Arckaringa Basin Geophysical Operations

Statement of Environmental Objectives

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RPS ecos

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1 Introduction

This Statement of Environmental Objectives (SEO) for geophysical operations in the Arckaringa Basin has been prepared to meet the requirements of Sections 99 and 100 of the South Australian *Petroleum Act 2000* and Regulations 12 and 13 of the *Petroleum Regulations 2000*.

This SEO is based on the Cooper Basin Statement of Environmental Objectives: Geophysical Operations (Santos 2006).

1.1 Purpose

The intent of this SEO is to outline the environmental objectives that SAPEX Limited (SAPEX) are required to achieve during seismic exploration operations and the criteria upon which these objectives are to be assessed.

The SEO details the environmental objectives that need to be demonstrably achieved by SAPEX to address the risks associated with this activity as detailed in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* (RPS Ecos 2007).

The Petroleum Act broadly defines the environment to include natural, social, cultural and economic aspects. The environmental objectives outlined in the SEO incorporate all of these elements.

1.2 Scope

This SEO applies to all of SAPEX's geophysical operations in the Arckaringa Basin (PEL 117,118, 119, 121, 122, 123 and 124), as described in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* (RPS Ecos 2007).

Figure 1 shows the Arckaringa Basin region.

There is one park within the Arckaringa Basin, Tallaringa Conservation Park. This park has access for mining and petroleum exploration activities and is covered by this SEO.

Activities associated with the geophysical operations that are covered by this SEO are as follows:

- line and access track preparation (starts after cultural heritage clearance has been completed)
- line surveying (starts after line preparation)
- recording (seismic, gravimetric, ground magnetic, electromagnetic and others)
- campsites and associated activities
- uphole drilling and logging (during or after recording phase, as and when required)
- monitoring and auditing of selected locations (before and after line preparation and after restoration)
- line access track and campsite restoration where required (after completion of recording and uphole drilling/logging).

The nature of these activities is outlined in detail in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* (RPS Ecos 2007). Additional technical detail on seismic data acquisition is provided in the *Environmental Impact Report Geophysical Operations* (Santos 2006).

Petroleum activities that are not discussed in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* or covered by this SEO, are:

- airborne geophysical operations
- drilling and well operations
- production and processing operations.

