALM and Department of Agriculture coordination re: preparation of Emergency Response Plan.<br>• Personnel training to include fire incidents.<br>• Water trucks available for fire fighting.<br>• Require fire plan for camp.<br>• Reference will be made to key documents such as the Batavia Coast Strategy, Dec. 2001, section 6.9, page 64. |

| Environmental Factor | Activity | Event/ Description | Potential Impact | Safeguards/ Management Methods |
|---|---|---|---|---|
| Infrastructure and services | Line preparation (town areas). | • Vibration and force.<br>• Vehicle movements.<br>• Public usage of lines for access to amenities. | • Damage to roads pipes, drains, buildings, services.<br>• Soil lost through erosion by vehicles from turns.<br>• Damage to paddocks.<br>• Disturbance to livestock.<br>• Generation of litter<br>• Degradation of visual amenity. | • Consultation with Shire Engineer to ensure compatibility of equipment and infrastructure.<br>• Pre-planning.<br>• Prior experience in area.<br>• Public consultation.<br>• Compliance with Australian Standards on vibration of structures.<br>• Control of drive levels to remain within limits. |

# Attachment 2
# Identification of environmental studies and investigations

**Table A2.1 Identification of environmental studies and investigations**

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| **INTEGRATION** | | | |
| Biodiversity | Desktop studies and field-based surveys of flora and fauna (HSA 1998a, 1998b, 2001a, 2001b, 2001c, 2003). | Refer to Flora and Fauna below. | Further consultation with CALM is planned to determine if further surveys are required and in which locations additional surveys need to be carried out. |
| **BIOPHYSICAL** | | | |
| Flora | Desktop study and field-based survey of flora (HSA 1998a). | Location: L1 and L2, east of Dongara, including the northern half of the Yardanogo Nature Reserve and other unvested reserves to the east of Yardanogo NR.<br>Timing: Not stated.<br>Scope: Investigated vegetation assemblages.<br>Refer to Attachment 12 of the Denison 3D Seismic Survey EMP. | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to avoid significant environmental features of agreed high conservation value.<br>The alignment of the lines will chosen with agreement from CALM. Advice will also be sought from CALM on the requirement for additional flora surveys for lines located in Nature Reserves. |
| | Desktop study and field-based survey of flora (HSA 1998b). | Location: L1 and L2, east of Dongara, including sections of the Irwin River.<br>Timing: Not stated.<br>Scope: Investigated vegetation assemblages.<br>Refer to Attachment 11 of the Denison 3D Seismic Survey EMP. | |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Desktop study and field-based survey of flora (HSA 2001a). | Location: EP320, L1 and L11, southeast of Dongara, including north-eastern sections of Yardanogo Nature Reserve, other smaller reserves and sections of the Irwin River.<br>Timing: Not stated.<br>Scope: Investigated vegetation assemblages; landform; presence of dieback; regeneration of vegetation 18 month-3 years after seismic surveys.<br>Refer to Attachment 9 of the Denison 3D Seismic Survey EMP | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to ensure that no DRF, Priority or EPBC Act-listed flora are encountered, and will deviate the lines to avoid these flora as required. This survey would also identify other significant features such as fauna burrows, significant weed areas, wetlands, dunes, and areas of high erosion potential (see specific factors listed below). |
| | Desktop study and field-based survey of flora (HSA 2001b). | Location: EP413, south of Dongara, mostly covering Beekeepers Nature Reserve.<br>Timing: Not stated.<br>Scope: Investigated vegetation assemblages; regeneration of vegetation 18 month-3 years after seismic surveys.<br>Refer to Attachment 13 of the Denison 3D Seismic Survey EMP | |
| | Desktop study and field-based survey of flora (HSA 2001c). | Location: L1 southeast of Dongara, including north-western sections of Yardanogo Nature Reserve and other smaller reserves.<br>Timing: Not stated.<br>Scope: Investigated vegetation assemblages; landform; presence of dieback; regeneration of vegetation 18 months-3 years after seismic surveys.<br>Refer to Attachment 10 of the Denison 3D Seismic Survey EMP | |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Field-based survey of flora (HSA 2003). | Location: EP413, south of Dongara, bounded by Brand Highway, Kailis Drive, Indian Ocean Drive and including Beekeepers Nature Reserve and other smaller reserves. 20 sites surveyed across different vegetation assemblages identified in aerial photographs based on phototones.<br>Timing: June 2003; Sept/Oct 2003.<br>Scope: Investigated vegetation assemblages; DRF, Priority and EPBC Act-listed species; conservation values; presence of weeds.<br>Refer to Attachment 5 of the Denison 3D Seismic Survey EMP. | |
| | Risk assessment workshop. | The potential impacts and management measures related to flora were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| | Community and Other Stakeholder consultation. | Refer to Section 10: Community and Other Stakeholder Consultation. | |
| Fauna | Desktop study of fauna (HSA 2003). | Scope: Investigated records of the Western Australian Museum and CALM for rare and scheduled species, and EPBC Act-listed species.<br>Refer to Attachment 5 of the Denison 3D Seismic Survey EMP. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to ensure that no animal burrows or nesting areas (eg Mallee Fowl mounds) are encountered, and will deviate the lines to avoid animal burrows as required. |
| | Risk assessment workshop. | The potential impacts and management measures related to fauna were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| | Community and Other Stakeholder consultation. | Refer to Section 10: Community and Other Stakeholder Consultation. | |
| Conservation areas | Field-based surveys of flora (HSA 2001a, 2001b, 2001c, 2003). | Refer to Flora above. | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Risk assessment workshop. | The potential impacts and management measures related to conservation areas were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | avoid significant environmental features of agreed high conservation value.<br><br>Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to ensure that no DRF, Priority or EPBC Act-listed flora are encountered, and will deviate the lines to avoid these flora as required. |
| | Stakeholder consultation. | Refer to Section 10: Stakeholder Consultation. | |
| Weeds | Field-based survey of flora (HSA 2003). | Refer to Flora above. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to ensure that no areas heavily infested with weeds are encountered, and will deviate the lines to avoid weeds as required. |
| | Risk assessment workshop. | The potential impacts and management measures related to weeds were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| | Stakeholder consultation. | Refer to Section 10: Stakeholder Consultation. | |
