

# Environmental impact report

for  
ground based geophysical  
operations (non-seismic)  
in South Australia

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**Government of South Australia**  
Primary Industries and Resources SA

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## Abbreviations

APPEA	Australian Petroleum Producers & Explorers Association
DPC-AARD	Department of Premier and Cabinet – Aboriginal Affairs and Reconciliation Division
EIR	Environmental Impact Report
GIS	Geographic Information Systems
GPS	Global Positioning System
PIRSA	Primary Industries and Resources, South Australia
SEO	Statement of Environmental Objectives prepared in accordance with Section 99 and 100 of the Petroleum Act 2000 and Regulations 12 and 13.

## Measurement

Units of measurement used in this document are those of the International System of Units (SI) as well as units outside the SI that have been authorised for use within Australia's metric system.

km	kilometre (length; $10^3$ m)
m	metre (length)
mm	millimetre (length; $10^{-3}$ m)
L	litre (volume; $10^{-3}$ m <sup>3</sup> )

# CONTENTS

<b>EXECUTIVE SUMMARY</b> .....	<b>1</b>
<b>1 INTRODUCTION</b> .....	<b>1</b>
1.1 Purpose .....	1
1.2 Scope .....	1
1.3 Limitations .....	2
1.4 Definition.....	2
1.5 Environmental Commitment .....	2
<b>2 LEGISLATIVE REQUIREMENTS</b> .....	<b>2</b>
2.1 Assessment and Approval.....	3
<b>3 GROUND GEOPHYSICAL SURVEY OPERATIONS (NON-SEISMIC)</b> .....	<b>3</b>
3.1 Planning.....	3
3.2 Permitting .....	3
3.3 Field Operations .....	3
3.4 Data Recording.....	4
3.5 Campsites.....	4
3.6 De-permitting (Survey Area Checking).....	4
<b>4 OVERVIEW OF REGIONAL ENVIRONMENT</b> .....	<b>4</b>
4.1 South East .....	5
4.2 Kangaroo Island .....	6
4.3 Mount Lofty Ranges .....	6
4.4 Eyre Peninsula .....	6
4.5 Mid North/Yorke Peninsula.....	6
4.6 Northern Rangelands .....	7
4.7 Murray-Darling Basin.....	7
<b>5 ENVIRONMENTAL HAZARDS AND CONSEQUENCES</b> .....	<b>7</b>
5.1 Hazards .....	8
5.2 Consequences.....	8
5.3 Hazards and Consequences by Activity .....	8
<b>6 ENVIRONMENTAL RISK ASSESSMENT</b> .....	<b>8</b>
6.1 Risk Assessment .....	8
6.2 Assessment of Severity .....	9
6.3 Assessment of Likelihood.....	10
<b>7 MITIGATION STRATEGIES</b> .....	<b>11</b>
7.1 Disturbance to Landowners.....	11
7.2 Disturbance to Stock .....	11
7.3 Risk of Fire .....	11
7.4 Dust Generation .....	11
7.5 Waste Handling and Disposal .....	12
7.6 Damage to Crops and Pasture .....	12
7.7 Avoid Introduction of Weeds and Disease .....	12
7.8 Landowner Infrastructure .....	12
7.9 Cultural Heritage.....	12
7.10 Native Vegetation and Faunal Habitat.....	12
<b>8 GENERAL MANAGEMENT PROCEDURES</b> .....	<b>14</b>
8.1 Awareness Program .....	14
8.2 Site Specific Mitigation Strategies .....	14
<b>9 REFERENCES</b> .....	<b>15</b>
<b>APPENDIX 1 RELEVANT LEGISLATION</b> .....	<b>16</b>
<b>APPENDIX 2 PROTECTED AREAS</b> .....	<b>17</b>
<b>APPENDIX 3 CONTRACTUAL OBLIGATIONS</b> .....	<b>18</b>
<b>APPENDIX 4 STAKEHOLDER COMMENTS AND RESPONSES</b> .....	<b>19</b>

## LIST OF TABLES

Table 1	Hazard and consequence classifications for geophysical operations (non-seismic).....	8
Table 2	Severity of Consequences .....	10
Table 3	Likelihood of Consequences .....	10
Table 4	Risk Matrix.....	11
Table 5	Summary of Impacts and risk levels for ground geophysical operations (non-seismic) .....	13
Table 6	Proclaimed parks and reserves with applicable legislation.....	17

## LIST OF FIGURES

Figure 1	Regional biodiversity regions of South Australia. ....	5
Figure 2	Framework for environmental risk assessment.....	9

## **EXECUTIVE SUMMARY**

An Environmental Impact Report (EIR) for ground geophysical operations (non-seismic) in South Australia has been prepared in accordance with current legislative requirements. The EIR provides information on the South Australian physical, biophysical and social environment together with a basic description of how ground geophysical operations (non-seismic) are conducted in the state.

Ground geophysical operations (non-seismic) carry inherent low environmental risks. An environmental risk assessment has been conducted for the various activities to establish the level of risk and consequence of these operations. These risks together with the corresponding risk minimisation strategies are detailed for the various activities that occur during operations. These strategies are designed to be employed from the planning phase right through to the completion of field activities.

The document outlines the environmental hazards associated with ground geophysical operations (non-seismic) and identifies the following potential consequences

- Landowner disturbance.
- Damage to native vegetation and native fauna.
- Disturbance to cultural heritage (Aboriginal and European).
- Weed/disease introduction.
- Visual impact.
- Soil disturbance and contamination.
- Wildfire.
- Dust generation.
- Waste management and disposal.

All impacts have been assessed as being of low significance, based on their high degree of predictability and manageability. Mitigation strategies have also been proposed for each activity.

Based on this risk assessment a list of environmental objectives has been compiled. This list will form the basis of the Statement of Environmental Objectives (SEO).

The application of this document should be appropriate for most ground geophysical operations (non-seismic) undertaken in South Australia

The information contained in this document has been compiled from numerous datasets and the experience of prior operations in the State.

## **1 INTRODUCTION**

### **1.1 Purpose**

Ground geophysical operations (non-seismic) are regulated activities under the *Petroleum Act 2000* (the Act) and as such can only be carried out following the production of an EIR and approval of an SEO.