Figure 1: Arckaringa Basin Geophysical Operations

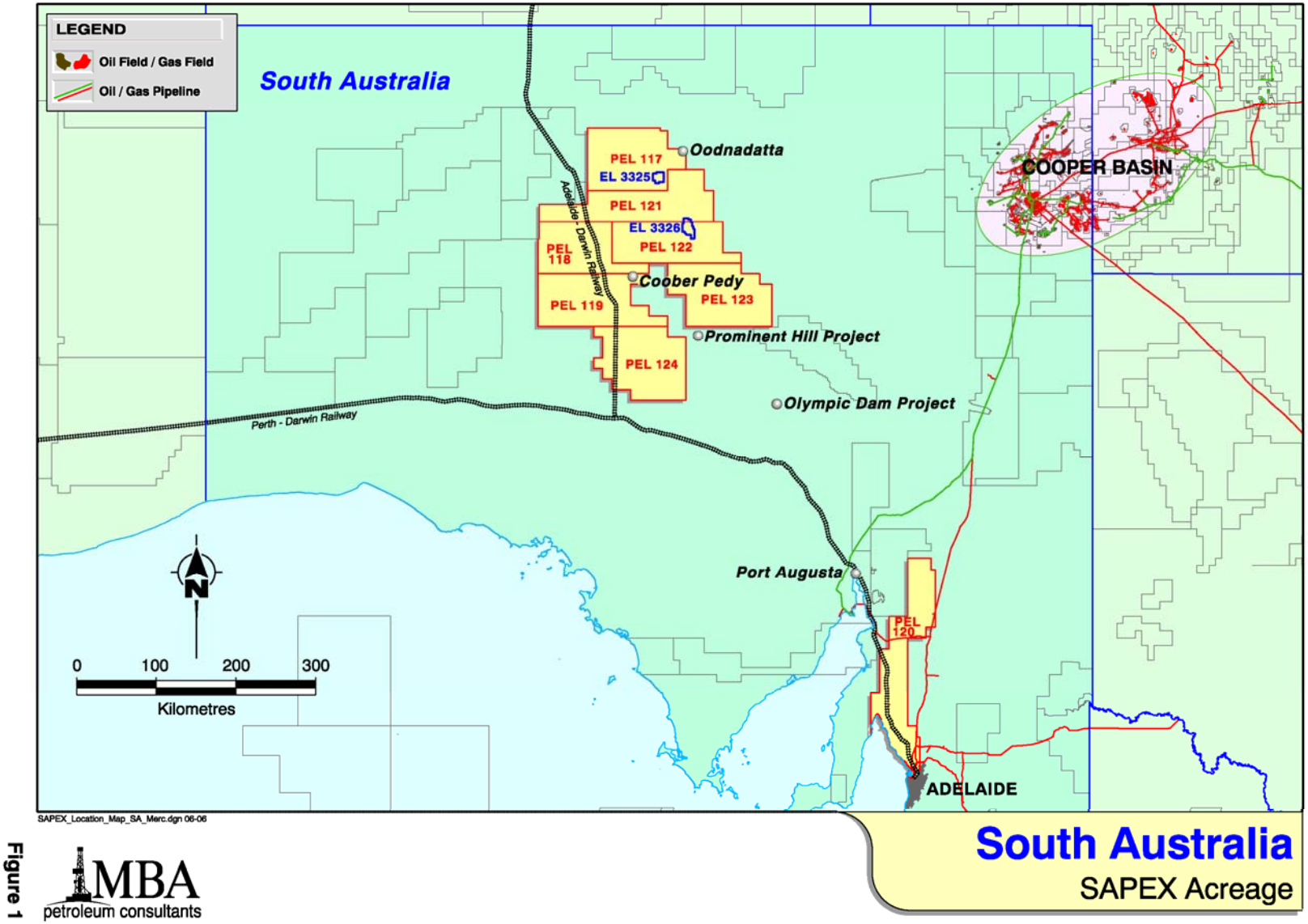

Figure 1

MBA petroleum consultants

2 Environmental Objectives

Relevant environmental objectives in the *Petroleum Act 2000*, include:

- to minimise environmental damage from activities involved in exploration for, or the recovery or commercial utilisation of, petroleum and other resources
- to minimise environmental damage from activities involved in geophysical operations.

Environmental hazards and risks of geophysical operations have been identified in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* (EIR) (RPS Ecos 2007).

The relevant environmental objectives for geophysical operations which must be achieved to address the risks identified in the EIR are:

1. Avoid disturbance to sites of cultural and heritage significance

2. Minimise disturbance to native vegetation and native fauna

3. Avoid the introduction or spread of exotic species and implement control measures as necessary

4. Minimise disturbance and contamination to soil resources

5. Minimise disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources

6. Minimise risks to the safety of the public, employees and other third parties

7. Minimise disturbance to livestock, pastoral infrastructure and landholders

8. Minimise the visual impact of operations

9. Minimise the impact on the environment of waste handling and disposal

10. Remediate and rehabilitate operational areas to agreed standards.

3 Assessment Criteria

The environmental objectives identified above are subject to an assessment to measure the level of achievement. The assessment criteria for each objective will be one of the following:

- defined conditions – objectives for activities that can only be managed through the prevention of unacceptable actions (e.g. "No disturbance to sites of Aboriginal or non-indigenous heritage significance")
- defined requirements – the achievement of an objective can be assessed against the implementation of specific procedures or actions required for an activity (e.g. compliance with Australian Standards)
- Goal Attainment Scaling (GAS) Criteria – objectives requiring visual assessment can be prone to uncertainties of subjective judgement. To minimise this occurring, GAS is used to measure such objectives against a series of criteria described by a written description and/or photographically. In this SEO, GAS is applied to: seismic line creation and restoration.

Appendix 1 tabulates the objectives and corresponding assessment criteria.

In some circumstances, additional methods for assessing the level of achievement of environmental objectives may be used. For example, PIRSA may conduct aerial video-monitoring as part of their assessment process, or scientific surveys or studies may be carried out to investigate particular issues or to develop or refine existing assessment criteria.

GAS criteria are presented in Appendix 2.

4 Reporting

It is a requirement under Section 85 of the *Petroleum Act 2000* that any incidents that are determined to be 'serious' or 'reportable' incidents must be reported to the Minister.

4.1 Definitions

The following descriptions have been provided to help clarify and elaborate on the definitions given in Section 85(1) of the *Petroleum Act 2000* and Regulation 32(1) of the *Petroleum Regulations 2000*.