| Dieback | Desktop study and field-based survey (HSA 1992). | The occurrence of dieback in the survey area was described in Section 3.6 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| | Risk assessment workshop. | The potential impacts and management measures related to dieback were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| | Community and Other Stakeholder consultation. | Refer to Section 10: Community and Other Stakeholder Consultation. | |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| Revegetation / rehabilitation | Desktop study and field-based surveys of flora (HSA 2001a, 2001c). | Refer to Flora above. | Evaluation of previous rehabilitation/ recovery survey results following vegetation clearing and/or disturbance activities.<br>Investigate and agree on completion criteria for areas of agreed high conservation value with CALM. |
| | Audit report (Origin 2003). | Environmental audit report of EP413, L1, EP320 and L11 for the Ularino 2D, Hibbertia 3D and Hovea 3D seismic surveys, and the Jingemia and various other well sites. The audit included an assessment of revegetation. | |
| | Risk assessment workshop. | The potential impacts and management measures related to revegetation and rehabilitation were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| | Stakeholder consultation. | Refer to Section 10: Community and Other Stakeholder Consultation. | |
| Wetlands (Irwin River) | Risk assessment workshop. | The potential impacts and management measures relating to crossings of the Irwin River were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to avoid significant environmental features in areas of agreed high conservation value.<br>Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to ensure that no new river crossings are made and that all crossings use existing roads and tracks. |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| Surface waters and drainage | Desktop study. | A desktop study was carried out during development of the Denison 3D Seismic Survey EMP. Refer to Section 3.4 of the Denison 3D Seismic Survey EMP. | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to avoid significant environmental features in areas of agreed high conservation value.<br><br>Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to check for significant features (eg areas of high erosion potential) and will deviate the lines to avoid significant features as required. |
| | Risk assessment workshop. | The potential impacts and management measures relating to surface waters and drainage patterns were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | |
| Groundwater | Desktop study. | A desktop study was carried out during development of the Denison 3D Seismic Survey EMP. Refer to Section 3.5 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| | Risk assessment workshop. | The potential impacts and management measures relating to groundwater were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Tables 4-1 and 4-2 of the Denison 3D Seismic Survey EMP. | |
| Land (soil) | Desktop study. | A desktop study was carried out during development of the Denison 3D Seismic Survey EMP. Refer to Section 3.3 of the Denison 3D Seismic Survey EMP. | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to avoid significant environmental features in areas of agreed high conservation value. |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Risk assessment workshop. | The potential impacts and management measures related to soil erosion were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value to check for significant features (eg areas of high erosion potential) and will deviate the lines to avoid significant features as required. |
| Land (geology/ geomorphology) | Desktop study. | A desktop study was carried out during development of the Denison 3D Seismic Survey EMP. Refer to Section 3.2 of the Denison 3D Seismic Survey EMP | Aerial photographs will be used to plan the alignment of the survey lines. The lines will be planned to avoid significant environmental features in areas of agreed high conservation value. |
| | Risk assessment workshop | The potential impacts and management measures relating to geology/geomorphology (eg steep dunes) were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | Prior to establishing the survey lines in the field, a specialist will survey the proposed line alignments in areas of agreed high conservation value, to check for significant features (e.g. areas of high erosion potential) and will deviate the lines to avoid significant features as required. |
| Land (caves) | Risk assessment workshop. | The potential impacts and management measures relating to caves were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Stakeholder consultation with the Speleological Research Group of WA. | No caves or surface openings are known to occur within the survey area. Refer to Section 10: Stakeholder Consultation. | |
| **POLLUTION MANAGEMENT** | | | |
| Noise | Risk assessment workshop. | The potential impacts and management measures relating to noise were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| Waste Management | Risk assessment workshop. | The potential impacts and management measures relating to contamination of surface or groundwater from hydrocarbon spills and hazardous materials were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-2 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| **SOCIAL, CULTURAL AND ECONOMIC** | | | |
| Cultural heritage | Desktop and field-based archaeological investigation (Quartermaine 2003). | Investigation on the location of indigenous heritage sites in October 2003. Refer to Section 3.9 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| | Risk assessment workshop. | The potential impacts and management measures relating to avoiding damage to buildings were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | Further consultation with the Shire Engineer is planned. |
| Infrastructure and services | Risk assessment workshop. | The potential impacts and management measures relating to avoiding damage to infrastructure and services were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-1 of the Denison 3D Seismic Survey EMP. | Further consultation with the Shire Engineer is planned. |

| Environmental Factor | Studies / Investigations carried out to date | Description | Additional studies / Investigations |
|---|---|---|---|
| | Community and Other Stakeholder consultation with the local landholders. | Refer to Section 10: Community and Other Stakeholder Consultation. | |
| Fire risks | Risk assessment workshop. | The potential impacts and management measures related to fire were covered during the Denison 3D Seismic Survey risk assessment workshop. Refer to Table 4-2 of the Denison 3D Seismic Survey EMP. | No further studies proposed. |
| | Stakeholder consultation with FESA. | Refer to Section 10: Community and Other Stakeholder Consultation. | |