As ground geophysical (non-seismic) survey work is of low environmental impact, it is considered that the preparation of an EIR for each survey may result in unnecessary expense and delays for proponents and regulators. Therefore PIRSA has proposed that a State-wide EIR and SEO will streamline the approval process for most ground geophysical operations (non-seismic) undertaken within South Australia without detriment to protection of environmental or social values.

This document has been prepared to meet the specific requirements of the Act and Regulations 10, 11 and 12 of the *Petroleum Regulations 2000* (the Regulations).

### **1.2 Scope**

In order to undertake ground geophysical (non-seismic) operations in their petroleum exploration and production license areas and geothermal exploration license areas proponents and their contractors require access to the land within the project area.

As a result, PIRSA has developed a State-wide EIR that will apply to most ground geophysical (non-seismic) operations to be undertaken by licensees and their contractors.

This EIR:

- identifies the limitations of the application of the EIR/SEO;
- describes the ground based geophysical (non-seismic) operation;
- describes the regional characteristics of the South Australian environment in which the operations take place;
- identifies the potential hazards and potential consequences; and
- proposes measures to minimise the potential consequences.

The types of survey operation covered by this document include:

- gravimetric;
- magnetic;
- electromagnetic;
- ground-penetrating radar;
- electrical;
- geochemical; and
- geological mapping.

Aspects associated with these geophysical operations (non-seismic) include:

- survey traverse surveying;
- data acquisition (gravimetric, ground magnetic, electromagnetic and others);
- survey site access (on existing tracks or cross country); and
- setting up and using campsites.

An accompanying draft SEO has subsequently been developed to outline the environmental objectives proponents engaged in ground based geophysical (non-seismic) operations must meet and the criteria upon which the achievement of these objectives will be assessed.

### **1.3 Limitations**

This EIR is limited to the State of South Australia. Once the SEO developed on the basis of this document is established, approval for ground based geophysical (non-seismic) operations will be given subject to that SEO.

This approval is however, subject to the proviso that any proposed survey operation can be demonstrated to be within the scope of this EIR.

This EIR and its companion SEO **do not** cover geophysical survey operations that require specific preparation of access tracks by earthmoving or the clearance of any native vegetation.

### **1.4 Definition**

In the Act, environment is broadly defined to include its natural, social, cultural and economic aspects. The environmental objectives outlined in the SEO incorporate all these aspects.

This EIR relates to ground based geophysical (non-seismic) operations. These survey operations are deemed to be regulated activities under the terms of the Petroleum Act 2000 as they are techniques used in the exploration for petroleum and other regulated resources.

### **1.5 Environmental Commitment**

Petroleum and geothermal exploration companies must be committed to the responsible environmental management of all phases of their operations and must commit to achieving environmental objectives included in the SEO.

## **2 LEGISLATIVE REQUIREMENTS**

This document fulfils the requirements of an EIR for ground based geophysical operations (non-seismic) and has been prepared in accordance with current legislative requirements, in particular, with Section 97 of the Act and Regulation 10 of the *Regulations under the Petroleum Act 2000*. Additionally, the Act and Regulations require the development and implementation of a SEO. A draft SEO has been produced in conjunction with this document (PIRSA 2007). This EIR and the draft SEO will be subjected to a review through an appropriate consultation process. Following address of any issues raised by this consultation process, the draft SEO will be subsequently submitted for Ministerial approval.

## **2.1 Assessment and Approval**

The EIR and draft SEO are assessed by PIRSA to determine whether the activities are to be classified as low, medium or high environmental impact. This in turn determines the level of consultation PIRSA will be required to undertake prior to final approval of the SEO.

- 'Low Impact' activities are subjected to a process of internal government consultation on the EIR and draft SEO prior to approval.
- For 'Medium Impact' activities, the EIR and proposed SEO are subject to a public consultation process, with comment sought for a period of at least 30 business days.
- 'High Impact' activities are required to undergo an environmental impact assessment under the provisions of the *Development Act 1993*.

The level of impact of a particular activity is assessed on the basis of the predictability and manageability of the impacts on the environment. Where the environmental impacts are predictable and readily managed, the impact of the activity is considered low. Where the environmental impacts are less predictable and are difficult to manage, the impact of the activity is potentially high.

Once the approval process is complete, all documentation (including this EIR and its associated SEO) must be entered on an environmental register. This public register is available on the PIRSA internet so that community access is readily available

## **3 GROUND BASED GEOPHYSICAL OPERATIONS (NON-SEISMIC)**

The geophysical operations covered by this document typically involve use of an appropriate meter to measure various physical properties of the Earth, such as variations in gravity, magnetic and electromagnetic force.

These techniques enable geophysicists to use the data produced to interpret what is beneath the surface of the Earth and thus identify areas where oil and gas may have accumulated or the location of source rocks with the potential to generate geothermal energy.

Surveys are typically undertaken by transporting the geophysical meter in light vehicles or on quad bikes along existing roads and tracks or across areas that do not require any prior surface preparation. They may also be undertaken partially on foot. Measurements of the various geophysical properties are recorded and processed to produce various geophysical maps of the target area.

### **3.1 Planning**

After the assessment of an exploration license area, the exploration team then identifies target areas for further investigation. This phase includes an assessment of all available geophysical and geological data that covers a petroleum or geothermal license. Possible petroleum bearing structures or potential geothermal sources are identified that may warrant further geophysical investigation or drilling over the anomaly.

The survey technique(s) are then selected and the survey designed. Survey design includes the data measurement spacing and number of measurements required. The proposed program is then plotted onto detailed topographic maps or satellite imagery. Data point spacing along survey traverses can range from a low as one hundred metre spacing for detail surveys and up to five hundred metres for semi-regional surveys that may provide data coverage over an entire license area.

The planning process also involves a search to identify the location of environmentally sensitive feature such as national parks, remnant native vegetation, geological monuments, and sites of significance for European and Aboriginal cultural heritage and rare and endangered fauna and flora.

### **3.2 Permitting**

Landowners and land managers whose properties may be need to be entered by operators wishing to conduct a survey are contacted and visited to explain the survey. During this visit any issues requiring special attention are identified. This process is called "permitting". Part of this process also includes providing the landowners with a "Notice of intended entry on Land" at least 21 days before entering land.