Serious Incidents

The Section 85(1) of the *Petroleum Act 2000* defines a 'serious incident' as an incident in which:

(a) A person is seriously injured or killed

(b) An imminent risk to public health or safety arises

(c) Serious environmental damage occurs or an imminent risk of serious environmental damage arises

(d) Security of natural gas supply is prejudiced or an imminent risk of prejudice to security of natural gas arises[1].

Pursuant to Regulation 12(2) of the *Petroleum Regulations 2000*, the events listed below, that may arise from seismic activities, are also considered to be serious incidents:

- any spill of fuel, oil or hazardous material which encroaches into surface water or groundwater
- disturbance to sites of Aboriginal or non-indigenous heritage significance
- removal of rare, vulnerable or endangered flora and fauna species, without appropriate permits and approvals.

[1] Note: As administrative policy, PIRSA interprets this as follows: after taking into account relevant factors on a day and its rights and obligations under contracts, a significant curtailment of firm service to a shipper that may be necessary and may detrimentally impact upon the gas supply to a significant number of gas users.

- uncontrolled flows to the surface from shallow drilling operations (upholes)
- initiation of fire where an imminent risk to human safety or property arises.

Reportable Incidents

Reportable incidents are defined under Section 85(1) of the Act as an incident (other than a serious incident) arising from activities conducted under a licence classified under the regulations of a reportable incident.

Reportable incidents are defined under Regulation 32(1) as:

(a) an unintended escape of petroleum, a processed substance, a chemical or a fuel that affects an area that has not been specifically designed to contain such an escape;

(b) an incident identified as a reportable incident under the relevant statement of environmental objectives.

Pursuant to Regulation 12(2) and Regulation 32(1) the following incidents are considered to be reportable incidents:

- a spill of fuel, oil or hazardous material that encroaches outside an area not specifically designed to contain such spills
- a reasonable complaint from a landholder in regard to seismic activities
- the introduction of weed species to the project area
- initiation of any unplanned fire that is not considered a serious incident
- any other non-compliance with SEO objectives.

4.2 Reporting Requirements

Serious Incidents must be reported to the Minister as soon as practicable after the occurrence, as per Section 85 of the *Petroleum Act 2000* and Regulation 32 of the *Petroleum Regulations 2000*.

Reportable Incidents must be reported to PIRSA on a quarterly basis within 1 month of the end of the quarter, as per Regulation 32 of the *Petroleum Regulations 2000*.

5 References

Kane, A. (2006) *Field Guide for the Environmental Assessment of Recently Completed Seismic Lines in the Cooper Basin, South Australia*. South Australia Department of Primary Industries and Resources. Earth Resources Information Sheet, P8. September 2006.

RPS Ecos (2007).*Arckaringa Basin Geophysical Operations Environmental Impact Report.* Prepared for SAPEX Ltd, May 2007.

Santos (2006) *Statement of Environmental Objectives Geophysical Operations*. Prepared for South Australian Cooper Basin Operators, June 2006.

Santos (2006) *Environmental Impact Report Geophysical Operations*. Prepared for South Australian Cooper Basin Operators, June 2006.

South Australian Health Commission (1995). *Standard for the Construction, Installation and Operation of Septic Tank Systems in South Australia.* South Australian Health Commission Code, March 1995.

Appendix 1:

Environmental Objectives & Assessment Criteria

Environmental Objectives and Assessment Criteria

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
1. Avoid disturbance to sites of cultural and heritage significance	A cultural heritage survey (or Work Area Clearance - WAC) has been undertaken of the proposed survey line locations and access tracks prior to commencement of survey. No disturbance to sites of Aboriginal or non-indigenous heritage significance	Any sites identified have been flagged and subsequently avoided. A procedure is in place for the appropriate response to any sites discovered during survey operations. Documents and/or reports of scouting for cultural/heritage are available for review. Reports of any accidental discoveries during the survey are available for review. Appropriate reports have been forwarded to Aboriginal Heritage Branch in compliance with the Aboriginal Heritage Act. Consult with Heritage Branch, DEH regarding location of non-indigenous heritage sites.	The aim of this objective is to ensure that any sites of Aboriginal and non-Aboriginal heritage significance are identified and protected. New sites located should be recorded and copies of the records submitted to the appropriate authorities.
2. Minimise disturbance to native vegetation and native fauna	<u>Campsite and survey line preparation</u> The attainment of either 0, +1 or +2 GAS criteria for 'Impact on vegetation' objective listed in Appendix 2. No mature trees are removed. No off-line or off-access driving. <u>Fuel and Chemical Storage and Management</u> No spills/leaks outside areas designed to contain them. Appropriate spill response equipment is available on site. <u>Fire Danger Season restrictions and education</u> Appropriate fire-fighting equipment is readily available. Appropriate personnel are readily available and suitably informed to action response. <u>Waste Management</u> Refer Objective 9. <u>Operations in Tallaringa Conservation Park</u> Impact on environmental values of Tallaringa Conservation Park is minimised. DEH requirements for notification and operation in Tallaringa CP are met.	<u>Campsite and survey line preparation</u> Terrain and vegetation is considered in planning stage when designing layout of the survey. Appropriately trained and experienced personnel have scouted proposed survey lines access tracks and campsites. Documents and/or reports of scouting for flora/fauna are available for review. Vehicle access to survey lines is to be via existing access tracks or pre-existing survey lines, except where they have rehabilitated. Other temporary access tracks may be utilised where such use is likely to result in less environmental impact than other options. Vegetation clearance has been minimised and the conservation needs of specific species have been considered. Exploration activity is avoided in Vegetation Heritage Agreement areas unless there is consultation with PIRSA, Native Vegetation Council and DEH prior to activity approval. Campsites are established in locations where the preparation of a new access track is not necessary. <u>Fuel and Chemical Storage and Management</u> No refuelling outside designated refuelling/servicing areas. Spills or leaks are immediately reported and clean up actions initiated. Records of spill events and corrective actions are maintained. Personnel have undertaken training in the use of spill response equipment.	Primary risks to native fauna include clearing of habitat and obstruction of movement through prepared areas. Current survey line and access track preparation techniques have been shown by a number of studies to have an insignificant impact on wildlife habitat and minimal impact on vegetation. This is due to the small and confined area of impact of survey lines and the rate of recovery of most vegetation types and surface morphology. The aim of this objective is to also maximise the potential for vegetation regrowth. Potential impacts of waste on vegetation and fauna also addressed under Objective 9.

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
		Fire Danger Season restrictions and education Fire Season education included in induction. All personnel are fully informed on the fire danger season and associated restrictions. Waste Management Refer to Objective 9. Fauna Management No domestic pets allowed at camps or worksites. Feeding of wildlife (e.g. dingoes) is not permitted. Operations in Tallaringa Conservation Park All personnel are aware of and comply with the *National Parks and Wildlife Act 1972* and Regulations pertaining to correct conduct in the park. District Ranger notified of the commencement date of activities at least ten days prior to work commencing and communication maintained during operations. Speed limit in park (40 km/h) observed. No firewood collection in the park.	
3. Avoid the introduction or spread of exotic species and implement control measures as necessary	Weeds or feral animals are not introduced into, or spread, in operational areas.	All vehicles and equipment appropriately cleaned prior to entering the Arckaringa Basin. Vehicles and equipment are to be cleaned when moving from areas within the Arckaringa Basin where weeds are present. Cleaning to be carried out in accordance with best practice guidelines. No domestic pets allowed at camps or worksites. Records of vehicle and equipment cleaning are kept and available for review. Records of detection, monitoring or eradication of exotic weed or other pest or noxious species introduced by industry activities are kept and are available for review.	A potential source of weed or pest introduction is from 'dirty' vehicles and equipment brought in from other regions of the State or interstate. The most effective way of preventing such introduction is by thoroughly cleaning vehicles and equipment (i.e. removal of plant material and mud) prior to entering the Arckaringa Basin.

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
4. Minimise disturbance and avoid contamination to soil resources	Campsite and survey line preparation Attainment of 0, +1 or +2 GAS criteria for 'Disturbance to land surface' objective, as listed in Appendix 2. Fuel and Chemical Storage and Management No spills/leaks outside areas designed to contain them. Appropriate spill response equipment is available on site. Waste Management Refer to Objective 9.	Campsite and survey line preparation Pre-survey planning has been undertaken to minimise impacts of operations and records are available for review. Proposed survey lines and campsites have been appropriately located and prepared to minimise the disturbance to soil resources. Survey line preparation techniques are monitored and documented to minimise soil disturbance, particularly in sensitive terrain (e.g. gibber, breakaways). Where applicable, side cuts on dune flanks and dune crests are minimised. Stony mantle has not been removed in gibber and tableland land systems. Stony surface is not ripped at campsites. There is no evidence of off-road driving or creation of shortcuts. No survey line or access track preparation is carried out on salt lakes or wetlands unless specific management measures have been developed in accordance with relevant authorities. Areas subject to inundation have been assessed for conduciveness to support vehicles. Fuel and Chemical Storage and Management No refuelling outside designated refuelling/servicing areas. Spills or leaks are immediately reported and clean up actions initiated. Records of spill events and corrective actions are maintained. Oil spill areas have been ripped to an appropriate depth. Personnel have received training in the use of spill response equipment Waste Management Refer to Objective 9.	The main sources of disturbance to soils are survey line preparation, vehicle traffic along tracks and restoration activity. The impacts associated with soil disturbance can potentially include wind and water erosion and dust generation. All fuel stored and used should be under the control of qualified or trained personnel.