### **3.3 Field Operations**

Access to survey areas is provided by the use of conventional four-wheeled drive vehicles, with other vehicles used where appropriate (quad bikes etc). GPS receivers or GPS/GIS field mapping systems are

used to obtain the geographic locations of survey points. The more traditional theodolite/survey measuring chain traversing methods are sometimes used. Stations can both be surveyed and marked with a peg prior to the reading of the geophysical data (e.g. gravimetric or magnetics) or done at the same time – thus negating the need to peg station locations. Gravimetric and magnetometer surveys commonly utilise seismic lines from current seismic surveys as traverses along which to acquire data. This is particularly the case in areas where existing data is sparse (e.g. the Officer Basin in the west of the State). The other ground based surveys could also use the location data generated during the seismic survey. An additional advantage is that the seismic recording crew's accommodation facilities may be able to be used by the personnel acquiring data.

### **3.4 Data Recording**

The data are acquired by survey party members on foot, in light 4WDs or on quad bikes travelling between survey points and taking the measurement using the appropriate meter/equipment.

### **3.5 Campsites**

Accommodation facilities in townships and pastoral quarters are used wherever possible and as a consequence camping during ground based geophysical operations (non-seismic) is a rare occurrence.

Campsites, if used, are generally small and typically may comprise up to a maximum of 6 personnel and wherever possible, are set up on sites previously used or on areas devoid of vegetation and always adjacent to any existing tracks to minimise impacts. Domestic wastes (e.g. food waste, paper) created at campsites are stored on site (along with plastics, cans, glass, etc) prior to transportation to an appropriate waste disposal facility. Recyclable materials (e.g. returnable bottles and cans) may be segregated and are also transported to an appropriate waste facility. Storage methods take issues such as scavenging animals into account to avoid litter scattering and impacts on wildlife.

If Campsites require the provision of systems for the management of sewage wastes, then this must be managed in accordance with the *Public and Environmental Health (Waste Control) Regulations 1995*. Approved environmental treatment units may be utilised where practical and appropriate. Following treatment via an approved system wastewater may be disposed of on-site (well away from watercourses or infra -structure) when in remote areas.

### **3.6 De-permitting (Survey Area Checking)**

At the end of the operation, all survey pegs, flagging and equipment are removed from the area. Some techniques (eg gravity surveys) may require the placement of a small number of permanent survey marks for the survey. Where possible, these marks are located along fence lines and other built infrastructure. Once the geophysical survey crew has left the area, landowners are again contacted to ensure that any issues resulting from the survey operations on their properties have been satisfactorily resolved.

## **4 OVERVIEW OF REGIONAL ENVIRONMENT**

It is not the intention of this EIR to describe all the significant environmental characteristics of South Australia and its associated regions, but rather to provide a general overview of the regional environments.

The existing environmental description of this report has largely been derived from regional biodiversity plans and district soil management plans. Biodiversity regions (Figure 1), developed by the Department for Environment and Heritage, have been referred to in this document to ensure consistency with current strategic government conservation and land use planning policies. Operators are advised to consult other available literature and relevant agencies for further site-specific information pertaining to the area covered by their surveys.

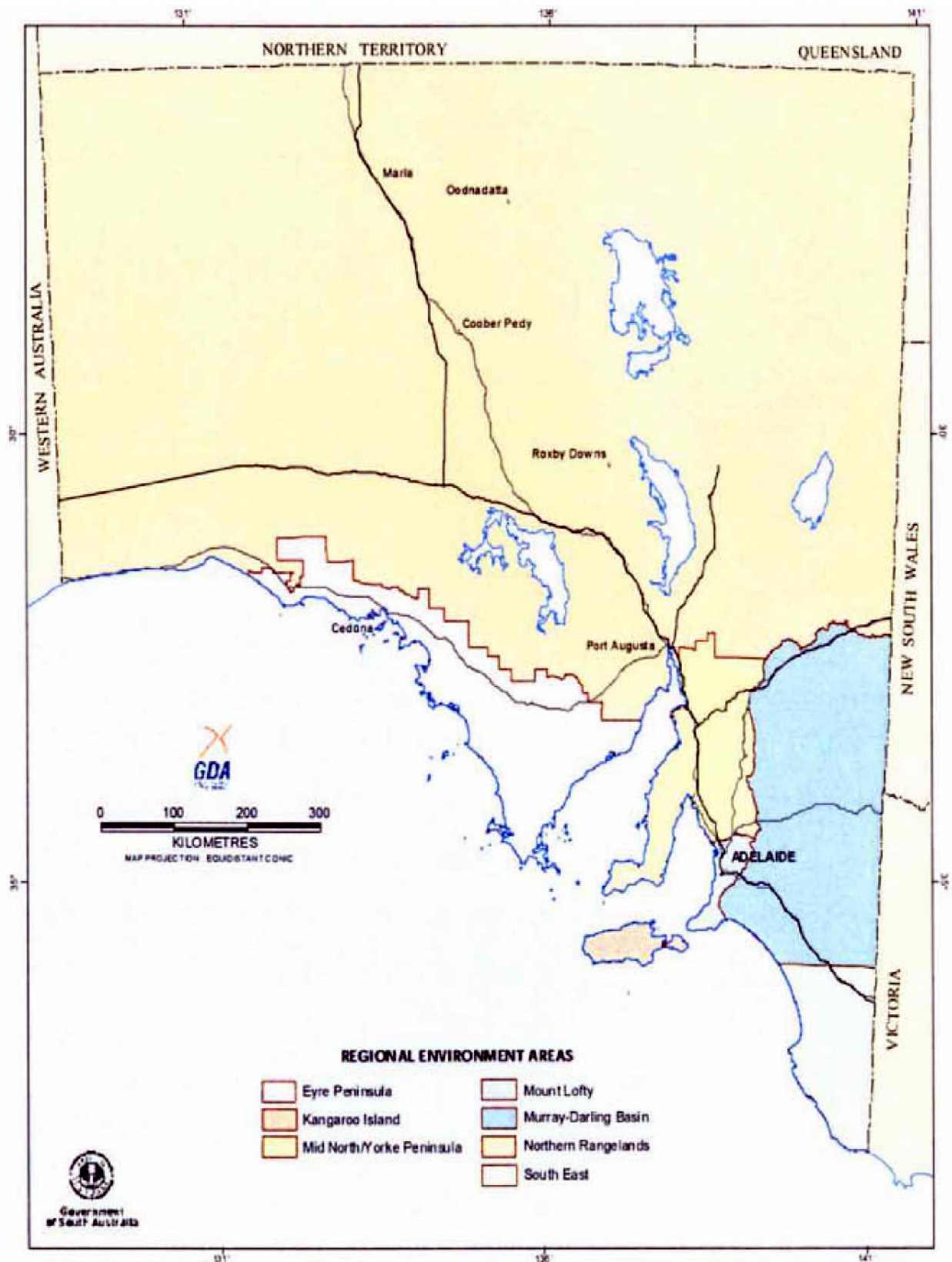


Figure 1 Regional biodiversity regions of South Australia.

#### 4.1 South East

The South East Region has a cool moist climate with cool wet winters and long mild dry summers. The general trend is for rainfall to decrease northwards and away from the coast (i.e. coastal rainfall recorded at a maximum of 850mm and 450mm to the north). Most rain falls in the winter months.

The South East Region has a low relief with unique landforms, originating from a long geological history. The region represents the limit of grassy woodland, forest and wetland plant communities more typical of south-eastern Australia and the southern limit of the mallee plant communities found in the north. It is estimated that 78% of the region comprises privately owned agricultural land, with 87% of native vegetation cleared primarily for agriculture. The remaining native vegetation is not evenly distributed, but concentrated in areas less suitable for agriculture. Most of the remaining areas of vegetation occur in conservation reserves, along roadsides, and in scattered woodland or as isolated trees within paddocks.

#### **4.2 Kangaroo Island**

Kangaroo Island lies approximately 15 kilometres off the tip of Fleurieu Peninsula in southern South Australia and is approximately 4,400 square kilometres in size. The Island comprises high coastal cliffs at the north-western end of the Island and a central plateau, which is tilted gently towards the more subdued topography of limestone plains and sand dunes along the southern coastline.

The Island has a reliable moderate to high rainfall ranging from 470 mm a year on the eastern and southern plains to 900 mm a year in the higher areas in the northwest.

Approximately 60% of the land within the region is used for dry land agriculture, while 27% is designated in the National Parks system. Farming mainly involves sheep for wool and meat production.

#### **4.3 Mount Lofty Ranges**

Mount Lofty is the single most important topographical feature causing the capital city of Adelaide to experience a different climate in contrast to areas of similar latitude. The Mount Lofty Region experiences a Mediterranean climate of warm dry summers and cool wet winters. Mean annual rainfall in the Range varies from 400mm to 1100mm, to 250-350mm elsewhere. The region is also susceptible to high intensity storms, which can cause serious erosion to unprotected land. Wind erosion may also occur on the lighter soils of the western plains when vegetation cover is not present.

The region comprises a well-defined zone of uplands, which extends from the Flinders Ranges through to the Fleurieu Peninsula. The major soil groups of the district are red-brown earths in the broad valleys to the east, loamy mallee soils to the west, and sandy mallee soils in the northern areas.

Over 85% of the native vegetation has been cleared for agriculture and urban expansion. A large proportion of remnant vegetation occurs on private land with 23% confined to conservation reserves; the latter represents just 4% of the total region. Most of the land in region is used for cropping and or grazing.

#### **4.4 Eyre Peninsula**

Being bounded by the sea to the east and west, the Eyre Peninsula Region has a predominantly mild climate. Droughts are infrequent, especially in those areas receiving more than 400mm per annum. Most rainfall occurs in the winter season. Although rare, intense rainfall events and strong winds with a potential to cause severe soil erosion can occur at any time of the year.

Approximately 72% of the region is cleared, and most of this is deemed to be arable. The main land use is cereal and grain legume cropping in rotation with grazed pastures. Other minor land uses include livestock production (sheep and cattle). Semi-arable cleared land, and areas with scattered vegetation (13% of the district) are used mainly for grazing.

Native vegetation in the region is generally restricted to lakes, coastal dunes and scattered remnant native vegetation communities, much of which is non-arable or semi-arable land. Of this, a high proportion is located within National Parks and Wildlife Service reserves. In addition a significant area of native vegetation is held under the native vegetation heritage agreement scheme. Strips of remnant vegetation have also been retained, or restored using native vegetation species, along fence lines as windbreaks and shelterbelts for stock and crops.

#### **4.5 Mid North/Yorke Peninsula**

This region experiences hot dry summers and mild winters. The Yorke Peninsula has a lower annual rainfall than the Mid North with an average yearly rainfall of approximately 480mm near Maitland. This contrasts markedly with coastal areas where it is as low as 280mm per annum. In the Mid North, the period from April to October receives the most rain with approximately yearly average of 650mm rainfall on the ranges and 325mm in coastal areas.

Much of the Mid North consists of a broad flat highland plateau in the east, which is flanked by a coastal plain in the west. On the Yorke Peninsula, the topography is gently undulating, with an average elevation of approximately 90 metres above sea level.

The major land use throughout the region is barley and wheat production. Sheep grazing for wool production is also a significant land use throughout the area.

Much of the native vegetation has been removed as a result of extensive cultivation and grazing. However, many roads were surveyed as stock routes and as a consequence, significant tracts of vegetation remains along road corridors. Few conservation reserves exist throughout the region, with Mount Remarkable National Park and Innes National Park being the only substantial areas of native vegetation held within reserves. Dominant vegetation types include and forest in inland areas and coastal dune vegetation along the coastline.

#### **4.6 Northern Rangelands**

The climate of the northern arid zone of South Australia is characterised by hot, usually dry summers and mild dry winters. Rainfall variability in the region is amongst the highest in Australia, while average annual totals are amongst the lowest. Mean annual rainfall ranges from less than 150 mm in the northeast to around 225mm in the far northwest. No seasonality of rainfall is apparent.

Land use in the region consists primarily of stock grazing, mining, tourism, defence industry operations and oil and gas exploration and production. Sixty percent of the land is used for pastoral production and the majority of the remainder is either Aboriginal land or in National Parks or other conservation reserves.

Claypans, dune fields, gibber plains and tablelands are all features of the region. The topography is relatively flat and throughout much of the region the vegetation comprises low open woodlands, grasslands and chenopod shrub lands.

#### **4.7 Murray-Darling Basin**

The rainfall of the Murray-Darling Basin is low, ranging from 250mm per year in the north to 400mm per year in the south. In the north, the rainfall is unreliable and droughts are common.