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
5. Minimise disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources	<u>Campsite and survey line preparation</u> The attainment of 0, +1 or +2 GAS criteria for 'disturbance to land surface' objective listed in Appendix 2. No uncontrolled flows to surface from aquifers intersected in upholes/shallow boreholes. There is no unnecessary interference with natural drainage features. <u>Fuel and Chemical Storage and Management</u> No spills occur outside of areas designed to contain them. Appropriate spill response equipment is available on site.	All access through watercourses area carefully assessed to determine the locations of least impact to channels and creek banks. Any artesian flows are to be immediately plugged and monitored to ensure effectiveness of plug(s). Any required remediation work carried out as soon as possible after completion of all activities. <u>Campsite and survey line preparation</u> Campsites and survey lines/traverses are located and constructed to avoid diversion of water flows. <u>Fuel and Chemical Storage and Management</u> No refuelling outside designated refuelling/servicing areas. Refuelling occurs at least 1km from watercourses or sensitive ecological environments (wetlands). Spills or leaks are immediately reported and clean up actions initiated promptly. Records of spill events and corrective actions are maintained. Personnel have received training in the use of spill response equipment.	The main threat to drainage patterns and surface waters is the interruption of natural flows as a result of access track preparation through watercourse channels and creek bank disturbance. Campsite and line preparation should aim to minimise impacts to drainage systems, by avoiding sensitive areas and using appropriate preparation methods to avoid or minimise the development of windrows. Any remediation work should be undertaken immediately upon completion of all activities. Localised contamination may result from spills or leaks of vehicles during storage and handling or vehicle travel. The major threat of spills is the threat to soil, vegetation and watercourses directly impacted by the spill. Therefore, the achievement of this objective also consequently contributes to the achievement of Objectives 2 and 4 in relation to minimising impacts on soil and natural habitats.
6. Minimise risks to the safety of the public, employees and other third parties	No injuries to the public or third parties as a result of seismic activities.	Compliance with relevant speed restrictions on roads and tracks (including 40 km/h in Tallaringa Conservation Park). Signage in place to warn of presence of seismic vehicles when activities undertaken in areas with public access (e.g. along public roads) Control production and dispersion of dust on unsealed roads. Liaison / consultation with relevant public road managers where seismic activities are concentrated on public roads. Third party use of seismic lines discouraged by measures under Objective 8 "Minimise the visual impact of operations" Appropriate, necessary authorisations are obtained for access to the Woomera Prohibited Area.	The main threat to the safety of the public, employees and third parties is associated with the movement of vehicles and the localised increase in traffic load for the duration of the survey. All reasonable steps will be taken to prevent unauthorised access to the survey area and warning signs will be appropriately located.