The major land use is cereal/sheep farming, with crops grown in rotation with annual medic pastures.

The district consists of a vast low lying plain, with sand dunes and gently undulating sandy rises interspersed by flats, depressions and low rises. Most of the sand dunes are parallel ridges that lie in an east-west direction but large, disordered and crescent shaped dunes also occur.

The soils are generally sandy in texture and highly erosive. Exceptions include very stony land and uncleared land. Shallow soils over limestone are common in the western portion of the region but virtually absent in the east. The low and unreliable rainfall in the north and water repellence in the south also increases the potential for wind erosion.

Much of the region was originally covered by thick mallee scrub. Approximately 80% of this has been cleared or degraded by agricultural development. Most of the remaining vegetation is in conservation parks. The uncleared land is primarily sand dunes and limestone outcrops that were deemed to be unsuitable for agriculture.

### **5 ENVIRONMENTAL HAZARDS AND CONSEQUENCES**

This section identifies and assesses potential environmental hazards and their consequences resulting from ground based geophysical operations (non-seismic) in South Australia. These are identified to enable assessment of environmental risks and as regulatory and management requirements.

A hazard is considered to be any source of potential environmental harm, or a situation or event with potential to cause loss (Joint Australian/New Zealand Standard AS/NZS 4360:2004, Risk management). To identify hazards, the various activities associated with each stage of the ground based geophysical operation (non-seismic) were considered along with the events that could lead to a hazardous situation. The possible consequences of such events were also identified and assessed.

Where possible, environmental hazards and potential consequences have been identified and assessed on the basis of existing information on the magnitude (e.g., quantity of waste) and/or frequency of activities associated with the geophysical activity. However, this information is not available with regard to

all activities and associated hazards. Where this is the case, environmental hazards and subsequent consequences have been identified on the basis of the experience of petroleum and geothermal industry personnel.

### 5.1 Hazards

Based on available information, environmental hazards that have potential to result in the most prominent environmental consequences are identified as:

- vehicle movement; and
- the disposal of domestic waste.

### 5.2 Consequences

- Key potential environmental consequences associated with the above hazards are:
- disturbance to Aboriginal and non-Aboriginal cultural heritage sites;
- loss of native vegetation and faunal habitat;
- soil compaction/deflation/contamination, wheel tracks, wheel ruts, noise generation, airborne dust;
- disturbance, injury or death to native fauna;
- disturbance, injury or death to livestock;
- introduction and or spread of weeds, pest plants, animals and pathogens; and
- damage to landholder infrastructure.

### 5.3 Hazards and Consequences by Activity

The various seismic activities are tabulated in Table 1 indicating hazard and consequence classifications associated with each.

**Table 1 Hazard and consequence classifications for geophysical activities (non-seismic)**

<b>Geophysical activity</b>	<b>Hazard</b>	<b>Potential consequences</b>
Line surveying	Vehicle movement	Soil compaction/deflation, wheel tracks, dust, noise Disturbance to native fauna Disturbance to stock Spread of weeds and plant pathogens Risk to third parties Fire destruction of vegetation and habitat Damage to landholder infrastructure
Data Recording	Vehicle movement	Soil compaction/disruption/deflation, wheel tracks, dust, noise Disturbance to native fauna Disturbance to stock Risk to third parties Spread of weeds and plant pathogens Damage to landholder infrastructure
Campsites and associated supplies	Vehicle movement, spills, waste disposal	Contamination of soil Loss of vegetation and habitat Soil compaction/disruption/deflation, wheel tracks, dust, noise Fire destruction of vegetation and habitat

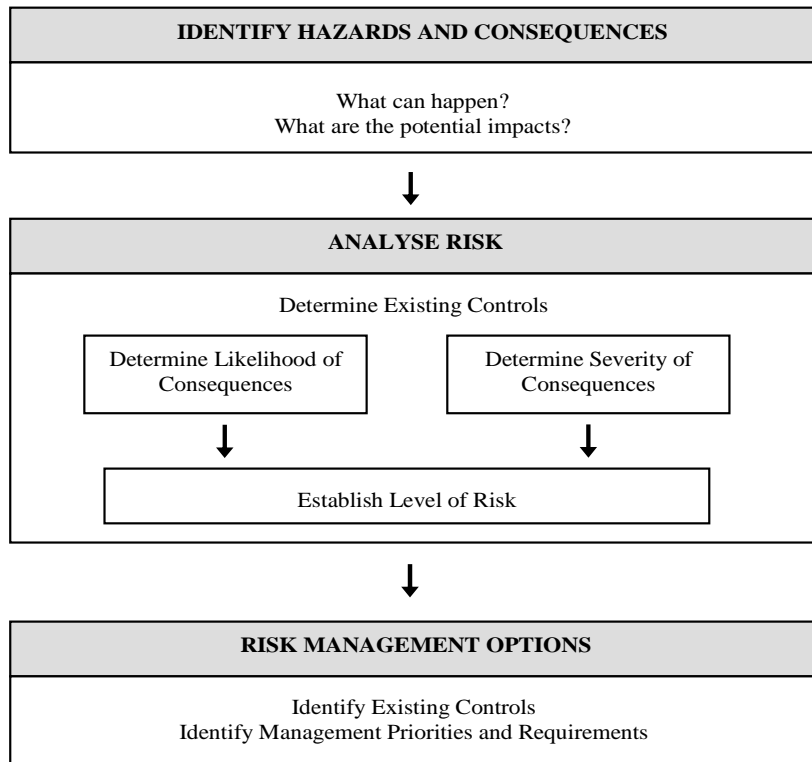
## 6 ENVIRONMENTAL RISK ASSESSMENT

### 6.1 Risk Assessment

The range of potential environmental risks that can be associated with ground based geophysical operations (non-seismic) is limited by the inherently benign nature of the activity. An environmental risk is the chance that an environmental consequence will result from a hazardous event or situation (Table 1). However with the implementation of appropriate management procedures, the risks can be avoided or reduced to an acceptable level.

Environmental risk assessment evaluates the level of environmental risk associated with the various activities and provides a framework for assessing risk management priorities and options based on the level of each assessed risk.

The main components of the environmental risk assessment process are illustrated in Figure 2.



**Figure 2 Framework for environmental risk assessment**

Risk assessment may be undertaken to various degrees of refinement depending upon the information and data available. Where possible, the frequency and severity of potential environmental consequences have been assessed on the basis of existing information.

However, in this generic document all pertinent information for all ground-based activities and associated consequences is not available. Therefore a qualitative (i.e. descriptive) risk assessment process was considered to be the most appropriate method to adopt. This approach uses descriptive scales to describe the likelihood of consequences (i.e. virtually certain to virtually impossible) and their severity (i.e. negligible to disastrous) and has been derived from Stoklosa (1999) and the AS/NZS 4360:2004 Standard for Risk Management.

## 6.2 Assessment of Severity

Environmental consequences can be categorised from negligible to disastrous using the methodology described by Stoklosa (1999; Table 2). These consequences are based upon definitions contained in AS/NZS 4360:2004, but have been expanded to incorporate impacts to environmental values such as flora, fauna and biomass.

**Table 2 Severity of Consequences**

Severity	Qualitative description of environmental consequences
<b>Negligible</b>	Possible incidental impacts to flora and fauna in a locally affected land system but without ecological consequence.
<b>Minor</b>	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected land system, but no changes to biodiversity or ecological function. Land system has a small amount of change but no long-term impact that will alter the terrain surface.
<b>Major</b>	Changes to the abundance or biomass of biota, and existing soil and/or water quality in the affected land system, with local changes to biodiversity but no loss of ecological function. Land system surface has changes that may cause long-term impacts.
<b>Severe</b>	Substantial changes to the abundance or biomass of biota, existing soil and/or water quality in the affected land system with significant change to biodiversity and change of ecological function. Eventual recovery of ecosystem possible, but not necessarily to the same pre-incident conditions. Substantial changes to terrain surface that will alter the terrain surface and drainage patterns.
<b>Disastrous</b>	Irreversible and irrecoverable changes to abundance/biomass or aquifers in the affected area. Loss of biodiversity on a regional scale. Loss of ecological functioning with little prospect of recovery to pre-incident conditions. Widespread impact upon the terrain surface and drainage patterns.

### 6.3 Assessment of Likelihood

The likelihood of potential environmental consequences occurring was qualitatively assessed and categorised according to the criteria outlined in Table 3.

Operation lifetime is relative to the ground based geophysical survey (non-seismic). Companies are responsible for each survey. For due diligence purposes, the life of a geophysical survey for this report will be ten years.

The distinction between temporary and long-term impact depends on many factors, but it is ultimately a value-judgement based on scientific evaluation and the level of community acceptance. These factors are generally related to climatic events, differing terrain units, vegetation units and timing of operations. Dependant on these factors, a general guideline is that the community should expect recovery from geophysical operations (non-seismic) in South Australia after about one year when current techniques are employed. Impacts that are irreversible or are expected to take significantly longer are defined as “long-term impacts”.

**Table 3 Likelihood of Consequences**

Likelihood of occurrence	Qualitative description of exposure
Virtually impossible	Has almost never occurred, but conceivably could
Rare	Has occurred a few times worldwide
Unlikely	Not likely during operation lifetime
Likely	Likely to occur during operation lifetime
Virtually certain	Includes continuous emissions

Severity and likelihood of consequences are combined to produce a level of risk for any given hazard. Table 4 shows an environmental risk assessment matrix that compares likelihood and severity of environmental consequences arising from the survey operations. The severity of the consequence is dependent on the resilience of the receiving environment. However, in most cases this does alter the risk matrix outcome.

The risk assessment described and detailed takes into consideration the mitigation measures, procedures and practices described elsewhere within this document.

**Table 4 Risk Matrix**

			LIKELIHOOD OF CONSEQUENCE				
			1	2	3	4	5
			Virtually Impossible	Rare	Unlikely	Likely	Virtually Certain
SEVERITY OF CONSEQUENCE	E	Negligible Effect	LOW	LOW	LOW	LOW	LOW
	D	Minor Effect	LOW	LOW	MEDIUM	MEDIUM	MEDIUM
	C	Major Effect	MEDIUM	MEDIUM	MEDIUM,	MEDIUM	HIGH
	B	Severe Effect	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
	A	Disastrous Effect	MEDIUM	MEDIUM	HIGH	HIGH	HIGH

The objective of the risk assessment process is to separate the minor acceptable risks from the major risks and to provide data to assist in the evaluation and management of risks.

## 7 MITIGATION STRATEGIES

The following procedures aimed at mitigating risks and potential impacts are normal practice in current geophysical surveying activities. These control measures are taken into consideration in the assessment of the environmental risks shown in Table 5.

### 7.1 Disturbance to Landowners

- Advise landowners of scope, schedule and duration of survey.
- When planning the survey, include locations of landowner infrastructure and operations.
- Wherever practical, accommodate landowner's specific requirements.
- Wherever practical, any damage is repaired to the satisfaction of the landowner.
- Drive slowly when on private property especially in the vicinity of residences.
- No pets to be kept on survey crew.
- No vehicle operations are permitted during wet weather and able only to recommence when the potential for damage has passed.
- The approval of a landowner must be obtained prior to setting up a camp.

### 7.2 Disturbance to Stock

- Where practical, avoid critical times such as lambing and mustering operations.
- Leave gates as found.
- Drive slowly.

### 7.3 Risk of Fire

- Ensure all vehicles are fitted with appropriate fire-fighting equipment and spark arrestors.
- No smoking on landowners properties.
- Along driving over long dry grass.
- Cease operations during fire bans.

### 7.4 Dust Generation

- Drive slowly when on private property.

## **7.5 Waste Handling and Disposal**

- All fuel and oil spills shall be appropriately managed.
- All temporary pegs and flagging tape removed at end of survey.
- All rubbish remove from campsites.

## **7.6 Damage to Crops and Pasture**

- Time survey to avoid critical cycles in crop growing process (e.g. sowing and harvesting).
- Avoid wet weather operations.

## **7.7 Avoid Introduction of Weeds and Disease**

- Strictly comply with any quarantine restrictions.
- Steam clean all vehicles prior to entering the survey area.
- Consider season and climate during survey planning as some diseases are transported during certain climatic conditions.

## **7.8 Landowner Infrastructure**

- Survey traverses are planned or deviated in the field to avoid homesteads, associated buildings, dams bore and tanks etc.
- Work is scheduled to fit in with stock locations and landowner work programs (eg mustering and lambing).
- Fences are not laid down unless the landowner has given specific permission.