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
7. Minimise disturbance to livestock, pastoral infrastructure and landholders	The attainment of 0, +1 or +2 GAS criteria for 'Impact on infrastructure' objective listed in Appendix 2. No adverse impact on livestock as a result of activities. No reasonable concerns raised by stakeholders are left unresolved. Compliance with relevant sections of the *Petroleum Act 2000* in relation to notification of landholders.	Relevant landowners and occupiers are notified prior to survey of preparation of campsites and survey lines and undertaking of operations (pursuant to the Petroleum Regulations). Requirements of the Cattle Care and Organic Beef accreditation programs are complied with. System is in place for logging landholder complaints to ensure that issues are addressed as appropriate. Seismic sources are not to operate within 20 m (or more for explosive-sources) of any pipeline, utility, installation or building. Damage to roads and tracks is avoided. Operations in wet weather are not allowed. All gates are left in the condition in which they were found (i.e. open/closed). When necessary, all fences are restored to satisfaction of landowner/managers Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues. In recognised conservation reserves excavations are left in a state as agreed with the responsible statutory body. Appropriate, necessary authorisations are obtained for access to the Woomera Prohibited Area. Potential sources of contamination are fenced as appropriate to prevent stock access. In the event of an oil spill, contingency plan to be implemented after the spill event.	Communication and the establishment of good relations with landowners and community are fundamental to minimising disturbance as much as practicably possible. Many pastoral properties are certified under the Organic Beef or Cattle Care accreditation schemes and therefore may be affected by fuel and chemical storage, moving machinery and contaminated sites. Note: The PIRSA publication *Liaison guidelines for landholders and petroleum explorers in South Australia* is a recommended source for effective liaison with landowners. Land access is a key factor for the petroleum industry. Community support is vital to allow continued access to land and the resources beneath it. It is imperative that resource companies establish and maintain good relations with landowners/occupiers particularly pastoralists and managers of parks/ reserves and tourist interests.
8. Minimise the visual impact of operations	The attainment of 0, +1 or +2 GAS criteria for 'visual impact' objective listed in Appendix 2. <u>Campsite and survey line preparation</u> Proposed survey lines and campsites have been appropriately located and prepared to minimise the visual impact.	Pre-survey planning has been undertaken to minimise visibility of operations and records are available for review. Maximise use of vegetation or land forms to disguise operations and discourage third party access. Where applicable, offset sand dune crest cuts and avoid extensive side cuts on dune flanks to minimise visibility. Lessen visual impact of uphole cuttings, by returning cuttings to the hole in their original stratigraphic level or by burying contrasting colours. Avoid cutting land features that are in close proximity to or are visible from tourist access tracks. All litter is to be disposed of correctly.	If techniques to disguise their presence are not implemented, the visual impact of survey lines can be significant, especially in sparsely vegetated landscapes. Location of and preparation techniques for survey lines are key factors in determining visual impact.

Environmental Objective	Assessment Criteria	Guide to How Objectives Can Be Achieved	Comments
9. Minimise the impact on the environment of waste handling and disposal.	0, +1 or +2 GAS criteria are attained for 'Pollution or litter' objective listed in Appendix 2. Wastewater disposal and spills have been managed appropriately.	Covered bins are provided for the collection and storage of wastes. All loads of rubbish are covered during transport to an approved waste facility. With the exception of sewage and greywater, wastes are segregated and transported to an Environment Protection Authority (EPA) approved waste disposal facility for recycling or disposal in accordance with approved procedures and EPA licence conditions. All wastewater disposed in accordance with the *Public and Environmental Health (Waste Control) Regulations 1995* (i.e. the waste water disposal system must either comply with the *Standard for the Construction, Installation and Operation of Septic Tank Systems in SA* or be operated to the satisfaction of the Department of Health). Treated sewage wastewater disposed of onto land, well away from any place from which it is reasonably likely to enter any waters. Production of waste is minimised by purchasing reusable, biodegradable or recyclable materials where practical.	Bins are covered to prevent access by fauna and the spread of rubbish by wind. Waste reduction requires continual improvement in purchasing, efficiency of use and reuse. Due to the distances involved, the cost of recycling a large range of products may be prohibitive. Ongoing review of recycling options is required to ensure that improvements are implemented as far as practical. Responsible handling and disposal of waste will reduce both short-term and long-term impacts of waste on the environment.
10. Remediate and rehabilitate operational areas to agreed standards	The attainment of 0, +1 or +2 GAS criteria for ▪ 'Visual impact' ▪ 'Impact on infrastructure' ▪ 'uphole site restoration' ▪ 'disturbance to land surface' Measures/goals listed in Appendix 2.	Rehabilitation/abandonment plans for surface activities will be developed in consultation with relevant stakeholders Refer to Objectives 4, 5, 7, 8, 9.	Refer to Objectives 4, 5, 7, 8, 9. Depending on circumstance, other assessment criteria may be required. These would typically be determined during the activity approval process.