## **7.9 Cultural Heritage**

- Appropriate representatives clear survey area prior to commencement of data acquisition.
- Any area of interest is flagged and traverses deviated around them.
- All survey personnel receive appropriate cultural heritage training prior to work.

## **7.10 Native Vegetation and Faunal Habitat**

- No native vegetation is to be removed.
- All vehicles are to be thoroughly cleaned.
- No bush bashing allowed.
- Survey traverses are planned to avoid impact to known significant species and habitat locations.
- Number of vehicles and vehicle passes minimises

**Table 5 Summary of Impacts and risk levels for Ground Based Geophysical Operations (non-seismic)**

Activity	Hazard	Potential consequence	Severity	Likelihood	Risk
Survey traverse surveying	<i>Vehicle movements</i>	Introduction and spread of weeds and plant pathogens etc.	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Disturbance to native fauna	Minor	Rare	Low
		Disturbance to stock	Minor	Rare	Low
		Impact and/or damage to significant Aboriginal sites	Major	Unlikely	Medium
		Fire damage to vegetation and habitat	Minor	Rare	Low
		Wheel tracks, wheel ruts, bulldust generation, airborne dust	Negligible	Likely	Low
Data Recording	<i>Vehicle movements</i>	Introduction and spread of weeds and plant pathogens etc	Major	Rare	Medium
		Wheel tracks, wheel ruts, bulldust generation, airborne dust			
Data recording	<i>Vehicle movements</i>	Impact and/or damage to significant Aboriginal sites	Major	Rare	Medium
		Disturbance to native fauna	Minor	Rare	Low
Data recording	<i>Vehicle movements</i>	Disturbance to stock	Negligible	Rare	Low
		Damage to landholder infrastructure	Minor	Rare	Low
		Damage to petroleum infrastructure	Minor	Rare	Low
Campsites and associated supply logistics	<i>Vehicle movements</i>	Wheel tracks, wheel ruts, bulldust generation, soil compaction, noise generation, airborne dust, visual impact	Negligible	Likely	Low
		Fire damage to vegetation and habitat	Minor	Rare	Low
		Introduction and spread of weeds and plant pathogens	Major	Rare	Medium
		Damage to landholder infrastructure	Minor	Rare	Low
		Damage to petroleum infrastructure	Minor	Rare	Low
		Impact and/or damage to significant Aboriginal sites	Major	Unlikely	Medium
	<i>Spills and leaks</i>	Contamination of soil, groundwater, water courses	Minor	Rare	Low
	<i>Disposal of domestic waste</i>	Contamination of soil, groundwater, water courses	Minor	Rare	Low

Key potential environmental consequences associated with the above hazards are:

- disturbance to Aboriginal and non-Aboriginal cultural heritage sites;
- loss of native vegetation and habitat;
- soil compaction/disruption/contamination, wheel tracks, bulldust generation, noise generation, airborne dust;

- disturbance, injury or death to native fauna;
- disturbance, injury or death to livestock;
- introduction and spread of weeds, pest plants, animals and pathogens; and
- damage to landowner infrastructure.

The extent of a consequence is determined by the nature of the receiving environment (eg pasture land) and the size and nature of the hazard (eg vehicle movements and setting up camp sites). Potential environmental hazards and consequences associated with the survey activities are depicted in Table 1.

## **8 GENERAL MANAGEMENT PROCEDURES**

In addition to issue specific operating procedure, proponents are required to implement the following general management procedures.

### **8.1 Awareness Program**

Operators shall ensure that all personnel involved with ground based geophysical operations (non-seismic) are aware of this EIR. Operators shall also ensure that all personnel are especially aware of the relevant impact mitigation strategies. In undertaking activities proponents need to be mindful of their obligations under legislation relevant to ground based geophysical operations (non-seismic).

### **8.2 Site Specific Mitigation Strategies**

License operators and their contractors shall develop site (i.e. area) specific mitigation strategies.

## 9 REFERENCES

The following documents were key resources used in the preparation of this Statement of Environmental Objectives.

Ecos Consulting (Aust) Pty Ltd 2001. *Primary Survey Licence – South Australian Environmental Impact Report*. Unpublished Report to PIRSA.

Ecos Consulting (Aust) Pty Ltd 2001. *Primary Survey Licence – Statement of Environmental Objectives*. Unpublished Report to PIRSA .

Kane, A. 2007. Statement of environmental objectives for geophysical operations in the Otway Basin, South Australia. *South Australia. Department of Primary Industries and Resources SA. Report Book 2006/020*.

Santos Ltd. 2006. *South Australian Cooper Basin Operators Statement of environmental objectives: geophysical operations*. Primary Industries & Resources SA. Adelaide.

Santos Ltd. 2006. *South Australian Cooper Basin Operators Environmental impact report: geophysical operations*. Primary Industries & Resources SA. Adelaide.

Standards Australia (1999). *AS/NZS 4360: 1999 Risk Management*. Standards Australia, NSW.

Stoklosa, R.T. (1999). Practical Application of Environmental Risk Management - Gorgon LNG Project Case Study. *The APPEA Journal*, 606 -621.

## **APPENDIX 1 RELEVANT LEGISLATION**

In undertaking activities, operators and their contractors need to be mindful of their obligations under relevant legislation including but not limited to:

### **Commonwealth**

*Aboriginal and Torres Strait Islander Heritage Protection Act 1985*  
*Environmental Protection and Biodiversity Conservation Act 1999*

### **South Australia**

*Aboriginal Heritage Act 1988*  
*Animal and Plant Control (Agricultural and Other Purposes) Act 1986*  
*Crown Lands Act 1929*  
*Environment Protection Act 1993*  
*Fire and Emergency Services Act 2005*  
*Forestry Act 1950*  
*Heritage Places Act 1993*  
*National Parks and Wildlife Act 1972 (Table 6)*  
*National Trust of South Australia Act 1955*  
*Native Vegetation Act 1991*  
*Natural Resources Management Act 2004*  
*Occupational Health, Safety and Welfare Act 1986*  
*Petroleum Act 2000*  
*Public and Environmental Health (Waste Control) Regulations 1995*

## APPENDIX 2 PROTECTED AREAS

Specific conditions relating to any specific park or reserve proclaimed under the *National Parks and Wildlife Act 1972* should be sourced from Government gazettals or through the Petroleum and Geothermal Group of the South Australian Department of Primary Industries and Resources (PIRSA).