Appendix 2:

Goal Attainment Scaling

GAS Criteria for Seismic Activities

Land system	Measure Associated Goals	Score				
		+2	+1	0	-1	-2
Non land system specific	Visual impact	No evidence of survey operations.	Only wheel tracks are evident. Line of sight is significantly impaired.	Established roads and tracks have been reshouldered. Doglegs have been placed at established roads and tracks, particularly in vegetated areas. Dozer or grader has been walked 50m either side of established road or track. Line weaves through vegetated areas at least every 100m. Line of sight is impaired. Line follows route that is most conducive to access by utilising naturally clear areas through vegetation.	No doglegs at established roads or tracks, particularly in vegetated areas. Weaving is not appropriate to terrain traversed. Line of sight is unimpaired. Uphole cuttings clearly visible in landscape.	Line is clearly evident and dominates the landscape.
	Impact on infrastructure	No impact to any pastoral, tourist or mining infrastructure.	No observable repair or damage to infrastructure.	Any impact to infrastructure has been reported and reinstated or repaired.	Repair to damaged infrastructure is incomplete or inappropriate. Damage has not been reported.	Damage to any infrastructure has been left un-repaired and not reported.
	Uphole site restoration	No evidence of upholes.	No evidence of cuttings. Some evidence of operations.	Cuttings are evident but dispersed around hole. No subsidence. Hole has been plugged. Aquifers have been plugged.	Cuttings form mound. Subsidence is evident. Cuttings markedly discoloured compared to surface.	Hole is open. Water is flowing from hole.

Land system	Measure Associated Goals	Score				
		+2	+1	0	-1	-2
	Pollution or litter	No pollution or litter.	No evidence of water or oil pollution. Maximum of 1 pin flag/km.	Wastewater and vehicle oil spills have been managed appropriately. Maximum of 2 pin flags/km. No other litter.	Wastewater forms ponds or extensive boggy ground. Vehicle oil spills have not been remedied. Maximum of 9 pin flags/km. Maximum of 4 items of other litter/km.	Extensive wastewater ponding. Oil spills of more than 20L have not been remedied. Ten or more pin flags/km. Five or more items of other litter/km.
Wetlands (including GAB spring tails)	Disturbance to land surface	No evidence of survey line. No disturbance to vegetation.	No evidence of shotholes. Little evidence of foot trafficking. No disturbance to vegetation.	Only footprints are evident. No significant evidence of shotholes. Evidence of minor disturbance of vegetation.	Wheel tracks exist and are <0.2m deep. Minor evidence of shotholes. Evidence of disturbance of vegetation.	Wheel tracks exist and are >0.2m deep. Bog holes are evident. Dominant evidence of shotholes (e.g. cratering, blow out, discolouration). Vegetation has been removed.
Drainage Lines & Floodplains	Impact on vegetation	No removal of vegetation.	No removal of Priority 1 and 2 vegetation. No removal of Priority 3 vegetation >1m.	No removal of Priority 1 and 2 vegetation. No removal of Priority 3 shrubs >2m high. Less than 10% of tree branches have been removed from individual trees. Rootstock is intact.	Priority 1 and 2 vegetation <2m high have been removed. Priority 3 shrubs >2m high have been removed.	Trees and/or shrubs >2m high have been removed. Rootstock has been removed.
	Disturbance to land surface	No windrows. No interference with drainage channels.	Windrows are <0.1m high for more than 50% of line length. Only creek banks <0.5m high have been cut.	Windrows are <0.1m high. Creek banks <1m high have been cut. Creeks are not blocked. Wheel tracks are <0.1m deep.	Windrows are <0.3m high. Windrows are generally continuous. Creek banks 1–2m high have been cut and not restored. Creeks are blocked by material <1m deep. Off line trafficking is evident. Wheel tracks are >0.1m	Windrows are >0.3m high. Windrows are continuous. Creek banks >2m high have been cut. Creeks are blocked by material >1m deep.