With respect to the *Native Vegetation Act 1991* and the *Native Vegetation Regulations 2003*, ground based geophysical (non-seismic) surveys subject to this SEO, are deemed to be exploration activities under the *Petroleum Act 2000*. Although any resultant clearance of native vegetation is considered to be exempt provided that the management practices employed to manage the activity are recognised by the Native Vegetation Council, the Minister for Mineral Resource Development, has deemed that any activity that requires clearance of native vegetation **is not** covered by this SEO.

**Table 6 Proclaimed parks and reserves with applicable legislation**

<b>Reserve Type</b>	<b>Legislation</b>
National Park	<i>National Parks and Wildlife Act 1972</i>
Conservation Park	<i>National Parks and Wildlife Act 1972</i>
Wilderness Protection Area	<i>Wilderness Protection Act 1992</i>
Game reserve	<i>National Parks and Wildlife Act 1972</i>
Regional Reserve	<i>National Parks and Wildlife Act 1972</i>
Recreation Park	<i>National Parks and Wildlife Act 1972</i>
Conservation Reserve	<i>Crown Lands Act 1929</i>

### **APPENDIX 3 CONTRACTUAL OBLIGATIONS**

All contracts with companies undertaking ground based geophysical operations (non-seismic) shall include a requirement to:

- operate in a manner consistent with the proponent's Environmental Policy; and
- follow the mitigation strategies outlined in this EIR – as well as any site-specific mitigation strategies developed by the operator.

#### **REPORTING**

Should a complaint be made by landowner/occupiers as a direct result of ground based geophysical operations (non-seismic), the contractor shall report this to the proponent.

#### **CONSULTATION/NOTIFICATION**

There are specific requirements for activity notification in the Act. In light of this requirement and the need for good oilfield/business practice, consultation with external stakeholders must be conducted during the planning and implementation phases of the operation. Records of all consultations must be kept.

Proponents will consult/notify, as appropriate with:

- State Government Departments (in particular PIRSA, and the Department for Environment and Heritage);
- Native Title holders/claimants
- Local Government; and
- Landowner/occupiers.

Regulation 10(e) of the Act requires the identification and listing of all landowners who may be affected by ground based geophysical operations (non-seismic). As this EIR applies to the whole State, this requirement is considered to be impractical. However as a demonstration of compliance with this requirement, it will be a condition that prior to any work being undertaken, the proponent shall supply PIRSA with a list of all landowners affected by the survey.

## APPENDIX 4 STAKEHOLDER COMMENTS AND RESPONSES

Stakeholder	Stakeholder Comment	PIRSA Response
<b>Environment Protection Authority</b>	Recommend EIR is reviewed to ensure soil contamination from storage of liquids or liquid waste disposal from campsites is addressed.	EIR amended to address this issue.
	The SEO generally provides a thorough representation of the proposed activity, the environmental objectives to be achieved throughout the project including how achievement can be attained and assessed.	Noted.
	Refer EIR – table 1 page 11. A potential consequence of spills and waste disposal identified in the EIR is contamination of soil. This is not clearly covered in the draft SEO. It is recommended that the hazards and consequences associated with liquid storage, refuelling and collection of liquid waste be addressed within the SEO in the form of an Environmental Objective and Assessment Criteria.	Included (page 13 – Appendix 1).
	Refer SEO Objective 2 – Minimise disturbance to native vegetation, fauna and associated wildlife habitats (Table – page 10) The current guide to achieve the objective includes waste management focussing specifically on solid waste. Appropriate measures for management of liquid waste (including septic waste should also be included here).	Included (Page 10 – Appendix 1).
<b>Native Vegetation Council</b>	EPA agrees with low impact assessment of the activity as provided by PIRSA	Noted.
	NVC notes that the SEO does not allow for the clearance of native vegetation and that should clearance of native vegetation be required it is the responsibility of the company to produce an SEO that provides form management procedures to cater for clearance of vegetation. Given that the intent for this document is to provide a framework for more detailed individual company SEOs and SOPs, the NVC Secretariat has no further comment at this time	Noted.
<b>Department for Environment and Heritage</b> EIR Page 20	DEH supports the low significance level assessment when managed correctly. In response to the draft, DEH believes that the objectives developed are appropriate for those impacts identified	Noted.
	Native vegetation and faunal – Add survey traverses are planned or deviated to avoid or minimise impact to known significant species of habitat locations, Number of vehicles and vehicle passes minimises DEH advised that they would like to see a strategy which focuses the proponent on the need to identify, and give greater consideration in planning, to sensitive environmental (on and off park) and heritage areas and sites e.g. <i>Significant Environmental and Heritage Areas</i>	Included. PIRSA notes that this strategy is undertaken as part of standard planning procedures and is implicit in various company management and environmental systems (e.g. Beach Petroleum – <i>Environmental Procedures for seismic operations in the Cooper and Eromanga Basins, South Australia</i> ) and company codes of environmental practice (e.g. Santos <i>Code of Environmental Practice – Seismic Operations</i> ). As part of its activity approval procedures, PIRSA assesses specific activity applications and notifications. This procedure includes an assessment of the proponent's specific planning process for the proposed survey.
EIR table 5	Survey traverse surveying Should include the consequence “Wheel tracks, wheel ruts, bull dust generation, airborne dust”	Included.
EIR Page 21	Key potential consequences Have overlooked economic consequences	Where relevant, the economic consequences are implicit in the key environmental consequences (e.g. economic loss is directly associated with damage to landowner infrastructure).
<b>Scope-Implementation Strategies</b>	Correction – “ <i>Natural</i> ” for “ <i>National</i> ” <i>Resources Management Act 2004</i>	Altered.
<b>Serious and Reportable Incidents</b>	For consistency with other SEOs such as the Cooper Basin Drilling SEO, <i>any disturbance to sites of Aboriginal or non-aboriginal heritage significance</i> should be listed as a serious incident	Altered.
<b>Appendix 3 Objective 2</b>	Regards the assessment criteria – suggest add: No vegetation clearance occurred; Known significant species; Sites have been flagged and avoided; No off traverse driving recorded.	All Added.