Land system	Measure Associated Goals	Score				
		+2	+1	0	-1	-2
					deep.	
Moon Plains	Disturbance to land surface	No evidence of survey line.	Only wheel tracks are evident <10cm deep.	Line has been rolled or walked. No blade work in erodible soils. Drainage lines have been cut only where necessary and have not been blocked.	Windrows exist but are <0.5m high. Off line trafficking is evident. Extensive wheel ruts exist.	Gypsiferous mantle has been removed. Drainage lines are blocked by material Windrows are >0.5m high.
Breakaways & Stony Hills	Impact on vegetation	No disturbance to vegetation.	No removal of vegetation.	Maximum of two trees 1–3m high have been unavoidably removed at creek crossings or escarpments. Less than 10% of tree branches have been removed from individual trees. Creek crossings are doglegged.	Vegetation has been removed unnecessarily. Three or more trees 1–3m high have been removed on escarpments.	Trees have been removed unnecessarily. Two or more trees >3m high have been removed on escarpments.
	Disturbance to land surface	No evidence of survey line.	No evidence of shotholes. On steep slopes, little evidence of foot trafficking, no evidence of wheel tracks. On gentle slopes, criteria for Stony Plains apply.	No significant evidence of shotholes. On steep slopes, minor disturbance from foot trafficking, no evidence of wheel tracks. On gentle slopes, criteria for Stony Plains apply.	Minor evidence of shotholes On steep slopes, wheel tracks exist. On gentle slopes, criteria for Stony Plains apply.	Dominant evidence of shotholes (e.g. cratering, blow out, discolouration). On step slopes, extensive wheel ruts exist, surface blading has occurred. On gentle slopes, criteria for Stony Plains apply.
Stony Plains	Impact on vegetation	No disturbance to vegetation.	No removal of vegetation.	Maximum of two trees 1–3m high have been unavoidably removed at creek crossings or escarpments. Less than 10% of tree branches have been removed from individual trees. Creek crossings are	Vegetation has been removed unnecessarily. Three or more trees 1–3m high have been removed at creek crossings or escarpments.	Trees have been removed unnecessarily. Two or more trees >3m high have been removed at creek crossings or escarpments.

Land system	Measure Associated Goals	Score				
		+2	+1	0	-1	-2
				doglegged.		
	Disturbance to land surface	No evidence of survey line.	Only wheel tracks are evident <10cm deep.	Line has been rolled or walked. No blade work. Creek banks have been cut only where necessary. Creeks are not blocked.	Creek banks 1–2m high have been cut and not restored. Creeks are blocked by material <1m deep. Windrows exist but are <0.5m high. Off line trafficking is evident. Extensive wheel ruts exist.	Gibber mantle has been removed. Creek banks >2m high have been cut and not restored. Creeks are blocked by material >1m deep. Windrows are >0.5m high.
Dunefields & Sandy Plains	Impact on vegetation	No removal of vegetation.	Only herbs and shrubs less than 0.5m high removed on dunes. No removal of vegetation in swales.	No removal of Priority 1 and 2 vegetation. No removal of Priority 3 shrubs >2m high. Less than 30% of tree branches have been removed from individual trees.	Priority 1 or 2 vegetation <2m high have been removed, including rootstock. Priority 3 shrubs >2m high have been removed, including rootstock.	Priority 1 or 2 vegetation >2m high have been removed.
	Disturbance to land surface	No dune cuts. No windrows.	Dune cuts are <0.5m deep. No blade cutting in swales.	Dune cuts are 0.5–1m deep. Clay-rich dune cuts are <1m deep. Side cuts in clay rich dunes <0.75m. Sand is stacked along side of cut. Windrows in swale are <0.1m high and not continuous.	Dune cuts are 1–2m deep. Side cuts in clay dunes >0.75m. Clay dune cuts >1m. Off line trafficking is evident. Minor ramping of sand onto swale. Windrows in swale are 0.1–0.3m high.	Dune cuts are >2m deep. Extensive ramping of sand onto swale. Windrows in swales are continuous. Windrows in swales are >0.3m high. Claypans have been cut.
Salt lakes	Disturbance to land surface	No evidence of survey line.	No evidence of shotholes. Little evidence of foot trafficking.	Only footprints are evident. No significant evidence of shotholes.	Wheel tracks exist and are <0.2m deep. Minor evidence of shotholes.	Wheel tracks exist and are >0.2m deep. Bog holes are evident. Dominant evidence of shotholes (e.g. cratering, blow out, discolouration).

Notes:

(a) Priority classification refers to Priority Plant species as described in the *Arckaringa Basin Geophysical Operations Environmental Impact Report* (RPS Ecos 2007).

(b) Windrows in this context refers to the mounding of soil or gibbers through the action of wheel trafficking and associated dispersal of soil/gibbers away from wheel tracks.

(c) All vertical measurements to be measured from normal ground surface.

(d) If any criterion (dot point) within a -1 or -2 cell occurs, then a score of -1 or -2 will be allocated.

(e) For 0, +1 and +2 cells, all relevant criteria (dot point) within the cell must be satisfied to score at that level.

(f) Some criteria at -2 levels may also be subject to defined conditions, but are included in this table to ensure that they are clearly identified.

(g) The *Field Guide for the Environmental Assessment of Recently Completed Seismic Lines in the Cooper Basin, South Australia*. (Kane, A , 2006, PIRSA Information Sheet, P8) provides photographic outcomes for some of the Land Systems found in the Arckaringa Basin.